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Case studies of farm mechanisation and industrialisation in Sweden and the United States 1830–1930

BY

JAN KUUSE

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INTRODUCTION

Economists from Adam Smith to Keynes have seen the accumulation of capital as the strategic factor in economic progress. Factors which have stimulated or impeded the accumulation of capital have therefore been very carefully analysed. The classical writers on economic science such as Adam Smith, Ricardo and Malthus have shown how economic growth has been halted by too small national assets and too large a population increase. Even if Ricardo, for example, did not rule out the possibility of technology modifying the rock-hard law of scarcity, he did not believe that the technological advances would be of sufficient importance to bring economic progress in the long run. In particular Ricardo studied how economic stagnation developed: because of the population increase more and more inferior soil had to be cultivated and with this the rents on the better land were increased. A static situation is reached when land rents become very high. Advances in agricultural engineering can change the static situation so that the highly inferior land does not have to be cultivated, and it is therefore possible to avoid very high land rents. However, according to Ricardo, this progress was only a way of maintaining artificial respiration without any real long-term effects.

It is not surprising that economists like Ricardo and Malthus took a basically pessimistic view of the development. In 1800 the average European was a farmer with production engineering which was on the whole unchanged while at the same time the population increase was accelerating.[1] Pessimistic views prevailed around the year 1800.

The successors of the classic economists laid much greater stress

[1] Malthus was of the opinion that it was essentially the productivity of agriculture (i.e. the food supplies) which governed the growth of the population. In her work *The Conditions of Agricultural Growth. The Economics of Agrarian Change under Population Pressure* (London 1965) Ester Boserup takes the converse view: it is the population growth which basically determines the development of agriculture.

on the role of technology in economic growth, but these successors were also active during the first half of the nineteenth century when technological development started to expand. The community began to look on the new technology as a transformer. The difference between the static feudal system and the constant process of transformation within the capitalist society was noted. Scientists such as Sombart, Weber and Schumpeter have pointed out that capitalism cannot survive without a constant stream of technical and social changes, and that it can only continue in a climate which accepts and assimilates these changes fairly easily. On the whole the nineteenth century signified a more positive view of progress, when Auguste Comte's work *Cours de Philosophie Positive,* among others, contributed to new thinking about the rôle of technology and science in society.

Nowadays the importance of technology is not questioned, but the discussions as to how technology can best serve mankind are all the more vigorous. In particular interest is shown in the potential and the obstacles to progress in the underdeveloped countries. The industrialised world has not been unwilling to give advice about technical-economic development, but the advice has been mixed to say the least. On the one hand reference has been made to the benefits of growth through gradual industrialisation via agriculture and the consumer goods industry, which was roughly what happened in the developed countries a hundred years ago. On the other hand planned industrial development with a more direct emphasis on industry, especially heavy industry, has been recommended, roughly as happened in the Soviet Union after 1928. In the case of each of the alternatives there was the question of creating a surplus in the agricultural sector and channelling the surplus over into the industrial sector. The factors which distinguished the two alternatives from each other were inter alia the gradient of the transition and who was to bear the cost of industrialisation. The various strategies of industrialisation will not be discussed here, but the present work will deal, in the form of examples, with the interaction between agriculture and industry as it took place in the industrialised countries at the end of the nineteenth and the beginning of the twentieth centuries. Concrete examples have been taken from Sweden and the USA.

The pattern of interaction between agriculture and industry is a complex one. Profound changes in agriculture influenced industry to a great extent during the initial stages of industrialisation. But the reshaping of industry had repercussions on agriculture. An example of such repercussions across national borders is the great importance of American industry for the development of Soviet collective agriculture. Around 1930 94 per cent of the Soviet Union's imports of tractors came from the USA and about 75 per cent of all the tractors in use in the Soviet Union at this time were of American origin. Thus during the important initial stage of the first five-year-plan American agrarian technology contributed to the development of Soviet agriculture and thereby also to a more rapid industrialisation of the Soviet economy.[2]

In the introductory chapter the rôles in the national economy of agriculture and agrarian industry respectively and the development of the ways in which they came into contact with each other are described. Techniques of trade and distribution became of greater importance in meeting the increased need for contact. Chapter II is the nub of the account. In it there is discussion of certain selected companies manufacturing agricultural implements/machinery and of the importance of agriculture's orders from industry. The mechanisation of farming was made possible by the engineering industry's provision of agrarian technology. Thus the engineering industry made an important contribution to the economic development of the agrarian sector. For its part, because of its size, agriculture played an important rôle in the industrialisation process as a buyer of engineering products. In considering some engineering companies with an outlet orientated towards agriculture the particular market forces which developed through the interaction between agriculture and industry will be examined.

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[2] Dalrymple, D., 'American Technology and Soviet Agricultural Development, 1924–1933' (in *Agricultural History*, 1966, pp. 187 ff.).

Probably even the USA benefited from the exports of agricultural machines to the Soviet Union during the depression years around 1930.

I. THE RÔLE OF AGRICULTURE IN THE ECONOMY

During the period which is usually called the age of industrial breakthrough in Europe and North America, farming still constituted a dominant part of economic life. During the nineteenth century the proportion engaged in the agricultural sector was still great. Great Britain was an exception.

Table 1. *The proportion engaged in farming in percentages*

	1870	1910
Great Britain	15	8
USA	51	32
Sweden	72	48

In spite of its relative decline, farming was an important sector in Sweden and the USA. Therefore in those countries and others like them changes within the farming sector had profound consequences for the economy as a whole.

A. The market expansion

The industrialisation which started in earnest in Europe and the USA around the middle of the nineteenth century can be readily gauged from the process of urbanisation. As a rule the urban population increased much faster than the rural population, above all in North-Western Europe and the USA from 1850. In Britain this process had already begun before 1800. Between 1850 and 1913 the urban population in Germany increased from 10 million to 40 million and in France from 10 million to 20 million. In Britain the urbanisation continued, and in the USA metropolitan centres sprung up, with New York and Chicago in the forefront. Contemporaneously with the urbanisation the rural areas in the new industrial countries were being industrialised. Thus from about 1850 the non-agrarian population increased at a very rapid rate.

During the latter part of the nineteenth century and up to the First World War average real wages rose continually in the new industrial countries. The improvement in real wages and the increase in the non-agrarian population would lead to a great consumer demand for farming products. This demand constituted a basic factor in the nineteenth century economy.

Apart from some important exceptions the free trade principle was lasting to the outbreak of the First World War through Britain's very act of removing the grain tariffs in 1846. As regards the increased demand, agriculture reacted to the new conditions. Conditions for production and outlets on a larger scale had been created.

As to the farmers' response to the new market situation, some of them thought that renewed and improved methods of production were justified in principle. No homogeneous response from the farmers was to be found in the new industrial world. The reaction showed great national variations, and within each nation such factors as the size of farms and the topography of the land among other things exerted an influence. But the main principle stands firm: an increasing number of farmers believed that they had the basis for farm production on a large scale, carried out in a more mechanised and specialised form and with increasing production for sale.

The free trade principle stimulated international division of labour, specialisation and increased foreign trade. However, the new situation also brought about new upheavals and new conditions of competition. Before the First World War, for example, Britain became both a large net importer of farm products and an important market for several industrialised countries. The USA became a significant net exporter, while Sweden, from having previously had a net export of farm products, after 1880 became a net importer of grain but a net exporter of butter.

As a result of the new production methods mass-production of farm products occurred. The mechanisation also led to overproduction and crises. It is possible to say that the response to the increased demand became, at least in part, too vigorous. During the end of the nineteenth century the USA, for example, went through a crisis of overproduction in agriculture. In Europe during the 1880s farming was exposed to ever stiffer competition from Russian and American grain exports. It can be established that the period 1850–1914 signified growing markets for farm products, although with elements of partial overproduction. The overproduction before the First World War was, however, on a smaller scale and more transient in character than the overproduction which developed with failing markets during the period between the wars.

The farmers' response to the new situation occurred in several dimensions. Part of the response resulted in an increased disposition towards new and more mechanised forms of operation. The question of this increased disposition is however a complex one. For a long time the willingness to develop and the ability to benefit from the possibilities of an innovation have been considered more or less self-evident. With a closer look it has become clear that various kinds of obstacles have had repressive effects on the diffusion of innovations. The tempo of progress in the industrialised countries has not been self-evident. Due to their large numbers the underdeveloped countries have made the industrialised countries of Europe and North America stand out as exceptions to the general rule. As regards their capacity to benefit from innovations there are interesting differences between countries which are now industrialised and underdeveloped countries, whatever the causes of such differences may be.

A vital condition for the diffusion of something new is of course that the innovation shall become known. The spread of the field of information in space and time is of course dependent on how the transmitters and receivers of information function. Difficulties in communication can occur in both channels. For example a technical innovation could be marketed in an inadequate fashion by the innovator or producer. Perhaps those who, it was assumed, would receive the information, were not capable of understanding and accepting the innovation or did not wish to do so. Marketing and the transmission of information about technical and social innovations were in general still very undeveloped during the nineteenth century and could therefore have hindered the acceptance of new techniques, but the decisive obstacle was to be found in the receiving channel.

Not all farmers by any means bothered to keep themselves informed about the latest agrarian technology, apart from the fact that many had neither the time nor the ability (or believed that they had not). Some of those who kept up with technical developments could not afford the cost of the new technology. The analysis of profitability was a key factor when it came to introducing new agrarian techniques of production. The economic base of the farmers played a decisive rôle in this analysis of profitability. If the economic base was wide—and this was determined by such factors as the size of the farm, the topography and fertility of the land, the livestock and the supply of ready money—and there were potential markets for farm produce, there would probably have been the incentive for new agrarian techniques. In an earlier study of Swedish agriculture the author has also established how rapidly and to how great an extent farmers with a bigger economic base reacted to agrarian innovations as compared with farmers with smaller scope. Most of the farmers in Sweden—about 80 per cent—had not mechanised their production to any great extent just before the First World War. This applied to smallholdings and smaller farms which in fact improved the standard of the quality and quantity of their equipment during the latter part of the nineteenth century and the beginning of the twentieth century, but which had not been incorporated into commercial forms of operation.[3] This tendency was

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[3] Kuuse, J., *Från redskap till maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1910*.

present in countries which were then at the same level of development as Sweden. It is probable that the inclination to acquire farming machinery was held in check by the shortness of the period for which the machines could be used. Therefore profitability during the actual period of use must have been considered very important by those who extended their machine parks.

Thus the importance of the economic framework for the inclination to acquire the more highly qualified agrarian mechanics in particular is obvious. The tendency was further reinforced by the whole way of life—dictated by economic resources—which was to characterise "the gentry" during the nineteenth century. Landed proprietors, especially in Europe, strove to attain a social position in society which would correspond to their economic position. Through education they tried to attain the ideal of an educated landowning class who were accepted in higher circles. The pattern of education often included study abroad or general travelling or both, which gave the greater landowners opportunities of extending their contacts. More often than other farmers, the upper class in agriculture came into contact with innovations, for example at international agricultural exhibitions. Therefore this upper class would naturally develop some sort of curiosity about innovations. Thus the whole economic framework and environment produced a group which was basically less conservative, at least as far as technical innovations were concerned. There are also examples of landowners overreaching themselves in their technical ambitions, especially when their economic base shrunk, for example where the homestead was split up. Economic realities did not by any means invariably keep pace with social and technical ambitions.

B. The process of commercialisation

The so-called transport revolution constituted one factor in the expansion of social contacts, above all for the upper class, during the nineteenth century. Transport by sea and land was gradually improved. Steamships and steam engines replaced the older means of transport. The growing transport system provided for much faster, cheaper and more comfortable passenger transport, internationally as well as nationally. But although the consequences of the constantly improving passenger traffic should not be underestimated, it was of course in the carriage of goods that the transport system was of great importance economically.

The faster and cheaper carriage of goods in the middle of the nineteenth century opened up completely new markets for agricultural and industrial goods. Local and regional markets were strongly supplemented by national and international ones. The trade route was extended. In addition the new transport system threw existing production completely out of gear. For large groups the process of adjustment and adaptation became difficult. Here reference need only be made to the situation as regards competition to which the European farmers were exposed, above all during the 1880s. Inexpensive Russian and American grain flowed onto the market as a result of increased production and cheaper and speedier transport.

Thus the transport revolution made a very concrete contribution to paving the way for mass-production and extended markets for industrial and agricultural goods. At the same time as mass-production replaced older forms of production, deeper specialisation within agriculture and industry became necessary. As regards agriculture, this especially concerned the developing production in the food industry. During the period in question it would be misleading to describe the production of food as industrialised. It would be just as appropriate to regard the food manufacturing industry as a technical industry ancillary to agriculture, and for a long time the difference between the actual processed produce of agriculture and the food manufacturing industry was one of degree rather than kind. In any case agriculture through its deliveries of raw materials constituted the basis for the food manufacturing industry. Gradually, however, production in the manufacture of food became more and more specialised and operated in industrialised forms. The centralisation of operations, together with the formation of metropolitan areas which took place, accentuated the need for a better technique of distribution and a viable commercial system. Thus through the food manufacturing industry agriculture could process and distribute its goods in a manner which was more rational and better suited to the changes in the community.

Mention has already been made of the great importance for the whole economy of the technique of transporting goods. This applied especially to the carriage of heavy and bulky goods. To a great extent it was those types of goods which were to be increasingly transported to and from the farms. As regards transport to the farms, E. F. Heckscher stresses the special importance of the railways for the distribution of farm machinery and fertilizers. After the 1880s farming in several European countries was to produce foodstuffs from animals to a greater extent. Speed of transport is of the greatest importance for animal products. The railways and transoceanic shipping contributed to a high degree to the changed objective in production. In this context the refrigeration equipment with which ships and trains were fitted from the 1870s onwards played an important part. Thereafter frozen meat could be transported over distances which were practically unlimited. As regards Sweden, at the turn of the nineteenth century the average distance for transport on the state railways was 410 kilometres for meat, 540 kilometres for cheese and 330 kilometres for butter. The average distance for the transporting of grain was shorter, about 70 kilometres, but considerably longer for flour, about 250 kilometres.[4]

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[4] Heckscher, E. F., *Till belysning af järnvägarnas betydelse för Sveriges ekonomiska utveckling*, pp. 109 f. and 118 ff.

Today the problems connected with the stock-keeping of agricultural products in many underdeveloped countries constitute a parallel with the problems of transport and storage which began to be solved through refrigeration in the transporting of food about 100 years ago. It is difficult to estimate the total loss of grain spoilt through faulty transport and methods of storage, but in any event

C. Industries connected with agriculture

The contacts between agriculture and industry developed through the rôle of agriculture partly as seller and supplier to industry and partly as customer and buyer of industrial products. As the food manufacturing industry started to free itself from actual farming and to expand in consequence, contact was organised between farming and the food manufacturing industry, the branch of industry which mainly processed farm products. With mechanisation the demand for farming tools or machinery or both increased, as well as the demand for fertilizers. It was above all the engineering works and the fertilizer industry which were to meet the demands of agriculture during the latter part of the nineteenth century. Previously agriculture's demand for tools had often been supplied by manufacture in the village blacksmith's shop or in the farms themselves. It is probable that for a long time the village blacksmith held a key position as far as the diffusion of agrarian technology locally was concerned. Many blacksmiths' shops gradually developed into significant workshops with production concentrated on farming machinery. The orders for machinery from the food manufacturing industry, which very closely resembled that of farming in character, also played an important rôle as a customer of engineerings works.

Farming exerted a direct influence on the whole process of industrialisation through the consumer goods, engineering and fertilizer industries. In the text which follows there will be a discussion, with examples, of the importance in the USA and Sweden of those particular branches of industry in comparison with industry as a whole.

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this constitutes a significant deficit item in world economy. The problems of wastage have now begun to be tackled. However, this is taking place in many different ways (not including planned destruction), and it is probable that no short-term solution will be found. However, distribution and storage technology is faced here with a world economic problem.

1. Industries based on deliveries from agriculture

There are various ways of assessing the industrial breakthrough which occurred in the USA and Sweden during the latter part of the nineteenth century, somewhat earlier in the USA than in Sweden. The change in the deployment of labour to farming and industry constitutes a rough gauge (see table 1), and the development of the industry's production in terms of value a further gauge. If industrial development is assessed on the basis of the industry's production value, it is striking how large a proportion of the production value came from the branches of industry which were completely dependent for their production on farm products. This applied at the beginning of the twentieth century too. At the start of the First World War the food manufacturing industry was the dominant branch of industry—in terms of the value of the end products—in Sweden as well as the USA. In all probability this was also the case in countries at the same level of development. The leather and textile industry could also be included among the branches of industry which were based on farm products, even if agriculture's contacts with the food manufacturing industry were more direct and more extensive than with the leather and textile industry. In any case the deliveries of raw materials from farming constituted the basis for the leather and textile industry. The food manufacturing and the leather and textile industries are both representatives of light industry (consumer goods industry) which played a decisive rôle during the first phases of industrialisation in the countries which developed in a similar way to the USA and Sweden.[5]

Tables 2 and 3 illustrate the level of development of various

[5] The forestry industry has not been included among the industries based on supplies from agriculture. Forestry has often been closely connected with the original farming (forests owned by farmers) which could have warranted the inclusion of the forestry industry. However, only the raw materials from the original farming have been related to the process of industrialisation here. The forestry industry is also different in character to the consumer goods industry. But it is apparent that agriculture in a wider sense, i.e. including forestry, has through its supplies influenced industrial development to an even greater degree than directly appears from the present section.

Table 2. *The value in millions of Swedish crowns of the production of industries in Sweden based on farm products*[a]

Branch	1896	1900	1910
Mills	53.3	83.6	106.4
Distilleries	45.6	61.1	64.7
Dairies	41.5	45.9	61.5
Sugar refineries	36.9	47.5	65.1
Breweries	21.7	33.6	39.0
Slaughterhouses	7.5	6.6	16.3
Bakeries	2.9	5.6	17.2
Margarine factories	1.8	10.2	18.9
A=the whole of the food manufacturing industry	211.2	294.1	389.1
B=the textile industry (spinning mills+weaving mills)	80.7	105.8	158.3
C=tanneries	7.7	11.1	28.9
D=the whole of industry	733.9	1 092.1	1 664.7
E=A as % of D	29%	27%	23%
F=B+C as % of D	12%	11%	11%

[a] Dairy production has been included in the table in spite of the fact that dairies are not considered as a branch of industry in Swedish statistics. On the other hand the value of the production of raw sugar has not been included.

Source Bidrag till Sveriges Officiella Statistik. D Fabriker och handtverk. Meddelanden från Kungl. Lantbruksstyrelsen.

branches of industry within the consumer industries in Sweden and the USA after industrialisation had begun. In spite of the fact that the industrial statistics in Sweden were reorganised in 1896, and from then onwards show an improvement in several respects, the statistical material after that date cannot stand up to scrutiny in detail. This also applies to the American statistics. For example the statistics contain certain duplicated entries, but nevertheless these cannot affect the broad pattern in tables 2 and 3. The relative importance of light industry in comparison with industry as a whole at the beginning of the twentieth century is established irrespective of the shortcomings of the statistics, and it then constituted around 40 per cent of the total value of industrial production in both Sweden and the USA.

Table 3. *The value in millions of dollars of the production of industries in the USA based on farm products*

Branch	1900	1905
Slaughterhouses+meat packing industries	783 (1.1)	913 (1.1)
Mills	501 (1.2)	713 (1.2)
Breweries+distilleries	381 (4.9)	500 (4.3)
Sugar refineries	240 (1.1)	277 (1.1)
Bakeries	175 (1.8)	270 (1.7)
Dairies	145 (1.2)	181 (1.2)
Others	475	492
A=the whole of the food manufacturing industry	2 700	3 346
B=the textile industry	1 637	2 147
C=the leather industry	584 (1.3)	706 (1.3)
D=the whole of industry	11 406 (1.7)	14 743 (1.7)
E=A as % of D	24%	23%
F=B as % of D	14%	14%
G=C as % of D	5%	5%

Note The figures in parentheses give the processing coefficient. The processing coefficient=the end value of the product divided by the value of the raw materials. The processing coefficient for the cotton industry was 1.9 and for the wool industry 1.6 in 1900. In 1905 the coefficient was 1.6 for both branches of industry.

Source Statistical Abstracts of the United States 1910 and 1912.

There is a striking similarity between Sweden and the USA as regards the relative importance of the branches of industry. As appears from tables 2 and 3, in Sweden in the year 1900 the food manufacturing sector accounted for 27 per cent and the leather and textile sector 11 per cent of the value of the production of the whole of industry. The corresponding figures for the USA were 24 per cent and 19 per cent respectively. However, certain national characteristics can be distinguished. The fact that the textile industry played a somewhat greater part in the USA is not surprising, because of the extensive domestic growing of cotton. Sweden on the other hand has been completely dependent on imported cotton.

Another national difference was the relative importance of slaughterhouses. Slaughterhouses have played a comparatively minor rôle in the Swedish food manufacturing industry, whereas the slaughtering and meat packing industry expanded in a completely different way in the United States. Tendencies towards the concentration of operations could be discerned in the American slaughtering and meat packing sector at an early stage. The consequences of centralised operations at a few large production units became apparent, inter alia on the technological level. The meat packing sector was the first branch of industry to introduce the conveyor belt before 1850. The technique of refrigeration, to which reference has already been made, began to be used during the 1870s and it became of great importance for the localisation and expansion of the meat packing industry. By means of new refrigeration devices on the railway wagons meat production on an industrial scale could be freed from the demand for proximity to a consumer centre in the Eastern USA. Frozen meat could tolerate long journeys and therefore the packing of meat could be located and concentrated in production centres, viz. the cattle districts round Chicago and in the Middle-West. Then a few large factories dominated the whole of the meat packing industry.

As far as the dairies were concerned a converse situation prevailed. After the crises in European agriculture during the 1880s farming policy in several cases changed to greater livestock production. In Sweden this led to a sharp increase in the production of dairy butter, which was mainly sold on the foreign market. The production of butter required a more intensive form of cattle-farming which was also practised in Sweden. Cattle-farming in the USA, however, was practised more extensively and concentrated on meat instead of milk and butter.

The value of production is an inadequate gauge of the contribution made by various branches of industry to industrial development. It includes not only the value of the industrial production process but also the value of the raw materials. Therefore the processing value gives a supplementary and fairer picture of the importance of the various industries. It is clear from table 3 that the processing value (processing coefficient) in the American consumer goods industries was usually considerably lower than in industry as a whole (cf. tables 3 and 5). With the exception of the beverage industry, raw materials in the consumer goods industry (farm goods) were very high in value in comparison with the end products. However the textile industry and the bakeries tended to come near to the average for industry as a whole. By virtue of the fact that the processing level in the consumer goods industries had been lower from a general point of view than in several other industries, the significance of the consumer industry was reduced to a certain extent. Even if the processing value is used as a gauge, light industry took up the leading position among the industries. However, as regards processing value, the metal industry in the USA had overtaken light industry before the First World War.[6]

The processing coefficients which appear in table 3 have been taken from the USA. With reservations for small differences in detail, they probably apply to countries with a corresponding industrial level. Similar tendencies to those in Sweden and the USA before the First World War would probably be apparent in the countries which were industrialised during the latter part of the nineteenth century. Thus the consumer goods industry played a dominant rôle during the initial stages of industrialisation. However, a decline in the relative importance of this sector of industry can be traced before 1914, and other industries gradually take over the dominant industrial position. The factor above all which altered the old positions was the growth of the metal industry, including the engineering industry.

2. Industries based on deliveries to agriculture

The mechanisation in farming meant an increased demand for certain industrial products. Farming played an important part as a customer of industry as far as engineering works and the fertilizer industry were concerned. Indirectly the development of agriculture, conditioned by market forces, became of great importance because of the expansion of the food manufacturing industry. Of course in its turn the food manufacturing industry required industrial products, mainly machinery from the engineering industry. The producers of agricul-

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[6] *Statistical Abstract of the United States 1910,* pp. 175ff.; 1912, pp. 199ff.

tural implements and machines also had to give orders to the tool industry for their own production. Thus a chain reaction occurred within the industry and a network of sub-suppliers grew up. As far as the engineering industry was concerned the various branches of industry were the biggest customers, and only a minor part of the value of the engineering works' production came from engineering companies which had farming as a customer. But from the customer's point of view the importance of farming for industrialisation through the chain reaction which has been referred to was greater than is shown directly by the statistics. Apart from its direct orders to industry, farming also acted as one of the catalysts in industrial development.[7]

In value the production of the engineering works constituted 5–6 per cent of the whole of industry both in Sweden and the USA during the beginning of the twentieth century. The corresponding proportion for the fertilizer industry was barely 1 per cent. In Sweden the production value of the agricultural implements/machinery amounted to 25–30 per cent of that of the engineering industry (table 4A). In the USA the corresponding figures were lower (11–24 per cent) which can be explained by the fact that dairy machinery which constituted a large entry in table 4A has not been included in table 5.

As with the consumer goods industries in relation to the engineering works and fertilizer industry, it is striking how similar in comparative importance the branches of industry were in Sweden and the USA. When assessing development from the point of view of the

[7] Hans Modig in his work *Järnvägarnas efterfrågan och den svenska industrin 1860–1914* approaches the problem of demand on the basis of the transport service as a customer of industry. He studies the spreading effect of railway construction on domestic industry and finds that this effect was fairly limited. The reason for this was that Swedish railway building was to a great extent made possible by imports of railway materials. Thus the spreading effect was not to any great extent easy to gauge in Sweden.

The situation was different as regards the spreading effect of the orders placed by agriculture with the Swedish engineering industry. After the 1880s the exports of agricultural implements and machinery were greater than the imports and the difference gradually increased before 1914. Therefore the spreading effect of these orders was to remain within the country to a much higher degree, of which more in chapter 4.

Table 4A. *The production value of the engineering industry in Sweden in thousands of Swedish crowns*

Tools/machinery	1896	1900	1906	1910
Locomobiles	394	705	1 168	1 188
Ploughs, harrows	590	796	1 510	1 655
Harvesters+sowing machines	1 210	1 198	2 670	6 618
Threshing machines	634	993	1 469	2 353
Chaff cutters and others	146	171	284	309
Dairy machinery	4 675	8 020	10 337	11 404
Other agricultural implements	822	932	1 246	1 280
A=total tools+machinery	8 471	12 815	18 684	24 807
B=total of engineering industry	31 694	53 029	72 769	82 334
C=A as % of B	26.7	24.2	25.7	30.1

Source Supplement to SOS D Fabriker och handtverk.

production value of the industry it is also clear that farming was of greater importance as a supplier to industry than as a customer for industrial products. But the dual rôles of farming in industrialisation appear better balanced when the degree of processing is taken into consideration. As appears from table 5 the processing coefficient was considerably higher in the engineering industry than in industry as a whole. The difference in the degree of processing is especially great when the engineering works are compared with the consumer goods industry. From a comparative viewpoint, therefore, the

Table 4B. *The production value of the engineering works, the fertilizer industry and industry as a whole in Sweden in millions of Swedish crowns*

Year	A=in-dustry	B=the engi-neering works	B as % of A	C=the fertilizer industry	C as % of A
1896	692.4	31.7	4.6	4.4	0.6
1900	1 046.2	53.0	5.1	5.2	0.5
1910	1 003.2	82.3	5.1	11.5	0.7

Source Supplement to SOS D Fabriker och handtverk.

Table 5. *The production value in millions of dollars of industries in the USA based on deliveries to agriculture*

Branch	1880	1890	1900	1905	1910
A=Agricultural implements	68 (2.1)	81 (2.5)	101 (2.3)	112 (2.3)	146 (2.4)
B=Foundries+engineering works	215 (2.1)	413 (2.4)	644 (2.3)	799 (2.5)	1 228 (2.3)
C=Fertilizer industry	24 (1.5)	39 (1.6)	45 (1.6)	57 (1.5)	104 (1.5)
D=Industry as a whole			11 406 (1.7)	14 743 (1.7)	20 672 (1.7)
E=A as % of B+A	24	16	14	14	11
F=A+B as % of D			6.5	5.5	6.6
G=C as % of D			0.4	0.4	0.5

Note Dairy machinery is not included under the heading 'Agricultural implements'. The figures in parentheses indicate the processing coefficient.

Source Statistical Abstracts of the United States 1910 and 1912.

industrial production phase was of far greater importance in the engineering industry than it was in light industry.

Farming occupied a central position during the initial stage of industrialisation before the First World War. About 50 per cent of the

Table 6. *Number of companies and number of workers in thousands in industries in Sweden based on deliveries to agriculture*

	1896	1900	1910
Number of companies			
A. Engineering works	296	315	459
B. Fertilizer industry[a]	89	72	50
C. Industry as a whole	8 812	10 549	11 435
Number of workers (in thousands)			
A. Engineering works	16	21	22
B. Fertilizer industry	1	1	1
C. Industry as a whole	202	265	302

[a] A small number (4–6) of superphosphate factories dominated the production of fertilizers.

Source Supplement to SOS D Fabriker och handtverk.

Table 7. *Number of companies, number of workers in thousands and capital in millions of dollars in industries in the USA based on deliveries to agriculture*

	1880	1890	1900	1910
Number of companies				
A. Production of agricultural implements	1 943	910	715	640
B. Foundries+engineering works	4 984	6 500	9 316	13 253
C. Fertilizer industry	364	390	422	550
D. Industry as a whole			207 514	268 491
Number of workers (in thousands)				
A. Production of agricultural implements	40	39	46	51
B. Foundries+engineering works	145	231	350	531
C. Fertilizer industry	9	9	12	18
D. Industry as a whole			4 713	6 615
Capital (in millions of dollars)				
A. Production of agricultural implements	62	145	157	256
B. Foundries+engineering works	155	383	663	1 514
C. Fertilizer industry	18	41	61	122
D. Industry as a whole			8 975	18 428

Source Statistical Abstracts of the United States 1910 and 1912.

production value of industry as a whole came from industries which were in various ways directly connected with agriculture. This applied to countries like Sweden and the USA during the initial decades of industrialisation before 1914, and probably also to countries on a corresponding industrial level. Therefore the interaction between farming and industry stands out as a fundamental factor in the process of industrialisation. More than anything else, what happened in agriculture, with its wide base and its large area of contact with industry, was to have ramifications for the growth of industry as well as the economy as a whole.

II. THE PRODUCTION AND MARKETING OF AGRICULTURAL IMPLEMENTS AND AGRICULTURAL MACHINERY

A. Introduction

Whereas the development of agrarian technology has been studied from a producer's point of view in the present work, in an earlier study agrarian technology was analysed mainly from a consumer's point of view. In this earlier study particular attention was devoted to the question of how agrarian technical innovations were introduced, accepted and adapted by the farmers in Sweden between 1860 and 1910 (see note 3). The main question was which farmers reacted to the increased demand for agricultural products by increasing mechanisation and which did not. Thus the spread of mechanisation in the various social and economic strata of agriculture was considered fundamental. In earlier research into economic history insufficient attention has been paid to the processes of spreading in the development of agriculture and industry. In American research the problems connected with the diffusion of agrarian technology have in fact been dealt with comparatively extensively, but the process of diffusion has not yet been tackled in an integrated and more systematic way. The development of agriculture is one of those areas of research in which it is difficult to obtain hard facts. The large number of very small units of production have not left behind very many sources. As regards summaries of information, there are statistical accounts of agriculture on a national and regional level, but the individual units of agricultural production, as distinct from several industrial companies, have not provided any material which would make it possible to study each primary unit of production individually. However there is one source which, in Sweden at any rate, can provide information about the possession of agricultural implements and machinery, viz. the Estate Inventory Deeds.

Thus research into the diffusion of mechanisation in Swedish agriculture has been based on Inventory Deeds of people who at the time of their death were actively engaged in farming. Estate Inventory Deeds for three counties in South and Central Sweden were analysed in terms of the possession of some fifteen farming implements and machines such as ploughs, harrows, rollers, sowing machines, harvesters, threshing-machines, separators and milking machines, and the farms which were examined were divided into four groups according to size: smallholdings, smaller farms, larger farms and large holdings. The material in the Inventory Deeds has been regarded as a very useful source for estimating the diffusion of agrarian technology. In addition the Inventory Deeds provide a direct answer to the important question as to which farmers did not possess the agricultural implements and machines referred to.

There is another side to the problem of the spread of mechanisation in agriculture which concerns the marketing of the industry. The question of the extent to which farming by virtue of its size and buying power was an important customer of industry in general and the engineering industry in particular is an important one, and has been made the focal point of the present work. However it is easier to understand the development of the industries which manufactured agricultural implements according to farming's requirements once it is known how the various farmers reacted to different forms of agricultural technology.

The mechanisation in farming meant an increase in the demand for industrially produced implements and machinery. Previously agriculture's demand for implements had been satisfied by the production of the village smithy itself. In the middle of the nineteenth century, of the engineering works which existed in Sweden only about twenty companies were above the handicraft level. In addition certain engineering products were manufactured at various iron works. Examples of larger engineering works of this time were Motala verkstad, Bolinders in Stockholm, Keillers in Gothenburg, Kockum in Malmö and Munktells in Eskilstuna.[8]

[8] Gårdlund, T., *Industrialismens samhälle*, pp. 32 f.

A rough outline of the development of the Swedish engineering industry during the latter part of the nineteenth century has already been given. Several companies were still assumed to produce a multiplicity of goods during the nineteenth century even though a tendency to specialise can be traced during the 1890s. Mention may be made of De Lavals separatorfabrik among those companies which formed the basis for the new specialised industries.[9]

Agriculture was of importance for industrialisation on account of its orders from the engineering industry. Therefore the interaction between agriculture and the engineering industry will be traced by studying six selected engineering companies with their markets directed towards agriculture. The selection of the engineering companies has been governed by a wish to have companies of different sizes and with different levels of specialisation represented. The companies analysed may be said to exemplify different grades of company which were current at the outbreak of the First World War. Groupings into three such grades have been made, and two companies are represented in each grade.

The first grade is made up of small engineering works with a mainly local market for their products. Two engineering works in Scania have been chosen as representing this type of company: AB Lilla Harrie Redskapsverkstad (10 kilometres north of Lund) and Bröderna Anderssons Gjuteri & Mekaniska Verkstad in Skurup.[10]

The next two companies will represent the larger companies which had the whole of Sweden as a market and in addition exported on a fairly large scale. Of the two examples Överums Bruk (in the north of Kalmar län) is the oldest, founded in 1654. However the production of agricultural implements only began in the middle of the nineteenth century. The other company, Munktells in Eskilstuna, originated early in the 19th century.

The two companies on the third and last level, AB Separator in Stockholm and the International Harvester Company in Chicago, represent companies which had already developed into multinational companies before the First World War. A very large part of their

[9] *Ibid.*, pp. 81ff. Jörberg, L., *Growth and Fluctuations of Swedish Industry 1869–1912.*

[10] The above-mentioned engineering works have expanded since 1914, and recently the local quality has diminished to a corresponding degree.

Lilla Harrie Redskapsfabrik Bröderna Andersson, Skurup	}	local grade
Överums Bruk Munktells, Eskilstuna	}	national grade
AB Separator, Stockholm International Harvester Company, Chicago	}	international grade

Figure 1. *The companies examined grouped by grades around 1914.*

production was exported. However the large domestic market in the USA was of greater importance to International Harvester than the Swedish market was to AB Separator.

Figure 1 shows the grouping of the companies into the grades which have been described. Naturally figure 1 constitutes a simplification of the reality for the purpose of demonstration. In actual fact there are several transitional forms and grades between companies in the local and the national grades and between companies in the national and the international grades. It should also be borne in mind that figure 1 only shows the situation at a certain given time (around 1914) and therefore what is shown is a static picture. During the period before 1914 Swedish industry was developing to a large extent in the rural areas in the form of many small company units. N. Wohlin has described the engineering industry (in 1912) in a somewhat colourful but accurate way as a highly diffuse small-scale industry from which a smaller number of companies of world renown rose up like giants among dwarfs.[11] Neither the dynamics and internal development of the company nor the numerous types of company are reflected in figure 1. But in the following text the individual development of the various companies will be traced. In this context certain general characteristics of development will be discussed on the basis of the individual company. In fact the specific and unique characteristics of the development of the individual company are at least as important for a good understanding of the interaction between agriculture and industry.

Before the development of the individual companies is discussed, J. Schumpeter's theory of entrepreneurs will be mentioned briefly, and his ideas will be of some assistance in the discussion which

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[11] Wohlin, N., *Driftskoncentrationer i svensk fabriksindustri*, p. 53.

Map 1 showing the location of the Swedish companies under examination which manufactured agricultural implements and machinery.

follows. The concept of the entrepreneur and the development of the company are closely connected. Joseph Schumpeter is the economist who has stressed most clearly the importance of the entrepreneur in economic development. He maintains that the entrepreneur's innovations are the most important mechanism for changing the national economy. Progress involves great changes and there must be individuals capable of directing the process of fundamental economic transformation. In Schumpeter's system this key rôle is filled by the entrepreneur. His task is to create or bring into operation new combinations of familiar individual processes. "The entrepreneur and his function are not difficult to conceptualize: the defining characteristic is simply the doing of new things or the doing of things that are already being done in a new way (innovation). It should be observed at once that the "new thing" need not be spectacular or of historic importance. It need not be Bessemer steel or the internal combustion engine. It can be the Deerfoot sausage. To see the phenomenon even at the humblest levels of the business world is quite essential though it may be difficult to find the humble entrepreneurs, historically."[12]

Certain distinctions are of importance with regard to Schumpeter's concept of the entrepreneur. First, there has to be a distinction between an entrepreneur and management. It is one thing to build up a company and to realize a new idea and another thing to lead the administration of an established company, even if the two tasks often overlap. Furthermore, the function of the entrepreneur is not identical with that of the capital owner, which consists of providing money for investment. The essential thing in the business community is to put something new on the market. Thus the person whose importance for the development process is decisive is the person who directs the use of the capital invested, not the person who provides it. The entrepreneur creates the capital and makes credit necessary at the same time. Finally, it is of particular importance to keep the entrepreneur separate from the inventor. Many inventors have become entrepreneurs but there is no absolute connection between the two functions. The inventor produces ideas, the entrepreneur puts them into practice, which can, but need not, mean anything new scientifically. An idea or a scientific principle is not in itself of economic significance. During classical antiquity Greek natural science probably had the collective knowledge necessary for the construction of a steam engine. But this did not help the Greeks or the Romans to build the steam engine.

As has been stated, the entrepreneur may also play other parts than that of entrepreneur. He may be an inventor, administrator, capital owner and entrepreneur all in one, but there is no necessary connection between any of the four rôles. The fact that in reality it is seldom possible to encounter one rôle in its pure form is a different matter. What Schumpeter means is that the entrepreneur holds the key position in the control of the production processes. He has also pointed out that there is never a shortage of ideas for technical improvements. What may be in short supply is the manufacturer's ability which is necessary to introduce these innova-

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[12] Schumpeter, J., 'The Creative Response in Economic History' (in the *Journal of Economic History*, no. 2 1947).

tions to the public. It is often people of a unique type of personality who have sparked off the process of progress in a country.[13] We therefore need to study more closely how these individuals have arisen and do arise in a society.

[13] *Ibid.* According to Schumpeter capitalism is the most favourable environment for entrepreneurs and consequently also for changes in the national economy.

B. Small companies with local markets

There was a rapid growth in the formation of companies connected with the industrialisation of Sweden during the latter part of the nineteenth century. This also applied to a great extent to the engineering works. From the middle of the nineteenth century there was a noticeable trend towards an engineering industry independent of the iron works. For a long time this limited engineering industry had rather a special character. Production often took place to order. The marketing was usually local or regional. Although, thanks to the epoch-making milling machine, some larger companies introduced specialised production in quantities before the end of the nineteenth century, the specialisation did not extend very far before the First World War. As E. Dahmén says: "Several great innovations in production technique apart from the milling machine are to be found during the latter part of the nineteenth century, but they were not put into general circulation".[14]

[14] Dahmén, E., *Svensk industriell företagarverksamhet.* I, pp. 16f. Dahmén dates the quantitative breakthrough of Swedish production technique to the period after 1895. Gårdlund, T., *Industrialismens samhälle,* pp. 90ff.

Without the milling machine it would have been impossible to produce gear wheels or worm wheels for the speeds needed in separators and steam turbines, for example.

Gårdlund draws a distinction between two different types of Swedish engineering works around the turn of the nineteenth century, and at the same time gives a descriptive account of the inner lives of the two types of engineering works. In the smaller and more versatile type of workshop the old-style master mechanic was king. He was the man who knew everything and he represented the old tradition. He wore a collar and had often been to technical evening classes and as far as knowledge was concerned he differed very little from the workers. He was often conservative and careful with money.

In the office of the workshop he negotiated with the customers. The work was usually done without precise measurement. Different parts of machinery and pieces to be machined were ground in with a file by each worker in a highly individual way. There was no machine or construction which was so demanding that it could not be made in a workshop of the smaller versatile type. There was an ambition not to refuse any orders, to show that the workshop could manufacture whatever

The number of engineering works grew with special rapidity after 1895.

Number of engineering works

Year	Rural areas	Towns	Total
1885	130	94	224
1896	166	130	296
1910	244	215	459

It was above all the smaller companies which increased the most, especially in rural areas. In 1896 the number employed in rural engineering works was on average 37, while the corresponding figure for the town engineering works was 77. The average number of employees in rural engineering works was unchanged in 1910. The fact that the industrial statistics in this particular case are incomplete must be taken into account. Several of the smaller newly formed engineering companies were so small that they were not taken into account in the industrial statistics. When this is taken into consideration there will be a reduction in the already low average number of employees in rural engineering works.[15]

There are various reasons for the increase in the number of small companies which were started. It was possible to start a smaller works without any great capital investment, often in rented premises. Moreover, the general mechanisation in society increased the need for sub-contractors and repair workshops. In spite of the increased specialisation of production, or perhaps because of it, there was a simultaneous growth of the need for workshops for customers who mainly required products which were technically less advanced. For such customers factors such as proximity and easy availability were of great importance.

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the customer ordered. For many heavy implements and machines this technique fulfilled its purpose very well. But when it came to the mass-production of heavy machines at low prices or machines for precision work and with interchangeable spare parts, this system was inadequate. The other type of workshop geared to rational standard production and far-reaching specialisation is described in connection with the development of AB Separator (see note 115).

[15] *Ibid.*, pp. 87 f. *Bi SOS D Fabriker och handtverk.*

The setting up of small companies will be regarded as a form of industry on which the skilled worker could support his family. This became of special importance during years of economic crises. Here too the increased level of mechanisation after 1890 may in the long run have created employment problems for skilled engineering workers, which in turn may have prompted them to start their own workshops.[16]

1. *Lilla Harrie redskapsverkstad*

Lilla Harrie redskapsverkstad was founded in 1890 by blacksmith Nils Holmqvist. He was born in 1851 in Torrlösa near Svalöv. During his adolescence he worked with his father, who was also a master blacksmith. After some years of practical training in Malmö, Nils Holmqvist returned to Torrlösa, where in 1875 he rented a small blacksmith's shop. Together with an assistant he kept up this country smithy until 1890. During those 15 years he manufactured simpler agricultural implements, work trucks and even some steam threshing-machines. Thus when Nils Holmqvist took over an old smithy in Lilla Harrie he had already had long experience in his trade.[17]

The village smithy was bought by Nils Holmqvist for 2 150 Swedish crowns, which amounted approximately to his total assets at that time. At the start production was carried on as a handicraft, and the production programme resembled that of the smithy in Torrlösa. In the middle of the 1890s Holmqvist started to manufacture single-furrow ploughs of an American type. A couple of years after the turn of the century a new type of three-furrow skim plough was developed, and thereafter several thousands of these were produced. In fact the most important branch of production

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[16] Hammarström, I., *Stockholm i svensk ekonomi 1850–1914*, pp. 349 f.

[17] *AB Lilla Harrie Redskapsverkstad*. Minnesskrift, pp. 5 f.

It is clear from the memorial publication that Holmqvist's assistants who went to Lilla Harrie did not regard the move with any great enthusiasm. Therefore the driving force behind the move to Lilla Harrie was most probably Nils Holmqvist.

Table 8. *The number of agricultural implements marketed by Lilla Harrie redskapsverkstad*

	Harrows			Ploughs				Horse hoes		
	Län			Län				Län		
Year	M	N	Total	L	M	N	Total	L	M	Total
1892	10	–	10	–	5	–	5	–	1	1
1893	10	–	10	–	10	–	10	–	–	–
1894	7	–	7	–	38	–	38	–	2	2
1895	13	–	13	–	24	1	25	–	2	2
1896	11	–	11	–	19	–	19	–	9	9
1897	10	–	10	–	7	–	7	–	7	7
1898	30	–	30	1	7	–	8	–	10	10
1899	103	–	103	–	15	–	15	–	12	12
1900	8	4	12	–	10	–	10	–	9	9
1901	36	–	36	–	10	–	10	–	22	22
1902	25	–	25	–	14	–	14	2	46	48
1903			47				16			52
1904			161				42			60
1905			350							
1906			800							
1907			1 400							

Source Lilla Harrie redskapsverkstad's records: 1892–1902, ledgers; 1903–1904, monthly journals, memorandum book; 1905–1907, Lilla Harrie redskapsverkstad: Minnesskrift.

in the workshop was not to be the manufacture of ploughs but the production of harrows. Horse hoes were also manufactured to some extent. Tables 8 and 9 show the extent of production during the initial years of the company. During the first decade from 1892 to 1902 there were also produced ten threshing-machines, saltpetre spreaders, horse hay rakes, seed drilling machines and straw elevators, all with a market within Malmöhus län (county). The local character of the market appears clearly from tables 8 and 9. Up to and including the year 1902 the company's products were sold almost entirely within Scania. During the company's first ten years its local character is underlined by the fact that 90 per cent

Table 9. *The number of agricultural implements marketed by Lilla Harrie redskapsverkstad 1903–1904*

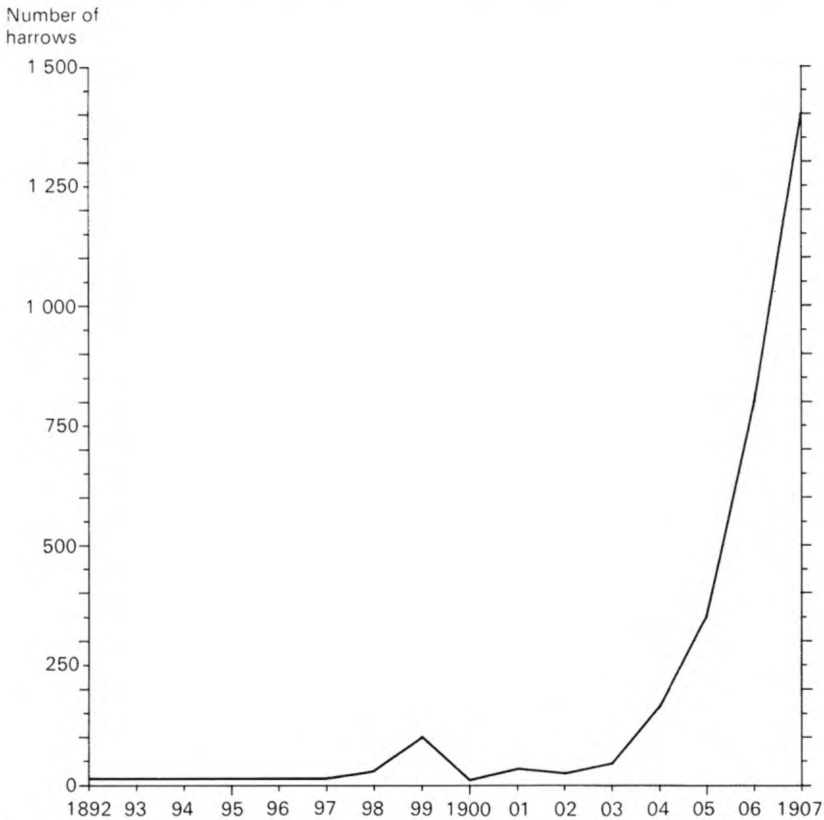
	Harrows		Ploughs		Horse hoes	
Län/Country	1903	1904	1903	1904	1903	1904
A	–	5	–	16	–	4
B	–	–	–	–	–	–
C	–	–	–	–	–	–
D	–	–	–	1	–	–
E	1	–	–	–	–	–
F	–	–	–	–	–	–
G	–	–	–	–	–	–
H	–	–	–	–	–	–
I	1	–	–	2	–	–
K	–	–	–	2	–	1
L	–	10	–	1	3	1
M	44	117	15	20	49	52
N	–	2	–	–	–	1
O	–	–	–	–	–	–
P	–	–	–	–	–	–
R	1	–	–	–	–	–
S	–	–	–	–	–	–
T	–	6	–	–	–	–
U	–	–	–	–	–	–
W	–	–	–	–	–	–
X	–	–	–	–	–	–
Y	–	–	–	–	–	–
Z	–	–	–	–	–	–
AC	–	–	–	–	–	–
BD	–	–	–	–	–	–
Denmark	–	21	1	–	–	–
Finland	–	–	–	–	–	1
Total	47	161	16	42	52	60

Source Lilla Harrie redskapsverkstad's records: Monthly journals, memorandum book.

of the products sold within the län of Malmöhus stayed within a radius of 10 kilometres from where they were sold.[18]

[18] *Ibid.*, pp. 6f. The records of Lilla Harrie redskapsverkstad for the company's first 10–15 years in operation are the best preserved of those for the early period. From 1904 until modern times it is not possible to trace the production and sales

Diagram 1. *Number of harrows sold by Lilla Harrie redskapsverkstad in 1892–1907*



Source: See table 8.

The years 1902–1903 marked the beginning of the company's growth. During the 1890s the labour force had never exceeded five men. But around the turn of the nineteenth century there was a development in production technique in that manual power was replaced by mechanical motor power, for example in turning lathes, drilling machines, shearing machines and bellows. At the same time a kerosene engine was acquired. The smithy was extended and a

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with the aid of records. However, Minnesskriften AB Lilla Harrie Redskapsverkstad gives certain information in this connection.

Table 10. *Number of men employed in Lilla Harrie redskapsverkstad 1900–1911*

Year	Number employed		
	Full-time	Part-time	Total
1900	5	–	5
1903	5	4	9
1904	11	3	14
1905	17	–	17
1906	25	–	25
1907	28	–	28
1908	29	–	29
1909	29	–	29
1910	31	–	31
1911	32	–	32

Source Lilla Harrie redskapsverkstad's records: Wages accounts. The number of men employed represents the situation at the end of the year.

smaller warehouse was built. These changes have to be considered in the light of the interest which Nils Holmqvist then developed in a new type of agricultural implement which began to be introduced into Sweden, viz. the cultivator, a special form of harrow. The new cultivator, which was equipped with three small wheels, had sold very successfully abroad, and Holmqvist committed his company to this product. Since that time the production of cultivators has formed the backbone of the workshop's production. In spite of the mechanisation around 1900 the increase in production demanded an extension of the labour force.

In connection with the start of the expansion in production the company opened a small department for sales, administration and accounting when Nils Holmqvist's eldest son Carl joined the staff in 1903 as business manager of the company. Continuity in the management of the company was further reinforced in 1922 when the founder's youngest son Gustav joined as managing director. Before that Nils Holmqvist himself had managed the division of labour on the shop floor until 1908 when this function was delegated to a foreman. The marketing organisation was extended under the management of Carl Holmqvist. During the first ten years the company was mainly in direct contact with its farming customers, but gradually distribution was arranged completely through wholesalers, dealers in machinery, ironmongers, village shopkeepers and blacksmiths. During the 1910s Söderberg & Haak AB in Stockholm became the company's exclusive agent for Northern and Central Sweden.[19]

As shown in tables 8–10 and diagram 1, the first decade of the twentieth century was a decade of expansion for the company. After 1902 its products began to be marketed outside Malmöhus län and some were exported. The tendency towards a geographical expansion of the market is also underlined in table 11. The geographical spread of the products can be traced directly down to and including the year 1904. But the geographical spread of customers can be established in general terms from the entries of outstanding debts in the stock book.[20] Table 11 shows the inherent probability that the geographical area of the market expanded simultaneously with the sharp increase in production. However the market within Malmöhus län remained dominant in 1910. According to the company's memorial publication in 1950, agricultural implements and machinery have spread all over the country and abroad since the Second World War, but the spread within Scania was still dominant in 1950.

A great factor in the expansion of the company during the first ten years of the twentieth century was the establishment of the

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[19] *Ibid.*, pp. 7 ff. Carl Holmqvist had had a background of commercial training and five years' experience with the import firm of Paulsson & Co.'s Eslöv maskinaffär (mainly agricultural machinery) when he joined the staff of the company. His younger brother Gustav had a technological training behind him when he joined the company. After leaving technical college in Malmö he was employed as a constructor in Germany, at Landsverk in Landskrona and at SKF in Gothenburg.

Nils Holmqvist continued to manage the company until his death in 1932, when he was succeeded by his son Carl. Of late Gustav Holmqvist has been head of the company.

[20] Cf. Dahl, S., 'Travelling Pedlars in Nineteenth Century Sweden' (in *Scandinavian Economic History Review*, 1959, pp. 167 ff.)

S. Dahl has mapped out the field of operations of the travelling pedlars by examining bankruptcy documents to see where the travelling pedlars had had outstanding claims.

Table 11. *Outstanding debts of over 50 Swedish crowns, classified according to the geographical address of the customer, which were owing to Lilla Harrie redskapsverkstad in the years 1904–1910*

Län/Country	1904	1905	1906	1907	1908	1909	1910
A	2	1	1	1	3	1	2
B	–	–	1	1	–	2	2
C	–	1	–	–	–	1	–
D	–	–	–	–	–	–	1
E	–	–	4	1	3	3	2
F	–	–	–	–	–	–	–
G	–	–	–	–	–	1	–
H	1	–	–	1	–	–	2
I	–	3	2	1	1	2	1
K	–	–	1	–	–	9	29
L	3	3	8	5	9	9	13
M	62	65	66	61	135	102	97
N	1	2	3	2	2	4	4
O	–	–	–	–	1	3	1
P	–	–	1	2	–	3	7
R	–	1	–	–	2	4	2
S	–	–	–	–	–	1	1
T	1	1	–	–	1	–	2
U	–	–	–	1	–	1	–
W	–	–	–	–	–	–	1
X	–	–	–	–	–	–	1
Y	–	–	–	–	–	–	–
Z	–	–	–	–	–	–	–
AC	–	–	–	–	–	–	–
BD	–	–	–	–	–	–	–
Denmark	–	–	1	–	1	1	1
Finland	1	–	–	–	2	1	–
Norway	–	–	–	–	–	1	–
Russia	–	–	–	1	1	1	–
Total	71	77	87	77	161	150	169

Source Lilla Harrie redskapsverkstad's records: Stock books.

Kävlinge–Sjöbo railway, which was opened to traffic in 1906. Through the railway Lilla Harrie made contact with Örtofta (four kilometres from Lilla Harrie) on the main line from Stockholm to Malmö. The railway made a very real contribution to the extension of the workshop's market areas. In conjunction with the establishment of the railway the first section of a machine workshop was built, to which the production was completely transferred. Repair work was to be discontinued and henceforth the company devoted itself exclusively to new production. In 1910 the production reached a capacity of 2540 articles, and the tools were worth 152000 Swedish crowns. The production was then distributed along various production lines as follows:

	Sw. kr.
Cultivators, harrows	122 000
Saltpetre spreaders	17 000
Straw elevators	5 000
Spare parts	8 000
Total	152 000

Source Riksarkivet, Kommerskollegii arkiv. Primäruppgifter till industristatistiken.

The concentration on cultivators and harrows is clear. About 80 per cent of the total production in 1910 could be ascribed to those implements. In less than twenty years the diversified smithy had been developed into a specialised workshop. In spite of the fact that in 1910 the workshop employed somewhat fewer (31) workers than the average number for rural workshops (37) the company's share constituted about 7 per cent of the total Swedish market in ploughs and harrows. If harrows alone were counted, the share of the market would be twice as big. This shows two things. Even a small company could, through a high level of specialisation, attain a comparatively large share of the market for its special products. Furthermore, the share of the market could become comparatively large, in spite of the fact that the company had a typical local market for its special products. Naturally it is of importance in this context that the local market was to be found in the dense farming area in Malmöhus län.[21]

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[21] Riksarkivet, Kommerskollegii arkiv. Primäruppgifter till industristatistiken. *AB Lilla Harrie redskapsverkstads minnesskrift* passim. *Svenska industrien, 1911–1912,* pp. 370f.

Since the beginning of the twentieth century the company has had most of the implements tested at the Statens Maskin- och Redskapsprovningsanstalt with consistently favourable verdicts. Several awards "for outstanding agricultural implements" were given to the company, among other occasions at the Allmänna Svenska Lantbruksmötet 1906 in Norrköping.

A change in organisation took place in 1911 when the company became a limited company. No capital worth mentioning was introduced. The share capital amounted to 75 000 Sw. kr. and the shares were almost exactly the equivalent of the assets of the company. The ownership of the shares remained in the Holmqvist family (family company). There was less expansion in the 1910s than in the previous decade, although the First World War brought about a boom in Swedish agriculture, which resulted in increased demands for the company's products. The total value of production in 1918 amounted to 475 000 Sw. kr. (the equivalent of about 200 000 Sw. kr. in 1914's prices), and the number of men employed had risen to 50. At the same point in time the share capital was increased to 100 000 Sw. kr.[22] Thus in comparison with the expansion during the first decade of the twentieth century, the 1910s became a period of consolidation. Since the company's "gründer" period up to 1910 stands out as the most interesting epoch in the development of the workshop, attention has been deliberately focused on this period.

It was throughout a principle of the company that expansion in the form of new plant or an extension of machinery must be self-financing. Thus the rate of expansion was entirely determined by the money which was available within the company. In fact only seasonal and occasional borrowing took place, so that the stock could be maintained. However, the whole extent of self-financing contributed to the company's lack of capacity to meet growing domestic and foreign demands. In management security clearly took precedence over growth. However the manufacture of agricultural implements and machinery was often a gamble with unknown factors. It was not like many other businesses in which one could wait for the orders and then buy the materials needed in order finally to start the manufacturing. Instead the size of the production series had to be decided years in advance and purchases made for it. Agreements for sales and deliveries did not come until much later. Therefore stock-keeping was a constant problem, especially as the products were bulky in relation to their price.

The viability of the business depended on the orders from the

[22] *Svensk Industrikalender 1918*, p. 119.

farms, placed either through direct contact or through dealers of some kind. It is possible to trace in general terms the social composition of the customers during the period of growth between 1890 and 1910. Judging by the names, titles and farm addresses of the customers, the products of the company during this period seem to have gone almost exclusively to peasant farms. Only to the small extent of about 10 per cent were the products sold to so-called people of standing (squires, landed gentry, county councillors, etc.) with estates or large holdings. Thus the marketing was directed to a considerable extent towards the peasant farms of Scania.[23]

(*a*) Summary

Does the development of Lilla Harrie redskapsverkstad in its initial stage fit into Schumpeter's entrepreneur framework? Was the company's founder, Nils Holmqvist, an innovator in the market for agricultural implements and machinery with consequences for economic development? Nils Holmqvist was certainly no revolutionary innovator. But he contributed to the introduction of a new product (the cultivator on wheels) onto the Swedish market. The Scanian market, the orders from which provided work for his company, was the richest section of the Swedish market. Therefore the old village blacksmith's shop could be developed into a workshop company. Schumpeter distinguished very carefully between the four rôles of inventor, entrepreneur, administrator and capital owner. In reality in the world of manufacturing two or more of the rôles often overlap, and a combination of all four rôles is most likely to produce the best results. The rôles played by Nils Holmqvist were those of innovator and manufacturer. There are various pieces of evidence about his experiments and inventions on a smaller scale.[24] As a manufacturer he applied foreign innovations and in-

[23] *AB Lilla Harrie Redskapsverkstads minnesskrift, passim.*

The social composition of the customers does not seem to have changed in any decisive way during modern times.

During the first decades when the sales organisation was modest the workshop apparently had the ambition to follow the products via the distributor all the way through to the customer. The ambition was realised in that it was recorded on whose behalf the distributor had placed the order.

[24] *Ibid.*, p. 5. During the Torrlösa period 1875–1890 Holmqvist partly co-produced with the carpenter in the area. The two constructors arranged for contact between

troduced them onto the Swedish section of the market. Thus the product was not new, and in itself was hardly of revolutionary importance. Since according to Schumpeter the entrepreneur as creator of fresh markets plays the key rôle in economic development, the company's limited importance can be accounted for in this way. Nils Holmqvist did not play the rôles of administrator or capital owner, even though administrative expertise was gradually introduced into the company by the younger generation. Through Holmqvist's careful financing policy the growth of the company, the development of the market and its significance for the national economy were also curbed. His company became one of many.

2. *Bröderna Anderssons Gjuteri & Mekaniska Verkstad in Skurup*

When Emil Andersson in partnership with his brother Olof founded Bröderna Anderssons Gjuteri & Mekaniska Verkstad in Skurup in 1903, he already had ten years work as joint manager behind him. As a matter of fact he had founded the firm of F. W. Haker and Company in Skurup with F. W. Haker in 1892. The teamwork continued until 1902 when it ceased because of internal friction between the managers. The production of the Haker firm consisted above all of agricultural implements and castings. In 1902 the value of the production amounted to about 35 000 Sw. kr. and at that point in time the number of employees had risen to 20. Thus Emil Andersson stopped working with Haker and chose his brother Olof Andersson as his new partner. The production at the newly founded company, Bröderna Andersson, was on the whole constituted in the same way as production at Hakers.[25]

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the forge and the joinery workshop by means of a kind of "telephone connection" consisting of a wire and two mouthpieces.

[25] Interview with J. Vifot, Managing Director of Bröderna Anderssons Gjuteri, Skurup and son of Emil Andersson. *Svensk industrikalendar 1895. Svenska industrien 1907.*

Emil Andersson and F. W. Haker had each put up half the money in Haker's

The brothers Emil and Olof Andersson were born and brought up in a farming family outside Skurup. Both were interested in technical things. Emil was trained at Malmö technical school and Olof became a chemical engineer. In the light of their background it was natural that their technical interest and knowledge should be applied to agrarian technology. Emil went to the USA where he gained practical knowledge by working in McCormick's factories, and obtained valuable experience and inspiration for the future. Olof obtained employment at the laboratory of Jacob Lachmann's sugar refinery in Ystad. During the time when they were employed and during the Haker period the brothers were able to save a certain amount of capital with which the new firm was financed. However the financing also required a personal loan from their father. In 1904, one year after the foundation of the company, Bröderna Andersson were able to purchase the bankrupt estate of Löfberg's Smidesverkstad. This workshop had manufactured seed drilling machines in the years 1885–1904, and the purchase enabled the new company to expand more rapidly than would otherwise have been the case.[26]

The initial stage of the company's development was characterised by the variety of products and the local marketing of them. Thus in 1904 the tools and machines, about 70 in number, were sold only in the district round Skurup. Skurup is situated on the railway line between Malmö and Ystad which was completed in 1874. Thus

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firm. When the partners separated in 1902 it was mainly due to a difference of opinion about the organisation of the distribution of work. So at the auction which they held among themselves in 1902 Haker bought Emil Andersson out of the firm of F. W. Haker and Co.

[26] Interview with J. Vifot.

Emil Andersson was born in 1866, and at the age of twenty he emigrated to the USA, where for four years he was mainly employed in McCormick's factories in Chicago. He worked as a fitter in the harvesting machine workshops. On his return to Sweden around 1890 he got a job at C. Holmbergs mekaniska verkstad in Lund, where the production consisted mainly of steam engines and dairy implements. Emil Andersson had become friendly with C. O. Holmberg in Lund during their studies at the technical college in Malmö. His brother Olof was three years younger, and received his training as an engineer in Greifswald in Germany. In the partnership between the brothers from 1902 onwards Emil was responsible for the construction and production side and Olof for the business side.

Table 12. *Number of implements and machines produced at the Bröderna Andersson's works in 1904, 1914 and 1920*

Implement and machines	1904	1914	1920
Rollers	24	951	981
Horse hoes	8	703	1 114
Potato diggers		300	
Salt spreaders		113	59
Cultivators	8	57	239
Straw presses		45	
Chaff cutters	5	20	113
Harvesters	23		

Source Lund's Landsarkiv; Bröderna Andersson's Gjuteri & Mekaniska verkstad's records: Memorandum book, Production journals.

any marketing problem of transport was solved from the start. The value of production in 1904 amounted to 25 000 Sw. kr. but in 1910 it had increased sixfold. Over the same period the labour force doubled from 22 in 1904 to 45 in 1910. At the latter point in time the production values of the various lines of production were made up in Sw. kr. as follows:

	Sw. kr.
Castings	50 000
Rollers, harrows	40 000
Sowing and harvesting machines	49 000
Other machinery	11 000
Total	150 000

Thus the agricultural implements and machines accounted for two-thirds of the total production value. Gradually the production was concentrated on rollers and horse hoes. During the First World War the demand from abroad for implements and machinery increased, and in the case of Bröderna Andersson this resulted in exports to the other Nordic countries and to Germany and Russia. However, with the end of the war the exports ceased. The production value in 1916 was ten times as great as that in 1904 (calculated on the basis of the prices in 1914), while the number of people employed trebled over the same period. The expansion during the first two decades of the twentieth century is shown in tables 12 and 13 and

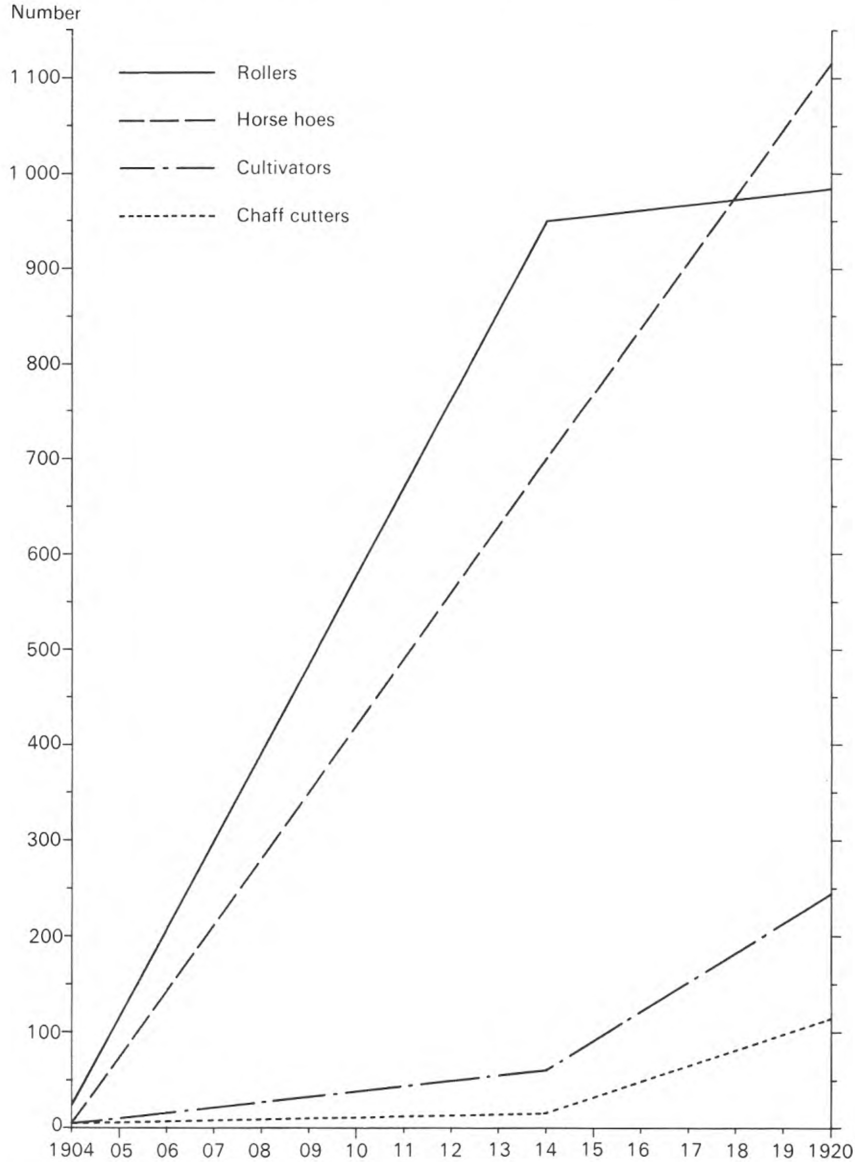
Table 13. *Implements delivered by Bröderna Andersson's engineering works, Skurup, in the years 1914 and 1920*

	Horse hoes		Rollers	
Län/Country	1914	1920	1914	1920
A	–	49	17	13
B	2	20	3	14
C	1	10	5	3
D	4	21	9	24
E	76	112	22	60
F	1	16	3	36
G	–	19	4	37
H	14	41	34	54
I	1	20	2	24
K	2	30	35	28
L	130	116	253	96
M	434	373	299	135
N	32	46	57	43
O	1	70	4	123
P	2	29	33	49
R	1	25	10	24
S	–	16	16	38
T	1	15	30	14
U	–	10	6	8
W	1	20	29	21
X	–	15	27	7
Y	–	25	12	21
Z	–	10	23	12
AC	–	6	2	4
BD	–	2	–	1
Norway	–	45	–	85
Denmark	–	–	4	–
Total	703	1 161	939	974

Source Lund's Landsarkiv, Bröderna Anderssons Gjuteri & Mekaniska verkstad's records: Sales accounts.

in diagram 2. The local character, which had been very strong at the start, diminished as production increased. The following chart shows the percentage distribution of the various markets of the company.

Diagram 2. *Number of tools and machines manufactured at Bröderna Andersson's works, Skurup, in the years 1904, 1914 and 1920.*



Source See table 12.

	Horse hoes			Rollers		
Year	Scania	The rest of Sweden	Total	Scania	The rest of Sweden	Total
1904	100	0	100	100	0	100
1914	76	24	100	55	45	100
1920	43	57	100	25	75	100

From a comparative point of view the company's market in Scania in 1920 was still larger than the others, but compared with Lilla Harrie, Bröderna Andersson had a less restricted market area for its agricultural implements.[27]

If Bröderna Andersson is compared with Skurups Mekaniska Verkstad, as Haker's firm was called after the split in 1902, the fact is that Bröderna Andersson expanded much more rapidly after 1903 than Skurups Mekaniska Verkstad. In 1905 the two companies were approximately on the same level as regards both production value and the number of men employed. Three years later the production value at Bröderna Andersson's works was three times higher than that at Skurups Mekaniska Verkstad, which was still at the level of 1905. The gap widened further and in 1916 Bröderna Andersson's production had quadrupled in comparison with Skurups Mekaniska Verkstad, and the former company employed twice as many workers as the latter. Apparently Emil Andersson was able through his break with Haker to give free rein to the forces of expansion at the beginning of the twentieth century. The local competition in which both manufacturers then engaged was to a large extent to Haker's disadvantage.[28]

In 1910 Bröderna Andersson's and Lilla Harrie's workshops had reached approximately the same level of capacity. As Lilla Harrie was founded in 1890 and Bröderna Andersson not until 1903 this meant that the rate of growth during the initial stage was much more rapid at Bröderna Andersson. A factor contributing to this

[27] Riksarkivet, kommerskollegii arkiv. Primary information for the industrial statistics. Lund's Landsarkiv, Bröderna Anderssons Gjuteri & Mekaniska Verkstad's arkiv. Memorial, production journals, sales ledgers.

[28] *Svenska Industrien 1907, 1911–1912* and *1918–1919*.

was that Lilla Harrie only obtained railway connections with the world in about 1906. In addition Bröderna Andersson had from the start the opportunity to purchase premises which were already functioning as a workshop. Furthermore the initial stage coincided with a decade when the demand for agricultural implements and machinery was exceptionally great. However during the 1910s the two companies grew at about the same rate. Specialisation was in operation for a longer time at Lilla Harrie than at Bröderna Andersson in Skurup. In 1910 Lilla Harrie had about 7 per cent of the Swedish market in implements through its concentration on harrows, while Bröderna Andersson only had 3 per cent of the same market at that time. In addition the Skurup company then had 1 per cent of the sowing and harvesting machine market. During the 1910s production was concentrated to a high degree on rollers and horse hoes.[29]

Bröderna Andersson's company became a limited company in 1918. The share capital amounted to 300000 Sw. kr. and all the shares remained in the Andersson family. The two brothers Emil and Olof Andersson were appointed managing directors of the company. From the older annual reports, which have only been preserved for the years 1918–1920, it appears that 65 per cent of the company's balance-sheet total of 550000 Sw. kr. came from its own capital and 20 per cent from short-term debts (credits from suppliers). Large parts of the assets were tied up in properties (16 per cent), machinery and tools (10 per cent) and stocks (65 per cent), while ready money only constituted 9 per cent. During these three years only small changes took place in the debit/credit balance. However the annual profit fluctuated considerably, reaching 15 per cent of the share capital in 1918, 5 per cent in 1919 and 7 per cent in 1920.[30]

The expansion brought about by the First World War was terminated by the very fact that the war came to an end. The peacetime depression which followed accounts for the stagnation in the

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[29] Riksarkivet, kommerskollegii arkiv. Primary information for the industrial statistics.

[30] Annual reports of AB Bröderna Anderssons Gjuteri, Skurup for the years 1918–1920. Interview with J. Vifot.

company's development which began to occur in the years following 1920. The decline lasted for the years 1920–1923 and thereafter business expanded again. The brothers Emil and Olof Andersson led the development of the company until Olof's death in 1947. Three years later Emil died, and a short time after that his son J. Vifot took over the management of the company. During the period of expansion production was to a comparatively great extent concerned with rollers and horse hoes. During the post-war period production had been orientated more towards stationary as well as mobile straw pressers.[31]

The selling side of the business has been studied through the sales records of the company which have been preserved from the year 1914 onwards. According to these, the agricultural implements and machinery were still mainly sold direct to the farmers or shopkeepers in 1914. From the time of the First World War Bröderna Andersson entered to a greater extent into contracts with wholesalers of implements and machines for the selling. The larger distributors were J. Slöör and A. Fischer in Stockholm, A. Paulsson's Maskinaffär and A. Hollingworth's branch in Eslöv, G. V. Rundström in Norrköping, Andersson & Mattson in Malmö and Nordiska Maskinkompaniet in Gothenburg. It is in fact possible, at least in the older sales records which have been preserved, to trace the orders back to the customers via the distributors. In essence the social composition of the customers seems to resemble that of Lilla Harrie. Thus the implements and machines were almost entirely distributed to peasant farms and only to a smaller extent to the estates.[32]

In the same way as at Lilla Harrie growth at Bröderna Andersson took place at the rate which self-financing permitted. Thus the ploughed-back profits took care of new investments. The problems of stockkeeping probably helped to restrict growth. The stocks held accounted for a large part of the total value of the assets of the smaller implement workshops.

In the case of Bröderna Andersson, at the end of the 1910s the

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[31] *Ibid.* Between 1909 and 1952 about 25 000 horse hoes were sold.

[32] Several of the trading firms mentioned here have appeared in the sales organisations of the other implement and machine manufacturers.

value of the stock constituted two-thirds of the total assets. The corresponding proportion at the works was barely one-sixth.

(*a*) Summary

The driving force at Bröderna Andersson appears to have been Emil Andersson. He was no revolutionary innovator in the implement market, but as a farmer's son he was well acquainted with the market which became the base for his activities. Through his employment in the USA with the world's leading producer of agricultural implements he acquired experience of advanced production technique and marketing. The comparatively rich field of experience probably in time threw Emil Andersson out of step with the more cautious and less travelled Haker. In spite of the fact that the complete break with Haker brought about a rapid expansion for Emil Andersson's and his brother's company, the growth took place within the framework of the smaller type of workshop. However the company started at what was an extremely favourable point in time as regards the great demand, but the main production during the first decades (rollers and horse hoes) did not bring about any new agrarian techniques or even any further development of existing ones. Also with the cautious financing which was in operation the target for the development of the company was probably a limited one. In this respect there are fundamental similarities between Bröderna Andersson and Lilla Harrie. Because of these they remained small company units. Looked at from a national perspective the many small workshops which supplied agriculture with implements and machinery had slight importance individually. Nor did the products which these workshops manufactured and marketed play an epoch-making rôle in the agricultural economy. However the many small and anonymous workshop companies together represented important values in the interaction between industry and agriculture. Due to their roots in local markets the small workshops were better able than the larger ones to know intuitively and meet local agrarian needs. They were not in the forefront, but in the national economy they performed the important function of spreading mechanisation down to the smaller farms. Conversely the market expansion also meant that peasant farming was partially and gradually orientated towards the production of agricultural wares to be offered for sale. Thus the increase in orders from peasant farms for implements and machines which resulted from this became an important factor in the development of smaller workshop industry.

C. Medium-sized companies with national markets

The setting-up of smaller workshops was a comparatively late occurrence in Swedish industrialisation. Several small workshops were founded after 1890, and most of them were still quite small companies in 1914. As a rule the larger companies in existence before the First World War had been started before 1890, and therefore had had time to expand. Of the larger and medium-sized workshops, which during the First World War had supplied agriculture's need for implements and machinery, none had been founded after 1890. The following medium-sized workshops making agricultural implements and machinery, and having between 100 and 500 employees, were in operation at the start of the twentieth century: *Överums Bruk* for ploughs (founded in 1654, the manufacture of ploughs started in 1851), *Munktells mekaniska verkstad, Eskilstuna,* for steam threshing-machines and traction-engines (founded in 1832, the production of traction-engines started in 1853), *Ystads gjuteri och mekaniska verkstad* for various implements and machines (1853), *Köping's mekaniska verkstad* for threshing-machines (1856), *Thermaenius mekaniska verkstad i Hallsberg* for threshing-machines and cleaning machines (1868), *Westerås mekaniska verkstad* for harvesters and sowing machines (1874) with the works transferred to Morgongåva in 1898, *Norrahammars gjuteri & mekaniska verkstad* for implements (1877) and *Arvika mekaniska verkstad* for mowing machines and harvesters (1889).[33] Överums Bruk and Munktells mekaniska verkstad have been chosen as representatives of the medium-sized companies. Above all the choice has been governed by the facts that Överum's manufacture of ploughs is the oldest on an industrial scale in Sweden and that Munktells produced the really advanced and expensive farming machines such as steam threshing-machines and traction engines. Furthermore, the sources for these two workshops are the best preserved.

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[33] *Svenska industrien 1907.*

1. *Överums Bruk*

Immigrant Walloons founded Överums järnbruk in 1654 and thereby continued the initiative which the Walloons De Geer and de Besche had taken during the early parts of the seventeenth century, and which in Sweden had been directed mainly towards the production of cannon. When Henrik de Trij, the founder of Överums Bruk, moved to Sweden in the 1630s he was first employed by De Geer as foreman at the factory in Norrköping. In 1640 he married the daughter of Hubert de Besche, which seems to indicate that he held a high social position among the immigrant Walloons. In 1654 with two partners (the de Besche brothers-in-law) de Trij built a blast furnace in Överum and in the following year received letters patent from the Bergskollegium. The foundry had to regulate its production of iron so that the consumption of charcoal did not exhaust the forests. Cannon casting remained the foundry's main work for more than 150 years in spite of changes in ownership and management.[34] When Johan Carl Adelswärd bought Överums Bruk in 1816 the orders for cannon had already decreased to such an extent that cannon casting only constituted a minor part of a production which had become very greatly diversified. During Adelswärd's ownership up to 1852 the programme of diversified production continued.[35]

In 1847 Baron Adelswärd employed Johan Bergwik as works manager. On Bergwik's initiative the toolmaker Carl Petter Spångberg was offered employment as works foreman at Överum in 1850, which he accepted. It was the aim of the management of the foundry that Spångberg would set up and manage a department for agricultural implements. When Spångberg received the offer from Överums Bruk he was a toolmaker at Ultuna agricultural institute, which was opened in 1848. In 1850 he also received an offer from Ultuna to become works foreman of the institute, but Spångberg wanted a larger field of operations for tool production than he could get at Ultuna.[36]

[34] Jansson, E. A., *Överums Bruk Tre hundra år 1654–1954,* pp. 9ff.

[35] *Ibid.,* p. 141. In addition to the hammered iron the works was mainly occupied during the first half of the nineteenth century in producing household goods: pots, kettles, pans, ovens, mortars, dampers and other similar articles.

[36] Ibid., pp. 142ff. When Spångberg came to Överum in 1850 he was 28 years old. He was born in Södermanland and was the son of Erik Spångberg, a groom;

Spångberg's arrival at Överum marked the revival of the foundry. In 1851 the production of ploughs began, and in spite of changing economic trends this constituted the essential part of the company ever since. In the first year 94 ploughs were manufactured, of which 20 were sold during the same year, mainly to persons of social standing in the läns of Östergötland and Kalmar. The engineering works grew in relation to the foundry because of the fact that the foundry went over from cannon to ploughs. Cannon casting gradually ceased during the first half of the nineteenth century and the diversity of production which had begun at that time also continued when the production of ploughs predominated. As a result of Spångberg's contributions the workshop expanded during the 1850s and new jobs were created. The number of employees in 1862 was 184 of which 78 were in Spångberg's workshop. The workshop production also meant that the company was able to process its earlier products—steel rods, castings and timber—to a greater degree. Thereby the profits from the processing could remain within the foundry which had a well integrated process of production. To a large extent the ore was taken from the company's own mines in Östergötland. At the foundry iron rods, pig-iron and castings were produced, while the foundry's forest and saw-mill took care of the fuel and timber supply. The iron and timber were processed mainly into ploughs, the majority of which were sold, though some were used in farming by the company itself.[37]

Within a period of ten years there was an agricultural implement industry at Överums Bruk. In 1862 the annual production of ploughs had risen to 2 669. In addition the year's production also included 1 819 plough parts, 1 345 ploughshares and 590 other implements and machines as well. Spångberg's work of development was behind this expansion during the 1850s. The first ploughs were virtually plagiarised copies of English and American models, while

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he was educated in agrarian technology at Väderbrunns agricultural college (near Nyköping) during the years 1845–1848. The college was run by the famous agronomist J. T. Nathorst and his son Hjalmar. In 1848 Spångberg came to Ultuna, and he worked at Överums Bruk for 37 years. He died in 1892.

[37] *Ibid.*, pp. 146 ff. Överums Bruks arkiv: Capitalbok for the year 1851. Avräkningsbok för bruksarbetare for the year 1862. Reqvisitionsbok for the year 1851.

plough no. 9 (the first specimen dating from 1854) was made in Sweden by Spångberg but was certainly an American model. Plough no. 9 became the prototype for the Swedish ploughs, which were marketed by Överum and achieved international recognition. Överums Bruk was the only Swedish exhibitor of agricultural implements to be awarded first prize at the world exhibitions in 1862 (London), 1863 (Hamburg) and 1867 (Paris).[38] During the latter part of the 1850s the sales department was reinforced by virtue of the fact that distributors in the larger towns were engaged in the selling of the company's implements. At this time printed and illustrated price-lists of various implements and machines began to be distributed to advertise the company's products widely. A price-list from 1861 shows the diversity of production:

	Riksdaler
Allen's harvesting machine	600
Barret's threshing-machine	600
Wood's harvesting machine	400
Ransome's tedder	250
Corne's chaff cutter	200
Glover's skim plough with Överum's improvements	75
"Överum's new chaff cutter"	50
Clover sowing machine	40
Plough no. 1 based on an English model	33
Plough no. 7 with wooden frame and iron ploughshare	16[39]

The selling side of the business can best be studied in the case of Överum through the 'order books' of the foundry, which have been preserved throughout in the records of the company. The order books contain information about the nature of the order, the quantities and date and the customer's name and address as well. In the course of the mechanisation of Swedish economic life

[38] Plough no. 9 was foremost among Överum's ploughs. Of the 25 659 ploughs, of about 30 models, which were produced in 1861–1870, 36% were of the no. 9 type.

[39] Price-list from 1861. Reqvisitionsböcker from Överums Bruks arkiv. The sales of seed drilling machines first became of economic importance after 1890. The prices of seed drilling machines around the turn of the nineteenth century varied according to the number of shares on the machines. The most common types of machine had 12 or 16 shares and fetched prices of 165 Sw. kr. and 195 Sw. kr., respectively.

wholesale firms were established, which dealt in tools and machinery among other lines. Trading companies of this kind are to be found in Överum's order books, which show that sales were made through distributors to an increasing extent. Examples of larger trading companies which sold Överum's products were J. Slöör, A. Fischer and J. Danielsson in Stockholm, G. Bolander in Gothenburg, G. V. Rundström in Norrköping, O. Harling and M. Hyden in Linköping and M. Alfort and A. Hollingworth in Örebro. In some cases the distributor sold the tools and machines direct over the counter, and therefore in these cases there is no means of knowing where the tools and machines went. Probably they were sold to farmers who lived fairly near the outlet. Where a customer placed an order with a distributor it is possible to follow the orders in the order books as far as the customer. Apart from the larger distributors, around the year 1900 Överums bruk still sold about 50 per cent of its implements and machines direct to farmers and smaller ironmongers and village shopkeepers. The large number of implements and also the difficulty in ascertaining their final destination has made it impossible to group the company's customers socially. On the other hand it has been possible to trace in a satisfactory way the geographical development of the foundry's market for agricultural implements and machinery. In this connection it should be mentioned that each order was ticked off when it was delivered. Notes relating to cancelled orders, special conditions of delivery, date of delivery and means of delivery were consistently entered in the order books.[40]

The volume and distribution in time and place of the sales of tools and machines are shown in tables 14–20 and diagrams 3 and 4. Apart from the products dealt with in the tables, others connected with agrarian technology consisted of a smaller number of threshing machines and harvesting and other machines, but the large volume of the various implement and machine parts which were produced were of greater importance economically. During the greater part of the period 1851–1913 ploughs were predominant, but after 1895 they

[40] The sales abroad were concentrated on Russia to a high degree, especially during the years immediately before and after 1880, and were organised mainly by the Rabotnik agencies in St. Petersburg and Moscow and also by Siebert, Wieprecht and Grahmann in Riga.

were counterbalanced to a great extent in terms of value by the sowing machines. In 1870 the manufacture of ploughs constituted 65 per cent of the foundry's total production value, corresponding at that time to 395 000 riksdaler (rd).[41]

In terms of Swedish crowns, production in 1896 and 1910 was divided along the following lines:

Value of production in thousands of Swedish crowns

	1896	%	1910	%
Castings	75	15	90	21
Ploughs etc.	204	41	80	18
Sowing and harvesting machines	162	33	120	28
Other farming machinery	27	6	31	7
Other products (mainly machine products)	24	5	114	26
Total	492	100	435	100

Source Riksarkivet, Kommerskollegii arkiv. Primary information for the industrial statistics.

There was concentration on ploughs from the start of the 1850s up to the 1890s when plough manufacturing's proportionate share of the production of the foundry started to decrease. The figures 65 per cent (1870), 41 per cent (1896) and 18 per cent (1910) speak for themselves. At the last two points in time sowing machines accounted for about one-third of the production, calculated in Swedish crowns. Between 1896 and 1910 an absolute decline in production took place, due entirely to a sharp comparative decline for agricultural implements and machines. In 1896 manufacturing connected with agriculture accounted for 80 per cent of the company's total activity, but in 1910 it only accounted for half.

Överum was one of the larger manufacturers of agricultural implements in Sweden, and as far as ploughs were concerned in about 1860 the foundry was probably the leader on the Swedish market, a position which it maintained and consolidated for a couple of decades thereafter. During the 1860s Överum developed into a comparatively modern tool industry recognised interna-

[41] Jansson, E. A., *Överums Bruk*, pp. 190f.

tionally, which had a good influence on its marketing. But competition came. In the Swedish general industry calendar of 1865, 32 iron foundries and engineering works are reviewed as manufacturers of agricultural implements. Norrahammar's Gjuteri & Mekaniska verkstad (9 kilometres from Jönköping) was founded in 1870. A large part of Norrahammar's production consisted of agricultural implements, especially ploughs, harrows and rollers. The management at Överum in the administration report for 1883 emphasises that the cause of the recent decline in sales is the steadily growing competition within Sweden. Particular mention is made of Norrahammar's policy of low prices through big discounts. The difference in price for comparable models of plough was said to amount to 15 per cent, which helped to account for the fact that Norrahammar diverted important markets from Överum, especially in the south-west of Sweden.[42]

During the latter part of the 1880s Överum was faced with sales difficulties partly because of the economic decline in farming, and partly because of the increasing competition from Norrahammar and other workshops. During the 1870s and several decades to follow Överums bruk came under the influence of English interests, which may also have contributed to the company's difficulties in asserting itself on the Swedish market. When the economic situation improved again during the 1890s Norrahammar was better able to respond to the increased demand for ploughs. A year or so after the turn of the century three times as many ploughs and thirty times as many harrows were produced at Norrahammar as at Överum. Around 1914 the manufacturing of implements (ploughs,

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[42] Unconcealed indignation appears in Överum's administration report for 1883. "The result (of Norrahammar's discount policy) has already been seen in that Norrahammar has almost pushed Överum out of some areas such as Scania, Halland, Bohuslän and Västergötland, where it is now hardly possible to sell an Överum plough except to those who look at the quality of the product rather than the price."

In this connection a contributory factor was probably the engineer C. F. Hernberg, who after ten years or so at Överum's plough works moved to Norrahammar in 1882 to take up the post of chief engineer for plough production. In Norrahammar Hernberg retained the leading position in the company for more than three decades. He had probably taken with him some of Överum's production and sales techniques.

harrows and rollers) was five times as great in terms of quantity at Norrahammar as at Överum.[43] Information about the company's share of the Swedish market is also illuminating as regards the development at Överums bruk. In 1896 the market had been shaky for Överum for some time. Nevertheless the company had 35 per cent of the Swedish tool market at that time. In 1910 the corresponding share of the market was down to 5 per cent. The development shows two things: Överum's relative stagnation and the arrival of a series of tool manufacturers of whom Norrahammar became the most important. In the 1890s Överum tried to break into the market for sowing machines, and in 1896 the company controlled 13 per cent of the Swedish market. In spite of the fact that Överum produced a greater number of sowing machines and more advanced ones at the beginning of the twentieth century, its share of the market fell to 2 per cent in 1910.[44] A number of workshop companies geared to the manufacture of farming machinery had been set up around 1890, and their production expanded sharply during the first decade of the twentieth century (see table 4A).

At the middle of the nineteenth century Överum like other neighbouring foundries was a company with a local or regional market. In his thesis "Relationer mellan bruk och omland i östra Småland 1750–1900" O. Nordström deals inter alia with the market areas of the foundries around 1860. The foundries with which Nordström deals are situated in the län of Kronoberg and at that time they operated in a local/regional area, apart from their exports which went via Kalmar.[45] The main part of the production around 1860 was the manufacturing of rod-iron. The volume of production at Överum at that time was somewhat greater than at the foundries examined by Nordström, but the marketing conditions appear to

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[43] *Svenska industrien 1907, 1911–1912* and *1918–1919.*

[44] Riksarkivet, Kommerskollegii arkiv. Primary information for the industrial statistics. *Bi SOS Fabriker och handtverk.*

[45] Nordström, D., *Relationer mellan bruk och omland i östra Småland 1750–1900,* pp. 200 ff.

The works examined by Nordström are Klafreström, Orrefors and Sävsjöström iron foundries. Around 1860 their domestic market area was confined to south-eastern Småland, Blekinge and northern Scania.

Table 14. *Number of implement and machine units sold from Överums Bruk in 1851*

Län/Country	Ploughs	Harrows	Sowing machines
A	1	–	–
B	–	–	–
C	–	–	–
D	–	–	–
E	12	2	–
F	–	–	–
G	–	–	–
H	6	–	–
I	1	–	2
K	–	–	–
L	–	–	–
M	–	–	–
N	–	–	–
O	–	–	–
P	–	–	–
R	–	–	–
S	–	–	–
T	–	–	–
U	–	–	–
W	–	–	–
X	–	–	–
Y	–	–	–
Z	–	–	–
AC	–	–	–
BD	–	–	–
Total	20	2	2

Source The records of Överums Bruk: Order books.

have been similar. When in about 1850 Överum greatly expanded the workshop sector through tool manufacturing, there was a simultaneous expansion in the market area. The market for the most important product, the ploughs, became a national one.

The diffusion of the Överum ploughs within Sweden between 1864 and 1913 has been illustrated in table 23. When Överum entered the tool market the sales of ploughs were concentrated in Sweden during the first twenty years. At the beginning the Scaniar farmers were the company's biggest customers, followed imme-

Table 15. *Number of implement and machine units sold from Överums Bruk in 1864*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	249	5	19	–	–	15	–	7
B	30	–	12	–	–	–	–	–
C	–	–	–	–	–	–	–	–
D	78	21	34	1	–	1	–	13
E	279	250	23	1	3	4	–	11
F	8	–	4	–	1	–	–	6
G	24	–	–	–	–	–	–	–
H	315	1	54	1	–	6	–	8
I	10	5	1	–	–	–	–	–
K	53	–	7	–	–	3	–	4
L	277	1	36	–	2	6	1	13
M	337	–	56	3	2	14	–	32
N	106	–	21	1	–	4	–	5
O	30	–	–	–	–	–	–	–
P	10	–	7	–	–	–	–	5
R	192	3	66	1	6	8	1	7
S	59	–	21	–	–	–	1	6
T	215	28	21	1	–	3	–	4
U	68	–	29	2	1	1	–	13
W	7	16	1	–	–	2	–	1
X	11	–	–	–	–	–	–	8
Y	–	–	–	–	–	–	–	–
Z	–	–	–	–	–	–	–	–
AC	–	–	–	–	–	–	–	–
BD	–	–	–	–	–	–	–	–
Norway	610	–	88	–	5	19	2	28
France	8	–	12	–	1	6	1	4
Total	2 976	330	512	11	21	92	6	175

Source The records of Överums Bruk: Order books.

diately by the farmers on the plains of east Götaland and round Lake Mälaren. Sparsely cultivated areas such as inner Småland and the north of Sweden, played a subordinate part in Överum's sales of implements. In fact during the first year of sales 1851 the market area had a distinctly local character, but when the plough sales increased during the 1860s the domestic market expanded, and thereby attained a truly national character. The sales within

Table 16. *Number of implement and machine units sold from Överums Bruk in 1868*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	298	11	50	4	3	16	–	37
B	16	–	4	–	–	–	2	–
C	123	17	–	–	–	–	–	–
D	27	33	–	–	–	–	–	–
E	500	121	15	2	–	6	–	6
F	–	–	–	–	–	–	–	–
G	3	–	–	–	–	1	–	–
H	79	–	8	–	1	2	–	7
I	21	5	–	–	–	–	–	2
K	21	–	3	–	–	–	–	–
L	71	140	5	–	–	3	–	9
M	127	25	19	1	–	–	–	23
N	–	–	–	–	–	–	1	–
O	13	8	2	–	–	11	–	–
P	33	–	1	–	–	–	1	4
R	4	12	–	–	–	4	–	–
S	82	–	6	–	–	–	–	2
T	100	6	10	2	–	–	–	–
U	163	12	3	1	–	–	–	3
W	8	–	1	–	–	1	–	–
X	11	–	–	–	–	–	–	1
Y	18	–	–	–	–	–	–	–
Z	–	–	–	–	–	–	–	–
AC	–	–	–	–	–	–	–	–
BD	–	–	–	–	–	–	–	–
Norway	–	–	–	–	–	–	1	–
Finland	1	–	–	–	–	1	–	–
Russia	200	–	2	–	–	5	–	–
Total	1 919	390	129	10	5	49	5	94

Source The records of Överums Bruk: Order books.

Överum's own region (the coastal plain of Småland, Östergötland, Öland and Gotland) were not disproportionately large. Apparently factors other than geographical distance had a decisive effect on the company's marketing. The difference in this respect between Lilla Harrie and Överum, for example, is very striking.

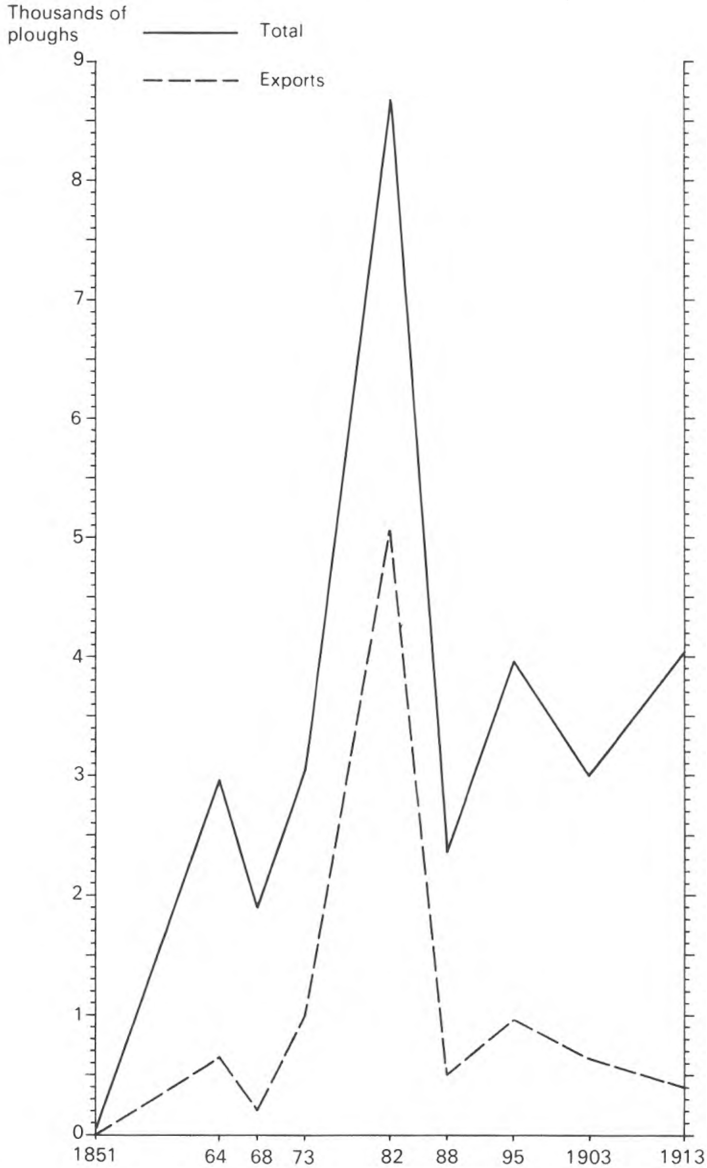
Table 17. *The number of implement and machine units sold from Överums Bruk in 1873*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	854	26	36	3	11	26	1	58
B	–	–	–	–	–	–	–	–
C	89	5	–	–	–	1	–	–
D	119	1	–	–	–	–	–	2
E	427	90	–	2	5	4	–	9
F	28	30	–	–	–	–	–	–
G	–	–	–	–	–	–	–	–
H	324	48	6	1	–	2	–	2
I	11	–	–	–	–	1	–	4
K	32	6	–	–	–	1	–	–
L	150	–	20	10	–	–	–	6
M	54	–	4	–	2	–	–	3
N	–	–	–	–	–	–	1	–
O	200	10	36	–	–	36	–	26
P	–	–	–	–	–	–	–	–
R	105	23	–	–	–	2	–	4
S	128	1	9	–	8	10	–	14
T	168	24	6	–	–	4	–	1
U	264	1	–	–	1	5	–	–
W	–	–	–	–	–	–	–	–
X	36	–	–	–	–	1	–	–
Y	114	–	–	–	–	–	–	–
Z	–	–	–	–	–	–	–	–
AC	–	–	–	–	–	–	–	–
BD	–	–	–	–	–	–	–	–
Norway	6	1	–	–	–	–	–	–
Finland	1	–	–	–	–	–	–	–
Russia	954	2 550	79	–	6	61	1	12
Austria	1	–	–	–	–	–	–	–
Hungary	–	–	–	–	–	1	–	–
Germany	–	–	1	–	–	2	–	2
Total	4 065	2 816	197	16	33	157	3	143

Source The records of Överums Bruk: Order books.

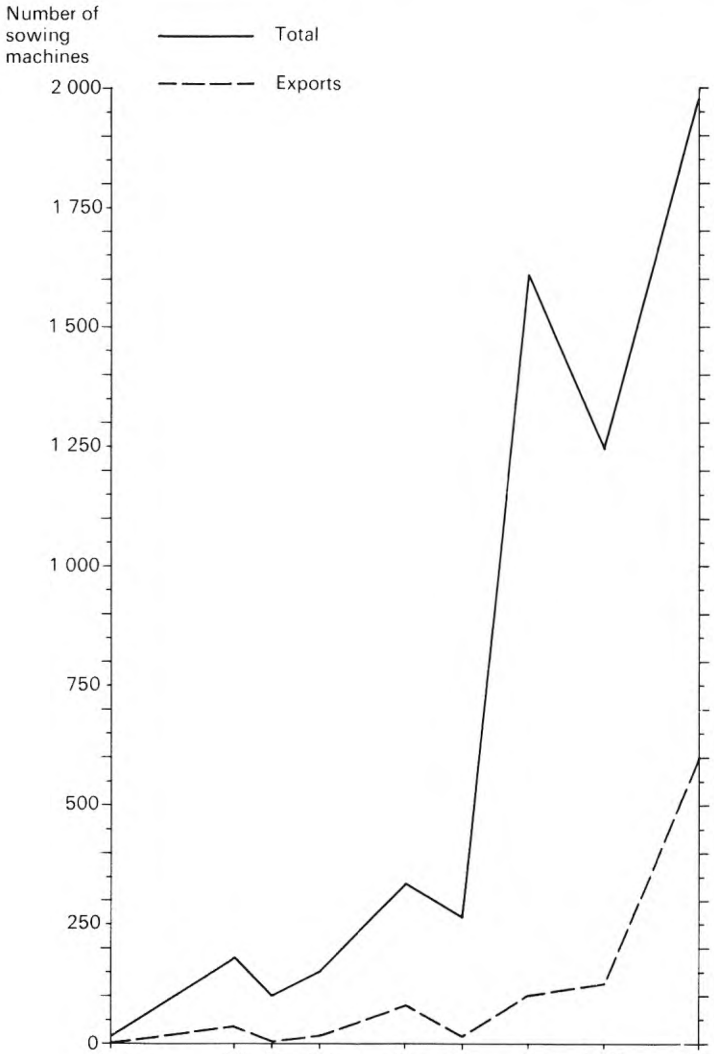
The farmers' purchases of agricultural implements and machines depended on the economy. Diagram 3 underlines this situation. The agricultural economy was hard hit by the difficult famine years of 1868–1869, and as a result the demand for implements

Diagram 3. *Number of ploughs sold by Överums Bruk 1851–1913.*



Source The records of Överums Bruk: Order books.

Diagram 4. *Number of sowing machines sold by Överums Bruk in 1851–1913.*



Source The records of Överums Bruk: Order books.

Table 18. *Number of implement and machine units sold from Överums Bruk in 1882*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	2 335	530	125	17	283	218	11	128
B	–	–	–	–	–	–	–	–
C	–	–	–	–	–	–	–	–
D	20	26	–	2	–	–	5	3
E	481	441	10	6	37	17	9	17
F	15	76	4	–	4	2	1	1
G	35	121	4	–	3	3	–	11
H	180	152	10	1	8	3	6	4
I	–	–	–	–	–	–	–	–
K	33	41	3	–	2	2	–	1
L	64	162	11	1	2	3	–	3
M	39	69	12	–	1	9	–	7
N	2	18	–	–	10	–	1	–
O	249	64	41	6	–	3	2	26
P	1	–	4	–	3	1	1	–
R	39	24	15	–	10	5	2	5
S	29	15	3	–	4	1	–	5
T	30	4	4	–	3	1	1	2
U	–	–	–	–	–	2	–	–
W	6	–	–	–	1	1	–	–
X	1	–	–	–	–	–	–	–
Y	1	–	–	–	–	–	–	–
Z	3	–	–	–	–	–	–	2
AC	–	–	–	–	–	–	–	–
BD	–	–	–	–	–	–	–	–
Finland	259	8	57	–	10	54	–	17
Denmark	2	–	2	–	–	–	–	–
Russia	4 515	1 000	67	3	–	98	5	54
Turkey	4	–	1	–	–	–	–	–
France	2	–	–	–	–	–	–	1
Spain	14	–	3	–	1	–	–	–
India	265	–	–	–	–	–	–	–
Total	8 624	2 751	376	36	382	423	44	287

Source The records of Överums Bruk: Order books.

Table 19. *Number of implement and machine units sold from Överums Bruk in 1888*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	1 182	618	50	15	381	249	1	177
B	–	–	–	–	–	–	–	–
C	–	–	–	–	–	–	–	–
D	16	3	–	–	–	–	–	–
E	143	389	8	–	32	6	–	34
F	28	42	2	–	3	1	–	11
G	12	44	2	–	2	–	–	2
H	182	129	3	1	14	13	4	2
I	18	7	–	–	–	22	–	3
K	5	22	1	–	3	1	–	–
L	10	90	–	–	9	1	–	4
M	23	59	–	1	–	–	–	4
N	–	–	5	–	–	–	–	8
O	85	45	4	1	2	–	–	7
P	24	15	3	–	1	–	–	4
R	18	10	2	–	2	–	–	–
S	1	2	–	–	–	–	–	–
T	60	52	–	–	–	2	–	1
U	1	–	–	–	–	1	–	–
W	1	–	2	–	–	2	–	–
X	–	1	–	–	–	–	–	–
Y	16	–	–	–	–	–	–	–
Z	–	–	–	–	–	–	–	–
AC	8	–	–	–	–	–	–	–
BD	2	–	–	–	–	25	–	–
Norway	13	7	3	–	–	5	–	2
Finland	3	1	–	–	–	–	–	–
Denmark	–	–	–	–	–	1	–	–
Russia	415	–	–	–	24	56	–	–
UK	50	–	–	–	–	–	–	–
Spain	1	–	–	–	1	–	2	–
Argentina	60	–	6	–	5	–	–	1
Total	2 377	1 536	91	18	479	385	7	261

Source The records of Överums Bruk: Order books.

Table 20. *Number of implement and machine units sold from Överums Bruk in 1895*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	1 217	667	63	14	742	25	41	664
B	3	–	–	1	3	2	1	1
C	5	–	5	2	–	–	2	3
D	23	16	13	–	–	–	59	62
E	191	488	59	5	42	2	489	75
F	56	47	7	3	3	–	5	6
G	27	36	3	–	3	–	–	3
H	235	260	73	6	27	35	13	20
I	358	42	19	–	21	61	10	12
K	23	70	9	–	2	–	–	–
L	35	132	7	–	18	–	1	10
M	94	142	12	–	5	1	–	2
N	27	8	2	–	9	–	–	10
O	310	102	72	2	104	6	2	38
P	17	22	14	–	1	–	–	9
R	36	53	–	–	–	1	1	38
S	5	–	–	–	–	–	–	–
T	25	10	1	1	2	–	5	2
U	2	14	–	–	–	–	7	–
W	47	–	–	–	–	–	–	–
X	12	–	5	–	–	–	–	–
Y	151	–	2	–	–	5	–	–
Z	8	–	–	–	–	–	–	–
AC	4	1	–	–	–	–	–	–
BD	–	–	–	–	–	1	–	–
Norway	49	5	–	–	1	5	–	–
Finland	–	–	–	–	–	–	–	5
Russia	787	–	–	–	–	73	–	5
UK	3	–	–	–	–	–	–	–
Spain	2	–	–	–	–	–	4	–
India	191	–	–	–	–	–	–	–
Argentina	5	–	–	–	–	–	–	5
Total	3 948	2 115	366	34	983	217	640	970

Source The records of Överums Bruk: Order books.

Table 21. *Number of implement and machine units sold from Överums Bruk in 1903*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	578	297	19	1	–	16	1	146
B	97	19	4	1	–	1	7	7
C	72	64	17	2	28	5	2	17
D	19	39	8	5	9	1	50	16
E	143	327	2	6	95	22	199	82
F	72	61	8	–	37	2	28	23
G	128	100	3	1	12	2	2	6
H	293	279	29	11	57	55	38	51
I	56	–	2	12	24	29	28	8
K	49	27	6	2	7	5	2	7
L	64	105	2	4	20	1	3	26
M	13	7	6	4	22	5	6	11
N	15	18	–	5	9	2	6	28
O	127	34	14	3	9	1	11	15
P	72	30	–	4	12	10	15	13
R	176	77	–	3	7	18	51	31
S	42	2	8	2	11	1	19	2
T	52	60	6	2	13	11	35	30
U	44	11	1	3	6	–	8	20
W	140	8	1	–	–	8	16	8
X	43	6	–	–	1	–	4	5
Y	80	–	2	–	3	1	10	7
Z	35	7	11	–	–	2	–	5
AC	14	–	1	–	–	1	1	9
BD	20	–	–	–	–	–	–	1
Norway	296	–	5	–	–	88	5	25
Finland	3	–	2	1	–	1	–	96
Russia	315	–	–	–	–	31	–	–
Argentina	15	–	–	–	–	–	–	–
Total	3 073	1 578	157	72	382	319	547	695

Source The records of Överums Bruk: Order books.

Table 22. *Number of implement and machine units sold from Överums Bruk in 1913*

Län/ Country	Ploughs	Plough bodies	Harrows	Rollers	Horse hay-rakes	Chaff cutters	Seed drills	Sowing machines
A	292	88	–	–	18	3	1	40
B	109	19	6	1	9	2	17	19
C	198	66	–	–	–	2	14	13
D	104	15	19	13	16	6	87	19
E	622	159	60	47	69	25	138	105
F	239	156	–	3	21	4	69	15
G	203	111	2	–	–	9	4	2
H	248	259	28	23	30	22	168	24
I	16	–	18	–	4	6	18	11
K	43	26	1	–	6	2	7	4
L	92	30	5	–	10	3	21	21
M	31	2	4	–	8	2	10	4
N	33	3	–	–	1	25	37	13
O	83	10	2	–	3	8	10	12
P	117	9	9	–	30	16	36	15
R	193	72	5	–	7	24	91	19
S	102	2	–	–	2	9	30	3
T	89	20	1	–	2	10	55	10
U	78	13	7	–	–	–	28	9
W	209	3	–	–	–	13	52	4
X	127	7	1	–	–	–	30	2
Y	84	3	11	–	–	2	25	9
Z	113	3	5	–	–	2	9	17
AC	109	–	6	–	–	–	13	7
BD	81	–	19	–	–	5	8	2
Norway	86	4	–	–	–	22	393	54
Finland	67	–	–	–	–	–	65	84
Denmark	–	–	–	–	–	–	2	–
Russia	153	–	–	–	–	3	–	–
India	100	–	–	–	–	–	–	–
Total	4 021	1 080	209	87	236	225	1 438	537

Source The records of Överums Bruk: Order books.

and machines declined. Överum's stocks of implements piled up. Because of the Franco-Prussian war of 1870–1871 the economic situation improved, sales increased, and Överum's stocks were depleted. Because of the bulky nature of the products, stock-keeping became a great problem and it functioned like a concertina be-

Table 23. *Överum's distribution of ploughs divided into various regions in Sweden (percentage figures)*

Region	1864	1868	1873	1882	1888	1895	1903	1913
A+B+C+D+U The Mälar province	18	37	43	66	64	43	32	22
E+H+I Plain of Eastern Götaland	25	35	25	19	19	27	19	25
F+G Inner Småland	1	0	1	1	2	3	8	12
L+M+N Scania and Halland	30	12	7	3	2	5	3	4
W+X+Y+Z+AC+BD Dalarna and Norrland	1	2	5	0	2	8	13	21
The rest of Sweden	25	14	19	11	11	14	25	16
Swedish total	100	100	100	100	100	100	100	100

Source The records of Överums Bruk: Order books.

tween boom and slump periods. In the sales resistance of the years of famine Överum lost a large part of the Scanian market. When the economic situation improved again during the 1870s Överum were unable to regain it. Competition from Norrahammar began to tell in 1870, above all in the South-West of Sweden. The assessment in the administration report of 1883 which was mentioned above certainly was not without foundation (see note 42). Instead the Mälar province became the most important market area, but its comparative importance declined at the start of the twentieth century. To the same degree as the share of the Mälar area decreased, there was an increase in the share of the sparsely cultivated areas in inner Småland and North Sweden. The farmers in these districts started to buy Överum's ploughs at a late stage, but in 1913 they accounted for one-third of all the Swedish orders. The first year of the 1880s brought sharply expanding markets for Överum, both domestic and foreign. The economic decline which followed was a general depression in European agriculture caused by Russian and American competition, and it became noticeable even at Överum. When the economic situation improved again during the 1890s, as far as Överum was concerned it was impossible for various reasons to meet the increase in demand. The years 1895–1913 meant stagnation in the history of the foundry, in complete contrast to the general development of the workshop companies connected with agricultural technology.

In all, the domestic market meant more to Överum than the foreign one. Apart from at the start of the 1860s, the exports on the whole went eastwards. Russia was clearly the largest importing country, but Finland and India also ordered quantities of implements at times. The advent of the railway line between Norsholm and Västervik in 1879 helped to extend the trade in Överum's products. Through the railway Överum got faster and cheaper direct transport to the seaport of Västervik and with the main line in the South at Norsholm (between Norrköping and Linköping). The importance of the railway to the foundry was immediately apparent when the export of ploughs from Västervik to Russia increased sharply during the years immediately after 1879. The value of the ploughs exported to Russia rose by more than 600 per cent between 1879 and 1883. During 1882, the year under investigation, more than 50 per cent of Överum's ploughs were sold on the Russian market.

At the same time as Överums bruk was extending its engineering works, important changes took place in production technique. Production was organised into different departments, among which the workshop and casting shop were prominent. Above all the foundry's own metalware and tool forges met the demands of the engineering works in manufacturing tools. The works was divided into various subdivisions, with equipment and machinery for lathe operators, milling machine operators, filers, grinders, sheet metal workers and joiners. As far as metal production was concerned the company's labour force was comparatively constant during the latter half of the nineteenth century, and amounted to almost 200 men. In 1910 only 130 workers were recorded, which is connected with a comparative decline in production at the beginning of the twentieth century.[46]

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[46] See note 44. *Svenska Industrien 1907*.

For more than two hundred years the head of the foundry, at least nominally, was the proprietor of the foundry. After the death of Adelswärd in 1852 the foundry was carried on by his widow until 1861 when her son-in-law Count A. Stackelberg became the manager until 1871. But such worldly things as the manufacturing of ploughs did not interest the deeply religious Stackelberg. Foreman Spångberg managed the department instead. On the death of Stackelberg in 1871 the executors tried to convert Överums Bruk into a limited company. The company was thought to be in need of increased working capital, and so the formation of a limited company with a share capital of 2.2 million Swedish crowns was proposed.[47] However, the formation of the limited company did not take place, and in 1872 the foundry estate was sold to an English company. Six years later the English company transferred the foundry to another English company, a holding company (The Överum Estate Company) with important interests in English tool manufacturing. In 1882 the company was converted into a limited company (Aktiebolaget Överums Bruk) with a share capital of 1 million Swedish crowns. The newly formed limited company formally purchased the foundry estate from the English consortium, but in reality the English controlled AB Överums Bruk by virtue of the fact that the Överum Estate Company bought almost all of the capital stock. The English period in the history of Överum lasted until 1918.

A decline in production and business afflicted with losses are noticeable, especially under the manager H. Hasluck from 1894 to 1915. The finances seem to have been particularly badly managed around the turn of the nineteenth century, with a total loss on the balance sheet of over 300 000 Swedish crowns, and to

[47] Inbjudning till bildande af Öfverums Aktie Bolag (printed in Linköping in 1871). In the invitation to subscribe the company's agricultural implements were specially advertised. Rich foreign markets were also put forward as a bait: "As it is now recognised that Öfverum's agricultural implements are at least as good as the English ones, which cost considerably more, and since the costs of freight are lower in competition with manufacturers in England, Öfverum must be able to drive these away from the Russian market." There was the desire to underline the importance of the Russian market further by giving information of the fact that in 1869 England had sold 15.5 million riksdalers worth of agricultural implements to Russia.

cap it all part of the company's own shares had been entered as an asset of 200 000 Swedish crowns.[48]

Aktiebolaget Överums bruk was sold in 1918 by the English to the Svenska Tändsticks AB, which was managed by Ivar Kreuger. Kreuger's motive in buying Överum was to secure the vast forest estate. On the other hand he had no interest in the workshop production. Carl Sundberg was employed as foundry manager in 1920. He took over a company on its last legs.[49] Under Sundberg's management the business was reorganised, and the sales figures trebled during the first five years of the 1920s. An innovation was introduced onto the Swedish market in 1926 when Överum released the first tractor plough, which arrived at the right time for the breakthrough in the use of tractors. In addition, in 1929 Överum was able to regain its leading rôle on the plough market when Norrahammar's plough manufacturing was bought by Överum with financial assistance from Tändsticksbolaget. In doing this the company eliminated its fiercest competitor.

(*a*) Summary

The real innovator in Överum was the works foreman, Spångberg, who took models of ploughs with a foreign design and adapted them to suit northern conditions. Thus in actual fact Spångberg was more of a developer than an innovator. But his contributions achieved great importance and within a short time Överum's ploughs attained international recognition. In Sweden Överum quickly took over the leading position in the plough market. In spite of Spångberg's contributions his authority and sphere of

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[48] Jansson, E. A., *Överums Bruk*, pp. 187 ff.

[49] *Ibid.*, p. 242. The works manager, Sundberg, expressed the following view inter alia when he inspected the works: "The machines which were to be found in the workshop were extremely old and worn out. The forging presses which were fundamental for plough manufacturing were not to be found at all, no, there was actually one, but it was placed along a wall and had never been used, because nobody had solved the problem of how to make the necessary tools. Types of plough and other articles which were manufactured then were just as ancient and were to a great extent obsolete, all of which resulted in a decline in production to almost nothing." In a later report he writes: "During my first years at Överum it was not possible to record a turnover of 200 000 Sw. kr., which was almost equivalent to what a large village smithy could achieve at that time."

activity were limited, and he did not have the supreme power of directing how Överum's capital should be invested. The combination of a Spångberg with supreme authority and increased capital might have brought about a real breakthrough for Överum. But such a figure failed to materialise. Probably the English tool manufacturers were uneasy because after the death of the unworldly Stackelberg in 1871 Överum tried to raise further capital through subscription for shares. The English feared competition on the Russian market above all, and Överum's favourable position in relation to the economics of transport, and its ploughs which were well-known and fairly cheap and which were adapted to the conditions of Northern Europe, were regarded as constituting a real threat. The threat was eliminated because Överum was bought up. After ten years or so the English-owned company stagnated and new competitors appeared on the Swedish market, above all Norrahammar. The English epoch in the history of Överum ceased in the year after the Russian revolution of 1917. Under more energetic management combined with I. Kreuger's contribution of capital Överum was able to regain its leading position after 1920. The tractor plough was launched onto the market at the right time and it fulfilled agriculture's new needs in the use of tractors. But they had also learnt something from the English. In 1928 Överum bought up the plough manufacturing side of its fiercest competitor, Norrahammar. After a long period of stagnation and decline dating back to the 1880s Överums bruk was able to become the leader of the Swedish plough market again in the 1920s by meeting the demand for new agricultural technology. In so doing Överum regained the position in plough manufacturing which it had once held in the middle of the nineteenth century.

2. *Munktells mekaniska verkstad, Eskilstuna*

Theofron Munktell, the founder of Munktells verkstad in Eskilstuna, was born in 1805 at a parsonage in Kärrbo in Västmanland. He does not appear to have received any protracted academic education in general, but as a youth he was employed by an instrument maker in Västerås. Through his father's contacts and kinship with mining people in Falun, Munktell was apprenticed at the age of seventeen to one of the best-known engineers and metallurgists of his day in Sweden, Gustaf Broling of Stockholm. After one year's practical training as a filer and lathe operator Theofron Munktell got a higher post at the cast steel works which Broling had recently started, and he there became the driving force for some years. Simultaneously with this work Munktell was employed in the Royal Mint, and in 1826 he became works foreman there. While he was employed at the Royal Mint Munktell constructed a number of new implements and machines for stamping coins.[50]

The English-born industrialist Samuel Owen had started a workshop and casting shop on Kungsholmen next to the Royal Mint. During his time in Stockholm Munktell had become a close friend of Owen, whose workshop he visited very often. Through his business on Kungsholmen Owen played a central part in the beginning of Swedish industrialisation. He was of great importance as a producer of factory equipment and farming machinery but his greatest achievement was in his rôle as an industrial pioneer and teacher. At the beginning of the nineteenth century he alone was able to exploit the technical innovations which had been made in English industry. In Sweden Munktell could not have had better teachers than Broling and Owen.[51]

His activity in Broling's steel works was gradually diminishing and in 1832 Munktell's work at the Royal Mint ceased. In the

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[50] Hellberg, K., *Järnets och smedernas Eskilstuna,* Andra delen, pp. 115 ff.

T. Munktell gave early proof, in several different independent constructions, of technical knowledge and imagination which were prerequisites for employment with Broling. He himself in 1797–1799 had studied the most prominent iron foundries and engineering works of that time in England, and he thereafter became a pioneer in the Swedish iron industry and machine construction. Of the technological constructions carried out by Munktell during the Stockholm period mention may be made of a slide rule (1823) which won general esteem, and which was ordered by all the members of the Jernkontor. In addition, he designed the printing presses for Lars Johan Hierta's Aftonblad during the paper's first year.

[51] *Ibid.,* pp. 119 f. *Svenska män och kvinnor.* In his operations up to 1843 Owen produced more than 1 000 threshing machines, among other items.

same year he moved to Eskilstuna and founded the Eskilstuna mekaniska verkstad. The work in the beginning consisted mainly of repairs for the foundries and textile industry in Södermanland. Because of his penchant for experiment and his earlier contact with skilled engineers Munktell had good prospects of success in his new work as an independent industrialist. But he wanted to learn more, and in 1835, only a few years after his arrival in Eskilstuna, Munktell travelled to England to study the British iron industry for himself.[52]

The business in Eskilstuna started on a small scale, but after his return from England Munktell expanded the workshop into an engineering factory. During the 1840s activities at Munktell's company were geared to a great extent to the State arms factory, which ordered a number of new machines. At the same time Munktell introduced standardised production of tool machines. This was later to become of great importance in the production programme.

In the next decade, the 1850s, the business was characterised by the production of big machines. In fact at that time Munktell delivered Sweden's first locomotive and traction engines. There was never any large scale production of locomotives, but the first traction engine in 1853 marked the start of a new trend in the workshop. The production thereafter was to be mainly connected with agriculture, as was further emphasised in 1859 by the start of threshing-machine production. The traction engine, which was the source of power for the steam threshing-machine, was the only inanimate source of energy used in Sweden before the First World War. Traction engines as well as steam threshing-machines were manufactured in series on a gradually increasing scale and constituted the basis of the business in the workshop up to the First World War. Apart from this production, mechanical threshing-machines, steam mills, steam pumping plants, water elevator

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[52] Hellberg, K., *Järnets och smedernas Eskilstuna,* Andra delen, pp. 121 ff.

The study visit to England was made with a government grant. On his return from England Munktell extended his business and in 1837 he bought building sites on the Eskilstuna River on which to set up factories. In that connection he also acquired the right to the river's water-power. Five years after the foundation of the company in 1837 about 25 workers were employed at Eskilstuna mekaniska verkstad.

frames for mines, steam dredgers, steam boilers and steam engines were manufactured during the latter part of the nineteenth century.[53]

In connection with the changeover to production of larger agricultural machines Munktell extended the capacity of the workshop. The number of people employed had more than quadrupled between 1837 and 1860 and at the latter date amounted to 112. As a result of the development in production techniques during the latter part of the nineteenth century the need for lathe operators, filers and other engineers increased the most, while more craft groups of workers such as blacksmiths, sheet metal workers and joiners were required in a lesser capacity. However the number of threshing-machine joiners increased rapidly from the end of the 1890s. In 1910 threshing-machine joiners constituted around 20 per cent of the labour force at Munktell and filers, lathe operators and other engineers constituted about 50 per cent.[54]

During the nineteenth century a large part of the Swedish iron and metal industry was located in Eskilstuna, "the Sheffield of Sweden". In this industrial environment the Munktell workshop expanded more rapidly than any of the town's other factories, and in the middle of the 1870s Munktell employed three times as many workers as the next largest company, Eskilstuna Jernmanufaktur

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[53] *Ibid.*, pp. 123 ff. From 1853 up to the First World War about 7 000 traction engines were produced, with a total horse-power of about 50 000. Jobs were created for Munktell's dredger and pumping stations through the lowering of the Hjälmaren and the two Kvismare lakes in Närke. The lake conservancy company was one of the largest in the world, and was founded as a result of the devastating effects of the spring spate on farming around the lakes in question. The work went on for eleven years (1877–1888) at a total cost of around 4 million Sw. kr. The result was that almost 19 000 hectares were reclaimed for cultivation.

[54] *Ibid.*, pp. 126 ff. The factory expansion in 1859–1860 brought about the construction of a new foundry and the broadening of the management of the firm when the son of the founder Theofron Munktell became a partner in the firm in 1859. In 1857–1859 he studied at Falun bergsskola and thereafter remained in his father's firm until 1889. After the formation of the limited company in 1879 he succeeded his father as works manager and managing director, a position he held until 1889. Theofron Munktell Jr. also occupied a central position in the development of Eskilstuna, since he was chairman of the town council for 30 years from 1865. The management of the company became even broader when the founder's nephew, Theofron Boberg, an engineer, joined the firm as a partner in 1863.

Table 24. *Production values for Munktell's engineering works and other industries in Eskilstuna. The amounts are given in thousands of Swedish crowns*

Year	Munk-tell	Söder-bloms mek. verkst.	Bero-nius mek. verkst.	Eskils-tuna Jernmanu-faktur AB	Eskils-tuna Stålpress-nings AB	Carl Gustafs Gevärs-faktori
1875	544					
1885	575	165				
1890	787	170				
1895	813	200	150	450	200	
1896	1 016					522
1900	2 617	420	330	1 140	700	1 296
1910	4 425	600	450		2 000	1 380
1916	12 000	1 100	1 000	2 080	6 000	

Note In 1885 the production value at the 66 forging works in Eskilstuna amounted to a total of 1.2 million Sw. kr., while the corresponding value for the 72 forging works in 1890 had risen to 1.8 million Sw. kr.

	Number of factories			Production value in 1 000 Sw. kr.		
	1896	1900	1910	1896	1900	1910
Industry as a whole in Eskilstuna	148	132	151	5 646	9 018	20 143
Engineering works in Eskilstuna	9	8	11	1 312	2 277	5 606
Munktell	1	1	1	1 016	2 617	4 425

Source Bidrag till Sveriges officiella statistik: D, Fabriker och handtverk; Svenska industrien 1911–1912 and 1918–1919; Hellberg, K., Järnets och smedernas Eskilstuna. Part II.

AB. From table 24 it is possible to see Munktell's comparative importance in the economic life of Eskilstuna. In 1900 Munktell alone accounted for 29 per cent of the total industry of the town and for 35 per cent of the iron and metal industry, which in turn accounted for 80 per cent of the production value of the whole industry. Munktell even became the town's pioneer in production techniques, and he introduced steam and electric power in Eskilstuna in the 1860s and 1880s respectively.

It was the arms factories which pioneered the use of the new milling machines in workshop production in Sweden and Munktell's contacts with the arms manufacturers in Eskilstuna proved valuable, not least in the context of production technology. Modern workshop techniques were brought over to Sweden from America. When the Carl Gustav gevärsfactori in Eskilstuna received a large government order for modern rifles in 1867 the manager of the factory Major C. Fries and the engineer at Munktell's workshop, Theofron Broberg (the nephew of Munktell senior) went to the USA, and there for six months they studied the production at Remington's arms factory. When they returned to Eskilstuna they brought with them American milling and drilling machines and templates for mass-production. In order to supply the factory in Eskilstuna with new machines Munktell started to produce machines using the ones brought from America as patterns. From Eskilstuna the new techniques spread to Swedish industry, but often with a time-lag of ten or twenty years.[55]

In spite of the fact that Munktell, partly as a result of the fruitful contacts with the arms industry, introduced an advanced technique for mass-production at an early stage, Torsten Gårdlund still described Munktell as a many-sided company immediately after the First World War. The production was then spread among 98 different kinds of engine, 40 different kinds of traction engine and 100 different kinds of machine tool. It was the aim of the older workshop directors not to turn away any orders and to show that the workshop could produce whatever the customers ordered. However, it is right to bear in mind that some of the companies with a mixed production were so large that they had specialised departments which attained a greater production than companies which were specialised in the usual sense. Machine tools constituted a small part of Munktell's total production, while at the same time the company was the largest producer of machine tools in the country.[56] The same was true to a still greater degree of the heavy agricultural machines, the steam threshing-machines and traction engines.

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[55] Gårdlund, T., *Industrialismens samhälle*, pp. 244 f.

[56] *Ibid.*, pp. 84 ff.

Production value in thousands of Sw. kr. at Munktell

	1896	(%)	1910	(%)
Castings	163	16	555	13
Steam boilers	78	8	315	7
Traction engines	304	30	1 159	26
Other steam engines	77	7	319	7
Machine tools, engines	111	11	645	15
Threshing machines	134	13	1 008	23
Others	149	15	424	9
Total	1 016	100	4 425	100

Source Riksarkivet, Kommerskollegii arkiv. Primärmaterial till industristatistiken.

Thus in the years before and after the turn of the nineteenth century traction engines and steam threshers accounted for almost half of the production value (43 per cent in 1896 and 49 per cent in 1910). Munktell's share of the Swedish market in traction engines increased from 77 per cent in 1896 to around 98 per cent in 1910, while the company's share of the threshing-machine market was 21 per cent in 1896 and 43 per cent in 1910. If steam threshing-machines alone are included Munktell's share of the market would be considerably larger. In practice Munktell controlled the Swedish market in traction engines and steam threshers at the outbreak of the First World War. The traction engines were special agricultural machines in the sense that it was necessary to have the assistance of special joiners to assemble them. Therefore the manufacturers of traction engines would have to keep a fairly large service personnel in the field. This probably proved an obstacle to the attempts at expansion made by smaller manufacturers, and militated towards a monopoly in this field.

During the twenty years which preceded the First World War there was a decisive increase in the domestic demand for machines and tools, particularly because of the mechanisation of industry and agriculture. The engineering industry was also able to an increasing extent to cope with domestic demands. Among the most important groups of machines—where the domestic production in 1913 covered at least 75 per cent of the consumption—were steam engines and motors, woodwork machines, machines for hoisting and pressing and for use in the mineral industry, armaments and agricultural machines and implements. The acceleration in the establishment of new engineering companies from the 1890s onwards must be regarded as a response to the increase in demand. With this, competition was intensified. One factor which contributed to keener competition was the accounting and cost accounting system which had long been underdeveloped. The lack of proper cost analysis often led to the fixing of prices at random or on the basis of a competitor's (perhaps unrealistic) price. However some of the larger companies such as Separator and Munktell introduced rational planning of production and cost accounting before the First World War. In 1912 Munktell set up an operating cost office, which employed 34 people in 1917.[57]

The sale of Munktell's products was affected by the trends in economic activity. This was true of sales in general and especially of the sales of farming machinery. The period from 1860 to 1914 can be roughly sub-divided into two shorter periods, from 1860 to 1890 and from 1890 to 1914. The first period was relatively speaking a static one, though it had clear economic declines and booms, and the second period one of expansion caused by intermittent booms due to the economic trend. The years 1895–1900 and 1905–1910 were particularly years of expansion. Diagram 8 shows clearly the restrictive effect which the years of bad crops 1867–1869 had on the economy, and the subsequent boom at the start of the 1870s. The end of the 1870s saw a new decline followed by a short but striking boom at the start of the 1880s. The depression which struck European agriculture in the 1880s affected Munktell most in the years 1886–1887. On the other hand the expanding sales of heavy farming machines at Munktell after 1890 are a clear indication of an upward economic trend in agriculture at that time.

Thus the trends in agrarian economy were to a high degree decisive for Munktell's sales figures. In turn the sales figures dictated the limits of the company's capacity, and thus the company's fixing of wage levels and wage-paying capacity were directly

[57] *Ibid.*, pp. 88 f.

Table 25. *Wages paid to different groups of workers at Munktells mekaniska verkstad in the years 1877–1910. Amounts are given in thousands of Sw. kr.*

Year	Pattern-makers	Thresher-makers	Filers turners fitters	Forgers	Platers	Others	Amount of wages	Number of workers
1877	4	4	52	10	8	19	97	224
1878	5	6	66	11	8	16	112	
1879	5	6	60	9	8	4	92	
1880	5	8	73	11	10	5	112	
1881	5	13	77	12	15	5	127	
1882	6	15	88	13	17	5	144	
1883	7	17	107	16	18	15	180	244
1884	10	20	106	17	20	21	194	252
1885	7	18	92	15	15	11	158	
1886	6	14	76	11	12	6	125	213
1887	7	15	77	11	12	5	127	
1888	8	16	93	14	16	9	156	
1889	8	18	136	20	33	12	227	251
1890	11	18	147	21	42	13	252	
1891	12	21	148	24	41	15	261	
1896	14	31	164	22	32	14	277	
1897	16	31	223	28	45	16	359	438
1898	18	40	258	34	44	29	423	
1899	22	62	319	46	54	42	545	
1900	22	80	315	56	69	56	598	
1901	17	68	266	46	53	43	493	
1902	18	68	215	42	44	36	423	
1903	20	78	245	48	56	38	485	
1906	22	89	306	57	63	47	584	
1907	23	101	358	68	81	65	696	
1908	30	118	426	76	95	66	811	
1909	26	150	354	62	58	66	716	
1910	35	191	455	76	67	78	902	839

Source The records of Bolinder Munktell, Eskilstuna: Wage-books

dependent on the sales figures. Diagram 7 shows that on the whole the wages paid at Munktell varied according to the sales. In fact the wages ratio dropped from 30–35 per cent at the end of the nineteenth century to 20–25 per cent at the beginning of the twentieth century. However the profit ratio decreased at the same time,

Table 26. *Sales, wages paid and profits before deductions at Munktell 1877–1910 in thousands of Sw. kr.*

Year	Sales	Payments of wages	Profits
1877	444	97	94
1878	528	112	114
1879	361	92	55
1880	380	112	56
1881	444	127	100
1882	644	144	160
1883	578	180	143
1884	612	194	142
1885	436	158	63
1886	444	125	17
1887	387	127	19
1888	539	156	40
1889	757	227	75
1890	788	252	87
1891	832	261	70
1896	1 075	277	58
1897	1 488	359	186
1898	1 629	423	188
1899	1 774	545	101
1900	2 226	598	100
1901	1 917	493	48
1902	1 991	423	85
1903	2 242	485	126
1906	2 979	584	127
1907	3 937	696	193
1908	4 264	811	301
1909	4 022	716	220
1910	4 031	902	68

Source The records of Bolinder Munktell, Eskilstuna: Wage books. Gårdlund T., Svensk industrifinansiering under genombrottsskedet 1830–1913, pp. 116* ff.

usually very much faster than the wages ratio. To put it another way, other items of expenditure such as the cost of raw materials, operating costs and the costs of interest and investment played a greater part during Munktell's breakthrough phase. Simultaneously with these tendencies the trend in wages has meant that the amount

Table 27. *The relationship between sales, wages paid, and profits before deductions at Munktell 1880–1910 (sales=100)*

Year	Sales	Payments of wages	Profits
1880	100	30	15
1885	100	36	14
1890	100	32	11
1896	100	26	5
1900	100	27	4
1906	100	20	4
1910	100	22	2

of the individual worker's wage had increased accordingly between 1877 and 1910.

Year	Wage per worker, Sw. kr.
1877	435
1883	740
1886	585
1897	820
1910	1 075

The economic situation affected different groups of workers in various high degrees. The 'other workers' group was the most sensitive to the development of the economic situation, and as regards employment functioned like a concertina according to the economic trend. The employment situation was considerably more stable for forgers, toolmakers and platers of the craftsmen groups.

Munktell's concentration on agricultural machinery was followed up by various kinds of marketing measures. The agricultural exhibitions which recurred on regional, national and international levels during the latter part of the nineteenth century afforded manufacturers great opportunities to advertise their products. World fairs attracted special interest and Munktell was represented at several of them in Paris, London, Vienna, Moscow, Riga, Brussels, Madrid, Copenhagen, Christiania and also Bogota in South

Table 28. *The relationship between sales, wages paid, and profits before deductions at Munktell 1880–1910 (wages paid=100)*

Year	Sales	Payments of wages	Profits
1880	340	100	50
1885	276	100	40
1890	313	100	35
1896	388	100	21
1900	375	100	17
1906	510	100	22
1910	446	100	8

Source See table 26.

America. However Munktell did not achieve any exports of agricultural machines worth mentioning before 1895. After that sales increased much more rapidly, at home as well as abroad, and in the years 1910–1914 about half of the steam threshers and traction engines which Munktell delivered went to the foreign market. 80 per cent of the exports in the years 1900–1914 went eastwards (to Russia and Finland) and Russia alone accounted for 70 per cent of all exports.[58]

In the period before the First World War traction engines were the most costly machine investment for agriculture. The prices in Swedish crowns varied according to the size of the machine, as follows:

Traction engines

Year	4 h.p.	6 h.p.	8 h.p.	10 h.p.	12 h.p.	18 h.p.	20 h.p.
1887	2 600	3 200	3 750	4 350	5 000	7 600	8 300
1907		3 350	4 000	4 700	5 500	7 600	8 200
1913		3 350	4 000	4 700	5 500	7 600	8 200

[58] Hellberg, K., *Järnets och smedernas Eskilstuna*. Andra delen, p. 126. Munktell's largest foreign agents were E. Hamrin in Moscow, Silfverhjelm & Ullgren in Riga, P. Sidorow and AB Agros in Helsingfors and A. Malmkvist in Copenhagen.

Steam threshers

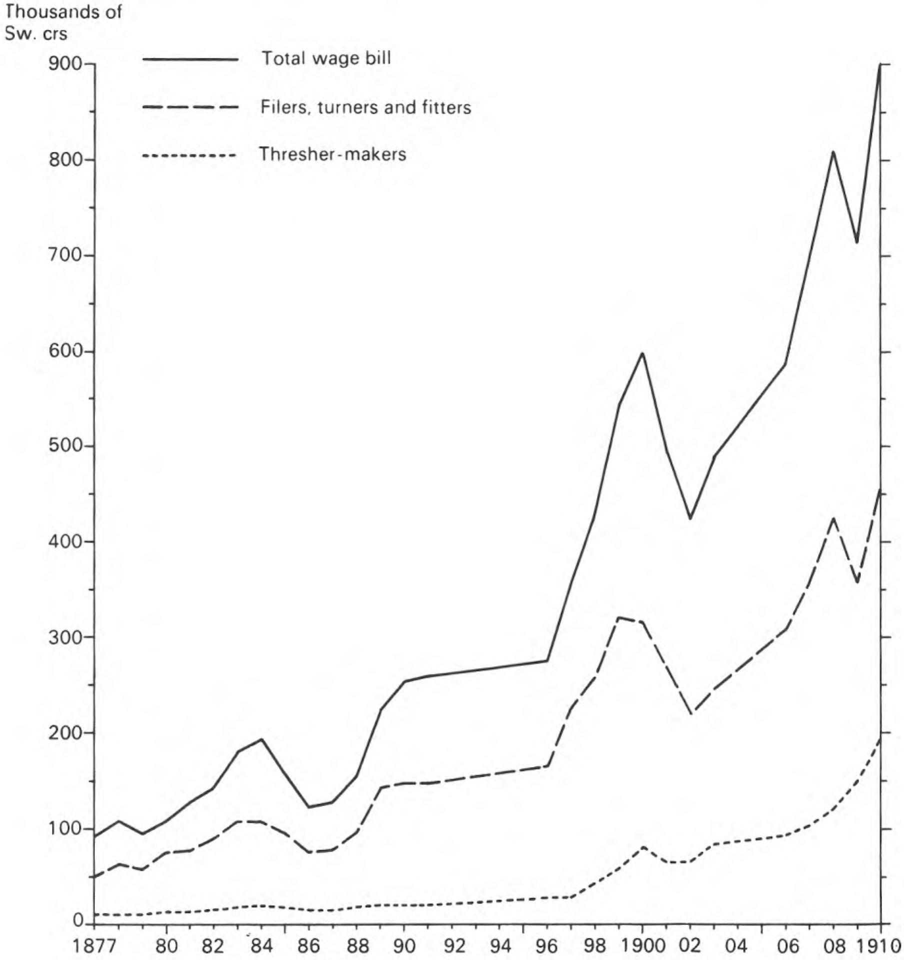
Year	3½ feet	4 feet	4½ feet
1887	2 200	2 400	2 500
1907	2 850	3 050	3 250
1913	3 100	3 350	3 600

The most common types of traction engine were of 6–8 h.p. and steam threshers with a working width of 4 feet predominated. Thus in 1907 an ordinary steam thresher with a traction engine cost about 7 000 Sw. kr. Therefore an ordinary steam thresher with a traction engine cost at least ten times as much as the next most expensive farming machine, the reaper. In addition, at the beginning of the twentieth century more and more steam threshers were being equipped with straw balers; in 1913 the self-binding type cost 3 000 Sw.Kr. while a smaller straw baler cost 1 700 Sw.kr.[59]

The high cost of buying a steam thresher with a traction engine together with their limited period of use account for the fact that Swedish farmers only bought these machines to a small extent. But the comparatively limited number of steam threshers with traction engines (about 7 000) has made it possible to study their distribution in Sweden from a social as well as a geographical viewpoint. The deliveries of traction engines and threshing machines can be traced in Munktell's order books, one of which was kept specially for traction engines and another for threshing machines. If the people who ordered farming machines are simply grouped socially according to whether or not their surnames end in '-son' a significant difference becomes apparent. The early orders came to a great extent from farmers with non-sonnames. This group consists almost exclusively of estate owners and people of social standing, and with the aid of information about titles or farm addresses or both it has been possible to verify the group identification to a great extent. Thus 93 per cent of the orders before 1880 came from people with non-sonnames, and only 7 per cent from farmers with son-names. The number of people with

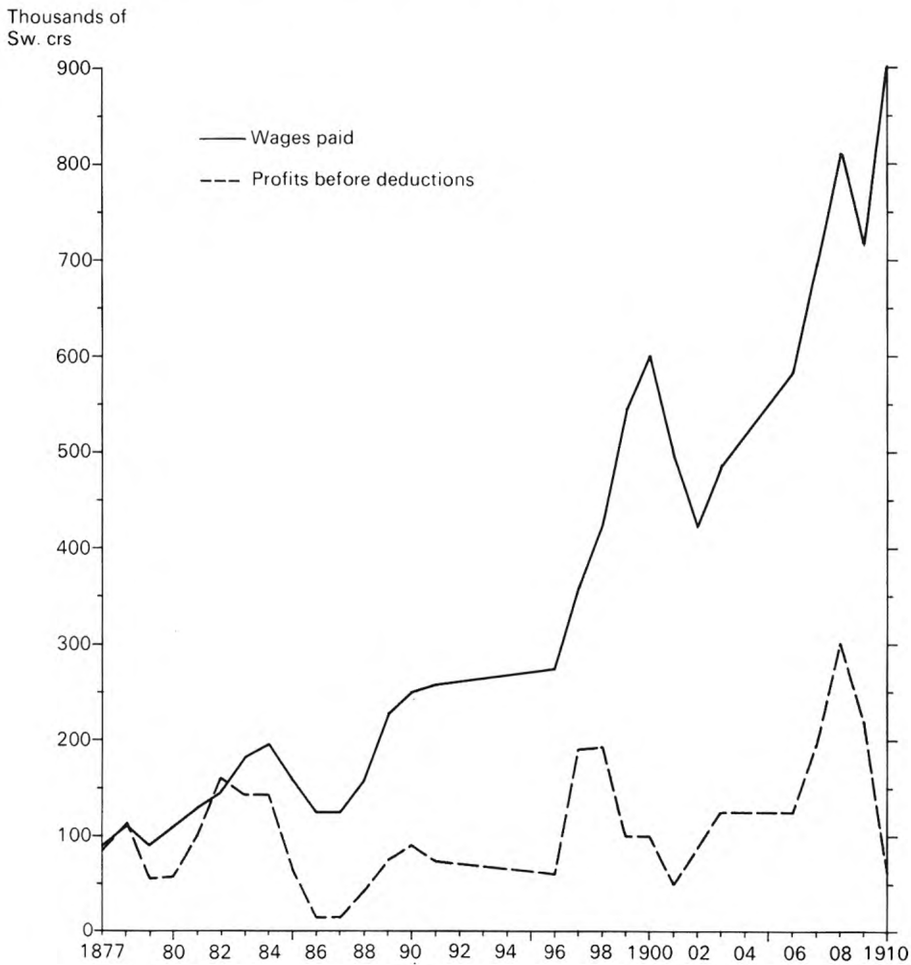
[59] Price-lists from Munktell.

Diagram 5. *Amounts of wages for thresher-makers and also filers, turners and fitters in relation to the total wage bill at Munktell's mekaniska verkstad in Eskilstuna 1877–1910.*



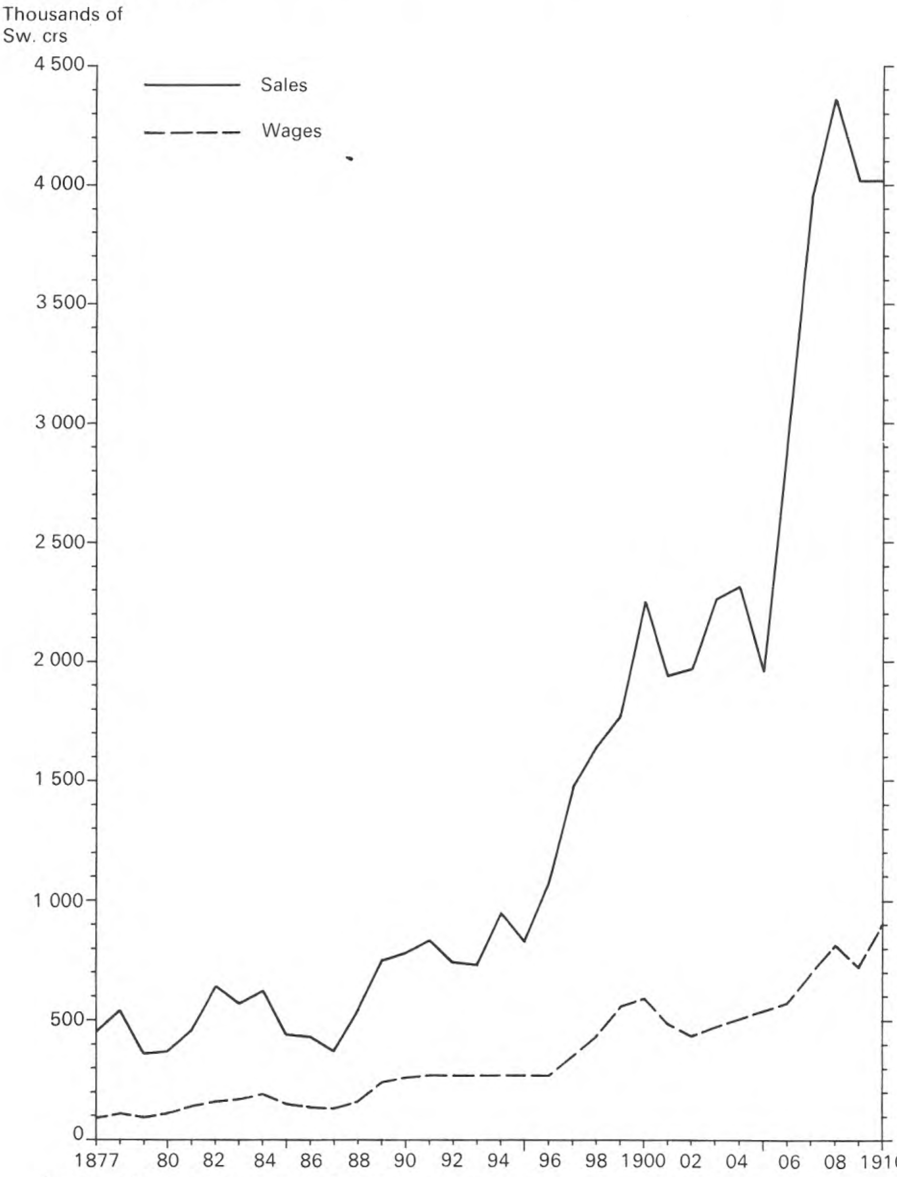
Source The records of Bolinder Munktell, Eskilstuna: Wage books.

Diagram 6. *The development of wages and profits at Munktell 1877–1910.*



Source See table 26.

Diagram 7. *Sales and wages paid at Munktells mekaniska verkstad, Eskilstuna 1877–1910.*



Source The records of Bolinder Munktell, Eskilstuna: Wage books. Gårdlund, T., Svensk industrifinansiering under genombrottsskedet 1830–1913, pp. 116* f.

Table 29. *Number of threshing-machines delivered*

Year	Sweden	Abroad	Total	Year	Sweden	Abroad	Total
1860	–	1	1	1880	26	1	27
1861	3	–	3	1881	23	3	26
1862	9	–	9	1882	45	1	46
1863	15	–	15	1883	48	1	49
1864	10	–	10	1884	42	3	45
1865	7	–	7	1885	41	3	44
1866	6	–	6	1886	22	5	27
1867	6	–	6	1887	16	7	23
1868	6	–	6	1888	36	1	37
1869	9	–	9	1889	17	6	23
1870	11	–	11	1890	50	1	51
1871	13	1	14	1891	33	4	37
1872	16	–	16	1892	66	–	66
1873	17	–	17	1893	43	–	43
1874	16	2	18	1894	74	10	84
1875	17	1	18	1895	71	5	76
1876	21	–	21	1896	52	10	62
1877	11	–	11	1897	87	5	92
1878	23	–	23	1898	96	5	101
1879	18	–	18	1899	118	10	128
				1900	106	19	125

Year	Sweden	Denmark	Finland	Russia	Others	Total
1901	100	7	3	6	–	116
1902	128	10	1	5	–	144
1903	136	8	1	15	–	160
1904	113	9	3	22	1	148
1905	94	8	–	13	–	115
1906	151	7	3	21	–	182
1907	185	4	1	28	–	218
1908	202	17	1	33	1	254
1909	196	15	5	55	1	272
1910	181	2	2	135	9	329
1911	167	10	1	126	27	331
1912	203	20	4	82	14	323
1913	190	15	4	142	14	365
1914	128	15	1	115	10	269
1915	126	12	1	–	–	139

Source The records of Bolinder Munktell, Eskilstuna: Order books.

Table 30. *Number of traction-engines delivered*

Year	Sweden	Abroad	Total	Year	Sweden	Abroad	Total
1853	1	–	1	1877	24	2	26
1854	1	–	1	1878	34	–	34
1855	4	–	4	1879	30	–	30
1856	5	–	5	1880	34	2	36
1857	5	–	5	1881	38	3	41
1858	11	–	11	1882	66	–	66
1859	10	–	10	1883	70	2	72
1860	13	1	14	1884	49	8	57
1861	8	–	8	1885	41	4	45
1862	22	1	23	1886	32	7	39
1863	27	–	27	1887	21	5	26
1864	17	–	17	1888	40	3	43
1865	16	–	16	1889	29	4	33
1866	14	–	14	1890	42	3	45
1867	11	–	11	1891	40	3	43
1868	12	–	12	1892	69	–	69
1869	14	–	14	1893	51	–	51
1870	11	–	11	1894	80	13	93
1871	15	1	16	1895	67	9	76
1872	34	–	34	1896	91	11	102
1873	26	–	26	1897	127	9	136
1874	38	1	39	1898	142	9	151
1875	44	1	45	1899	176	15	191
1876	45	–	45	1900	165	28	193

Year	Sweden	Denmark	Finland	Russia	Others	Total
1901	162	1	4	7	3	117
1902	195	8	7	9	1	220
1903	219	6	5	21	3	254
1904	179	9	18	22	–	228
1905	138	6	20	15	1	180
1906	183	4	44	21	2	254
1907	214	9	21	23	3	270
1908	191	30	38	38	5	302
1909	150	20	20	52	3	245
1910	154	3	20	124	7	308
1911	88	5	10	123	22	248
1912	126	10	5	70	17	228
1913	117	6	14	110	1	248
1914	61	2	4	116	2	185
1915	87	4	8	6	1	106

Source The records of Bolinder Munktell, Eskilstuna: Order books.

Table 31. *Number of kerosene engines delivered*

Year	Sweden	Denmark	Finland	Russia	Others	Total
1907	6	–	–	–	–	6
1908	78	–	–	–	–	78
1909	48	2	–	42	6	98
1910	40	–	–	116	25	181
1911	43	3	–	91	53	190
1912	54	5	–	55	30	144
1913	65	2	–	103	19	189
1914	57	8	4	37	18	124
1915	3	2	3	5	8	21

Table 32. *Number of straw presses delivered*

Year	Sweden	Denmark	Finland	Russia	Others	Total
1904	2	–	–	–	–	2
1905	8	1	–	–	–	9
1906	22	–	–	–	–	22
1907	51	–	–	–	–	51
1908	87	15	–	–	–	102
1909	100	11	1	–	–	112
1910	85	4	–	–	–	89
1911	77	2	–	–	2	81
1912	85	5	–	–	–	90
1913	69	4	–	–	–	73
1914	35	5	1	31	–	72
1915	2	2	–	–	–	4
1916	67	15	–	2	–	84
1917	24	8	–	–	–	32
1918	37	1	–	–	–	38
1919	36	5	–	–	–	41
1920	4	–	–	–	–	4

Source The records of Bolinder Munktell, Eskilstuna: Order books.

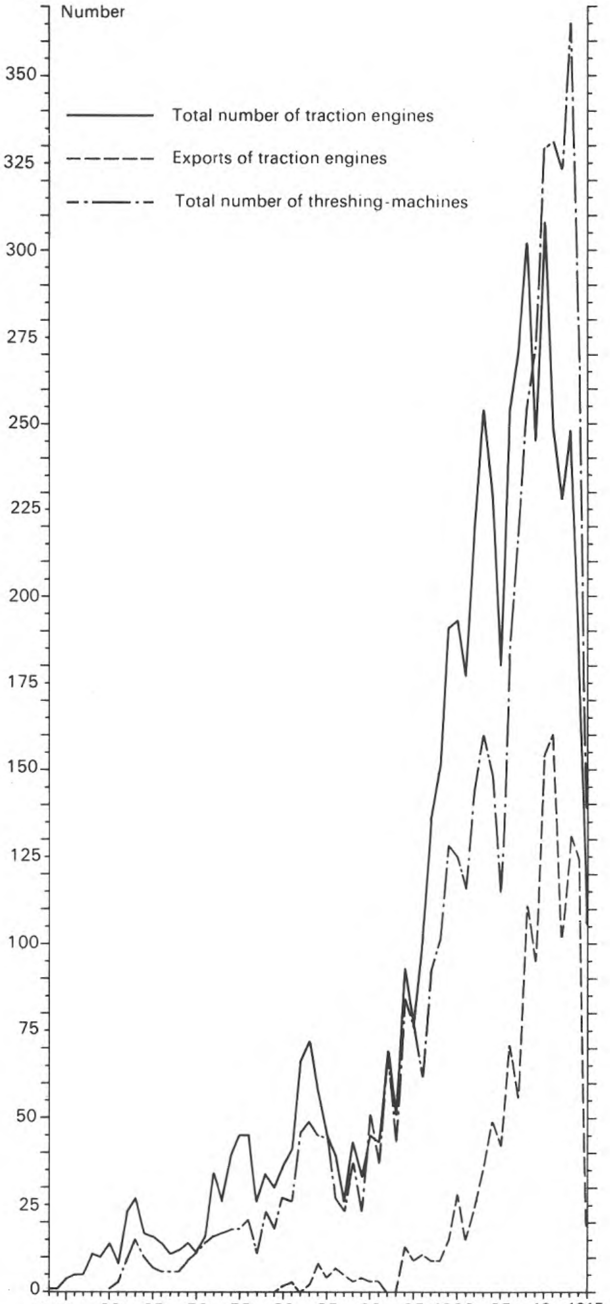


Diagram 8. *Number of traction engines and threshing-machines delivered.*
Source Records of Bolinder Munktell, Eskilstuna: Order books.

son-names who placed orders certainly increased during the 1880s but up to 1890 it still only constituted 15 per cent of the total number of buyers. During the decade after 1890 the orders were 'democratised' to such an extent that customers with son-names almost counterbalanced the customers with non-sonnames, but up until 1900 69 per cent of all the orders came from farmers with non-sonnames. Thus two out of every three deliveries before 1900 went to the estates, and above all to the Mälar area and Östergötland in which there were many estates, (see table 33, counties B, C, D, U and E, and maps 2–7). On the other hand from the beginning of the twentieth century farmers with non-son-names —a substantial number of whom resided in Scania—were predominant. A new and larger marketing group, consisting mainly of larger Scanian peasant farms, then succeeded the central Swedish estates as the most important buyers of Munktell's steam threshing machines and later of straw presses too. In fact for 30–40 years heavy farming machines from Munktell had only been distributed outside the estate-owning class to a small extent. It took a long time before the steam threshers were in circulation on the next agrarian level, viz. the larger peasant farms on the country's best land. The trend of development mentioned above strongly confirms the results of earlier research into the diffusion of mechanisation within agriculture. In research into the diffusion of mechanisation in Swedish agriculture between 1860 and 1910 based on material from estate inventories it appeared that in the year 1890 rather more than 40 per cent of the large holdings under examination were in possession of steam threshers, as compared with only a few of the larger peasant farms under investigation. Twenty years later there were steam threshers on 60–70 per cent of the large holdings, while the corresponding figure for the larger peasant farms was 15–20 per cent.[60]

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[60] Munktell's order books for traction engines and threshers contain information about delivery dates, machine sizes, customers, possible middlemen, machine joiners and customers' addresses. On the whole the non-son-names bore the imprint of remarkably "high social standing" typified by Adlercreutz, Brannerhjelm, Cassel, Celsing, Coyet, Fries, Hamilton, Lagerheim, Lybecker, Piper, Posse, Rappe, Rosin, Rålamb, Stjernstedt, Tersmeden et cetera. It has been possible to trace farm

The introduction of steam power into agriculture around 1850 marked the start of a new phase in the development of agricultural techniques. The first wave of mechanisation in farming during the first half of the nineteenth century was based on and dependent on an increase in the number of beasts of draught as a source of power. Examples of such agricultural techniques were the horse-drawn mowing and sowing machines and the thresher with the horse walking. During the second half of the nineteenth century several attempts were made to convert steam into a source of power in farming. This would enable a reduction to be made in the stock of beasts of draught. However most attempts to adapt steam power to the special needs of agriculture failed. As far as farming was concerned the steam engine was too heavy in relation to the power it produced, and therefore the steam ploughing system, for example, was only used to a very small extent. Steam power could only be used successfully in farming when the steam engine in operation could remain stationary on a firm surface, as when steam threshing. Undoubtedly the steam-powered thresher constituted the most expensive technical investment in agriculture before the First World War. The steam thresher with its accessories cost more than ten times as much as the next most expensive farming machine, the mowing machine or the separator. Therefore the very limited number of steam threshers in circulation outside the large holdings was not just a Swedish phenomenon but one which appeared generally wherever advanced farming was practised. Through J. M. G. van der Poel's company history of Boeke & Huidkoper, Groningen, a firm which exported farming machines, in which the whole of the

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addresses of people with non-son-names to well-known estates and farms, or, through maps, to specific manor houses or larger farms.

Percentage distribution of orders for machines according to the customer's surname

Period	*Non-son-names*	*Son-names*	*Total*
1860–69	98	2	100
1860–79	93	7	100
1860–89	85	15	100
1860–99	69	31	100

Kuuse, J., *Från redskap till maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1890*, pp. 47 ff.

Table 33. *Number of threshing-machines delivered to Swedish counties (län)*

Year	B	C	D	E	F	G	H	I	K	L	M	N	O	P	R	S	T	U	Others	Total
1860–69	9	11	15	12	1	1	3	2	–	2	2	2	–	–	–	–	2	6	–	59
1870–79	21	29	24	19	1	2	12	1	1	4	5	7	–	1	6	3	6	19	3	164
1880–89	34	25	62	52	3	1	14	–	2	8	35	4	3	4	14	2	7	38	2	310
1890–99	38	41	72	107	3	4	91	30	6	39	109	18	2	6	13	2	17	77	7	682
1900	10	6	11	10	–	1	13	3	–	4	22	1	–	–	2	1	3	6	–	93
1907	12	8	13	16	–	–	9	9	4	13	44	13	3	3	20	4	3	11	1	186
1913	20	21	16	7	1	1	11	4	5	9	40	7	1	2	4	7	2	23	4	187
Number of threshing-machines delivered to customers with non-sonnames in Swedish counties (län)																				
1860–69	9	11	15	12	1	1	3	1	–	2	2	2	–	–	–	–	2	6	–	58
1870–79	21	29	23	16	1	2	11	1	1	2	4	6	–	1	6	3	6	14	3	150
1880–89	33	22	56	36	3	1	11	–	2	3	21	3	3	4	10	2	7	28	2	247
1890–99	36	34	45	54	1	4	50	10	2	12	43	6	2	6	12	2	11	44	5	380
1900	8	5	9	2	–	1	4	1	–	–	8	1	–	–	1	1	3	4	–	48
1907	8	4	9	11	–	–	2	5	2	1	8	4	3	–	14	3	3	5	–	82
1913	13	13	11	3	1	–	4	1	1	–	7	2	1	2	4	5	2	16	2	88
Number of threshing-machines delivered to customers with son-names in Swedish counties (län)																				
1860–69	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
1870–79	–	–	1	3	–	–	1	–	–	2	1	1	–	–	–	–	–	5	–	14
1880–89	1	3	6	16	–	–	3	–	–	5	14	1	–	–	4	–	–	10	–	63
1890–99	2	7	27	53	2	–	41	20	4	27	66	12	–	–	1	–	6	33	2	302
1900	2	1	2	8	–	–	9	2	–	4	14	–	–	–	1	–	–	2	–	45
1907	4	4	4	5	–	–	7	4	2	12	36	9	–	3	6	1	–	6	1	104
1913	7	8	5	4	–	1	8	3	4	9	33	5	–	–	–	2	–	7	2	98

Source The records of Bolinder Munktell, Eskilstuna: Order books.

Table 34. *Number of traction-engines delivered to Swedish counties (län)*

Year	B	C	D	E	F	G	H	I	K	L	M	N	O	P	R	S	T	U	Others	Total
1853–59	1	3	6	5	–	–	1	–	–	1	3	1	–	–	1	3	3	3	5	36
1860–69	12	13	18	20	4	3	6	4	–	3	9	–	–	–	5	2	7	21	13	143
1870–79	26	35	46	32	1	4	19	2	2	5	4	7	2	1	8	3	21	41	30	289
1880–89	35	27	73	51	9	2	26	11	3	11	39	3	9	4	8	3	11	50	10	385
1890–95	26	14	28	44	2	1	32	18	2	15	33	7	1	2	7	1	8	33	7	281
1907	18	6	7	17	4	5	12	9	4	21	43	10	4	4	10	7	5	11	8	205
1913	6	10	1	5	2	3	12	8	3	5	32	5	1	1	–	4	1	8	1	108

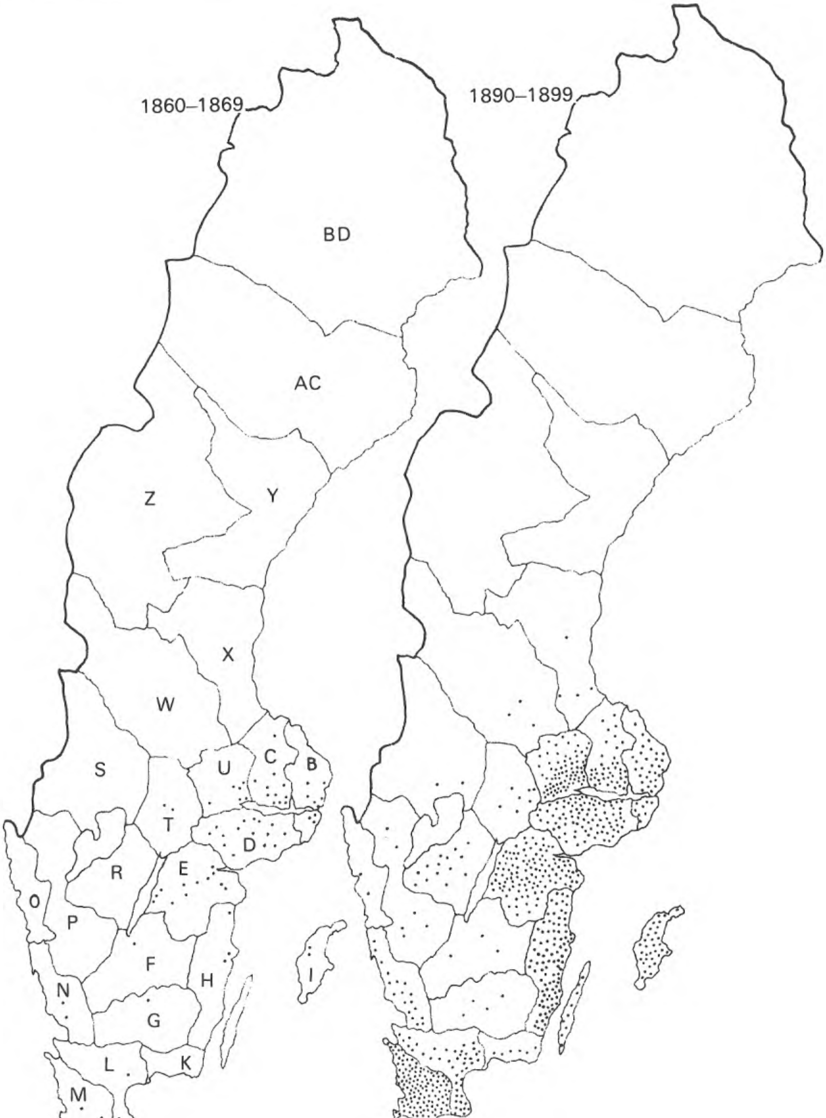
Source The records of Bolinder Munktell, Eskilstuna: Order books.

Table 35. *Number of threshing-machines delivered to steam thresher associations in Swedish counties (län)*

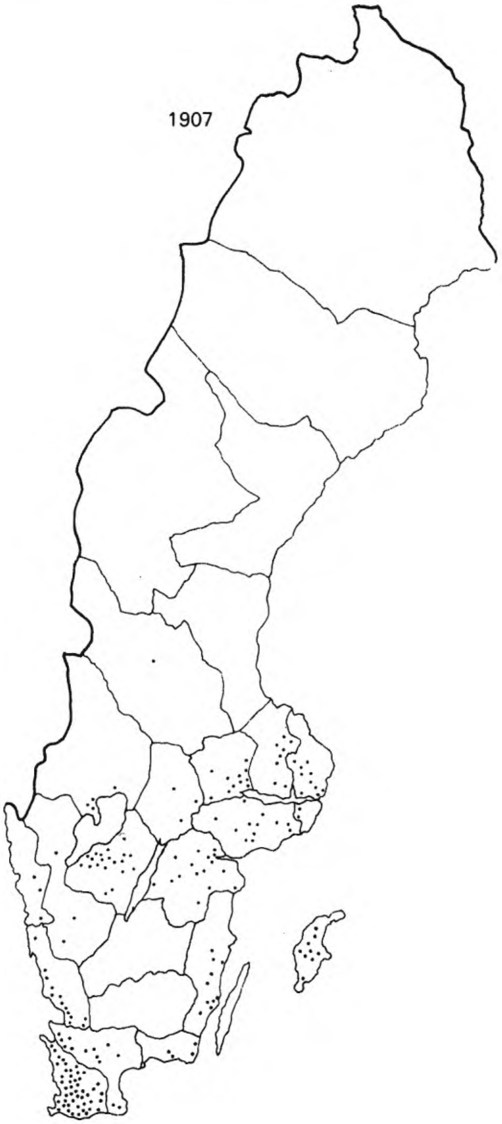
Year	B	C	D	E	F	G	H	I	K	L	M	N	O	P	R	S	T	U	Others	Total
1860–69	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1870–79	2	–	–	2	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	6
1880–89	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
1890–99	–	–	2	1	–	–	2	–	–	1	10	3	–	–	–	–	–	3	–	22
1900	–	–	1	–	–	–	5	–	–	1	3	–	–	–	–	–	–	–	–	10
1907	–	–	1	–	–	–	3	1	–	3	3	3	–	1	–	–	–	1	–	16
1913	–	–	–	1	–	–	1	1	–	2	3	1	–	–	–	1	–	1	–	11
Number of straw balers delivered to Swedish counties (län)																				
1904/05	–	–	–	–	–	–	–	–	–	2	2	5	–	–	1	–	–	–	–	10
1909	4	2	3	1	–	–	5	–	2	17	53	10	–	–	2	–	–	1	–	100
1913	2	3	3	–	–	–	–	1	1	10	38	7	–	2	–	–	–	3	–	69
Number of straw balers delivered to customers with non-sonnames in Swedish counties (län)																				
1904/05	–	–	–	–	–	–	–	–	–	1	–	4	–	–	1	–	–	–	–	6
1909	3	2	1	–	–	–	3	–	–	10	13	5	–	–	2	–	–	1	–	40
1913	2	3	1	–	–	–	–	–	–	1	11	–	–	2	–	–	–	3	–	23
Number of straw balers delivered to customers with son-names in Swedish counties (län)																				
1904/05	–	–	–	–	–	–	–	–	–	1	2	1	–	–	–	–	–	–	–	4
1909	1	–	2	1	–	–	2	–	2	7	40	5	–	–	–	–	–	–	–	60
1913	–	–	1	–	–	–	–	1	1	9	27	7	–	–	–	–	–	–	–	46

Source The records of Bolinder Munktell, Eskilstuna: Order books.

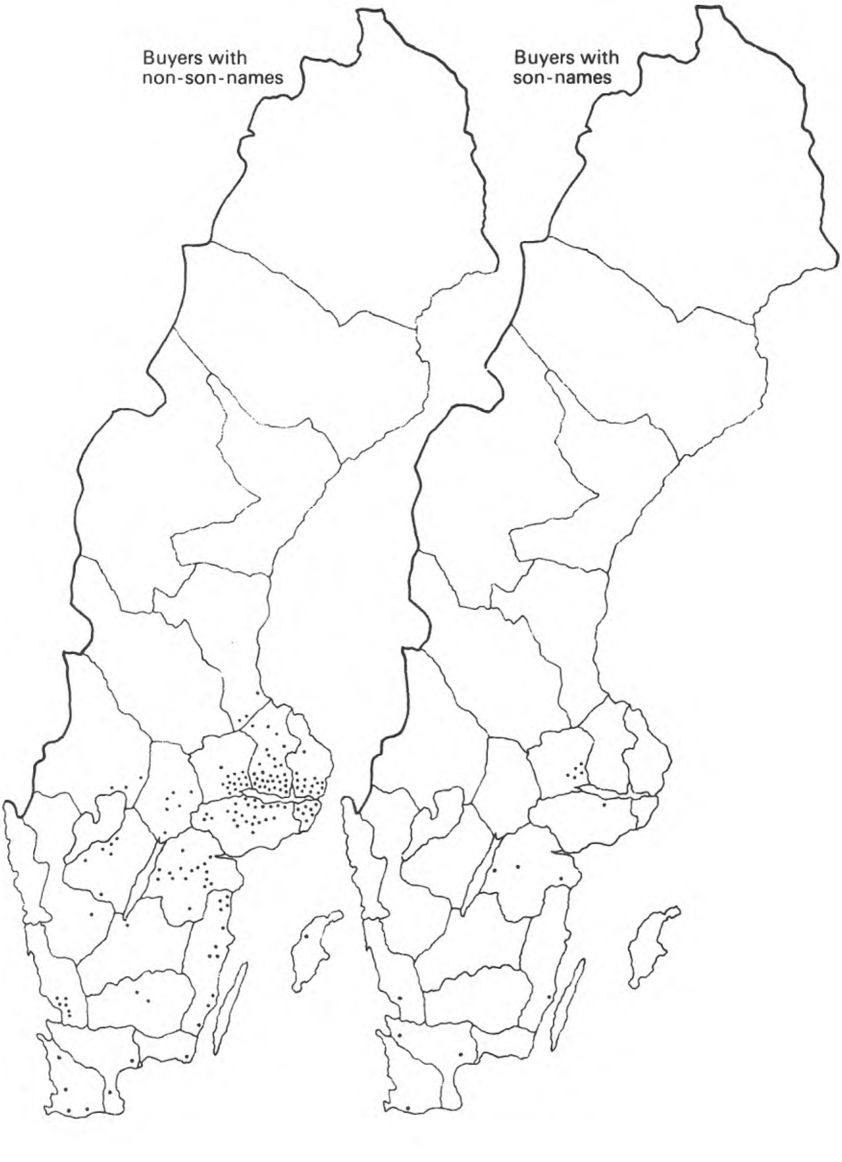
Map 2. *Buyers of Munktells steam threshers.*



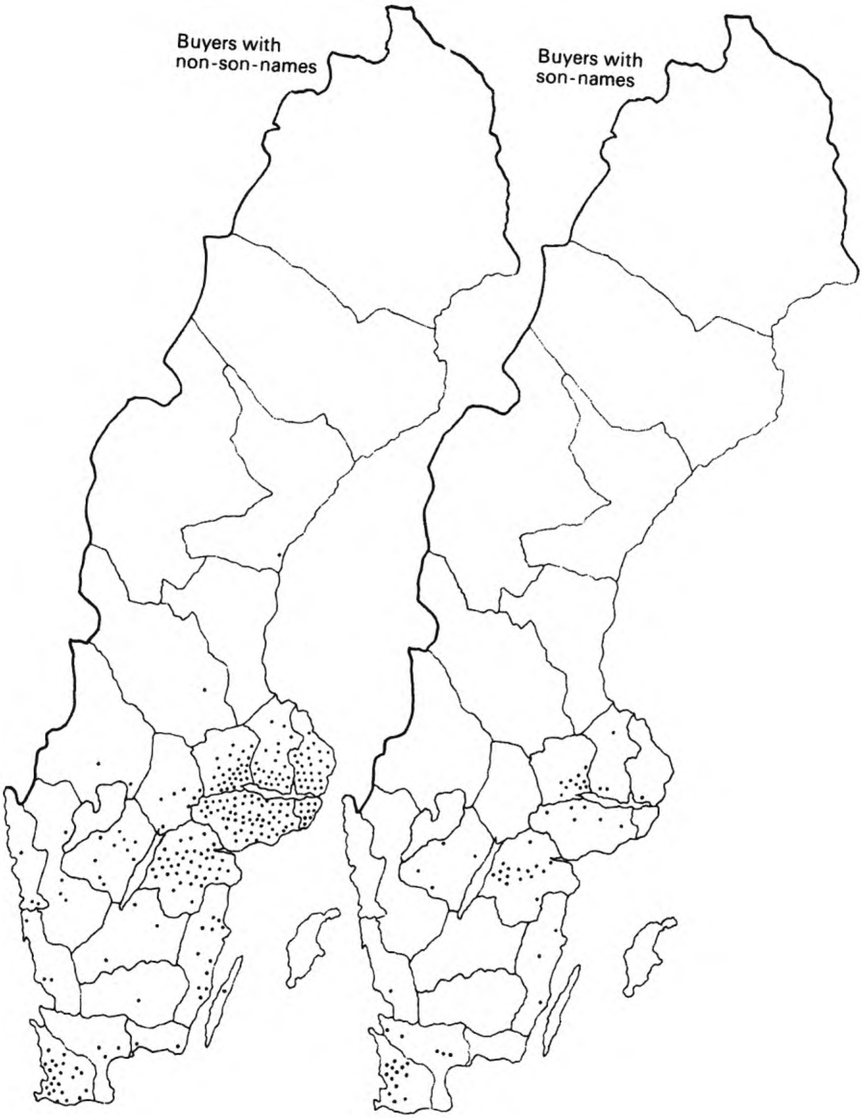
Map 3. *Buyers of Munktell's steam threshers.*



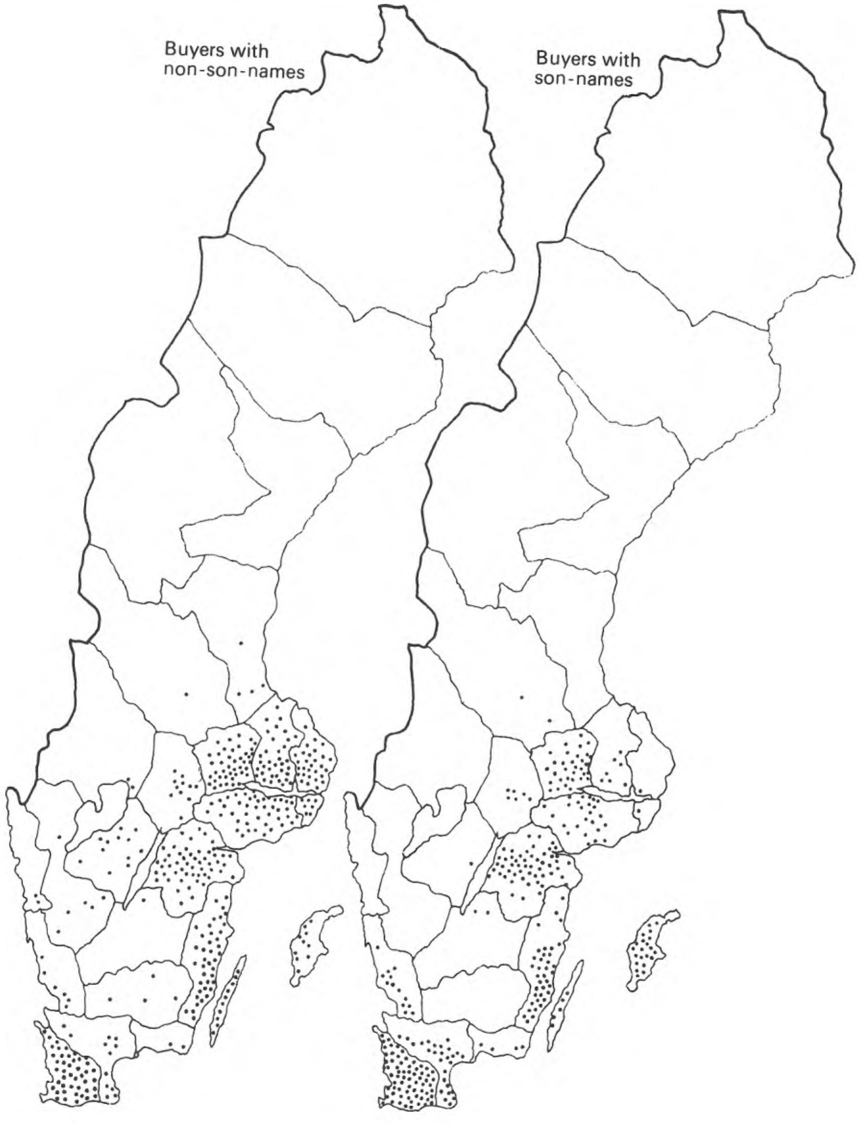
Map 4. *Buyers of Munktell's steam threshers 1870–1879.*



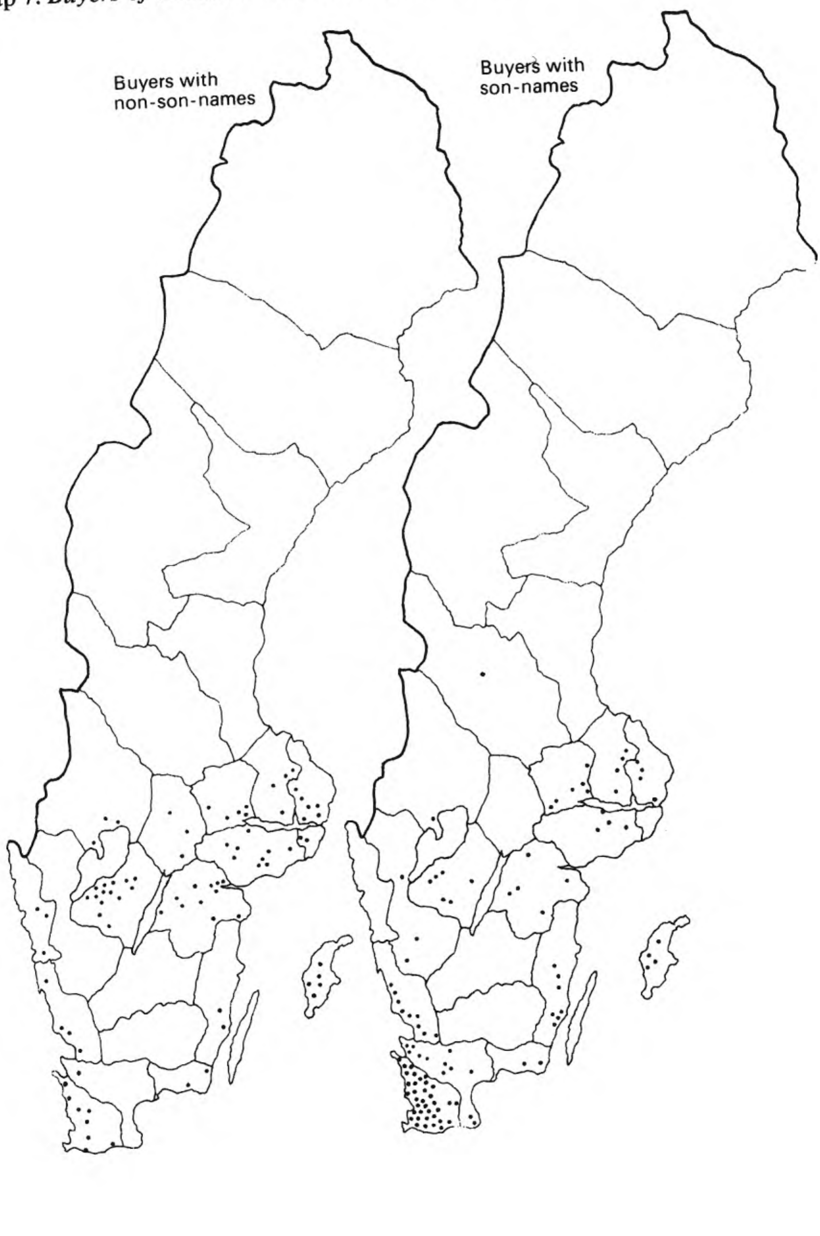
Map 5. *Buyers of Munktell's steam threshers 1880–1889.*



Map 6. *Buyers of Munktell's steam threshers 1890–1899.*



Map 7. *Buyers of Munktell's steam threshers 1907.*



technical development of Dutch agriculture is also dealt with to a certain extent, it is possible to follow the spread of the steam thresher in the Netherlands after 1870. The slow diffusion of the steam thresher in Sweden was matched by an even slower rate of diffusion in the Netherlands. In 1870 there were 30 and in 1900 barely 300, whereas Sweden had about 70 in 1870 and about 1500 around the year 1900. The reason for the slow development of the curve of the spread in the Netherlands was that the farming community in relation to the acreage of arable land was larger in the Netherlands than it was in Sweden. Thus the potential buyers of steam threshers, the large holdings, were more numerous in Sweden than in the Netherlands. In addition the domestic production of steam threshers in Sweden may have contributed to the fact that they spread quicker in Sweden than in the Netherlands where steam threshers had to be imported. In 1900 almost 85 per cent of the Dutch steam threshers were to be found in the three northern regions of Groningen, Friesland and Noordholland where most of the large farms were situated. Furthermore, in 1885 83 per cent of all the soil drainage in the Netherlands had been carried out in these three regions in spite of the fact that together they only accounted for a quarter of the country's area and population. Apparently the steam thresher was as densely distributed amongst the large holdings in Holland as it was in Sweden. Over a long period steam power in European agriculture was only utilised by established large holdings, and it was not until towards the end of the nineteenth century, when farmers started to form so-called steam thresher associations to share the investment costs, that steam power also reached the peasant farms. Another farming machine which also spread selectively to the larger farms was the fertilizer distributor, and around 1900 four out of five Dutch fertilizer distributors were in use in the three most northern regions of the country.[61]

[61] *Ibid.*, pp. 103 ff. van der Poel, J. M. G., *Honderd Jaar Landbouwmechanisatie in Nederland*, pp. 151, 194, 211 ff. The firm of Boeke & Huidekoper was AB Separator's general agent in Holland. During the First World War the demand for agricultural machines was especially great in Europe, and at that time journeys were made from Boeke & Huidekoper inter alia to Sweden in order to ensure deliveries of agricultural machines from AB Separator's factories in Stockholm and International Harvester's factories in Norrköping.

Well-developed communications were a necessary condition for a more extensive distribution of farming machinery. The opening of the railway line between Eskilstuna and Oxelösund in 1877 gave Munktell the opportunity of transporting its heavy machines in a more rational way. However it was to take fifteen to twenty years before the railway's capacity in this respect was used to a greater extent. Munktells mekaniska verkstad's branch in Åstorp in Scania became of more immediate importance for the spread of the machines. From the start of the twentieth century the branch served the growing Scanian market with sales and repair work. During the period before the First World War apart from the branch in Åstorp Munktell set up local offices for sales operations in Stockholm, Örebro, Linköping, Kristinehamn, Falun, Skövde, Växjö, Copenhagen, Moscow and Yekaterinodar (now Krasnodar, to the north-east of the Black Sea in the Russian black earth belt).[62] The decline in the deliveries of traction engines after 1914 was due partly to the outbreak of war but mainly to the fact that the driving power was modernised. The steam-driven traction engines were replaced by kerosene-driven engines at the time when the steam thresher was replaced by the motor thresher.

In Sweden during the earlier phase of industrialisation the accumulation of capital seems to have been brought about by the companies ploughing back their own profits. This applied especially to the engineering works, which were usually founded as quite small companies. An industrious technician could borrow a few thousand Swedish crowns and equip a small workshop with a few filing benches and metalwork machines. Then a gradual expansion could take place towards a production which was worth millions. Although there are instances of companies which were founded from the start as large workshops—by merchants—it normally happened that the workshops were started on a small scale by young technicians and then expanded with the aid of ploughed-back profits. The conversion into a limited company then took place, in order to limit liability and not in order to facilitate the raising of capital. The foregoing description applies in its entirety to the financial development of Munktell. From the founding of the com-

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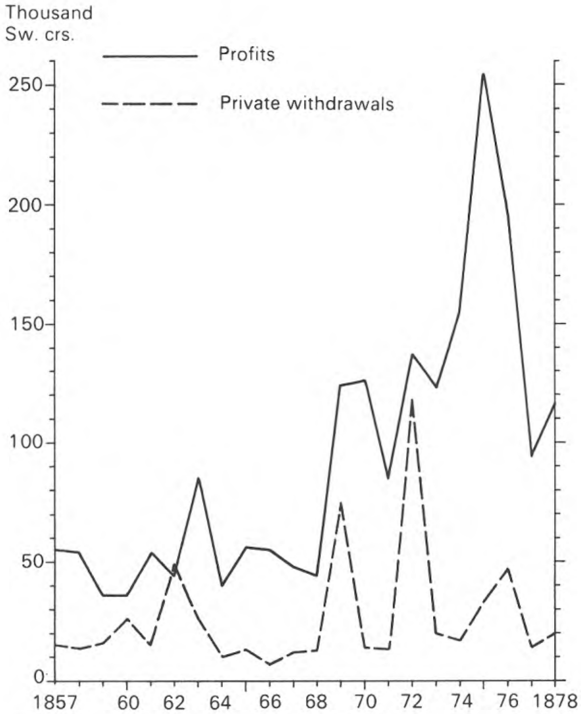
[62] *Svenska industrien 1907* and *1918–1919*.

Diagram 9. *Profits realised before allowance for depreciation and Munktell's private withdrawals before the formation of the limited company in 1857–1878.*



Source **Gårdlund, T., Svensk industrifinansiering under genombrottsskedet 1830–1913, pp. 118* f.**

pany in 1832 to the end of the 1850s when an expansion connected with the transition to farming machines took place, Munktell had expanded gradually after a modest start. Theofron Munktell had not inherited any starting capital from his family. By the end of the 1850s the company had grown and Munktell's personal withdrawals from this time onwards indicate a high standard of living. During the twenty years which preceded the formation of the limited company in 1879, Munktell's personal withdrawals constituted on average 40 per cent of the profits. Thus the greater part remained in the company. In spite of this it was possible for Munktell to withdraw on average 25000 Swedish crowns during the 1860s and

1870s for his personal use. This put his level of expenditure above the salaries of the top civil servants.[63]

After its incorporation in 1879 Munktell remained a family company, and in 1895 the ten largest shareholders held 94 per cent of the total share capital of 850000 Swedish crowns. During the period from 1879 to 1913 no new shares were issued. Instead the expansion of Munktell from the 1890s up to the First World War was brought about to a great extent with the aid of outside capital. As the following compilation shows, long-term borrowing increased especially during the latter part of the period.

Principal categories of debt as percentages of the balance sheet total

Year	Short-term debts	Long-term debts	Own capital	Total
1860	11	13	76	100
1870	1	13	86	100
1880	1	12	87	100
1885	7	13	80	100
1890	6	23	71	100
1895	7	16	77	100
1900	14	40	46	100
1905	6	54	40	100
1910	15	57	28	100
1913	13	56	31	100

During the latter part of the period the long-term credits were arranged mainly through mortgage loans from the commercial banks and a supplementary bond loan. On the assets side the development was distinguished by the decreasing share of the fixed assets from 65 per cent in 1860 to 22 per cent in 1913, while over

[63] Gårdlund, T., *Svensk industrifinansiering under genombrottsskedet 1830–1913*, pp. 43 ff. For the purposes of comparison annual salaries in Sw. kr. of certain high officials are given:

Office	*1850*	*1860*	*1870*	*1880*
Secretary of State	10500	15000	17000	17000
Chief Justice of Appeal	7500	9000	9000	10000
Regimental commander	5400	6000	6740	7500
Justice of Appeal	3900	5000	5000	6400

the same period the stock assets grew from 12 per cent to 36 per cent. In the expansion from the middle of the 1890s to 1913 the liquid assets were multiplied twenty times over (almost entirely trade debts). Thus in 1913 trade debts constituted 42 per cent of the total assets and were therefore the largest item in the assets.[64]

Continuity in the management of the company was also maintained after 1889 when Theofron Munktell Jr. retired as a director of the company. He was then succeeded by the engineer at Munktell, C. G. Thunberg, who remained a director until his death in 1907. Under Thunberg's management significant new building construction and expansion took place in the years 1895–1898, and the turnover almost trebled between 1895 and 1900.

During the boom period of the First World War Munktell expanded the business by purchasing Beronius mekaniska verkstad in Eskilstuna in 1918: this had previously been an independent company specialising in woodwork machines. After the First World War Munktell in common with the whole of the export industry was hit by a gnawing depression during 1921–1923, with decreasing markets and limited orders as a result. The company entered into a serious decline and went into liquidation in 1922. According to contracts of sale a large part of the production and sales at Munktell's factories in 1920–1925 were handled by Nydqvist & Holm in Trollhättan, who had large orders from Russia during these years. In 1926 the Handelsbank took over financial responsibility for Munktell which was extended as the economic trend improved during the latter part of the 1920s, through mergers, on the one hand in 1929 with AB Avancemotor, with tractors as the principal product, and on the other hand in 1932 with J. & C. G. Bolinders Mekaniska Verkstad in Stockholm. The merger between AB Bolinder and Munktell in 1932 signified a fundamental change and widening of the production programme. Bolinder, which produced mainly marine and stationary oil engines, transferred its machine and engine production to Munktell in Eskilstuna, and this became an important branch of the production of the merged companies. The former production of traction engines and steam engines at Munktell had ceased after the First World War. However

[64] *Ibid.*, pp. 36 ff., p. 112.

in the future farming machinery, together with roadbuilding machinery, was also to play a significant part in the production of the company, but with new products such as motor threshers, combine harvesters and tractors.

After the merger in 1932 Bolinder-Munktell developed into a multinational company with seven foreign subsidiary companies in Helsingfors, Oslo, London, Paris, Rotterdam, Milan and New York, and a worldwide agency business was organised for the selling. When the sale of Bolinder-Munktell was mooted after the Second World War, negotiations for its acquisition took place in 1949 with International Harvester among others. However in the following year the company was purchased by Volvo, who had begun to make tractors during the 1940s and had had an agreement with Bolinder-Munktell for cooperation on the construction side since 1943. Thus in 1950 Bolinder-Munktell was linked to the motor car industry and became part of the Volvo group of companies as the subsidiary BM-Volvo.[65]

3. Summary

When Munktell and Överum began to supply engineering products to agriculture in the 1850s, the companies resembled one another in some respects. In the middle of the nineteenth century both could be regarded as companies on an intermediate level with a largely regional field of operations, and both had had connections with the armaments industry before the transition to agricultural implements and machinery. Furthermore, following the concentration on agricultural implements and machinery, the markets of the two companies developed rapidly in their penetration of the national market. But there on the whole the similarities ended. Överum's phase of expansion occurred comparatively early in 1860–1885, when the foundry's ploughs quickly won international recognition

[65] Attman, A., *Göteborg 1863–1962*. I: 2, pp. 62 ff. Hildebrand, K. G., *I omvandlingens tjänst. Svenska Handelsbanken 1871–1955*, pp. 300 ff.

Hellberg, K., *Järnets och smedernas Eskilstuna*, II, pp. 329 ff. A new foundry for machinery was set up in 1918 to supply Munktell's various machine works with materials and semi-manufactured products. During the period between the wars the foundry was the largest for heavy machinery in the Nordic countries.

and dominance on the national market. From then until 1920 Överum can be described as a company which slowed down, while Munktell grew comparatively slowly until 1890, to expand rapidly thereafter.

Munktell introduced traction engines into Sweden in 1853. In Britain the first threshing machine with a traction engine had been shown in Liverpool in 1841. Ten years later the number of steam threshers in Britain was estimated at 8 000.[66] In Sweden the diffusion of the steam thresher was not so rapid, and Munktell, which dominated the Swedish market, only delivered about 7 000 machines in over 60 years. Of these only a small proportion were delivered during the first 40 years. The difference in the rate of diffusion is due to the difference in market conditions. There were comparatively many estates in Britain and therefore the demand grew fast, while the comparatively few estates in Sweden, which for a long time had been the sole buyers of steam threshers, constituted a small market for the producers. The breakthrough in steam thresher deliveries at Munktell only occurred when around the turn of the nineteenth century the larger peasant farms started to acquire steam threshers in large quantities. From this perspective it is possible to establish that Munktell with its heavy farming machinery arrived too early on the Swedish market.

Traction engines and steam threshers, which Munktell introduced onto the Swedish market, were no new products. At the beginning of the 1850s these farming machines were in use on many British estates. For various reasons the traction engine industry developed a tendency to favour the producers on the home market.[67] In addition problems connected with the servicing of the machines hindered the expansion of the smaller domestic producers. In this situation Munktell was able to gain a firmer hold on the Swedish part of the market. Munktell completely dominated the production of traction engines in Sweden, and up to the First World War it was able to conquer an ever increasing proportion of the

[66] Fussel, G. E., *The Farmer's Tools. The History of British Farm Implements, Tools and Machinery before the Tractor came 1500–1900*, pp. 218 ff.

[67] The tariff walls which the Swedish industrial protectionists forced into existence during the latter part of the nineteenth century were a contributory factor in this connection.

country's sales of steam threshers. After 1895 Munktell was able to start exporting on a large scale, and around 1910 the foreign market accounted for about half of the company's total sales. Eighty per cent of the exports went eastwards and Russia, who had a growing but inadequate domestic agricultural machine industry, accounted for the majority of these exports. Russian agriculture, which was expanding but lacked agricultural techniques, required Munktell's steam thresher on an ever increasing scale at the start of the twentieth century.

Eskilstuna's foremost personality in the industrial development of the nineteenth century was Theofron Munktell, who combined technical imagination with enterprise. He was both an inventor and an entrepreneur. The metal industry in Eskilstuna soon took the lead in the country through its prompt application of British and American technology during the nineteenth century. The industrial scene there acted as a spearhead for the rest of the country. The development of Munktell can be explained at least in part by the industrial hot-house climate in which the company functioned. Munktell became an advanced company from the point of view of production technique, but progress was retarded for reasons relating to the market. From a global point of view Th. Munktell created no fresh markets. He opened up the Swedish part of the market. The important concentration on heavy agricultural machines only had economic consequences inside Sweden. Certainly a large number of heavy agricultural machines from Munktell were in due course exported to Russia, but from a Russian point of view these exports were only a drop in the ocean. Even if Munktell exerted a great influence on the economy of the large farms in Sweden, the Swedish part of the market, consisting of the top stratum of agriculture, was too small for Munktell to make a real breakthrough as did another Swedish company dealing in agricultural machines, viz. AB Separator. It was possible for Munktell to develop into a large-scale company in the period between the wars through the merger of companies with different types of production, and at that time the production of agricultural machines only constituted a less important part of the whole business.

D. Large companies with international markets

Before 1914 the manufacturing of agricultural machines on a large scale developed primarily in the USA and Canada. This was quite natural when one bears in mind the many large farm units on the prairies and the existing shortage of labour. Outside North America before the First World War there were no real manufacturers of agricultural machines apart from a few small ones (by American standards) in Britain, Germany, Sweden and France. From an international point of view there were ten really large producers of agricultural machines at the turn of the century, and most of these were in North America. It is therefore reasonable to choose one of the large American producers of agricultural machines to represent the large-scale companies in this research. In addition it has been thought desirable to examine also a large-scale company which produced agricultural technology for a sector of agriculture other than arable farming, viz. cattle farming. On this basis International Harvester Company, Chicago and AB Separator, Stockholm have been chosen as subjects for research on the level of the large-scale company. AB Separator became one of the few large European producers of agricultural machines, and it developed into one of Sweden's largest companies at the start of the twentieth century. The company quickly became the foremost in the world in the field of cattle-farming machines. During the twentieth century the International Harvester Company has been the world's largest producer of agricultural implements and machines, and the equivalent position during the nineteenth century was held by the company's best-known predecessor, the McCormick Machine Harvesting Company, which specialised in harvesting machines.

1. *AB Separator, Stockholm*

(*a*) The background to de Laval's separator

Several foreign visitors came to Sweden during the seventeenth century because of her position as a Great Power. The technical prowess of the Walloons has already been mentioned in connection with the development of Överums Bruk. During the Thirty Years War several families of European soldiers who had joined the Swedish army in Germany followed the Swedish troops home to Sweden. The French Huguenot Claude de Laval also joined the foreign soldiers who emigrated to Sweden. He came to Sweden in 1622 and after serving as an officer he became governor of Vadstena castle in 1640 and was ennobled in 1646. Members of the Swedish branch of the de Laval family generally became officers. One of these officers was Jacques de Laval and in 1844 he was appointed a captain and director of the Orsa Kompani in Dalarna. In the following year (1845) his son Gustaf was born. On his mother's side Gustaf de Laval was a descendant of the Walloon family Martin, who had emigrated to Sweden around 1680. Apart from being an officer, Captain Jacques de Laval was also a land surveyor and a farmer.[68]

Thus Gustaf de Laval who 'invented' the separator in 1878 came partly from a farming background. His personal development after he went to high school in Falun has been thoroughly described by T. Althin. The diary which Gustaf de Laval already began to keep as a youth has helped to make the picture of him unusually detailed. After the student examination in 1863 Gustaf de Laval was enrolled at Uppsala University but instead he began to study at the Technical Institute in Stockholm, from which he graduated as an engineer in 1866.[69]

The difficulties in finding appropriate work drove Gustaf de Laval back to studying at Uppsala University in 1868. He studied chemistry and mineralogy mainly, and in 1872 he defended his thesis 'On Wolfram and its chloride compounds'. However Gustaf

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[68] Althin, T., *Gustaf de Laval 1845–1913. De höga hastigheternas man*, pp. 308 ff. Aktiebolaget Separator, Stockholm. (Memorial publication by C. Kullberg) p. 8. In 1850 the de Laval family moved to Leksand and in 1859 to Falun, where Gustaf began his studies at the high school.

[69] Althin, T., *op. cit.*, pp. 31 f. Gustaf de Laval had difficulty in finding employment as an engineer at the end of the 1860s. The demand for engineers was small since Swedish industry was at that time passing through a period of depression, and so he was first employed as materials book-keeper at Stora Kopparbergs Bergslag.

de Laval had already decided at an early stage to study and carry out research mainly in order to make practical use of his knowledge in fields of economic importance. In the diaries for 1868–1870 manifestos for future businesses often appear. "Surely you are not going to be a scientist in the strict sense. You are only to acquire it insofar as it is necessary for your practical work in the future and useful in independent research and invention! Thus you shall become a scientist in knowledge, that is to say you shall try to reach the top in technology and the technical branch of science; to be a true scientist will never be your goal." (12/2 1870.) The above manifesto was often coupled with patriotism, as in the phrase "Sweden's natural resources for the Swedes!". He predicted that "Sweden could come first in industry as well as in general wellbeing if only the right inventions could be made". Finally he plotted his own course: "My actual field of work looks like being the practical one, mining and metallurgy, agronomy and business involving products connected with these." (10/10 1868.)[70]

In 1874 after his academic studies Gustaf de Laval started his own industrial company manufacturing glass bottles in Falun. The method of production was based on one of de Laval's inventions, in which the bottles were shaped by rapid rotation of the molten glass and centrifugal force. Thus there was no glass-blowing. The company was financed by de Laval's partner Oskar Karlsson, director of Stora Kopparbergs Läns Sparbank. From a financial point of view the business was a failure, mainly because of the fall in the price of bottles in 1874 (the collapse of glass). Production had to be terminated in 1875, but from a technical point of view the enterprise was a success. The centrifugal force principle had proved workable, but de Laval was to use this in a context other than the manufacture of glass.[71]

The first person to show how in theory centrifugal force was able to separate cream from milk is supposed to have been Professor C. J. Fuchs in Karlsruhe, who constructed a small centrifuge for testing cream in 1858. In 1864 in Munich the brewer A. Prandtl constructed a centrifugal machine which skimmed milk on

[70] Althin, T., *op. cit.*, pp. 42 ff. Diaries.

[71] Althin, T., *op. cit.*, pp. 52 f. Althin estimates that the loss of the bottle production amounted to about 40 000 Sw. kr.

a large scale. However he abandoned the experiment when he found that he could not solve the problems of power consumption. In the middle of the 1870s the engineer W. Lefeld, who also came from Germany, started new experiments into the skimming of milk centrifugally. The skimming capacity was 100 kilos of milk an hour, but the skimming efficiency was negligibly higher than when the skimming was done by hand. In spite of the fact that Lefeld improved his machine in 1877, problems of skimming and the disproportionate power required still remained. Lefeld's experiments may therefore be regarded as interesting scientifically but not as providing a practical solution to the problems of skimming milk by the use of centrifugal force.[72]

Gustaf de Laval happened by chance, after the failure of his glass bottle business, to read an article about Lefeld's experiments with centrifugal force. As de Laval himself had used the same principle in the production of bottles he had the qualifications for getting down quickly to the practical side of solving the problems. A machine which revolutionised the milk economy would be tailor-made above all for European agriculture's change-over to the production of livestock under pressure of competition in grain from across the ocean from the 1870s onwards. But the concentration on livestock was not merely a necessary condition for the introduction of mechanised milk production and dairy management, but by and by it also became to a high degree a consequence of this mechanisation.[73]

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[72] The ability to separate two substances of different densities by centrifugal force has been known for several thousands of years. In the older civilisations of China it was possible to let a sling rotate and through the force of the arm separate various fruit juices and oils. Attempts to separate the cream from the rest of the milk centrifugally did not take place until around 1860. Before that simpler sugar and honey centrifuges had been used in Europe. For a more detailed study of the earlier technological history of the milk separator, see Martiny, B., *Geschichte der Rahmgewinnung*. Zweiter Teil: *Die Schleuderentrahmung*. I. Band pp. 7 ff.

[73] The experimental interest which did not begin to be directed towards milk separation until 1860 shows that at that time the market forces in livestock production started to become a force to be reckoned with in the agricultural sector. The expansion of the market forces stimulated a re-thinking about the techniques of milk production. It is probably no accident that the first milking machine was exhibited in 1862 (Fussel, G. E., *The Farmer's Tools 1500–1900*, p. 194). E. Boserup

Table 36. *Production techniques used in Swedish dairies in 1895. Comparative figures*

Area	Farm dairies			Other dairies		
	Ice method	Separator	Total	Ice method	Separator	Total
Eastern Sweden (ABCDEU)	23	77	100	21	79	100
South-Eastern Sweden (FGHIK)	24	76	100	12	88	100
Southern Sweden (LMN)	7	93	100	4	96	100
Western Sweden (OPRST)	23	77	100	6	94	100
Dalarna+ Norrland	30	70	100	26	74	100
Total	20	80	100	12	88	100
	N=533			N=315		

Note N means the number of dairies supplying information about their production technique.

Source Key-Åberg, K., Sveriges industrikalender 1895, p. 574 ff.

Lefeld's milk-skimming machine, which gave de Laval the incentive to develop it further, suffered from the fundamental defect that it could not work continuously. Frequent stoppages had to be made during the skimming which cost time and money. Gustaf de Laval's first milk skimmer was not continuous either, but in 1878

puts forward similar views in trying to explain changes in agrarian techniques. Many of the production methods which began to be used during the agricultural revolution in Europe had been known earlier and were latent until the population increase in Europe increased the demand for agricultural products. The plough had been known in Asia and Europe for many thousands of years. However, less intensive methods of cultivation such as burn-beating have co-existed with plough cultures as late as the 20th century in certain places where outside conditions (the population pressure, according to Boserup) have been lacking for the transition to more intensive farming. In this respect E. Boserup's view of man's development is an optimistic one, since according to her he is able to adapt himself to new conditions. Boserup, E., *The Conditions of Agricultural Growth. The Economics of Agrarian Change under Population Pressure*, pp. 37 f. and pp. 56 f.

he had discovered the principle of the skimming centrifuge which could work continuously. Only when this separator was devised was it possible to say that the problem of skimming by machine had been solved, and only then was it possible for centrifugal skimming to become of great practical importance.[74]

During the 1860s the dairy industry had developed rapidly in Sweden. In order to increase the turnover the dairies began to organise branches known as skimming stations. From these the cream was transported to the main dairy where the making of butter took place. Through this the dairy industry was also able to reach the smaller and more remote farms. The main reason for the boom in dairying during the 1860s was the new method of cream setting introduced at that time, known as the ice method. This involved the cooling down of the milk with ice immediately after milking to a temperature of nearly zero degrees Celsius. After a day or so of cream setting the cream was skimmed by hand and through the chilling of the milk, more cream was extracted. It also became possible for dairies to extend their reception areas so that remotely situated farmers were also able to deliver fresh cream to the dairies. The ice method spread generally and during the 1870s it was the only method used in Sweden. From there it spread to the rest of the Nordic countries and through their good supplies of ice these gained an advantage over competitors in Germany, Holland and Britain. When de Laval's separator first came onto the Swedish market at the end of the 1870s it therefore faced keen competition from the well-established ice method.[75] It is interesting to note that the ice method survived

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[74] Martiny, B., *op. cit.*, p. 23. *AB Separator*, pp. 6f.

Gustaf de Laval, who acquired a patent on his continuously working separator in Sweden, Germany and Britain in 1878 and in most other countries in the following year, was not the first to take out a patent on such a machine. In France in 1874 La Compagnie de Fives Lille had already acquired a patent on a continuous centrifuge. Even though there had been a greater interest in wine rather than in milk separation in France, the patented machine could also be fully used for milk skimming. However, the centrifuge exploded on its first trial run and killed the inventor, and the invention only became known in France to a limited extent. An American patent on a continuous milk centrifuge which was taken out a year or so later by Houston & Thomson also had no practical influence whatever.

[75] The organised operation of dairying was initiated by the Academy of Agricul-

in Sweden for a long time in spite of the fact that Sweden became the world's leading country in the production of separators. Long after the Alpha separator had been introduced, the ice method was in sole use in the newly established co-operative dairies and above all in several of the farm dairies on the estates and model farms. In fact by 1895 the separator had come to most of the Swedish dairies, but a surprisingly large number kept to the old technique of production in spite of the fact that the newer method had been in use for more than fifteen years. It was expected that the farm dairies and other dairies, especially in Sweden, would have accepted the new technique represented by machine separating more quickly than they did.

(*b*) The introduction of the separator onto the market

In order to develop his invention commercially, de Laval needed help from assistants with great business experience. Only two of the 92 objects which he patented, the separator and the steam turbine, were to have any practical value. It may be mentioned in passing that the steam turbine became of great importance for the working of the separator. The turbine engine, with its minimal demands for space, in fact replaced other sources of power which required space, and thus considerably reduced the costs of installing separators. As an inventor de Laval was a firebrand with vivid imagination and enterprise. His boldness in attacking technical problems is reminiscent of Christopher Polhem and Alfred Nobel. In his comprehensive but unpublished history of AB Separator Birger Steckzén describes Gustaf de Laval as the most prominent of the many technicians and 'gründer'-types working in Sweden during the latter part of the nineteenth century. During this period there was a great spate of technical inventions both in the USA and Europe which created a belief in rapid and revolutionary success. This optimism also fired Gustaf de Laval to a high degree and brought ideas to him in a flash of inspiration, but as an inventor and the founder of a company he lacked patience and

ture, various farming institutes and agricultural societies which carried out research and supplied information for agriculture.

The ice method was introduced at the beginning of the 1860s by the estate owner J. G. Swartz at Hofgården in Östergötland.

showed little interest in methodical work on matters of detail. Without doubt the marketing of the separator would have been longer delayed and would have been more difficult if de Laval had not come into contact with Oscar Lamm Jr. He in fact was to play a prominent part in the continuing development of the separator, after de Laval and Lamm had entered into a business agreement for the production of separators under the company name of Oscar Lamm Jr. Lamm came to the fore and patents on the separator were taken out in his name. On the whole the association between the inventor de Laval and the businessman Oscar Lamm proved a fruitful one. They counterbalanced each other since de Laval concentrated mainly on the work of technical development while Lamm took care of the financial and commercial side. But the partners were so different that they had difficulty in understanding each other, and there was often the risk of a schism between the two. During the nine years for which Oscar Lamm ran the management side of de Laval's separator business he organised the company's finances and sales in Sweden and abroad. The early years were difficult in many respects and without Oscar Lamm's assistance de Laval's separators would not have reached the market level which they did.[76]

Oscar Lamm was born in 1848 and so he was three years younger than de Laval. After technical studies in Uppsala and Stockholm he became manager of the cannon foundry in Finspång in 1874. We see in Oscar Lamm a further representative of the Swedish industrialists and businessmen who in the nineteenth century entered the field of agricultural machines via the armaments industry. Through a scholarship from the Board of Commerce

[76] Althin, T., *op. cit.*, pp. 71 ff. *AB Separator*, pp. 13 ff. Steckzén, B., *AB Separators historia*, manuscript.

The effect of the business agreement was that de Laval was to provide machines and Lamm money, or as Oscar Lamm stated after the formation of the firm: "Well, my dear Gustaf, it is now I who give the orders in the business and you who get the machines ready." Lamm worked in an unobtrusive but methodical way, and de Laval's risky plans and rash views on the raising of capital were completely alien to him. In fact Gustaf de Laval was very eager that his separators should spread and become of practical importance, but he thought that the spreading would be achieved if only he solved the technical problems. Everything else was of peripheral importance to him.

Lamm was able in 1876–1877 to make a long trip to Germany, Austria, France and Britain in order to study industrial technology and market conditions. When he met de Laval through a mutual friend Oscar Lamm did not have much capital but he counted on financial help from his father, Ludvig Lamm, a wholesaler. Production of the first series of separators began in 1878 when Lamm and de Laval made twelve separators at Ludvigsbergs mekaniska verkstad in Stockholm, which belonged to Ludvig Lamm. The buyers of the first separators were estate owners, dairies and a few foreign industrial companies. To break down the resistance of domestic buyers Lamm had to obtain a statement from the agricultural experts as to the superiority of the separator over the ice method. Lamm and de Laval counted on more rapid sales success abroad. The possibility of this lay in the fact that a new product was being sold and in a new market area in which competition was weak to start with.[77]

The tests comparing the separator and the ice method which were carried out at Säbyholms gård in Scania in 1879 showed that 10 per cent more butter was extracted with the separator than with the ice method. In that same year the number of separators sold increased to 54, of which half were exported to Germany, Britain, Holland and Russia. The largest buyer was Bergedorfer Eisenwerk in Hamburg who purchased twelve separators. The development at the beginning of the 1880s was characterised by an increase in sales, above all abroad. In 1880 116 separators were sold and in the years 1881–1882 a total of 800, 75 per cent of which were sold to places outside Sweden. The reason for the increase in sales was the establishment of a network of selling agents within Sweden and abroad. Another contributing factor was the favourable outcome for the firm of Oscar Lamm Jr. of certain patenting disputes in Germany in 1880. Competing with the firm's keenest rivals on the separator market, the German firm of Lefeld and the Danes Nielsen & Petersen, who later assigned their patent to Burmeister & Wain, Copenhagen, de Laval's separators emerged victorious from

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[77] The firm of Oscar Lamm Jr. first received a loan of 4 000 Sw. kr. from Ludvig Lamm. Later on, Ludvig Lamm acted as intermediary between his bank and the firm in procuring further loans.

the conflict at a large number of exhibitions the world over, and this naturally stimulated further sales. In turn the increase in demand led to changes on the production side. In 1880 the firm established its own workshops in rented premises and employed fifteen workers there, and two years later the firm built its own workshop premises on the Kungsholmen in Stockholm where 42 workers were employed. The expansion in business led to the conversion of the trading company into a limited company (AB Separator) in 1883. Gustaf de Laval was elected chairman of the board of directors and Oscar Lamm managing director. These two held over 95 per cent of the share capital of 400000 Swedish crowns, and all the shareholders were also members of the board. Thus the management remained in the same hands as before and the change was one of form only.[78]

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[78] *AB Separator*, pp. 13ff. All the documents concerning AB Separator up to 1886 have probably been systematically destroyed. C. Kullberg in his work *AB Separator* has had access to some of Oscar Lamm's copy books which are now missing. In his unpublished historical account of the Separator limited company B. Steckzén has used the private records of Oscar Lamm which have been preserved, but these however contain significant gaps.

From trials which were made at Ultuna and Alnarp's agricultural institutes in 1881 it was confirmed that the separator was superior to the ice method in the manufacture of butter. During the period from 1878 to 1883 de Laval's separator had received 45 highest awards at the same number of shows in 12 different countries.

As sales in Sweden had been arranged through three agents—Carl Jacobsen & Co for central and northern Sweden, C. Holmberg in Lund and G. Bolander & Co. in Gothenburg for the rest of Sweden—Lamm was better able to concentrate on the export business. The first paragraph of the company's articles underlines the company's special concentration on dairying machines and separators: "This company (Aktiebolaget Separator) has as its object, after the purchases of patents and the business of the production and sales of centrifugal separators which was carried out by the firm of Oscar Lamm Jr. in Stockholm, to manufacture and sell centrifugal separators principally in accordance with the patents which Gustaf de Laval has acquired at home or abroad or will be able to acquire in the future for a centrifugal separator invented by him, as well as after acquiring the rights to manufacture and sell a so-called motor, invented by de Laval, in combination with a separator (turbine separator) principally according to the patents mentioned above, and also to manufacture, sell and instal other machines and implements appertaining to dairying."

(*c*) The international spread of the separator against the background of orders from agriculture

After the company was incorporated de Laval dropped out of it to a great extent apart from the work of technical development and he left the business to Lamm to an even greater degree. The international market in separators attracted Lamm and he tried by various means to acquire an increasing clientèle. He paid special attention to North America whose high tariffs made exports there more difficult. To avoid the tariff charges on Lamm's initiative in 1883 a subsidiary was formed inside the American tariff wall (the De Laval Cream Separator Co. with registered offices in New York and Montreal). The subsidiary took over the production of separators in North America with the exception of the separator bowls which were shipped from Sweden. Due to a shortage of capital the American company became indebted to AB Separator in Stockholm. Therefore an alteration in the American company was made in 1885 and it was converted into a new limited company, the De Laval Separator Co. (Lavalco). In the same year AB Separator organised sales in New Zealand, Australia and South Africa. The separator production was the first branch of production in Sweden which was consciously aimed at an international export market from the very start.[79]

Simultaneously with Lamm's efforts on the business side de Laval continued to develop new models of the separator. Incomparably the most important model from the economic point of view was his hand cream separator, which was ready for the market in 1886. In contrast to other hand cream separators de Laval's machine was small and simple to use. For a long time the hand separator was to be the basic product in AB Separator's business. The hand separator acquired enormous importance in the economy of agriculture since it spread to a great extent to the many small and medium-sized farms. In relation to the size of the population the hand separator had the biggest sales in Sweden, but it also became

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[79] *AB Separator*, pp. 35 ff. To start with AB Separator had only held the majority shareholding in the American engineering works, but in 1890 it acquired all the shares in the American company.

very common abroad in areas which concentrated on livestock production.[80]

Reference has already been made to the differences in character between Gustaf de Laval and Oscar Lamm. Lamm used to curb de Laval's bold plans as best he could. When de Laval tried to persuade Lamm and AB Separator to take over one of the lactometers which de Laval had invented, the laktokrit, Lamm refused on economic grounds. The affair led to a split, and Lamm resigned in 1886 as a member of the board and as a director of AB Separator. In the following year Oscar Lamm accepted K. A. Wallenberg's offer of the managing directorship of AB Atlas, and he remained there until 1909.[81]

In 1887 de Laval managed to get John Bernström to replace Lamm: like Lamm he was born in 1848. J. Bernström was a son of Peter Fredrik Bernström who became a farmer after being a master cooper in Helsingborg. After leaving school John Bernström had planned to join the army, but he changed his mind when he took a temporary job with the firm Graham Brothers mekaniska verkstad in Tingstäde on Gotland and he chose a technical-commercial career instead. During the years 1871–1873 he received a technical and commercial education in various employments in Sweden and England. In England he worked as an engineer at a shipyard in Newcastle. On his return to Sweden he was employed by Graham Brothers who had moved to Stockholm, but in 1877 he founded his own company, the machine business of John Bernström & Co. in Stockholm. As AB Separator became one of Bernström's customers he came into contact with de Laval.[82] They

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[80] Steckzén, B., AB Separators historia, Moderbolaget 1895–1903. The following statement emanated from Norwegian farming circles in the middle of the 1890s about the importance of the separator for agriculture: "There is no agricultural machine in our country which has been as wide-spread as the hand separator (mainly from AB Separator). There is no machine which has given agriculture such a boost, and there is no machine which has to the same extent understood, simplified and developed the main route for our sector of agriculture—cattle-farming." From corresponding quarters in Germany it was said: "Next to the plough the hand separator is the most essential implement for the German farmer."

[81] Althin, T., *op. cit.*, pp. 198 ff. Gasslander, O., *Bank och industriellt genombrott. Stockholms Enskilda Bank kring sekelskiftet 1900*. I, pp. 129 f.

[82] *Svenska Män och Kvinnor.*

collaborated more closely in 1884 when they had a common interest in Olofströms bruk. The foundry was the oldest steel pressing factory in Scandinavia and de Laval had noted its technical possibilities for manufacturing separators. However the economic situation at the foundry had for long been a difficult one and in 1884 the owners disposed of the whole foundry. Through Bernström, de Laval and many others Olofströms bruk was bought up and the capital required for the formation of a company (AB Olofströms bruk) was arranged. The business was reorganised. New steel pressing techniques were introduced which were completely suited to the requirements of the separator, and the orders increased rapidly. In 1887 this justified an increase in the share capital and a fundamental reconstruction into Svenska Stålpressnings AB Olofström. At Olofström de Laval was to appreciate in practice what he had learned about steel pressing during his visit to Germany in 1876. It was of great importance for AB Separator that its sheet metal components for the separators should be of a high quality. It is against this background that AB Separator's involvement in the art of processing steel plate must be looked at. Of course it was also important for the company in Olofström to achieve the large-scale production which AB Separator's orders at Olofström made possible.[83] AB Separator became one of Olofström's biggest and most important customers and the boom which AB Separator enjoyed in the 1890s was reflected in increased orders at Olofström. In 1893 Olofström acquired a competitor in the field of steel pressing when Eskilstuna Stålpressnings AB was formed. The driving force behind the formation of the company and the leading figure in the newly founded company was Viktor Larsson, son of the former owner of Olofströms bruk. Under his management the Eskilstuna company developed into a modern factory. In 1906 AB Separator bought the majority shareholding in Eskilstuna Stålpress-

[83] Söderberg, T., *Olofströms bruk 1735–1935*. Althin, T., *op. cit.*, pp. 201 ff.

Due to Olofström's large debts and the creditors' request to be released from their commitments de Laval was able with a partner to take over one part of the foundry. When the owners advertised the sale of the foundry in the daily newspapers in 1884, the machine firm of John Bernström & Co. in Stockholm replied to the advertisement. The Olofström transaction helped to bring John Bernström closer to de Laval's industrial company.

nings AB and on AB Separator's initiative the company in Eskilstuna in turn bought the majority shareholding in Svenska Stålpressnings AB Olofström. By virtue of the very fact that in 1906 the Olofström company was transformed into a subsidiary of the Stålpressning company in Eskilstuna, Viktor Larsson also became managing director of Olofström. In this way AB Separator obtained control over both the Olofström and the Eskilstuna companies. The course of events showed the importance which AB Separator attached to guaranteed deliveries of pressed steel and tinplate products which in the year 1906 amounted to about half a million Swedish crowns in value.[84]

During the 28 years in which John Bernström was managing director of AB Separator, from 1887 to 1916, he succeeded in bringing AB Separator into the limelight internationally. It can be said with complete justification that his contributions in the separator company showed the Swedish export industry the way to success on the world market. His greatest coup occurred after only two years when in 1889 he carried through the acquisition of the Alfa patent in the face of all the opposition from other members of the company's board. The inventor of the Alfa inset was the Austrian baron Clemens von Bechtolsheim. By accident he discovered experimentally that there was a considerable improvement in the skimming if the separator bowl, which constituted the rotor in the centrifugal separator, was split into a lot of cone-shaped discs. The actual separation of the milk took place in the bowl, and the Alfa inset which was fixed inside the bowl consisted mainly of these discs of sheet-metal. The skimming speed was also increased when von Bechtolsheim's Alfa inset was used. In spite of this fact he had difficulties in selling his patented invention to begin with. Negotiations with Burmeister & Wain in Copenhagen and also with German and English firms proved abortive. However at an exhibition in Breslau in 1889 von Bechtolsheim's Alfa separator was noticed by an agent of the firm Bergedorfer Eisenwerk, and he reported the invention to the firm. Bergedorfer Eisenwerk, who were AB Separator's principal agents and were responsible for sales in Germany, considered that it was worth forwarding the invention to John

[84] Steckzén, B., AB Separators historia. Moderbolaget.

Bernström in Stockholm. Bernström acted quickly: he immediately invited the inventor to Stockholm and reached an agreement with him for AB Separator to take over the patent rights. Thanks to his technical instinct Bernström at once appreciated the importance of the Alfa patent, and he quickly and high-handedly concluded a settlement with the owner of the patent. With the epoch-making invention of the Alfa inset which multipled the capacity of the separators, AB Separator was able at one bound to outstrip its competitors in that field. The striking difference in quality between Alfa-Laval separators and other separators appeared very clearly at all the exhibitions. The Alfa inset was to be used above all for hand separators which, with von Bechtolsheim's invention, spread generally throughout agriculture where advanced cattle-farming took place. Thus the Alfa patent became of greater importance to agriculture than to the dairy sector. Between 1890 and 1895 AB Separator's sales increased by 150 per cent and this occurred during a so-called economic slump. Through his agrarian background Bernström had a good understanding of the psychology of agricultural economy, and at his suggestion AB Separator bought Hamra farm in Tumba where a model farm for cattle-farming and dairying was built. In trying to convince farmers, who were technically conservative, it was necessary to be able to point to hard facts. It was also of great importance that the American subsidiary the De Laval Separator Co., which was reorganised financially in 1890 through Bernström's intervention, was able to use the parent company's Alfa patent. Thanks to this technological loan it was possible for the De Laval Separator Co. within the course of a few years to monopolise a large part of the American separator market.[85]

[85] *AB Separator, passim.* Steckzén, B., AB Separators historia. Moderbolaget.

After the transaction with von Bechtolsheim Bernström was accused by other members of the board of acting without authority. The patent rights cost AB Separator 46 000 Sw. kr. together with a yearly royalty during the currency of the patent (14 years). During this period von Bechtolsheim received a total of 3.1 million marks in royalties, but the party which gained most from the transaction was undoubtedly AB Separator.

At all the competitions or fairs in which Laval and Alfa-Laval separators had taken part, they had won the top prizes. During the years 1879–1907 these separators received 780 first prizes in competitions or fairs in 42 countries.

Table 37. *Number of dairy separators of the de Laval type sold in 1886–1895*

Area	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895
Sweden	157	138	176	100	115	14	2	–	–	–
Norway	7	7	8	7	3	2	1	–	–	–
Denmark	24	143	237	119	32	4	–	–	–	–
Finland	11	33	16	7	4	1	1	3	1	–
Russia	3	13	23	10	5	1	–	–	–	–
U.K.	61	103	101	78	75	2	1	2	1	1
Germany	288	395	451	315	278	66	–	1	5	1
Holland	3	11	15	22	6	–	–	–	–	–
Belgium	–	2	–	2	2	5	–	–	–	–
France	–	–	2	2	28	28	21	32	27	15
Spain	1	–	–	–	–	–	–	–	–	–
USA	–	–	–	10	–	–	–	–	–	–
Canada	–	–	–	–	–	–	–	–	–	–
South America	7	1	–	8	3	–	–	–	–	–
South Africa	2	–	2	–	1	–	–	–	–	–
Australia	77	130	198	166	186	162	79	48	15	9
Total	641	976	1 239	846	739	285	105	67	49	26

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Thus the separator had undergone a rapid technical development during the 1880s at the same time as European agriculture was faced with a difficult crisis of adjustment. The adjustment involved a transition to increased livestock production. In fact this very adjustment was one of the conditions for the rise of the separator, while the separator made it possible for the process of adjustment in agriculture to take place more rapidly. This explains why during the 1880s and the start of the 1890s AB Separator's development was more favourable than that of other engineering companies during the economic slump. The purchase of the Alfa patent in 1889 opened up large markets for AB Separator in a decisive way. Tables 37–41 and diagram 11 illustrate clearly that it was the Alfa patent which became the spring-board for the sales of the agricultural separators. The agricultural separator had rapidly developed into a productive machine which appealed to a very large clientèle. When the general economic situation improved considerably in 1895, international purchasing power increased and the spread of the

Table 38. *Number of turbine-powered dairy separators of the de Laval type sold in 1886–1895*

Area	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895
Sweden	14	31	62	29	22	3	–	5	3	–
Norway	–	3	3	1	7	–	–	–	–	–
Denmark	1	11	20	25	1	–	–	–	–	–
Finland	2	27	7	3	1	–	–	–	1	–
Russia	1	2	14	13	2	1	1	–	–	–
U.K.	6	17	15	4	2	–	–	–	–	–
Germany	2	16	39	43	42	6	1	1	6	9
Holland	–	1	3	3	7	–	–	–	–	–
Belgium	–	1	1	–	1	–	–	–	–	–
France	1	1	9	5	10	4	–	–	–	–
Spain	1	–	–	–	–	–	–	–	–	–
USA	7	40	90	146	–	–	–	–	–	–
Canada	–	1	–	–	–	–	–	–	–	–
South America	–	–	11	–	1	–	–	–	–	–
South Africa	–	–	–	–	–	–	–	–	–	–
Australia	–	3	34	15	–	5	63	11	19	5
Total	35	154	309	287	96	19	65	17	29	14

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

separator machines accelerated. The Separator group of companies expanded, especially in countries with advanced agriculture where they consciously aimed at and achieved large shares of the market. Around the turn of the nineteenth century the Separator group of companies had for example supplied 98 per cent of Denmark's dairy separators, 90 per cent of the dairy machines in the larger dairies in the Argentine, about 90 per cent of the dairy separators in Siberia and New Zealand and also 80 per cent of those in Sweden (where domestic competition had begun), 75 per cent of the Swiss market and 50 per cent of the important North American separator market. On the other hand the share of the market was considerably lower in countries with a small total demand for separators, for example Spain, Portugal, the Balkan states, Turkey, Persia, India, China, Brazil and Africa, apart from South Africa.[86]

[86] *AB Separator*, pp. 85ff. Steckzén, B., AB Separators historia.

Table 39. *Sales of hand separators of the de Laval type in 1886–1899. Number of machines*

Area	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899
Sweden	33	272	470	524	579	495	686	1 050	653	322	221	117	19	–
Norway	9	50	155	190	243	162	163	309	517	69	13	2	1	–
Denmark	5	41	33	124	16	13	6	8	–	–	2	–	–	–
Finland	10	67	130	148	95	158	138	153	146	173	214	21	2	–
Russia	8	66	150	108	87	47	29	10	–	–	1	–	–	–
U.K.	17	175	306	270	242	304	237	169	162	61	5	–	–	–
Germany	57	378	713	809	779	433	149	45	69	19	10	18	2	2
Holland	–	3	1	4	3	–	3	–	2	–	1	4	–	–
Belgium	–	9	9	57	87	64	50	17	7	6	12	7	–	–
France	5	15	7	19	28	20	22	2	22	–	–	–	–	–
Spain	1	–	–	3	–	–	–	–	–	–	–	–	–	–
USA	78	30	35	76	75	10	–	–	–	–	–	–	–	–
Canada	–	18	–	–	–	–	–	–	–	–	–	–	–	–
South America	–	1	23	15	5	–	–	–	3	–	–	–	–	–
South Africa	–	8	28	14	15	–	17	41	7	–	–	–	–	–
Asia	–	–	1	–	–	–	1	–	–	–	–	–	–	–
Australia	4	78	230	266	282	155	153	43	38	15	–	–	–	–
Total	230	1 211	2 291	2 621	2 536	1 861	1 654	1 847	1 626	665	479	165	24	2

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Table 40. *Number of dairy separators of the Alfa type sold in 1890–1903*

Area	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903
Sweden	10	68	77	103	151	61	54	52	32	17	17	21	22	20
Norway	–	4	9	15	24	26	25	58	66	52	16	15	18	15
Denmark	1	35	133	395	270	151	138	158	160	126	57	46	43	61
Finland	–	3	15	21	31	48	23	47	45	15	14	17	8	16
Russia	1	9	21	21	5	10	18	41	45	71	76	62	35	38
U.K.	–	14	27	9	24	36	76	170	231	223	185	137	93	75
Germany	5	338	311	247	347	242	366	414	442	482	504	452	532	455
Holland	–	12	7	7	15	12	33	94	76	105	71	97	38	60
Belgium	–	1	4	–	4	1	9	11	24	29	36	34	14	10
France	–	7	13	23	14	8	17	25	26	48	63	42	73	64
Austria	–	–	–	–	–	–	–	41	33	85	61	70	68	11
Hungary	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Switzerland	–	–	–	–	–	–	–	–	–	–	–	12	7	8
Italy	–	–	–	–	–	–	–	–	–	–	–	–	–	5
Spain	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Portugal	–	–	–	–	–	–	–	–	–	–	–	1	–	–
North America	1	12	–	1	–	2	–	–	–	–	–	–	–	–
South America	–	4	9	13	3	11	30	7	16	30	20	20	77	46
Africa	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Australia	–	54	177	122	293	107	183	219	197	176	168	149	199	114
Total	18	553	803	1 087	1 181	715	972	1 321	1 393	1 457	1 388	1 195	1 235	1 002

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

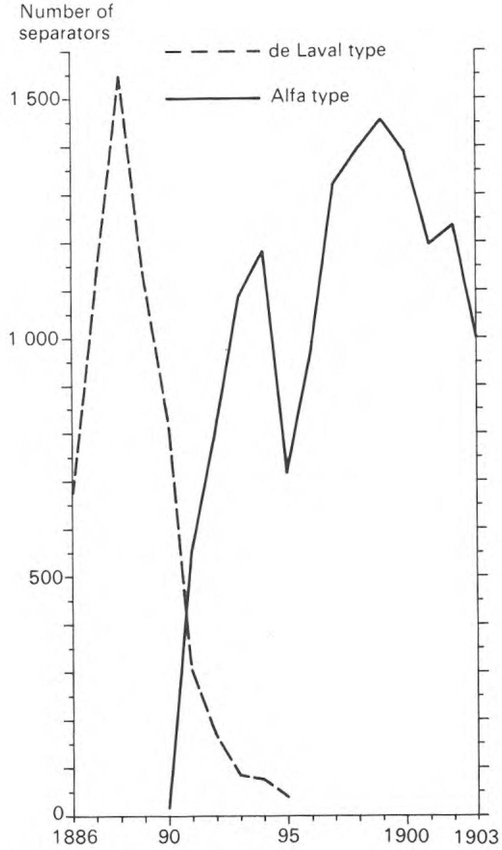
Table 41. *Number of hand separators with Alfa inset sold in 1890–1906*

Area	1890	1891	1892	1893	1894	1895	1896	1897	1898	1906
Sweden	–	58	101	270	1 256	1 628	2 736	3 773	7 010	4 912
Norway	1	55	123	421	344	1 355	1 421	1 282	1 405	1 265
Denmark	1	12	11	23	61	59	92	183	151	51
Finland	–	39	195	359	547	1 734	1 677	2 067	2 316	1 454
Russia	1	34	114	101	69	370	393	503	1 235	5 358
U.K.	2	96	130	226	692	1 345	1 852	1 309	1 532	1 549
Germany	100	712	1 588	2 421	3 451	4 057	3 539	2 975	2 828	14 358
Holland	–	5	7	41	56	74	122	144	89	304
Belgium	1	49	59	94	143	170	386	381	420	711
France	–	7	31	18	39	372	475	743	585	2 836
Austria	–	–	–	–	–	–	–	347	662	3 536
Hungary	–	–	–	–	–	–	–	–	–	150
Switzerland	–	–	–	–	–	–	–	–	–	150
Italy	–	–	–	–	–	–	–	–	–	122
Spain	–	–	–	–	–	–	–	5	–	1
Portugal	–	–	–	–	–	–	–	–	5	30
North America	100	22	–	1	3	5	–	2	1	2
South America	–	5	8	3	3	37	46	33	57	414
Africa	–	8	16	9	–	238	146	127	118	51
Australia	2	38	223	425	802	1 224	1 132	1 245	2 231	4 180
Total	208	1 140	2 606	4 412	8 520	12 668	14 017	15 364	20 741	41 434

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Since a very large part—about 90 per cent (see table 49)—of AB Separator's production was sold on the export market right from the start, it is only right to pause and deal at some length with the construction of the sales organisation. With the exception of North America, where AB Separator had its own factory and its own sales organisation (the De Laval Separator Co.) since 1883, the firm's sales abroad had been handled by the system which was then current of using general sales agents in different countries. The company operated what was known as indirect exporting. AB Separator entered into agreements with several large firms who for a discount sold the Alfa separators. Each general sales agent in his turn had local agents, who were often ironmongers. The local agents were in close contact with the customers and sometimes solicited custom from them with special travellers. In

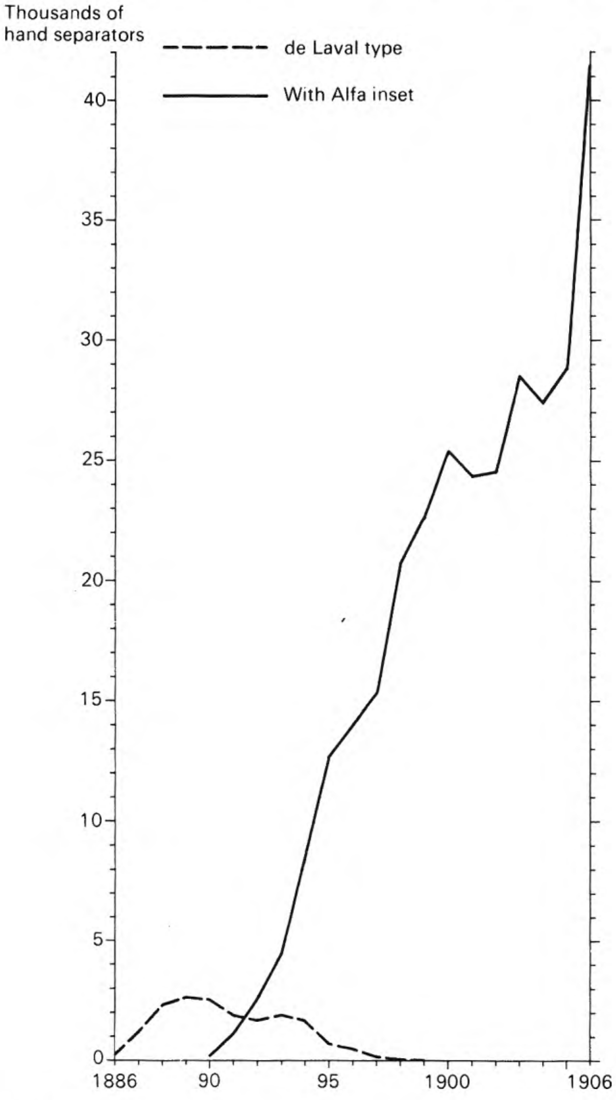
Diagram 10. *Number of dairy separators from AB Separator sold in 1886–1903.*



Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

addition the general sales agents had a number of travelling inspectors who each within his district would give the local agents information on technical matters and marketing, and who at the same time would supervise them and prod them into activity in making sales. The system of general sales agents had both advantages and disadvantages for the producer/exporter. The producer did not have to have any capital tied up in a branch office or risk his credit, but he had no guarantee that the general

Diagram 11. *Number of hand separators sold in 1886–1906.*



Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

sales agents, who usually represented several different export firms, would work the market area in the best interests of the individual producer/exporter. Often the general sales agent would sell at too high a price for the sake of his own profit, and thus would hinder the spread of the product among the clientèle. So the producer's opportunities of guiding developments in accordance with his own particular interests were limited. To remedy this the large companies in the leading industrial countries started at the end of the nineteenth century to change to a system of direct exports. In Sweden AB Separator paved the way for the new export system when at the end of the 1890s it organised the sales in certain countries with its own administration. But there were problems in the gradual and tactful elimination of an international network consisting of 35000 agents. It involved the risk that the general sales agents might be provoked into becoming agents for a competitor. Therefore the more important general sales agents were allowed to remain. The system of direct exports was first tried out by AB Separator in the virgin territories of South-Eastern Europe. In 1897 a branch was established in Vienna to direct the sales in Austria/Hungary and in the Balkans.[87] The agrarian economy of the Balkans was only orientated to a very small degree towards cattle-farming and dairying. Instead sheep farming dominated the more primitive and less differentiated agriculture. Therefore the first attempt at direct export sales was less successful. John Bernström realised that he had begun at the wrong end when he started the first sales company in a field which was as difficult to work as South-Eastern Europe. There had to be greater possibilities where farming and cattle-breeding were practised in more advanced forms as they were in Denmark and Germany. In 1900 AB Separator opened a sales branch (with a repair workshop) in Copenhagen and in the following year a similar branch was opened in Berlin. Something which further contributed to the company's concentration on direct exports to Denmark and Germany was the fact that domestic competitors there began to assert themselves again. From AB Separator's point of view it was desirable to meet the keener

[87] *AB Separator*. Steckzén, B., AB Separators historia. As the national mood of Austria-Hungary varied, the Vienna company established branches in Budapest for Hungary, in Prague for Bohemia, and in Cracow for Galicia.

competition which was expected by more effective use of the superior steering power which direct exporting offered, especially after the expiry of the Alfa patent in 1903. The new sales methods which AB Separator adopted, with direct channels of information in New York, Berlin, Vienna, Budapest and Copenhagen, resulted in its having better contact with international market conditions around the turn of the nineteenth century than other Swedish engineering companies. In 1903 AB Separator's sales abroad were organised as follows:

Europe

Norway AB A. Hollingworth & Co., Christiania
Denmark AB Separators Depot. Alfa-Laval, Copenhagen
Finland P. Sidorow, Suom. K. O., Helsingfors
Russia L. Nobel, St. Petersburg
Great Britain and Ireland Dairy Supply Co. Ltd., London W.C.
Germany Alfa-Laval Separator, A.G.m.b.H, Berlin
Holland Boeke & Huidekoper, Groningen
Belgium P. Gillain, Antwerp
Luxemburg E. Flammant, Luxemburg
France Th. Pilter, Paris
Austria and the Balkan States A.G. Alfa-Separator, Vienna
Hungary A.G. Alfa-Separator, Budapest
Switzerland Baumgartner & Baechler, Zurich
Italy M. Sordi, Lodi
Spain G. Hermanos, Yermo y C:ia, Bilbao
Portugal H. von Hafe, Oporto

Asia

Siberia L. Nobel, St. Petersburg
Persia W. Gilchrist & Co., Glasgow
British India, China and Japan Dairy Supply Co. Ltd., London W.C.

Africa

South Africa H. Farrar, Robinson & Co., Port Elizabeth and East London
Agents in Europe: F. A. Robinson & Co., London W.C.
Algeria Th. Pilter, Paris
Egypt Dairy Supply Co. Ltd., London W.C.

America

Canada The De Laval Separator Co., Montreal and the Canadian Dairy Supply Co., Montreal
The USA and Mexico The De Laval Separator Co. (Lavalco), New York

Brazil Ch. Causer & Hopkins, Birmingham, England
Rio Grande do Sul E. Berta & Co., Porto Alegre
Peru W. Walker, Wolverhampton, England
Uruguay E. Barth & Co., Montevideo
Argentina W. Goldkuhl & G. Broström, Buenos Aires

Australia and New Zealand

New South Wales Waugh & Josephson, Sydney
Victoria J. Bartram & Son, Melbourne
South Australia A. W. Sandford & Co., Adelaide
West Australia J. Bartram & Son, Melbourne
New Zealand Mason, Struthers & Co., Christchurch.

In terms of the parent company's sales, Russia, Germany and Australia were the biggest customers. On the other hand the total sales of the Separator group of companies went mainly to the USA, Germany and Russia, which is accounted for by the sales of the group's subsidiary in the USA and later in Germany (see diagrams 14 and 15 and also tables 43 and 45). Next came a group of medium-sized buying-countries consisting of Scandinavia, Australia, France and Austria. Sweden in fact bought the most separators in relation to the size of her farming population, and from an international point of view she had the widest distribution of separators at the beginning of the twentieth century. A comparatively large domestic market has been a fundamental factor in the development of a prominent export industry.

Thus the really large separator market was developed in *North America, Germany* and *Russia,* which together accounted for about 70 per cent of the sales of the Separator group of companies. The marketing of the company in these countries therefore merits a somewhat closer examination.

North America

When John Bernström joined AB Separator as managing director one of his first tasks at the end of the 1880s was to reorganise the subsidiary, the De Laval Separator Company in New York (Lavalco). New modern workshops were built in 1892 in Poughkeepsie outside New York. The head office was in New York with branches in Chicago, Philadelphia, San Francisco and Los Angeles,

Table 42. *Number of separator bowls sold, 1886–1907*

Area	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895
Sweden	–	4	5	4	8	224	186	175	171	114
Norway	–	–	–	–	2	11	16	24	21	16
Denmark	–	–	2	5	11	121	105	169	178	129
Finland	–	1	1	–	–	14	19	8	16	25
Russia	–	–	–	1	–	48	126	151	64	81
U.K.	–	–	5	17	6	40	27	17	46	52
Germany	6	–	56	37	12	540	518	408	348	290
Holland	–	–	2	5	–	20	9	9	7	3
Belgium	–	–	–	2	–	11	6	12	9	4
France	49	109	30	92	22	11	3	10	12	5
Austria	–	–	–	–	–	–	–	–	–	–
Hungary	–	–	–	–	–	–	–	–	–	–
Switzerland	–	–	–	–	–	–	–	–	–	–
Italy	–	–	–	–	–	–	–	–	–	–
Spain	–	–	–	–	–	–	–	–	–	–
Portugal	–	–	–	–	–	–	–	–	–	–
North America	197	145	300	491	1 350	1 545	1 975	5 650	2 057	2 652
South America	–	–	–	–	–	2	9	10	7	13
Africa	–	–	–	–	–	16	2	1	–	2
Australia	–	–	5	3	23	129	198	155	174	202
Total	252	259	406	657	1 434	2 732	3 199	6 800	3 110	3 588

Area	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907
Sweden	89	62	52	42	44	29	26	17	15	8	12	10
Norway	22	15	10	15	17	8	6	2	3	1	1	1
Denmark	115	47	55	59	87	142	76	65	64	281	185	360
Finland	24	22	17	16	44	14	4	4	1	3	1	4
Russia	171	130	33	5	7	30	14	10	–	–	203	121
U.K.	65	51	24	76	129	114	23	9	30	15	32	19
Germany	298	354	141	107	221	215	71	106	78	1 015	499	261
Holland	6	15	13	11	18	20	13	27	31	14	15	9
Belgium	11	6	22	11	6	8	2	9	3	2	2	–
France	21	7	5	9	35	55	19	20	8	9	4	33
Austria	–	14	13	1	37	3	77	6	35	12	145	7
Hungary	–	–	–	–	–	–	–	–	–	–	11	9
Switzerland	–	–	–	–	–	–	3	–	–	2	–	1
Italy	–	–	–	–	–	–	–	1	2	8	1	–
Spain	–	–	–	–	–	–	–	–	–	1	–	–
Portugal	–	–	–	–	–	4	–	1	2	1	–	1
North America	3 752	4 125	6 477	10 321	15 069	20 875	34 540	53 680	24 275	16 410	22 070	1 993
South America	10	2	1	1	14	–	8	16	36	24	15	6
Africa	–	2	4	6	6	39	5	–	13	5	18	4
Australia	105	86	59	43	440	193	101	242	270	183	242	53
Total	4 689	4 831	6 927	10 719	16 174	21 749	34 988	54 215	24 866	17 994	23 346	2 892

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Table 43. *Number of machines (including bowls) sold by AB Separator, 1886–1921*

Area	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Sweden	239	504	823	775	924	1 061	1 230	1 753	2 394	2 251	3 236	4 134	7 336	8 965	8 408
Norway	18	63	169	214	258	238	315	783	910	1 476	1 490	1 370	1 525	1 870	1 642
Denmark	33	223	346	356	78	195	270	608	523	339	348	406	384	259	164
Finland	32	160	159	167	114	218	394	561	765	2 030	1 957	2 180	2 415	906	946
Russia	13	82	202	144	103	150	311	327	149	475	614	695	1 358	2 005	2 932
The Baltic	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Poland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U.K.	91	304	478	414	371	505	447	439	954	1 560	2 112	1 976	1 955	1 964	1 910
Germany	372	835	1 507	1 472	1 356	2 194	2 664	3 178	4 263	4 673	4 391	3 828	3 529	3 075	3 339
Holland	3	17	24	47	28	46	34	69	88	93	171	285	193	458	465
Belgium	–	15	13	65	98	145	125	128	188	182	426	410	480	443	433
France	56	125	49	134	115	80	100	123	125	416	557	816	675	1 461	1 722
Austria	–	–	–	–	–	–	–	–	–	–	–	457	757	1 032	2 279
Hungary	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Switzerland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Italy	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Spain	4	–	–	3	–	–	–	–	–	–	–	10	–	1	8
Portugal	–	–	–	–	–	–	–	–	–	–	–	–	5	42	27
The Balkans	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North America	285	252	435	752	1 545	1 607	1 978	5 654	2 062	2 726	3 856	4 077	6 490	10 356	15 091
South America	7	2	35	27	20	17	30	53	23	87	135	78	103	111	246
Africa	5	8	30	15	16	24	36	57	159	240	154	158	131	134	190
Asia	–	–	1	–	–	–	4	–	–	–	–	–	–	–	–
Australia	77	213	493	477	524	547	924	887	1 485	1 624	1 489	1 642	2 698	3 150	4 549
Total	1 235	2 803	4 764	5 062	5 550	7 027	8 866	14 620	14 088	18 172	20 936	22 522	30 034	36 232	44 351

Table 43 cont.

Area	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Sweden	6 387	5 785	6 860	5 439	4 667	5 218	5 605	5 415	5 024	4 532	3 364	2 878	6 904
Norway	1 082	1 330	1 221	1 061	1 040	1 306	1 377	1 723	1 332	1 126	844	835	771
Denmark	239	163	189	467	928	289	500	383	334	64	164	114	86
Finland	628	791	733	1 132	1 178	1 488	1 053	1 230	1 282	966	1 218	1 011	1 192
Russia	3 366	2 840	2 823	1 824	3 129	5 746	9 547	3 350	13 079	4 391	17 716	13 836	17 737
The Baltic	–	–	–	–	–	–	–	–	–	–	–	–	–
Poland	–	–	–	–	–	–	–	–	–	–	–	–	–
U.K.	1 857	1 500	1 730	1 629	1 092	1 654	1 798	1 391	1 586	1 504	1 529	1 635	1 887
Germany	3 245	4 252	6 920	7 348	8 517	15 097	11 475	9 480	6 436	3 236	3 148	1 080	2 853
Holland	706	366	386	214	168	366	306	274	236	263	256	106	311
Belgium	650	885	717	485	461	747	798	886	611	813	673	702	1 060
France	1 769	1 916	2 170	1 505	2 147	2 956	4 151	3 977	5 380	5 829	7 319	9 361	10 958
Austria	2 657	3 187	1 672	2 641	3 355	3 828	5 233	5 602	5 974	5 647	7 308	6 627	7 640
Hungary	–	–	105	165	223	178	336	160	270	532	967	901	443
Switzerland	135	101	75	136	157	186	140	121	89	131	107	145	173
Italy	–	–	125	105	107	143	147	148	166	187	223	228	271
Spain	21	1	–	1	3	1	6	1	1	1	–	–	13
Portugal	18	33	19	40	48	44	42	29	38	32	36	38	21
The Balkans	–	–	–	–	–	–	9	23	25	56	31	52	11
North America	20 875	34 540	53 684	24 275	16 411	22 075	1 993	203	610	396	1 447	775	692
South America	293	620	349	365	433	536	675	927	1 123	654	1 230	1 285	2 310
Africa	318	394	269	311	239	69	340	454	546	333	707	956	1 892
Asia	–	–	–	–	–	–	–	–	–	6	–	9	5
Australia	3 908	2 917	4 678	4 577	4 316	4 472	4 838	4 018	4 865	6 617	5 855	5 186	6 737
Total	48 154	61 621	84 725	53 720	48 619	66 399	50 369	39 795	49 007	37 316	54 142	47 760	63 967

Table 43 cont.

Area	1914	1915	1916	1917	1918	1919	1920	1921	Total in 1886–1921 in %	
Sweden	6 891	7 394	10 051	13 350	18 029	11 165	10 481	6 970	14.2	Sweden
Norway	832	850	1 021	769	462	465	440	83	2.3	Norway
Denmark	132	101	83	84	36	52	122	51	0.7	Denmark
Finland	1 018	544	1 042	850	475	761	11	13	3.3	Finland
Russia	19 217	11 599	10 588	9 431	19 613	12 280	32	6 700	14.4	Russia
The Baltic	–	–	–	–	–	–	292	60	0.0	The Baltic
Poland	–	–	–	–	3 051	2 995	1 142	2	0.5	Poland
U.K.	1 885	2 517	2 283	1 513	1 611	562	1 296	755	3.5	U.K.
Germany	2 611	3 055	16 311	12 526	2 643	895	520	1 030	11.8	Germany
Holland	343	275	199	119	19	116	71	44	0.5	Holland
Belgium	895	458	999	418	279	1 488	338	60	1.3	Belgium
France	6 587	1 180	7 351	9 763	8 685	21 008	10 873	1 491	9.6	France
Austria	6 352	7 774	16 837	7 282	7 843	1 940	–	14	8.2	Austria
Hungary	357	183	782	717	23	–	–	3	0.5	Hungary
Switzerland	238	122	353	660	351	118	393	43	0.3	Switzerland
Italy	200	197	118	24	24	392	238	146	0.2	Italy
Spain	11	27	85	57	41	162	85	8	0.0	Spain
Portugal	22	29	87	48	28	124	64	15	0.1	Portugal
The Balkans	145	114	85	–	–	284	344	5	0.1	The Balkans
North America	1 526	369	1 085	1 402	30	2 655	840	556	17.6	North America
South America	1 661	1 559	2 600	1 369	1 329	1 782	4 728	1 439	2.0	South America
Africa	320	1 127	2 033	1 365	1 218	533	1 125	220	1.2	Africa
Asia	9	–	–	–	–	41	303	69	0.0	Asia
Australia	4 011	4 803	5 455	6 590	2 618	2 718	5 217	4 493	8.7	Australia
Total	55 263	44 277	79 618	68 337	68 408	62 536	38 955	24 270	100.0	Total=1 383 346

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Table 44. *Sales figures in thousands of Swedish crowns divided into different countries, 1887–1921*

Area	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901
Sweden	156	223	178	204	232	246	341	434	334	441	505	713	771	707	532
Norway	17	33	43	58	51	64	150	137	183	171	174	200	232	168	115
Denmark	94	168	132	36	68	135	379	270	160	152	155	154	123	107	88
Finland	59	49	44	29	67	111	137	173	383	340	376	403	150	111	78
Russia	23	57	37	28	39	71	65	26	78	106	142	265	379	494	689
The Baltic	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Poland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U.K.	108	133	103	108	128	120	104	180	307	440	456	494	461	414	356
Germany	279	437	451	433	671	765	814	971	961	947	857	792	744	743	722
Holland	7	11	18	11	16	12	20	30	25	62	116	80	140	118	152
Belgium	5	3	19	30	38	35	30	37	41	104	106	121	106	101	152
France	22	13	20	36	33	39	49	38	69	103	150	110	198	234	222
Austria	–	–	–	–	–	–	–	–	–	–	97	143	198	456	374
Hungary	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Switzerland	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27
Italy	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Spain	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1
Portugal	–	–	–	–	–	–	–	–	–	–	–	–	1	7	4
The Balkans	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
North America	51	74	180	173	147	107	272	145	105	204	233	270	350	594	739
South America	11	7	5	8	13	18	8	26	42	14	27	32	42	52	52
Africa	1	9	4	5	4	10	15	37	48	28	25	23	21	30	38
Asia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Australia	87	177	164	195	233	413	314	504	412	415	472	658	681	870	760
Repairs + spare parts	72	81	135	220	162	221	332	354	329	371	470	563	622	782	937
Total	992	1 475	1 533	1 574	1 902	2 367	3 030	3 362	3 498	3 898	4 362	5 021	5 219	5 989	6 038

Table 44 cont.

Area	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
Sweden	452	535	424	367	415	406	365	348	327	272	263	427	422
Norway	126	119	93	94	102	108	123	102	96	67	75	72	61
Denmark	61	75	67	108	66	114	108	154	43	80	60	74	76
Finland	86	87	131	144	138	99	99	99	75	104	91	95	86
Russia	495	436	204	397	776	1 220	431	1 376	512	1 541	1 336	1 422	1 410
The Baltic	–	–	–	–	–	–	–	–	–	–	–	–	–
Poland	–	–	–	–	–	–	–	–	–	–	–	–	–
U.K.	279	294	273	173	222	231	201	210	228	216	240	262	295
Germany	839	1 075	1 043	970	1 169	991	711	645	566	618	431	412	411
Holland	95	115	56	43	80	87	93	85	71	94	60	112	87
Belgium	136	106	81	81	90	106	113	88	126	61	82	124	89
France	266	284	202	262	312	427	408	531	590	699	850	992	546
Austria	413	201	273	332	332	492	520	567	567	661	569	664	543
Hungary	–	40	41	43	25	56	21	55	97	103	70	40	58
Switzerland	19	16	32	33	40	34	22	24	36	34	42	50	57
Italy	–	27	23	21	28	32	37	41	47	63	69	80	51
Spain	1	–	–	–	–	–	–	–	–	–	–	3	1
Portugal	3	1	4	4	4	4	2	3	2	2	2	1	2
The Balkans	–	–	–	–	–	–	1	1	4	2	3	1	8
North America	1 103	1 375	656	329	389	50	26	61	49	70	52	52	91
South America	151	75	64	90	83	99	144	169	85	174	189	312	221
Africa	64	37	34	28	5	35	43	55	25	69	81	155	30
Asia	–	–	–	–	–	–	1	–	3	–	–	–	–
Australia	571	791	730	656	630	684	565	689	1 038	892	820	941	565
Repairs + spare parts	813	885	946	1 050	947	975	708	628	769	1 066	1 458	1 502	1 369
Total	6 012	6 669	5 378	5 227	5 854	6 251	4 743	5 928	5 358	6 890	6 845	7 798	6 482

Table 44 cont.

Area	1915	1916	1917	1918	1919	1920	1921	Total in 1887–1921 in %	
Sweden	517	848	1 553	2 661	1 916	2 040	1 340	12.4	Sweden
Norway	74	117	110	99	105	112	29	2.1	Norway
Denmark	51	57	99	24	61	150	72	2.2	Denmark
Finland	47	109	120	73	150	13	12	2.5	Finland
Russia	1 053	1 277	1 148	3 794	2 486	21	1 592	14.4	Russia
The Baltic	–	–	–	–	–	38	11	0.0	The Baltic
Poland	–	–	–	456	553	72	1	0.6	Poland
U.K.	388	457	376	472	221	586	297	5.6	U.K.
Germany	401	1 681	1 360	454	335	53	229	14.2	Germany
Holland	91	139	113	29	127	78	50	1.4	Holland
Belgium	53	136	115	66	413	97	27	1.8	Belgium
France	194	981	1 628	1 662	4 567	2 394	397	11.1	France
Austria	701	1 620	874	1 474	335	–	–	7.0	Austria
Hungary	18	108	101	44	–	–	3	0.5	Hungary
Switzerland	27	65	131	132	25	86	12	0.5	Switzerland
Italy	81	37	9	10	205	96	104	0.6	Italy
Spain	4	13	10	10	33	25	3	0.1	Spain
Portugal	3	9	6	4	22	12	3	0.1	Portugal
The Balkans	9	14	–	–	57	69	1	0.1	The Balkans
North America	20	69	91	56	370	82	171	5.0	North America
South America	247	461	347	546	433	1 551	525	3.6	South America
Africa	76	167	133	169	96	199	40	1.0	Africa
Asia	–	–	–	–	15	75	14	0.1	Asia
Australia	631	920	963	644	743	1 655	1 517	13.1	Australia
Repairs+spare parts	1 879	2 215	1 983	1 676	2 346	1 922	2 439		
Total	6 562	11 541	11 297	14 547	14 947	11 481	8 887	100.0	Total (excl. repairs+spare parts)=176 115 Total (incl. repairs+spare parts)=209 342

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik. Amounts are given in current prices.

Table 45. *Number of hand separators sold within the Separator group of companies*

Year	AB Separator	AB Centrifug	Lavalco New York	Bergedorf Eisenwerk	AB Pump-Sep.	AB[a] Baltic	Total
1886	230	–	–	–	–	–	230
1887	1 211	–	–	–	–	–	1 211
1888	2 291	–	–	–	–	–	2 291
1889	2 621	–	–	–	–	–	2 621
1890	2 744	–	–	–	–	–	2 744
1891	3 001	–	–	–	–	–	3 001
1892	4 260	–	339	–	–	–	4 599
1893	6 322	–	4 496	–	–	–	10 818
1894	9 245	–	2 259	–	–	–	11 504
1895	13 304	–	4 472	–	–	–	17 776
1896	14 397	–	2 313	–	–	–	16 710
1897	15 290	–	2 367	–	–	–	17 657
1898	20 538	3 300	5 681	–	–	–	26 219
1899	22 808	9 600	7 001	–	–	–	29 809
1900	25 664	11 400	8 113	–	–	–	33 777
1901	24 129	16 000	12 436	–	–	–	36 565
1902	24 418	16 128	27 565	–	–	–	51 983
1903	28 614	14 900	39 234	–	900	–	67 848
1904	27 308	9 026	36 619	–	1 200	15 000	63 927
1905	28 948	8 246	16 213	–	3 700	15 000	45 161
1906	41 315	14 587	22 740	–	4 600	15 000	78 642
1907	44 863	14 022	35 615	–	4 000	15 000	94 500
1908	36 444	15 496	46 000	–	4 700	15 000	97 940
1909	43 786	16 002	57 715	4 168	14 800	15 000	121 671
1910	38 302	17 228	68 497	10 824	21 100	15 000	134 851
1911	45 047	13 982	65 243	11 750	30 000	15 000	136 022
1912	39 588	33 604	67 785	14 791	23 000	15 000	155 768
1913	51 889	34 826	74 561	15 050	42 200	38 109	176 326
1914	41 896	38 763	70 937	14 921	63 000	38 109	166 517
1915	34 743	44 677	74 948	21 365	67 300	38 109	175 733
1916	67 210	84 905	67 835	29 253	98 600	38 109	249 203
1917	57 754	56 826	70 461	26 279	123 000	38 109	211 320
1918	64 415	23 843	63 113	15 805	96 500	38 109	167 176
1919	51 559	35 019	78 806	20 319	104 600	38 109	185 703
1920	30 671	13 202	59 201	21 517	102 000	38 109	124 591

Table 45 cont.

Year	AB Separator	AB Centrifug	Lavalco New York	Bergedorfer Eisenwerk	AB Pump-Sep.	AB[a] Baltic	Total
1921	18 398	7 022	31 960	18 829	36 200	38 109	76 209
1922	19 091	16 234	49 383	9 414	30 000	38 109	94 122
1923	31 768	22 947	41 969	8 263	39 000	55 000	104 947
1924	62 431	27 301	38 874	17 331	68 192	55 000	145 937
1925	94 847	52 939	48 093	37 736	87 071	55 000	233 615
1926	108 561	62 996	47 655	42 140	99 072	55 000	261 352
1927	89 106	70 285	51 313	21 992	96 114	55 000	232 696
1928	81 839	68 640	43 256	10 940	85 287	55 000	204 675
1929	62 065	45 752	33 620	8 990	79 027	55 000	229 454
1930	59 062	44 160	20 700	7 360	63 935	55 000	195 217
1931	40 071	36 679	12 049	–	37 820		126 619

[a] From 1931 included in Pump-Sep.

In the total column only the sales of AB Centrifug, AB Pump-Separator and AB Baltic have been included below the line. The line marks the point when the abovementioned companies merged into the Separator group of companies.

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik, Avd. L. 15.4.1959.

and a large staff of local agents formed part of the sales organisation. The greater part of the sales went through the office in Chicago, as it was situated in the middle of the butter producing area of the USA. During the 1890s the De Laval Separator Co.'s sales increased significantly, and at the start of the twentieth century the De Laval Separator Co. was able to overtake the parent company in Stockholm. These successes were due to a series of favourable factors. First of all the De Laval Separator Co. had access to a large and continually growing home market. In contrast to the parent company, the De Laval Separator Co. could devote all its attention to domestic sales and did not need to incur costs in order to organise export trade. Even though cattle-farming in the USA centred round meat production more than it did in Europe, dairying started to develop rapidly during the 1890s. The farms were large and spread wide at great distances from the dairies, especially on the prairies in the Middle West. Therefore

Diagram 12. *Number of agricultural separators within the Separator group sold in 1886–1931.*

Source Alfa Lavals arkiv, Tumba: Försäljningsstatistik, Avd. L 15.4.1959.

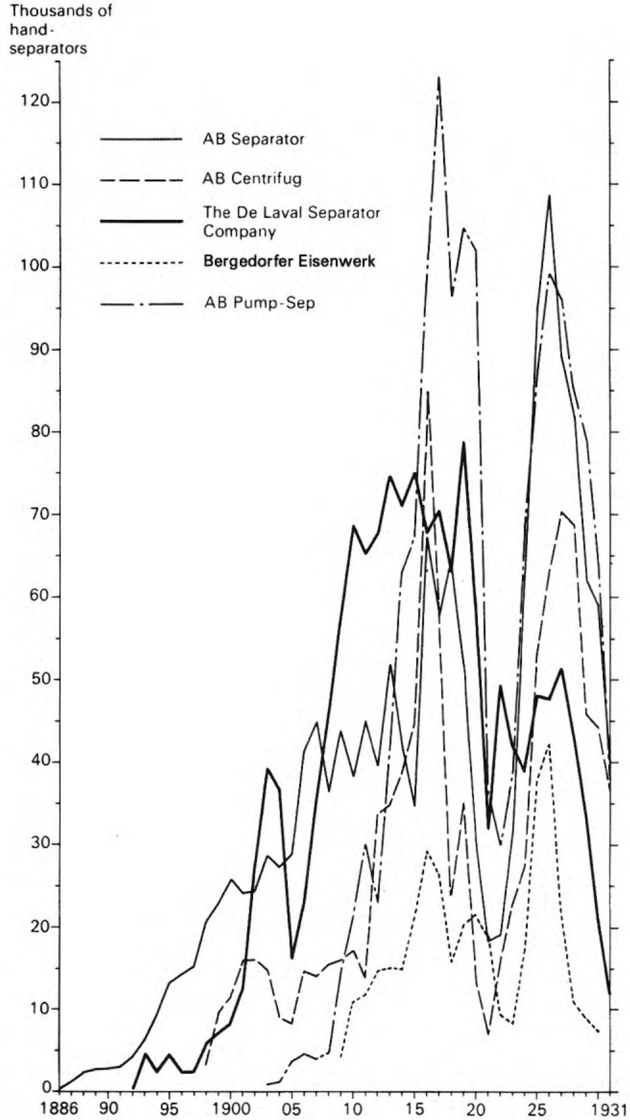


Diagram 13. *Number of hand separators within the Separator group sold in 1886–1931.*

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Diagram 14. *AB Separator's sales distribution in terms of value in percentages according to geographical localities for the period 1887–1921.*

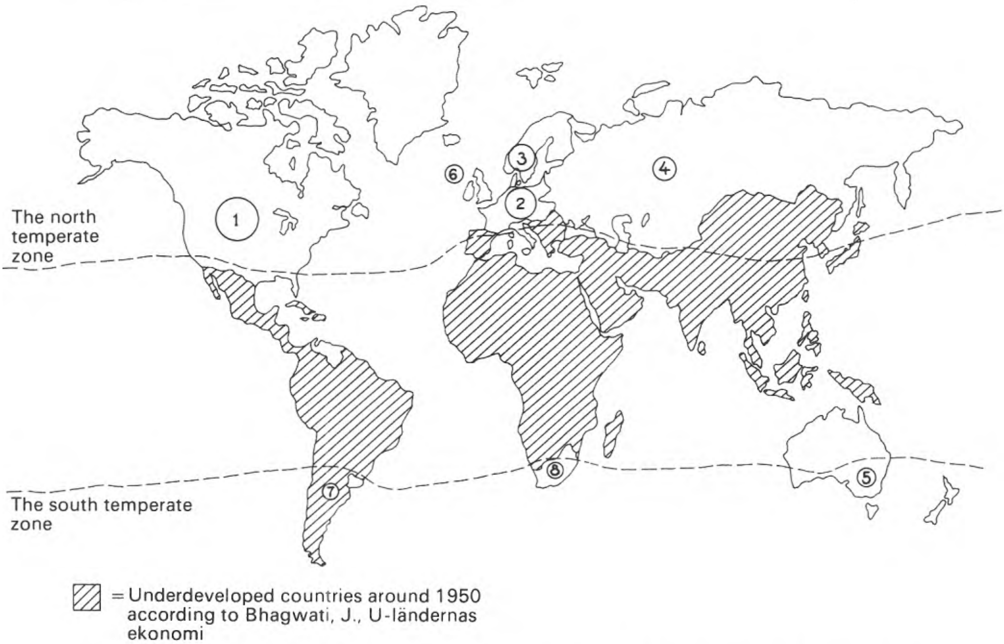
Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Diagram 15. *The distribution in percentages of separator sales localities for the Separator group of companies (excl. AB Centrifug) for the period 1886–1921.*

The total number of separators sold (excl. AB Centrifug) in the period 1886–1921 was about 2.5 million. If AB Centrifug is included the number of separators sold was about 3 million.

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

Map 8 showing the more important sales areas of the Separator group of companies (excl. AB Centrifug).



1=North America 45%; 2=Central Europe 27%; 3=Scandinavia 11%; 4=Russia with Siberia 8%; 5=Australia and New Zeeland 5%; 6=Great Britain 2%; 7=South America 1%; 8=South Africa 0.7%; 9=Others 0.3%.

the dairying had to be developed to a great extent within the individual farm. Here the farmer's need of a hand separator was greater than in other places. It was also the hand separator which dominated the American sales. In Europe, where the size of the average farm was smaller than in the USA the smaller hand separators (100–200 litres) usually supplied the needs of the farms, while the American farmer as a rule bought separators in the 300–400 litre range. In the battle for the American market the De Laval Separator Company had the great advantage of access to the Alfa patent and to the parent company's know-how, which was constantly given prominence in the advertising. For example the manufacture of the separator bowls took place in Sweden for a long time, whence they were exported for final assembly at the De Laval Separator Co.'s factory. On the other hand AB Separator took valuable soundings from the De Laval Separator Company about American implement machines and work methods for mass-production.

A year or so after the turn of the nineteenth century there was a noticeable boom in the sales of separators at the De Laval Separator Co. In farming circles there was rapidly increasing enthusiasm for dairying and farm separation. The optimism was due to the increase in butter prices in 1902, after the Congress in the USA had decided to restrict the trade in margarine. The pressure of demand gave rise to expansions in the De Laval Separator Co.'s production, and after some resistance from the parent company the De Laval Separator Co. got permission in 1903 to press its separator bowls itself. The decrease in the parent company's exports after 1903 which resulted from this is clearly shown in tables 42 and 43.[88]

At this time (1902) there were in the USA apart from the De Laval Separator Co.—which alone had about 50 per cent of the separator market—eight or nine separator manufacturers of which the most prominent were the Sharples Separator Company, the Empire Cream Separator Company and the Vermont Farm Machine Company. The Sharples and Empire companies in fact based their production on models of Swedish origin or which had been in-

[88] The information about the De Laval Separator Co. is mainly based on business correspondence between the De Laval Separator Co. and AB Separator, which has been subsequently collated by B. Steckzén. John Bernström acted as chairman of the board of the De Laval Separator Co. After 1893 the managing director Francis Arend was responsible for continuing the work. In 1901 John Bernström's son Richard was appointed as liaison man between AB Separator and the De Laval Separator Co. and thereafter he visited the USA every year. In particular there was extensive correspondence between Francis Arend and Richard Bernström.

In a letter from Richard to John Bernström on 29 April 1904 the son tries to persuade his father that it was sensible for the De Laval Separator Co. to start its own production of separator bowls. "The production capacity of the De Laval Separator Co. must be increased so that it can cope with the fierce rush to buy. The new law against margarine and the ensuing high butter prices have brought about an actual revolution in the separator market. Our Chicago office has requested by telephone at least seven wagon loads a week—we can produce four."

vented by Swedes. Sharples had been founded in 1890 by Philip Sharples who had manufactured separators for the De Laval Separator Co. during the 1880s and had thereby acquired a good understanding of the Alfa-separator's characteristics. When he started his own production he copied the Swedish separator to a large extent. Empire at the turn of the century had close technical and financial contacts with Svenska Centrifug AB, which was established in 1896 on the initiative of Gustaf Wallenberg. Since 1898 the Centrifug company and Empire had the same type of separator on the market (the Kronseparator), which had been constructed by the Swede Olof Ohlsson. In 1902 Gustaf Wallenberg sold his interest in the Centrifug company and bought the majority shareholding in Empire. Some years later Svenska Centrifug AB was bought by AB Separator.

The Alfa patent expired in 1903 and this triggered off an enormous amount of activity, above all among the De Laval Separator Co.'s competitors. The competitors who were established feared new rivals in the industry, and in 1903 they made several attempts to organise some form of merger in which the De Laval Separator Co., Sharples, Vermont, Empire and a few other separator companies could join. As for AB Separator and the De Laval Separator Co., they pursued a wait-and-see policy and they did not want to participate in a trust which amassed a large share capital by capitalisation of the assets which could later be sold off by the interested parties at their own discretion.[89]

In the years immediately after 1903 the separator market in the USA was characterised by keener competition and a decrease in the total demand. Even the De Laval Separator Co. was hit by this, but its older competitors were affected to an even greater degree. In fact the latter with their cheap separators had concentrated above all on the smaller farmer who had between 2 and 10 cows. The new competitive companies which were started after 1903 mainly solicited the same type of customer with cheaper and simpler machines, while the De Laval Separator Co.'s approach was mainly to the larger farmer with bigger and more expensive

[89] The attempts at a merger in 1903 were mainly provoked by a desire to make the market more difficult for the newcomers to the separator industry who were expected after the expiry of the Alfa patent.

machines. The mail order firms were a new feature of the competition, operating on small profit margins and selling everything "from pins to locomotives". The most important of these mail order firms was Sears, Roebuck and Co., which started its own separator production in 1905. The most disconcerting thing for the De Laval Separator Co. was the fact that in 1904 the world's largest manufacturer of agricultural machines, the International Harvester Company, seriously considered involving itself in the separator industry. With its efficient sales organisation of 57 000 agents and an advanced credit granting system International Harvester had a firmer hold on the ironmongers. It was convenient to combine agricultural machines and separators when International Harvester tried to develop the so-called full line principle, which meant that the company would sell all kinds of implements and machines which a farmer might need. However the company policy of International Harvester was diametrically opposed to that of the Separator group of companies which concentrated exclusively on one special product. Francis Arend of the De Laval Separator Co. launched a counter-attack in a memorandum to International Harvester in which he gave an account of the leading position of AB Separator and the De Laval Separator Co. in the separator industry. If International Harvester began in earnest to manufacture and sell separators through its dealers in agricultural machines, the De Laval Separator Co. would probably feel obliged to take certain counter-measures and fight International Harvester by starting to sell agricultural machines. But Arend finally suggested that it would be appropriate for the two companies to co-operate in order to be able to outdo other competitors. However no such co-operation ever took place.[90]

Because of the many newly established separator workshops (35 factories in the spring of 1906) and the increasing resistance of the customers the De Laval Separator Co. was to see its separator sales sharply reduced in 1905. In spite of this throughout the year reports came in to the effect that the De Laval Separator Co.

[90] In the correspondence between Francis Arend and Richard Bernström during the autumn of 1904 the topic of International Harvester's activities was frequently discussed. They agreed that International Harvester was able to extend its sales programme at a comparatively low cost.

still held a share of about half the market in the Middle West as well as in the USA as a whole. After three lean years from 1904 to 1906, 1907 brought a new boom for the De Laval Separator Co. with new models from AB Separator. The critical years hit the rival company Empire especially hard. The development caused problems for Gustaf Wallenberg, and he tried to interest AB Separator in purchasing the majority shareholding in Empire. But Empire was no longer looked on as a threat to the De Laval Separator Co. and the offer was declined. In Stockholm there was greater uneasiness about the doings of International Harvester. In 1908 Richard Bernström was not unfamiliar with measures which would facilitate the sale of the De Laval Separator Co. to International Harvester, through which in his view a large capital gain would accrue to AB Separator. But his ideas failed to win any response either in New York or in Stockholm. Francis Arend replies to Richard Bernström's argument and at the same time corrects the latter's sanguine view of the extent of the American separator market. Since Arend's letter analyses the state of the market in a nutshell it is quoted extensively here: "I don't quite know where you (Richard Bernström) got your idea about the possibilities of selling separators in this country, and I wish we could absorb a little of your tremendous enthusiasm about it. I am now thinking in particular about you saying that you believe the day will come when the sales of separators in the USA will easily reach 700 000 a year. According to my estimate there are two million farms in the USA and Canada which have three or more cows, where separators could be used within the next ten years. There are probably 800 000 separators in use today on those farms, of which 300 000, or to be more precise, 40 per cent are Alfa machines. In 1908 probably 165 000 separators were sold, of which 10 per cent replaced old machines; of that total about 35 per cent came from Lavalco. The selling becomes more difficult because of the fact that the bigger and more enterprising farmers already have separators. On the other hand the number of machines which are replaced must increase, and it is not impossible that total sales can reach 200 000 a year, but I think it is unlikely that they will exceed this maximum.

"Our share of the sales is of course another question. The question is whether we wouldn't be in a very good position with one-third, and whether it won't be hard for us to keep our position, let alone improve it, if we aim at half. However the conditions about sales can be changed. Twenty years ago we had to give one agent a district with a radius of 25–100 miles in order to get him to start selling separators. Since then we have reduced the extent of the agents' districts from year to year so that they now have a radius of 5 miles on average. The tendency still continues towards smaller districts and the time may come when we can try to sell to all the agents in a district instead of to only one out of about ten agents. We extend ourselves as far as we can and with as much speed as is possible at present, but we are handicapped in the choice of agents. We can offer what most people consider to be the best separator, but the best salesmen probably represent International Harvester. The dealers can't afford to forgo this gigantic complete range of implements and machines, which gives them material to work all year round, in order to sell a separator however excellent it is. International Harvester is now increasing the pressure on its agents to carry its separators. That this has not been done to a greater extent is due to the difficulties they have had with their machine. Difficulties which we assume International Harvester will overcome. Naturally we sometimes ask ourselves the question whether we ought not to tackle the agricultural implement industry on a wider basis and carry trailers, ploughs, harvesters, mowing-machines and so on. It is true that we don't wish to do so and ought not to do so if it can be avoided, but with the direction in which conditions seem to be taking the business perhaps we will be forced to do so in order to safeguard our own legitimate business."[91]

During the autumn of 1909 the financiers made fresh attempts to sell Empire to International Harvester or AB Separator. The Swedish financier William Olsson then came onto the scene as representative for Gustaf Wallenberg and in close accord with banks

[91] Francis Arend's letter to Richard Bernström 28/1 1909. In a subsequent letter to Richard Bernström on 7/10 1909 Arend reports that the John Deere Plow Co., the biggest firm in agricultural machinery next to International Harvester, had shown an eagerness to sell the De Laval Separator Co.'s separators. However, Arend felt obliged to refuse the offer on account of the agent organisation.

in London, New York and Stockholm which had interests in the Empire deal. True to type, William Olsson acted very independently and made much ado about the deal. He thought of resolving the Empire deal by linking it with risky transactions in which International Harvester and AB Separator would be played off one against the other. First William Olsson got in touch with International Harvester in Chicago and suggested that the company should acquire the greater part of the American separator industry by purchasing Empire and the De Laval Separator Co. But William Olsson went one step further and presented a grander alternative, viz. that International Harvester should also purchase AB Separator in Stockholm with its world-wide assets. Thereby International Harvester would also be the leader on the international separator market which would accord well with the company's "full-line" principle. Then William Olsson contacted the De Laval Separator Co. with the reverse offer: the De Laval Separator Co. should purchase Empire to reinforce its ability to compete with International Harvester. But there was little interest from either of the big groups of companies in William Olsson's plans in spite of the fact that he came back on several occasions with various suggestions for a solution. Among other things in 1910 he tried again to get the large separator companies to purchase Empire after the company had introduced a centrifugal machine for rubber, which according to William Olsson provided a rational solution to the problem of the coagulation of the rubber juice (latex).[92] The deal exemplifies the characteristics of the early 1900s in the USA, with company mergers the better to acquire new techniques and secure present and prospective markets.

In Europe interest increased by and by in the smaller and cheaper hand separators which best met the needs of the many small farmers. In order to meet competition on the European market AB Separator felt obliged to sell small and cheap hand

[92] William Olsson's letter to John Bernström 19/4 1910. Bearing in mind the increased demand for rubber from industry and motoring the rubber separator might be of great value in the future like the Alfa patent, and so John Bernström did not reject William Olsson's suggestion out of hand from the start. But after some time it turned out that Empire's rubber separator did not work in practice and William Olsson's labours were definitely in ruins.

separators there. At the beginning of the 1910s the parent company also wanted to introduce the smaller, cheaper separators into the USA, but met with powerful opposition from Arend in the De Laval Separator Co. According to him market conditions in the USA and Europe were fundamentally different. The need for larger separators was proportionately far stronger in the USA than it was in Europe, and competitive low-priced machines did not create any great obstacle for the De Laval Separator Co. No change was made in the production programme.

In 1913, the last year of peace, the De Laval Separator Co. reached a sales peak of 75 000 separators. In a detailed market report to AB Separator Richard Bernström also gives the De Laval Separator Co. much praise for its activities in the USA and Canada. He found that the workshops in Poughkeepsie had an annual production capacity of 80–90 000 separators, which considerable investments had made possible. The majority of the De Laval Separator Co.'s sales went through the office in Chicago which supplied the large farming districts in the Middle West. Richard Bernström also dealt with the situation as regards competition on the international market, and he found that The De Laval Separator Co. was able to keep its position even after International Harvester, with its superior network of agents, had begun to sell separators. In the report the total number of separators sold annually in the USA was estimated at 210 000. The De Laval Separator Co. sold about 75 000 of these, while the yearly sales figures of the other competitors was estimated as follows (page 162).

Another matter canvassed in the report was the question of the consequences of the reduction in the duty on separators which Congress had resolved in 1913. The earlier tariff rate of 45 per cent was abolished completely as far as cheaper separators were concerned (under $75) and was reduced to 25 per cent for the others. But since the American demand was mainly for the larger machines and European production was devoted to the smaller ones the decision was not regarded as a real threat.[93] The reduction in the

[93] Report from Richard Bernström to AB Separator 3/12 1913 after a tour of inspection lasting two months in the USA and Canada. On the subject of separator competition R. Bernström wrote: "In America International Harvester has led the way in pursuing a sales policy which has enabled local agricultural machine agents

tariff on butter in 1914 posed a much greater problem. The price of butter in the USA fell by 30 per cent mainly under pressure from Australian and European butter exports, which led to a decrease in the purchasing power of the American farmers and a reduction in the demand for separators.[94]

	Thousands of separators	In per cent of total
The De Laval Separator Co.	75	36
International Harvester[a]	30 (at the most)	14
Sears, Roebuck & Co. (mail order firm)	25	12
Sharples	25	12
Empire	15	7
United States	15	7
Marsh (Waterloo, Iowa)	5	2
Others	20	10
Total	210	100

[a] The De Laval Separator Co.'s estimate of International Harvester's yearly sales corresponds well with the reality. The sales in fact amounted to 25 thousand according to International Harvester's own book-keeping.

Source McCormick Collection. International Harvester Co.: Annual Settlement Records, 1912.

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to buy from the company about 75% of all the various implements which they need for their business. Through this the seller gains still further great influence over the agent which the seller exploits in order to force upon the agent the agency for the new products which the seller has decided to produce. This situation has left its mark on the operations of the De Laval Separator Co. in the latter years. In certain districts in America about 50% of International Harvester's local agents also work for the De Laval Separator Co., and therefore the De Laval Separator Co. has lost quite a lot of good agents since the International Harvester Co. started to produce and sell separators. However it turned out that the separators which were produced by International Harvester Co. were greatly inferior to those produced by the De Laval Separator Co., and at present the position is such that the Harvester company dares not compel those of its agents who prefer to sell the De Laval Separator Co. machines to stop doing so."

[94] According to the USA's trade statistics the net imports of butter increased by about 3 million pounds both from Australia and Europe in 1914.
Foreign Commerce and Navigation of the United States 1914–1915.

On the whole the economic trends from 1907 up to the First World War had been favourable, and during these seven years the turnover of the De Laval Separator Co. was doubled as well as its profits. Thus as regards finance the De Laval Separator Co. became of great importance to the parent company AB Separator. Furthermore the De Laval Separator Co. could invest its own profits in fixed assets which were later written off. This enabled AB Separator in 1910 to write up the value of its shares in the De Laval Separator Co. by about 11 million Swedish crowns. Altogether AB Separator was able to pocket almost 60 million Swedish crowns in profits of various kinds from the De Laval Separator Co. before the First World War. On the basis of the parent company's investment of barely half a million Swedish crowns in the subsidiary this can be regarded as an excellent yield. During these years the De Laval Separator Co. was the goose which laid the golden eggs.[95]

Germany

On the important German market AB Separator's interests had been managed from the start (1879) by the general agent Bergedorfer Eisenwerk near Hamburg. This firm was founded by Wilhelm Bergner in 1859. From the start the production comprised agricultural implements, agricultural machinery and dairy utensils, and so the selling of separators was easily added to the company's earlier activities. During the latter part of the nineteenth century dairying developed very rapidly in Germany. The number of co-operative dairies rose from 28 in 1880 to nearly 2 000 in 1900, and at the latter point in time dairying constituted the most important German branch of the economy as regards production value. Parallel with this development there was an expansion in the market for dairy and agricultural separators and Bergedorfer Eisenwerk became AB Separator's largest foreign dealer in Europe. At the turn of the nineteenth century AB Separator dominated the German market completely as regards dairy separators and was the largest manufacturer of hand separators.[96] As is shown in tables 43–44 the

[95] Cf. table 47.

[96] According to Alfa-Laval's internal statistics, in 1898 87% of the dairies in the Rhine area were equipped with Alfa-Laval separators. The remaining percentage

number of separators sold to Germany rose up to 1895. After that time there was a certain decline which was caused by the growing tension between AB Separator and Bergedorfer Eisenwerk, partly connected with the fact that Wilhelm Bergner handed over the management to his son Carl. His intention was to free himself from AB Separator when the Alfa patent expired in 1903. Through its position as general agent for AB Separator and as a large producer of other dairy equipment Bergedorfer Eisenwerk had excellent prospects of building up its own separator production. The company had its own sales organisation and very good contacts with the German dairy industry as well as with the farming community. They mastered the manufacturing of all the spare parts for the separator, apart from the centrifugal bowls, and in 1900 Bergedorfer Eisenwerk approached Friedrich Krupp about orders for centrifugal bowls. On the basis of what had occurred AB Separator threatened to withdraw the selling of hand separators from Bergedorfer Eisenwerk at the same time as a branch was opened in Berlin in 1901 for the selling of hand separators. However, for the time being Bergedorfer Eisenwerk was allowed to continue selling. Through the establishment of the Berlin branch there was another rapid increase in the sales of hand separators to Germany.

In spite of everything, AB Separator's position in the German separator market was comparatively secure when the Alfa patent expired in 1903. But German national feelings were being roused against the pressure of foreign competition and national propaganda against foreign companies became more and more aggressive at the turn of the century. Within the separator industry it was considered that the Swedish-owned AB Separator, established on the basis of an original German invention (the Alfa patent) was exploiting the German market. Consequently when the Alfa patent expired the company faced a two-pronged attack from new German separator factories on the one hand and national propaganda on the other.

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was divided among five manufacturers. Conditions in other parts of Germany were similar. The account of AB Separator's operations in Germany is mainly based on Alfa-Laval's own sales statistics, B. Steckzén's manuscript AB Separators historia: Bergedorfer Eisenwerk and Alfa-Laval Berlin 1900–1914 and also AB Separator 1883–1908, pp. 101–107.

As in the USA and Sweden, the inclination to invest arose in Germany after the expiry of the Alfa patent, and a large number of new separator factories were started. For example in Germany in 1903 there were about 20 native separator factories, but ten years later there were 125, most of them small and short-lived.

The relationship between AB Separator and its general agent Bergedorfer Eisenwerk deteriorated further in 1903. Bergedorfer Eisenwerk then signed a contract with the separator company Svea in Stockholm concerning the sales of its separators in Germany, which AB Separator regarded as a breach of contract. In these circumstances AB Separator transferred the selling of power separators from Bergedorfer Eisenwerk to its branch in Berlin. In addition in 1904 AB Separator began a long-drawn-out lawsuit against Bergedorfer Eisenwerk about a patent matter, and official contacts between the two companies were severed.[97]

Despite the parting from its general agent in Germany in 1904 AB Separator through its branch in Berlin was to see German orders increase rapidly during the following years. Requests were made for an increase in the production capacity and feelers for the purchase of a suitable factory were put out in 1906. It would seem to be profitable from several points of view for AB Separator to have a factory for its own production in Germany. The effect of the German national propaganda, which was directed against imports from abroad, would thereby be reduced, and the extra costs of duty and freight would be eliminated. Bergedorfer Eisenwerk had been faced with a series of problems after its parting from AB Separator. Among other things internal relations within the Bergner family had deteriorated rapidly as a result of financial difficulties. The company had had set-backs on the separator side, due partly to the dispute with AB Separator, and in 1907 Carl Bergner's relatives forced him to sell the majority shareholding to AB Separator. It was decided when the deal took place that Carl Bergner would act as managing director for the time being, but alongside him there

[97] The patent dispute mainly concerned an improvement of the Alfa patent, the central cross, which had been invented by an American called Berrigan, whose patent had been acquired by AB Separator. When Bergedorfer Eisenwerk began to produce the "Astra" model of separator in series AB Separator took the view that the model infringed the patent.

would be a co-director nominated by AB Separator. John Bernström joined the board as chairman. Bergedorfer Eisenwerk's production of separators was to cease and production was to be devoted instead to Alfa separators. The selling was organised so that in principle Bergedorfer Eisenwerk would sell power separators and the branch in Berlin hand separators. Direct exports of separators to Germany were to decrease because of the acquisition of a factory there, as is shown in table 43. The Separator group of companies was more than compensated for this loss by the production of the subsidiary in Germany (table 45). The deal attracted great attention in German dairying and industrial circles since it was unusual for foreign companies to gain control of a factory in a highly industrialised Germany, and in a sector of industry in which there had been many years of extensive domestic enterprise. It was also the first time that a Swedish engineering industry —in a Sweden which was at that period hardly expansive—had established itself in Germany.[98]

The reorganisation of the hand separator production meant that the Bergedorfer factory concentrated primarily on machines in the smaller size categories in order to meet the main German competition. The models for Bergedorfer Eisenwerk's separators came from Stockholm, and royalties were paid to AB Separator for these. Certain important separator parts were subsequently imported from Sweden. Even after the merger in 1907 Bergedorfer Eisenwerk kept up its production of dairy equipment such as refrigerating machines, pumps and cisterns, the total value of which exceeded that of the separators. The separators were sold on the domestic market while some of the other dairy equipment was exported, mainly to Finland and AB Separator's subsidiary in Russia.

A certain dualism characterised the relationship between the sister companies Bergedorfer Eisenwerk and AB Separator's branch in Berlin. The German dairies, which to a great extent bought Bergedorfer Eisenwerk's power separators, complained about the Berlin branch's large sales of hand separators to the farmers, thereby depriving the dairies of a large part of the milk produc-

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[98] As a result of AB Separator's purchase of Bergedorfer Eisenwerk the legal disputes which were going on between the two companies ceased.

tion.[99] According to calculations the total sales of hand separators in Germany in 1912 amounted to 125 000 machines. Of these the Alfa-Laval branch in Berlin sold almost 15 000 and Svenska Centrifug AB, which was owned by AB Separator, sold about 5 000. Thus the Separator group of companies controlled about 16 per cent of the German hand separator market. So its market position was not as strong in Germany as it was in the USA (36 per cent) but all the same it was considerably stronger than that of any of the group's main German competitors. The German farmers were AB Separator's biggest customer in Europe. As far as dairy separators were concerned the company was completely dominant in Germany.

In comparison with the activity of the Separator group of companies in the USA the company in Germany was not a financial success to the same extent. During the five year period from 1909 to 1913 Bergedorfer Eisenwerk paid 1.5 million German marks to AB Separator in royalties and dividends and at the same time a further one million marks were put aside to create capital, while the Berlin branch's contribution to the group's profits during the years 1909–1913 amounted to 0.7 million German marks.

Russia

The exporting of separators to Russia began on a small scale in the 1880s. In 1888 Carl Ludvig Nobel purchased the Russian patent for separators from Gustaf de Laval and started his own production in Nobels Mekaniska verkstad in St. Petersburg. The Nobel family had founded a works for the manufacture of arms and this had increased in size during the latter part of the nineteenth century. An important expansion in production had occurred after 1876 when machines for the oil industry had begun to be manufactured for Nobel's recently acquired petroleum interests in Russia.

During the latter part of the 1890s development of Russia's underdeveloped agriculture began in certain regions. There was particularly rapid expansion in the economic administration of milk

[99] Only about 25% of the German milk production went to the dairies, while the other 75% was churned into butter on the farms with the aid of hand separators. The butter which was not consumed by the farmers themselves was sold mainly on the local market.

and dairying in Siberia, which became one of the world's largest centres for butter production. For example in 1893, 7 tons were exported from there but ten years later a total of 35 000 tons were exported, and during the three years from 1899–1901 two thousand new dairies were built in Siberia. Most of the Siberian butter was bought up by the Danish company Sibiriska Kompaniet, which in turn mainly sold the butter in Britain.[100] The reason for the boom in agriculture was the colonisation of Siberia in connection with the building of the Trans-Siberian railway in 1891–99. Although it came fifty years later, the colonisation of the Russian East corresponded to the advance of the American frontier to the West. The colonisation was encouraged by the Russian government, and in order to assist in the modernisation of agriculture the import tariffs on agricultural machines (including separators) were abolished in 1897. The result of the colonisation was an increase in the demand for farming machines for two reasons. In part it was because agrarian techniques were sought by the colonisers in the large virgin territories, and partly because the crowding of the population and the supply of labour in the old areas decreased, and so there was an increased inclination to acquire machine power for farming there too. The result was that farming and cattle-farming were modernised in certain parts of European Russia, in particular southern Russia.[101]

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[100] Connolly, V., *Beyond the Urals. Economic Development in Soviet Asia,* pp. 15 ff. Agriculture in Siberia in 1914 was better equipped with agricultural implements and machinery than that in central Russia, which reflects the difference between a conventional agriculture fettered by tradition and a new, pioneering agriculture. Agricultural machines worth 20 million roubles were imported into Siberia in 1910–1911. The imports of separators and refrigerators were of great importance for the butter production and butter exports. In 1907 Russia's butter exports amounted to 47 million roubles and 97 % came from Siberia. Treadgold, D., p. 179.

[101] Treadgold, D., has given a detailed account of the colonisation of Siberia in *The Great Siberian Migration.* According to Treadgold the colonisation of Siberia is most like that of Canada in terms of size and geography. During the 19th century and up to 1914 about 8 million people emigrated to Siberia (p. 13). Most of the Siberian settlers emigrated from southern Russia (the black soil area) (pp. 89, 255). The basic reason for the extensive emigration was the shortage of land for the large mass of Russian farmers. The Emancipation Act of 1861 did not solve the important economic problem of land shortage. On the other hand serfdom ceased, and the farmers were liberated from their feudal masters, but their freedom

Nobel's manufacture of separators in St. Petersburg quickly became out of date as it was based on the older De-Laval models. When the import tariff was abolished in 1897 Nobel's separator business no longer proved profitable and it gradually ceased. Instead, the firm under the management of Emanuel Nobel, who had succeeded his brother Carl Ludvig (died 1893) took over the general agency for AB Separator in Russia. Emanuel Nobel had very good contacts in leading Russian circles, which was of particular importance in relation to Russian orders and he was among other things a member of the board of the Russian National Bank and was also appointed a member of the Russian Council of State in 1911. Through Nobel's agency AB Separator acquired an important sales channel into the Russian market. Thereafter Swedish exports of separators increased rapidly as a result of the agricultural development. In 1901 there were about 5 000 dairies in Siberia and about 90 per cent of these had Alfa separators. The Swedish separators became so well-known under the name "Lavalka" that this became a common Russian word for a separator. The demand for hand separators also grew with the expansion of dairying. Consequently Russia, who was starting to rebuild an old-fashioned agriculture, appeared at the turn of the nineteenth century to have enormous potential as a future market for producers of agrarian technology.[102]

However, the problem posed by the Russian market was greater than in most other places. The distances were vast. The farmers

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of action was limited by the *mir*. The *mir*, through which the more important questions were resolved with collective responsibility, was regarded by many farmers as constricting and as a fatal obstacle to agrarian technological development. Therefore the colonisation of Siberia, where the institution of the *mir* only developed to a small extent, offered possibilities for industrious and independent-minded farmers who felt repressed in European Russia. The institution of the *mir* developed to varying degrees in Russia, and therefore hindered in varying degrees individual attempts to break out. It is probably no accident that the emigration was comparatively greater from the rather more developed and sales-orientated farming districts in the South, where the *mir*'s hold on the farmers was not as far-reaching as in central Russia.

[102] The account of AB Separator's operations in Russia is mainly based on Alfa-Laval's own sales statistics and B. Steckzén's manuscript AB Separators historia: Alfa-Nobel, St. Petersburg 1900–1914.

were technically inexperienced and were always short of money. Therefore the salesmen had to give them much longer credit than in other countries. Sales in Russia bore exceptionally high costs due to the fact that it was a complicated and hazardous business. For these reasons AB Separator for three years from 1902 had its top expert on foreign business, travelling inspector A. Kullberg, attached to Nobel's firm. Kullberg modernised the sales organisation and after travelling extensively in European Russia and Siberia he set up branches in Warsaw, Omsk and Odessa. In addition he managed to persuade Emanuel Nobel to hive off the separator businesses from the other branches of the firm's extensive operations and to form the independent company Nobels Separatoravdelning. However the various measures had no immediate effect on the sales since the Russian-Japanese War in 1904–05 and the great political unrest at home substantially repressed investment in Russian industrial life. After the agrarian reforms of Prime Minister Stolypin in 1906 which were aimed at creating a politically stable farm-owning class with great purchasing power—kulaks—AB Separator's sales figures rose considerably. From then on with one or two exceptions the orders were to remain on a high level until the end of the First World War (see table 43).[103]

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[103] Treadgold, D., *op. cit.*, pp. 166f. and 176ff. Grossman, C., *The Industrialisation of Russia*, pp. 15ff.

Stolypin's reforms must be regarded primarily as an attack on the *mir*. After the 1905 revolution Stolypin proposed, partly as suitable anti-revolutionary tactics and reform strategy, to make it easier for the farmers to separate their farms from the *mir* and also that the village be given the opportunity to dismiss itself as land controller by a majority vote. But Stolypin also had far-reaching economic aims behind the agricultural reforms. Stolypin made the following statement in connection with a tour of inspection in Siberia in 1910: "The right of private property in land must serve as the chief security for the raising of the productivity of the peasant household and private property in land would permit industry and trade to develop." The reforms in general and Stolypin's views on the colonisation of Siberia in particular were probably influenced by the American Homestead Act of 1862 which was discussed in Russia at the beginning of the 20th century.

As regards Siberia, Stolypin was not completely satisfied with developments there. In actual fact he already became alarmed in 1910 by the dynamic power which Siberia showed during the first expansive decade of the 20th century, and which he himself had been a party to establishing and creating possibilities for. Stolypin feared that Siberia would outdo European Russia economically. "Siberia might crush

The latter part of the economic development of the Tsarist Russian epoch has constituted a fascinating chapter in the country's history and has interested a great number of economic historians. It should be borne in mind that the population (i.e. of the whole of Russia) increased from 74 million in 1860 to 178 million in 1913 and that this increase in population took place almost entirely within the agrarian sector. From this it is possible to gauge roughly the slow rate of increase in Russian industry during the close of the Tsarist period. Nevertheless Russia through her size as a nation in 1914 had developed into the world's fifth industrial country after the USA, Germany, Great Britain and France, while the per capita production in her industry was considerably lower than that in most of the industrialised countries. Emphasis has been laid on various factors as the causes of the industrial development in Russia. For example it is possible to see if Paul Bairoch's theory as to the leading rôle of agriculture in the process of industrialisation is valid in the case of Russia. Bairoch contends that farming played an extremely active rôle in the industrial breakthrough of the nineteenth century. The increase in demand and the purchasing power which the agricultural revolution created in many places both for consumer goods (textiles) and production goods (iron and steel) are seen by him as the most important factor in industrialisation. It is tempting to indulge in a mainly negative argument and declare that Bairoch is right. The institution of the Mir hampered the agrarian revolution in Russia and thus also the industrial revolution. The comparatively rapid industrialisation which took place at the start of the twentieth century could then be accounted for by the beginning of modernisation in agriculture. Stolypin's agricultural reforms were mainly directed towards liberating the individual farmer from the Mir. Even if the objective was not perhaps primarily an economic one but was to give the country social and political stability through a farming class with great purchasing power, the long-term economic effect was the increase in the productivity of agriculture and in the demand for industrial products. However, in certain cases the increase in demand affected

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the homeland." However, it was not Siberia but communism which seven years later was to crush the establishment in 'the homeland'!

the industrialisation of other countries. For example agrarian technology was bought to a large extent from the USA, Germany, Britain, and Sweden. (See note 7.) It may be observed that the

Russin import of agricultural machines in 1913. Figures in per cent.

	Export-countries				
	USA	Germany	Britain	Sweden	Others
Sowing machines	67	12	5	3	13
Self-disposing harvesters	51	4	16	5	24
Self-binding harvesters	44	16	24	7	9
Mowing machines	29	17	7	19	38
Horse hay-rakes	22	11	15	41	11

Source Linder, E., Den svenska mekaniska verkstadsindustriens utveckling intill krigsutbrottet, pp. 284 f.

exports of the USA were almost synonymous with those of International Harvester. In 1909 this company had started a factory to produce harvesting and mowing machines in Lubertzy outside Moscow which were to be specially selected for Russian agriculture. When it is borne in mind that the Lubertzy factory's production figures are not included in the statistics of imports given above the dominance of International Harvester is quite plain. However, as far as separators were concerned total Swedish sales in Russia, with AB Separator leading the way, were even more dominant. They probably had at least 80 per cent of the whole Russian separator market.

Alexander Gerschenkron gives an alternative kind of explanation for Russian industrialisation in his book "Economic Backwardness in Historical Perspective". According to him Russia is an example of how industrialisation took place "under conditions of economic backwardness". Gerschenkron stresses the active rôle of the state in Russian agriculture during the breakthrough of the 1890s. Here the state acted as a substitute for the individual manufacturers and investment banks which played a decisive rôle in the industrialisation of more advanced countries. An increase in purchasing power within the agrarian economy is an important motive for industrialisation, according to Gerschenkron, but it is only one of a number of possible alternatives which the Russian development presents. In his industrialisation plan in the 1890s, the finance minister Witte did not follow the theory that the increased demand from the farmers for industrial goods constituted a condition for successful industrialisation. On the contrary their consumption potential was reduced by the considerable pressure of taxation in order to increase the share of the national product in investments. Thus government policy was aimed at securing the existing production of the farmers rather than promoting an increase in production. In Russia the orders of the government were a substitute for the defective domestic market, and what was achieved in other countries through the influence of a freely expanding market. The industrialisation was concentrated round heavy industry (the iron, steel and engineering sectors) while agriculture played a passive rôle. Loans of foreign technology promoted the rise of large company units. The substitution processes reinforced the dualism within the economy and brought about an economic structure of a heterogeneous nature. As a strategic factor in the industrial breakthrough the technology created conflicts between the old and the new, and in an underdeveloped Russia these conflicts were particularly accentuated. The industrial boom of the 1890s ceased around 1900. The farmers' ability to pay taxes and their patience had been exhausted. After the war with Japan in 1904 came the revolution of 1905 in which the farmers rose up to good effect. When after Stolypin's reforms industrialisation started again in 1906 the substitution pattern rapidly altered, and the process of industrialisation became more conventional and more European in character.[104]

Bairoch and Gerschenkron adopt somewhat different approaches to industrialisation and they stress different factors. Bairoch lays stress generally on the influence of the agricultural sector on industrial development, while Gerschenkron emphasises the unprecedented and the discrepant in the pattern of Russian industrialisation. As regards Gerschenkron it is important to note that the

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[104] Bairoch, P., *Agriculture and the Industrial Revolution 1700–1914*. Gerschenkron, A., *Economic Backwardness in Historical Perspective*. Grossman, G., *The Industrialization of Russia*.

Russian industrial breakthrough in the 1890s suddenly stopped. At this time it was only possible to industrialise for a short period against the will of the farmers and at the expense of agricultural interests. After Stolypin's reforms industrialisation continued in Tsarist Russia following a pattern more in conformity with Bairoch's theories. In consequence Bairoch's argument seems to hold good even when tested against the development of Tsarist Russia. At the same time it is important to emphasise the interdependence in agricultural and industrial development. As Gerschenkron says quite rightly, the short industrial advance in Russia during the 1890s gave rise to market forces which among other things stimulated a more commercial agriculture after 1906.

During the period before 1914 Russia was a land of contrasts. Within the field of industrial and agrarian technology, in which AB Separator operated, the frontiers between old and new were more numerous and more clearly defined in Russia than in other places. However, the problems were at least as great for AB Separator's competitors on the Russian market. Nobel was well connected with the high Russian authorities and the agricultural societies, and the suspiciousness usually manifested towards foreigners, especially salesmen, by the Russians did not unduly affect Alfa-Laval. Furthermore Nobel had got hold of the best agents. In 1908 Nobel's Separatoravdelning had been reorganised into Handelshaus Alfa-Nobel, and was given greater resources in order to be able to meet the growing competition. At this point in time competition had come mainly from two sides, on the one hand from America and on the other from Swedish separator manufacturers. Next to Alfa-Nobel the largest dealer on the Russian market was Svenska Centrifug AB in Södertälje, Sweden, which opened branches in Moscow in 1901 and in Tscheljabinsk in Siberia in 1903. In 1905 Svenska Centrifug AB became a subsidiary of AB Separator. According to AB Separator's calculations the Swedish separator companies (Svenska Centrifug AB, AB Pumpseparator and AB Baltic) sold twelve thousand separators in Russia in 1911 as against eighteen thousand sold by AB Separator. Through its agricultural machines International Harvester had built up a strong position in Russian agriculture which will be dealt with in greater detail in due course. This position was also used in selling separators, and International Harvester was the largest non-Swedish separator supplier on the Russian market.

The tension between Alfa-Nobel and Svenska Centrifug AB increased as competition became keener, and Alfa-Nobel contended that it was preposterous for AB Separator to allow its subsidiary in Södertälje to compete with its general agent in St. Petersburg. After a visit to Russia in 1909 Richard Bernström decided to settle the differences between Alfa-Nobel and Svenska Centrifug AB by letting them co-operate as interested parties in a newly established company in Riga. However, Alfa-Nobel would still retain the general agency for Alfa separators. AB Separator, Eskilstuna Stålpressnings AB and AB Westeråsmaskiner would also participate in the newly established company as interested parties. In the same year AB Separator had acquired the majority share-holding in the last-mentioned company, which manufactured harvesters and mowing machines, ploughs and other agricultural machinery. Richard Bernström intended to broaden the selling through this acquisition and thus meet International Harvester's expansion. So the establishment of the Riga company served two purposes: on the one hand the differences between Alfa-Nobel and Svenska Centrifug AB would be attenuated, and on the other hand AB Separator would try to apply International Harvester's 'full-line' principle in Russia. Its own methods could be used against the American company to prevent it from improving its competitive position at AB Separator's expense.[105]

The business in Riga soon turned out to be an unwise speculation and it ran at an increasing loss. It proved inappropriate to

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[105] It was a firm principle at AB Separator not to divide the production and sales among various kinds of products but to concentrate on separators to a high degree. Thus the Riga company constituted an exception to this rule, and there was no lack of warnings from various leading quarters within the group. Among others Ossian Ström, the managing director of the subsidiary Svenska Centrifug AB, expressed reservations about the whole project by arguing that as a rule harvesters and separators were sold to different districts, viz. grain-cultivating and grass-cultivating areas respectively. Therefore the sales for the two sectors could not be organised jointly. However, as a subordinate Ossian Ström complied with AB Separator's decision.

Steckzén, B., AB Separators historia: Alfa-Nobel, St. Petersburg.

lump together separators from Södertälje, agricultural machines from Västerås and enamelware from Eskilstuna, since these products were so often aimed at different customers and required different sales methods. Therefore in 1913 AB Separator carried out a financial reorganisation of the Rigabolaget and at the same time the sales of AB Westeråsmaskiner's products were gradually made to taper off. AB Separator did not find it appropriate to combine separators with agricultural machines even on isolated export markets and this is why the company sold its shareholding in AB Westeråsmaskiner. Through these operations the business in Riga was given greater stability for the future.

It became the task of the Rigabolaget above all to sell the smaller and cheaper separators which were particularly sought after in Russia. AB Separator considered that conditions in Russia made it necessary to sell cheap separators through the Rigabolaget in accordance with the needs and purchasing power of the many customers. This operation meant that the smaller types of machine were spread particularly widely in Russia. However Alfa-Nobel construed this selling as a revival and extension of unfair competition, while AB Separator maintained that the separators of the Rigabolaget were aimed at foreign competitors. The competition within AB Separator's own sphere of influence was regarded as merely marginal, since Alfa-Nobel's larger and superior machines were mainly directed towards a group of customers different from the Rigabolaget's.

Relations between Alfa-Nobel and AB Separator were subjected to other conflicts in spite of the fact that in 1912 AB Separator had become a shareholder in Alfa-Nobel. As its representative in the Russian company AB Separator put in John Bernström's son-in-law Claes Asker, who had previously held a top post in Alfa-Berlin. The years immediately after Asker's appointment brought a boom in Alfa-Nobel's separator sales, but nevertheless the company showed significant losses in 1912–1913. On closer examination of the causes of the loss it turned out that AB Separator's and Nobel's interests had diverged. Nobel wanted to extend the separator business, mainly into cold-storage plants and engines, and to hive it off from the dairying branch. The separator business's share in Alfa-Nobel's organisation had fallen from 82 per cent in

1907 to 62 per cent in 1912. That branch of the business yielded continuous net profits while the non-separator business caused considerable losses. In order to make the business profitable AB Separator thought it necessary to have greater control than part-ownership of Alfa-Laval. Through the conversion of Alfa-Nobel in the new year of 1914 into a limited company "Handels- und Industrie AG Alfa-Nobel" AB Separator acquired the majority shareholding in the company. This meant that AB Separator took over the power of decision where Alfa-Nobel was concerned, and the latter was transformed from a Russian trading firm into a Swedish subsidiary, a change which attracted attention in the Russian capital.[106]

The fact that AB Separator increased its influence in St. Petersburg aroused disapproval in many Russian circles. In spite of a general suspicion of foreign elements in the Russian economy Alfa-Nobel was able to secure its Russian separator market in various ways in 1914. In this context the Russian government's agricultural instructors played an important rôle in continuing to recommend only Alfa-Laval separators even after 1914. It was a condition of a farmer in Russia getting a share of the grants for the purchase of machinery which the Ministry of Agriculture provided in substantial sums that the farmer must follow the recommendations of the instructor. Thanks to Nobel's involvement in the separator business, the sales agreements which Alfa-Nobel had concluded proved of value for AB Separator even after the reduction of Nobel's share in Alfa-Nobel. In particular as regards the most important sales area, Siberia, AB Separator had the advantage of Nobel's good connections with various Russian authorities. As the Siberian market expanded, competition for it became keener. In the spring of 1914 several of AB Separator's competitors tried to persuade the Danish-owned Sibiriska Kompaniet to cease trading with Alfa-Nobel. Certain of AB Separator's competitors offered Sibiriska Kompaniet discounts of up to 55 per cent. However the Danish company, bearing in mind the advantage of selling a machine which was recommended by the Russian agricultural authorities, renewed its contract with Alfa-Nobel. The importance

[106] *Ibid.*

of the extension of the contract was plain to AB Separator, since the Sibiriska Kompaniet was the largest customer for separators in Russia. The extensive Siberian sales made possible the expansion of the Omsk branch in 1914.[107]

AB Separator's Russian business can be summed up as large sales and small profits. From 1911 to 1917 the company had invested more than 5 million Swedish crowns in St. Petersburg and Riga. The avalanche-like development was completely contrary to John Bernström's cautious economic policy. In fact the investment policy in Russia had also been ratified by Richard Bernström. Political developments in Russia during the First World War made AB Separator's assets there extremely insecure. In 1918 AB Separator's assets in Alfa-Nobel were shown as 5.2 million Swedish crowns, but in 1921 these were drastically reduced to 1 Swedish crown. In spite of the fact that separator exports were disturbed in various ways throughout the First World War and the Russian Revolution in 1917, sales to Russia were able to continue on a comparatively high level during the latter part of the 1910s. This was largely due to the fact that the large sales to Siberia were comparatively unaffected by the war or even by the Revolution to start with. However the business turned out to have made heavy losses amounting to 0.9 million roubles during the years 1914–1918, mainly due to exchange losses resulting from the currency depreciation of the rouble, and extra costs connected with the war.[108]

The business in Russia also shows a course of events which was typical of that period. For a long time AB Separator delivered machines to a general agent against a cash payment. As sales increased so did the agent's credit requirements, and the agent turned to the producer. As the latter was interested in increased sales, especially on the potentially large Russian market, he did not refuse credit. But in order to be able to exert better control over the business in this situation AB Separator first acquired half the shareholding and later the majority shareholding in the general agent's company.

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[107] *Ibid.*

[108] *Ibid.* Administration reports and reports of the auditors for 1918 and 1921. In 1917 AB Separator had redeemed the Nobel family's shareholding in Alfa-Nobel with 1.2 million Sw. kr.

Thus from the viewpoint of business economics the profit of the Russian part of AB Separator's business during the period in question was small. In actual fact heavy losses were incurred. However, the large deliveries to the Russian farms and dairies were to acquire national economic importance in Sweden from the point of view of employment. It was above all the commercialised part of Russian agriculture, especially in Siberia, which profited most from the separator business, as it was able to offer for sale increasing quantities of butter. Moreover it is plain that it was the large profits on other foreign markets, especially in North America, which enabled AB Separator to conduct extensive business in Russia in the prevailing situation.

(*d*) AB Separator and competition: the situation

At the outbreak of the First World War, AB Separator, with subsidiaries in Sweden and abroad, had a firm hold on the international separator market. As regards dairy separators it was completely dominant in countries with developed dairying. Comparatively large difficulties faced competitors seeking to establish themselves on the machinery side of the dairy sector, since it was financially costly to produce and sell such equipment. The manufacture and marketing of agricultural separators were simpler and less costly and therefore more open to fresh competition. In the latter field the Separator group of companies' position on the international market was not as dominant as on the dairy side. Nevertheless at this point in time the group of companies was the largest international supplier of agricultural separators. The competition came mainly from other Swedish separator manufacturers and also to a certain extent from a few American and German companies. It can already be said by the end of the 1920s that the most prominent Swedish competitors had been incorporated within the Separator group of companies. A few examples will serve to illustrate what has been said. According to market research which AB Separator carried out in 1906, the company's share in the whole of the Russian market was 54 per cent. In Germany the share of the market in agricultural separators varied from 75 per cent in North Germany to 10 per cent in Westphalia, which had its own separator production. In Holland the Separator group of companies produced 80 per cent of the dairy separators and 30 per cent of the agricultural separators. 90 per cent of the dairies in Denmark, Siberia, Argentina and New Zealand were equipped with Alfa separators. Of all the agricultural separators which were sold on the most important market internationally, the USA, 35 per cent came from the Separator group of companies.

We have already seen how in several places new separator factories were established after the expiry of the Alfa patent. This happened not least in Sweden. It is therefore appropriate to pause and consider AB Separator's relationship with newly established competitors on the home market during the period following the turn of the nineteenth century, especially as in most cases the domestic competitors became AB Separator's most powerful competitors on the international separator market. In all about twenty Swedish separator companies were formed before the First World War, mainly in Stockholm and in the Mälar area. Among the newcomers to the industry AB Pumpseparator (1903) and AB Baltic (1904) were particularly prominent. AB Pumpseparator was able to introduce a technical innovation into the separator field in the form of its device for pumping the milk flowing to the separator. However, both AB Pumpseparator and AB Baltic were typical examples of companies with innovation difficulties. Above all the selling costs were heavy for the new companies, which were export-minded to a high degree. It was not until about 1910 that these were stabilised and had become profitable. AB Pumpseparator had developed a new model of separator which was smaller in size and had the high-sounding name of "Diabolo", and it became a highly marketable machine when it was introduced onto the market in 1909. In 1914 AB Pumpseparator sold the same number of machines as AB Separator (the parent company) even if the turnover was considerably lower because AB Pumpseparator's models of separator were smaller and cheaper. In 1912 AB Baltic was able to strengthen its market position in the USA by the acquisition of Empire Cream Separator. Gustaf Wallenberg, the person principally interested in Empire, had previously tried in vain to persuade AB Separator to buy Empire, which had an unstable financial position. With support from Gustaf's brother Marcus Wallenberg and Stockholms Enskilda Bank AB Baltic was able to acquire through loans the financial resources to buy and reorganise Empire. At the outbreak of the First World War AB Baltic's sales had risen to such an extent that in terms of the number of separators sold they were approaching AB Separator.[109]

AB Separator could see in several ways that the Swedish competition was increasing. It is clear from table 50 that AB Separator's share of production in Sweden fell from 84 per cent in 1896 to 64 per cent in 1903. In 1910 the corresponding share had fallen to 50 per cent. Furthermore AB Separator's share in the total of Swedish exports fell from 85 per cent in 1900 to about 40 per cent around 1920. On the Swedish market AB Separator's rôle declined even more rapidly. At the end of the 1890s the company controlled 80–90 per cent of the domestic separator market. However the company's share of separators in Sweden had already dropped to 30 per cent in 1903, mainly because of competition from the new smaller models which were exceptionally well suited to the small farms. As the platform which the Swedish market constituted was too small for a growing number of separator companies, it became necessary for competitors to concentrate on exports from the start, like AB Separator. It was a question of being able to extend the shop counter. In AB Separator's market reports for 1905 one can read of increasing Swedish competition on the most important separator markets in the USA, Germany, Russia, Australia and Scandinavia. To mitigate the effects of competition in 1905, as has already been mentioned, AB Separator bought Svenska Centrifug AB in Södertälje. In Denmark in spite of domestic production AB Separator was able to dominate completely the field of dairy separators (98 per cent in 1905) but from 1903 Burmeister & Wain had control over hand separators. The production of separators at Burmeister & Wain constituted only a small part of the company's total production. After protracted negotiations AB Separator was able in 1910 to come to an agreement with Burmeister & Wain under which the latter company would gradually close down its separator business in return for compensation. AB Separator aimed at restricting competition so that the Danish hand separator market

[109] Steckzén, B., AB Separator, Stockholm 1903–1914. Manuscript. Hammarström, I., *Stockholm i svensk ekonomi 1850–1914*, pp. 348f. *Svenska Industrien 1907, 1911–1912.*

Table 46. *Sales, wages, profits and dividends at AB Separator, 1883–1907. Amounts in thousands of Swedish crowns*

Year	Sales	Number of workers	Wages paid	Net profits after depreciations	Dividend
1883	260	61	56		
1884	397	72	86		
1885	400	196	91		
1886	537	208	138		
1887	974	211	299		
1888	1 485	289	317		
1889	1 546	337	337		
1890	1 573	337	358		up to and including 1891=
1891	1 897	350	377		645
1892	2 387	363	476	559	200
1893	3 000	380	544	803	300
1894	3 356	388	635	832	400
1895	3 574	400	610	1 443	600
1896	3 927	415	674	2 034	1 400
1897	4 347	517	879	2 188	1 800
1898	5 015	644	1 065	2 379	2 000
1899	5 205	772	1 343	2 402	2 000
1900	5 748	981	1 578	2 482	2 000
1901	6 037	998	1 473	2 582	2 000
1902	6 012	1 206	1 482	2 597	2 000
1903	6 669	1 097	1 717	2 743	2 000
1904	5 378	1 077	1 597	2 655	2 000
1905	5 227	793	1 135	2 919	2 200
1906	5 854	1 194	1 624	3 016	2 200
1907	6 251	1 326	1 990	3 244	2 200

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik, styrelseberättelser; AB Separators jubileumsskrift 1883–1908.

would also be available for the company. In spite of the agreement with Burmeister & Wain AB Separator was not able to open up this market to any greater extent, since other domestic manufacturers took advantage of the Danish farmer's national feelings. During this period AB Separator's exports to Denmark were very

Table 47. *Financial data relating to AB Separator (the parent company) in 1892–1921. Amounts in thousands of Sw. kr.*

Year	Share capital	Sales (the parent Co.)	Number of workers (the parent Co.)	Net profits after depreciation	The De Laval Company's contribution to the net profits	Funds	Dividend
1892	1 000	2 387	363	559	–	734	200
1893	2 000	3 000	380	803	–	483	300
1894	2 000	3 356	388	832	–	871	400
1895	2 000	3 574	400	1 443	507	1 565	600
1896	2 000	3 927	415	2 034	635	2 000	1 400
1897	4 000	4 347	517	2 188	670	2 388	1 800
1898	4 000	5 015	644	2 379	745	2 568	2 000
1899	4 000	5 205	772	2 402	1 246	3 000	2 000
1900	4 000	5 748	981	2 482	1 425	3 314	2 000
1901	4 000	6 037	998	2 582	1 781	3 382	2 000
1902	4 000	6 012	1 206	2 597	2 137	4 406	2 000
1903	4 000	6 669	1 097	2 743	2 480	3 916	2 000
1904	4 000	5 378	1 077	2 655	2 480	4 504	2 000
1905	4 400	5 227	793	2 919	2 830	5 946	2 200
1906	4 400	5 854	1 194	3 016	2 830	6 600	2 200
1907	5 000	6 251	1 326	3 244	2 830	12 700	2 200
1908	5 000	4 743	1 116	2 879	2 830	13 200	2 500
1909	5 000	5 928	877	3 164	2 830	13 750	2 500
1910	24 000	5 348	744	3 293	3 540	12 800	2 500
1911	24 000	6 890	826	4 311	3 540	12 800	3 600
1912	24 000	6 845	899	4 288	3 540	13 500	3 600
1913	24 000	7 798	925	4 707	3 740	14 000	3 840
1914	28 000	6 482	788	4 380	3 540	16 000	4 480
1915	28 000	6 562	783	6 730	4 774		4 480
1916	28 000	11 541	1 092	10 771	4 226		4 480
1917	42 000	11 297	908	8 577	2 707		6 720
1918	63 000	14 457	742	12 546	3 143		8 190
1919	63 000	14 947	821	11 699	3 206		8 190
1920	63 000	11 481	641	6 803	3 178		5 040
1921	63 000	8 887	390	988	1 331		1 890

Note The post funds relates to special reserve funds and general purpose funds. Cf. p. 199.

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik, styrelseberättelser; AB Separators jubileumsskrift 1883–1908; Steckzén, B., AB Separators historia.

Table 48. *Swedish separator exports in thousands of Swedish crowns, 1900–1921*

Year	A=total exports	B=AB Separ. exports	C=AB Separ.+ Centrifugs exports	D=B in % of A	E=C in % of A
1900	5 862	5 041		85	
1901	7 427	5 509		74	
1902	7 281	5 566		77	
1903	8 636	6 142		71	
1904	8 652	4 956		57	
1905	8 460	4 868		58	
1906	10 724	5 455		51	
1907	11 308	5 864		52	
1908	10 178	4 378		43	
1909	12 318	5 580		45	
1910	11 349	5 020		44	
1911	13 406	6 618		49	
1912	13 374	6 584		49	
1913	14 910	7 371		49	
1914	14 700	6 060		41	
1915	14 457	6 045	8 059	42	55
1916	26 978	10 693	15 031	40	56
1917	31 363	9 774	13 340	31	43
1918	29 100	11 885	13 988	41	48
1919	37 604	12 760	14 955	34	40
1920	25 912	9 161	10 633	35	41
1921	16 209	7 303	8 155	45	50

Source Bidrag till Sveriges officiella statistik, Handel; Sveriges officiella statistik, Handel; Steckzén, B., AB Separators historia (manuscript).

much smaller than to the other Nordic countries Norway and Finland.[110]

[110] Riksarkivet, Kommerskollegii arkiv. Primary information for the industrial statistics. Steckzén, B., op. cit. An extract from a promotions publication from AB Pumpseparator's director Erik Hirsch to a Canadian firm in Montreal in 1914 illustrates the ability of the new Swedish separator companies to analyse market conditions and make effective use of modern sales and advertising methods which apparently produced results.

"We know that your district is a fine part of the world for the sale of separators and it could be a very good business. If we could find the right firm we would

Table 49. *Proportion of exports in the total sales of AB Separator. Amounts in thousands of Swedish crowns*

Year	Total sales of AB Separator	Export sales	Proportion of exports in the total sales
1896	3 927	3 486	89
1897	4 347	3 842	88
1898	5 015	4 302	86
1899	5 205	4 434	85
1900	5 748	5 041	88
1901	6 037	5 509	91
1902	6 012	5 566	93
1903	6 669	6 142	92
1904	5 378	4 946	92
1905	5 227	4 868	93
1906	5 854	5 455	93
1907	6 251	5 864	94
1908	4 743	4 378	92
1909	5 928	5 580	94
1910	5 347	5 020	94
1911	6 890	6 618	96
1912	6 845	6 584	96
1913	7 798	7 371	95
1914	6 482	6 060	94
1915	6 562	6 045	92
1916	11 541	10 693	92
1917	11 297	9 774	86
1918	14 457	11 885	82
1919	14 947	12 760	85
1920	11 481	9 161	80
1921	8 887	7 303	82

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

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be willing to support it in every possible way, and we would very much like to hear from you if you would be interested in this matter. We enclose a few circulars about our Diabolo separator.

It is no more than five years since we brought out this machine onto the market but during this comparatively short period we have made the machine known and well-known almost all over the world. It may perhaps be of interest to you to learn that we are now the largest producer of milk separators in the world with the sole exception of AB Separator, though that company is now 35 years old. We

Table 50. *Production and exports of Swedish dairy machines in thousands of Swedish crowns*

Year	A=total production	B=AB Separ. production	C=B as a % of A	D=total exports[a]	E=D as a % of A
1896	4 675	3 927	84	3 694	79
1897	5 210	4 347	83	3 309	64
1898	6 557	5 015	76	3 692	56
1899	7 718	5 205	67	4 454	58
1900	8 020	5 748	72	5 862	73
1901	8 886	6 037	68	7 427	84
1902	9 445	6 012	63	7 281	77
1903	10 425	6 669	64	8 636	83

[a] The export figures for the years 1896–1899 are incomplete. The figures are clearly too low since AB Separator's exports alone exceeded the total volume of exports.

Source Bidrag till Sveriges officiella statistik, Handel; Steckzén, B., AB Separators historia. Moderbolaget (manuscript).

It is a distinctive feature of multinational companies, of which AB Separator was one of the first in Sweden, that their markets have no geographical borders to speak of. If a technically superior product has been developed the spread of its sales will not be determined by transport distances but by such factors as demand

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started barely a year ago in the USA and we now ship our separators there in consignments of over 1 000 a month. You probably know that Sweden is the birthplace of the separator industry. More separators originating from Sweden are sold than from all the rest of the world put together. You probably know that firms such as the De Laval Separator Co., Empire and others which now manufacture machines in America were originally Swedish firms, and you probably know that AB Separator also has its home here in Sweden, and that it started its production in this country long before it opened its factory in the USA. We mention this since it may be of interest to you to know that we in Sweden sell a greater number of Diabolo separators a year than AB Separator sells of Alfa separators.

The hand separator should only be used by smaller farms and not in large-scale farming. The farmer needs a machine which he can understand and maintain and which is robust. In these respects the Diabolo is an ideal separator. We maintain that the Diabolo separator is at least equal in merit to the very best separators of other makes. However, we maintain further that in some respects it is superior to all the others, while the Diabolo separator is simpler and consequently more durable than any other milk separator."

Table 51. *AB Separator's sales of the more important groups of products. Amounts in thousands of Swedish crowns*

Year	Dairy separators	Hand separators	Bowls	Others	Total
1887	440	226	31	277	974
1889	599	263	88	596	1 546
1890	450	648	84	390	1 572
1891	484	637	154	622	1 897
1893	777	1 337	497	429	3 040
1900	852	3 349	1 462	198	5 861
1906	490	3 691	521	1 152	5 854
1913	846	5 012	84	1 855	7 797

The relative importance of the groups of products in AB Separator's sales

Year	Dairy separators	Hand separators	Bowls	Others	Total
1887	45	23	3	29	100
1889	39	17	6	38	100
1890	29	41	5	25	100
1891	26	34	8	32	100
1893	26	44	16	14	100
1900	15	57	25	3	100
1906	8	63	9	20	100
1913	11	64	1	24	100

Source Alfa-Lavals arkiv, Tumba: Försäljningsstatistik.

and purchasing power. In principal the spread becomes global. This applied to a high degree to AB Separator and to Swedish separator production as a whole. In neighbouring Finland Swedish agricultural machines constituted 70 per cent of the country's imports of agrarian technology at the outbreak of the First World War. The same percentage applied to the share of the separators. Thus Sweden was Finland's main supplier of foreign agrarian technology. From the point of view of Sweden Australia may be regarded as antipodean to Finland in terms of distance, but nevertheless the Swedish separator industry played a more dominant rôle in

Table 52. *Development of prices of various separators at AB Separator*

Dairy separators				Hand separators			
Year	Type	Capacity (litres)	Price	Year	Type	Capacity (litres)	Price
de Laval separators				*de Laval separators*			
1879	A1	130	550	1886	K	150	400
1881	A1	250	620	1886	L	100	350
1883	A1	280	550	1886	S	50	260
1886	A1	400	550				
1885	A2	460	750	*Alfa separators*			
1886	A2	650	750	1890	K	250	475
				1890	S	125	275
Alfa separators				1893	S	150	225
1890	A1	800	850	1899	S	250	235
1893	A1	1 200	850	1890	B	250	425
1899	A1	1 400	900	1893	B	300	425
1907	A1	2 000	900	1896	B	350	425
1890	A2	1 500	1 050	1899	B	450	425
1893	A2	1 800	1 050	1897	Colibri	70	125
1899	A2	2 000	1 200	1898	Colibri	100	100
1907	A2	3 000	1 200	1899	Colibri	125	125
1910	A5	2 000	1 100	1906	Colibri	150	125
1910	A6	3 000	1 300				

Source Martiny, B., Geschichte der Rahmgewinnung. Zweiter Teil. Die Schleuderentrahmung, Band I, pp. 326 ff.

Australia than it did in Finland. For example in 1913 Swedish separator exports constituted 80 per cent of the total imports of Australia.[111]

(*e*) The rôle of the separator industry in the Swedish engineering industry

Immediately before the First World War the part of the Swedish engineering industry which manufactured agrarian technology had reached such a scale that a large part of the production could be

[111] *Kommersiella Meddelanden.* Reports from consuls and commercial attachés in 1914, pp. 301 and 578.

Table 53. *Price trend of a single Separator share in the years 1892–1911 including effects of issue*

Month	Year	Price (Sw. kr.)	Index
June	1892	2 500	100
Jan.	1894	5 000	200
Dec.	1894	10 200	408
Oct.	1895	18 000	720
Dec.	1895	16 000	640
April	1896	24 000	960
Dec.	1896	31 000	1 240
March	1897	38 800	1 552
Dec.	1898	34 400	1 376
Feb.	1899	39 200	1 568
Dec.	1900	28 000	1 120
Dec.	1901	28 400	1 136
Average	1902	26 800	1 072
Average	1903	26 800	1 072
Average	1904	30 400	1 216
Average	1905	38 000	1 520
Average	1906	50 000	2 000
Average	1907	37 600	1 504
Average	1908	38 000	1 520
Average	1909	40 000	1 600
Average	1910	52 000	2 080
Average	1911	64 000	2 560

Source Steckzén, B., AB Separators historia.

exported. During the latter half of the nineteenth century Sweden was on the whole a net importer of agrarian technology, with the exception of separators. However, growing purchasing power from a commercialised domestic agriculture stimulated the Swedish engineering industry to a level of production which gradually met the country's needs for agricultural implements and machinery. The next step was for the Swedish engineering industry with the home market as a base to extend the production and sales series to net exports during the 1890s. In 1910 80 per cent of the agricultural implements and machines, excluding separators, which were exported were sold to the East (Finland, Russia and Asia). Agriculture in Eastern Europe and Asia had not been developed to the same degree as that in the USA and Western Europe, but the difference in agrarian technology between Eastern Europe and Sweden was much smaller than between Eastern Europe and the USA. Therefore Swedish agrarian technology harmonised better with farming conditions in Eastern Europe and Asia, and this meant a favourable export situation for Swedish agricultural machinery, relatively speaking. As exports were increasing Sweden was importing a certain number of agricultural machines, mainly from the USA which manufactured machines which were most advanced technically. In this respect, with the exception of the separator factories, the Swedish engineering industry borrowed American agrarian technology. On the other hand Swedish separators, especially the Alfa separators, represented agrarian technology of a very high quality, internationally speaking, and they could therefore compete successfully with separators from other countries. The separators, in contrast with other Swedish agricultural machines, were particularly widespread in countries with advanced agriculture and were not sold to such a great extent to countries where the agriculture was less advanced.[112]

Through the early internationalisation of the market the separator industry was to account for a great part of the total exports of the Swedish engineering industry. If the export incomes from separators and the rest of agrarian technology are added together the result is that in 1894 these incomes constituted two-thirds of the total value of the engineering industry's exports. In 1913 the corresponding share had dropped to half in spite of the fact that the absolute value of the industry's exports had almost increased tenfold. This was due to the fact that other branches of the industry could export at an even faster pace. However in the agricultural machine sector the exports were principally net exports in

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[112] *Bidrag till SOS Handel.* Kindleberger, Ch. P., *Foreign Trade and the National Economy,* pp. 58 ff.

Kindleberger maintains that if exports are to produce results they must not be too different in terms of quality from the exporting country's home market consumption. For example, if the American farmers want expensive and technologically superior machines it is less profitable for the American machine manufacturers to produce cheaper and less advanced agricultural machines for export at the same time.

Table 54. *The value of the exports within the various sectors of the engineering industry. Relative figures*

Year	A=separators[a]	B=other agricultural machines	A+B	C=other eng. firms	Total
1894	59	7	66	34	100
1900	57	6	63	37	100
1910	40	16	56	44	100
1913	34	17	51	49	100

[a] In Swedish statistics separators are called dairy machines which is incorrect bearing in mind that the machines were mainly sold to the farms.

Source Linder, E., Den svenska mekaniska verkstadsindustriens utveckling intill krigsutbrottet, SOU: 31. SOS Handel.

character. The imports of separators into Sweden were completely irrelevant and imports of other agricultural machines constituted only a quarter of the exports in 1913. Of the separators which were manufactured in Sweden in 1913 more than 95 per cent were exported. The corresponding figure for other agricultural machines was 47 per cent, while in other engineering industries on average only 20 per cent of the production was exported. Thus the agricultural side of the engineering industry was the sector which yielded the most substantial export incomes, due partly to the extent of the production and partly to the fact that production was geared to such a high degree to exporting. At the beginning of the twentieth century butter was Sweden's most important export next to wood and paper products. Thus over and above the direct export incomes the Swedish separator industry made a considerable indirect contribution to exports. As a result of the fact that the separator was proportionately more widespread in Sweden than anywhere in the world, butter productivity could be increased to such an extent that both a rising domestic consumption and a considerable export were possible.[113]

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[113] Linder, E., *Den svenska mekaniska verkstadsindustriens utveckling intill krigsutbrottet*. SOU 1923:31, pp. 51 ff. *SOS Handel.* Nathorst, Hj., *Om handseparatorernas stora betydelse för de mindre jordbrukarna*. Kuuse, J., *Från redskap till*

(f) The separator and the economic situation

Since the Swedish controlled production of separators dominated the world market and this production was mainly marketed outside Sweden, the international economic conditions for the separator can be followed in table 45 and diagram 13. With the exception of 1904–1905 the beginning of the twentieth century until the outbreak of the First World War meant stable and favourable economic conditions for the separator. The First World War created an increased demand for agricultural products in general. With this stimulus there was an exceptional increase in the orders for separators. In general during the years 1914–1919 the farms of Europe, especially those in Russia, Germany, France, Austria and not least in neutral Sweden, bought unusually large quantities of separators. As is shown in table 49 AB Separator increased its share in the sales on the domestic market from 6 per cent in 1914 to 20 per cent in 1920. On the other hand the war did not seem to have had such a stimulating effect on American orders for separators. The peacetime depression of 1920–1922 hit the whole of the separator industry hard like all other industry. During the remainder of the 1920s non-American agriculture rapidly regained its purchasing power, and this was noticeable in the orders for separators among other things. However in the USA agriculture became an ailing sector during the 1920s in contrast to other expanding sectors. The reason for this was that after the First World War American agriculture lost many of its markets overseas. American agriculture had previously undergone a huge mechanisation which had given rise to an enormous increase in productivity. The production capacity vastly exceeded the normal needs of domestic consumption. Therefore when buyers could no longer be found for the surplus of

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maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1910, pp. 66 and 103 ff.

The hand separator was the most "democratic" of the agricultural machines in large parts of Sweden. In 1910 it had, relatively speaking, spread to large and small farms alike, though there was a certain extra spreading to the larger farms. The machine separation also helped to increase the uniformity in the quality of butter which was of special importance in connection with exports. A factor which contributed particularly to the diffusion of the hand separator was that the machines became cheaper through increased competition. See table 52.

American agricultural products the whole problem of over-production with falling prices and an urge to invest made itself felt with full force. The difference in the economic situations of the separator for the De Laval Separator Co. on the one hand and the European separator companies on the other is clear.[114]

(g) AB Separator's production conditions

Manufacturing techniques in the Swedish engineering industry in most cases altered comparatively slowly even after the breakthrough during the 1890s. Many prominent engineering workshops kept to old approved working methods in manufacturing multiple products. AB Separator's development was totally different. The whole business was built up round one idea and one special product. In Sweden a number of special new industries were founded which were based on original domestic inventions or on fundamental technical improvements. Examples of people who laid the foundations for ingenious industries were Palmcrantz in armaments, L. M. Ericsson in telephones, Dalén in acetylene generator sets, Wenström in three-phase motors, C. G. Johansson in special tools,

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[114] Steckzén, B., AB Separators historia 1914–1921. Manuscript Alfa-Lavals arkiv, Tumba. Sales statistics.

The Siberian separator orders to the value of 7.7 million Sw. kr., equivalent to 21% of the total Swedish separator exports, were an important factor in business abroad in 1919. The buyer was the Tsarist Russia emigration association, and the principal suppliers were AB Separator, AB Pumpseparator and AB Baltic. A certain number of separators were also shipped to southern Russia. The deliveries happened to coincide with violent civil strife in Siberia and southern Russia, and the transactions which were disrupted resulted in heavy losses for the Swedish companies.

It was appreciated in the USA at the end of 1919 that the market situation for the agricultural machine industry was beginning to be less profitable. An investigation of the international separator market which the American Foreign Trade Bureau carried out at that time must be looked at against this background among other things. It is clear from the investigation that Swedish separators completely dominated the important markets in Australia, Argentina and South Africa, and in spite of the confused situation, probably in Siberia too. The Swedish and German machines were dominant in Europe, and this dominance acted as an effective fetter on American separator expansion.

Wingquist in ball-bearings and de Laval in separators. Specialisation in production quickly changed the structure of the Swedish engineering industry before the First World War. In spite of the fact that the special engineering works were comparatively few, these companies captured or created new markets once they had survived the initial experimental stage which was difficult from a financial and commercial point of view, and in 1914 they could account for 40 per cent of the total production of the engineering industry. To a great extent this development was due to improvements in productivity. For example AB Separator doubled the production per worker between 1886 and 1908. From the start the new machines which the newly founded special industries introduced into production occupied a central position in this connection. The new engineering techniques also influenced the rôle of the engineering worker. His work had previously been not unlike that of the village blacksmith but the modern techniques' demand for precision made him resemble more the instrument maker. Because of its general utility as a universal implement, it was around the milling machine that modern techniques were built up. Torsten Gårdlund says in *Industrialismens samhälle:* "Without the milling machine it would be impossible to produce cog-wheels or worm-wheels for speeds that are attained in e.g. a separator or a steam turbine." The forerunners in the use of the new milling machines in Sweden were the armament factories which had borrowed technology from the USA at the end of the 1860s. The system of production which was built up round the milling machine was particularly suitable for the mass-production of standardised products. The Swedish companies which were to apply the new methods consistently were therefore those which from the start of the 1880s had begun to manufacture products such as bicycles, electric motors, combustion engines, separators, sewing machines, telephones and machine tools.

But the new engineering workshops had not been created through technical development alone. New principles of organisation were introduced in some of the larger Swedish companies during the decade before the First World War. AB Separator, which played an important part here, introduced rational operating programmes and cost accounting in 1908. Innovation on the shop floor was followed by innovation on the office side, and the whole of the work process was co-ordinated in the same way as the parts of a machine.[115]

It was important that the problems on the production side should be solved if AB Separator was to be able to cater for the extended market. In this connection the importance of production techniques and labour have already been discussed. Raw materials were another important factor. In Sweden AB Separator attached great importance to guaranteed deliveries of cast-iron and sheet-metal. Because of this AB Separator integrated two steel pressing companies in Olofström and Eskilstuna within the business of the group of companies, and in addition in 1901 the company established its own foundry in Hamra outside Stockholm, and there used American moulding techniques right from the start. During the period the foundry was able to deliver most of the castings which AB Separator needed. In the whole of the separator industry in Sweden in 1913 steel sheet-metal constituted 57 per cent of the raw materials consumed in terms of value while cast-iron constituted 19 per cent at the same point in time. In addition the separator production required certain metal alloys and these constituted almost a quarter of the raw materials in value. For the purposes of comparison it can be said that in workshops for other agricultural machines rolled iron and pipes constituted 46 per cent and cast-iron 39 per cent, thus together making up 85 per cent of the sector's costs of raw materials. The agrarian technical workshops' need for raw materials in most cases made it impossible to create vertical mergers as AB Separator did, but made it necessary to put orders out to a growing network of independent sub-contractors. This development was of great importance for the process of industrialisation. On the whole production side the main part of the need for raw materials was met by domestic sub-contractors. In this respect the traditionally strong position of the iron industry in Sweden played a great part. However the degree to which requirements were met varied a great deal. For example in 1913 in the separator industry 68 per cent of the raw materials in terms of value was of domestic origin, while the corresponding share for the rest of the agricultural machine industry was 83 per cent.

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[115] Gårdlund, T., *Industrialismens samhälle*, pp. 81 ff.

Among other things the difference was due to the fact that almost half of the metal alloys for the separator industry had to be obtained from abroad. On the other hand 73 per cent of the sheet-metal, which was the most important raw material in separator production, was supplied by Swedish companies. As far as the other agricultural machine sector was concerned the rolled iron and pipes were all ordered and produced within the country, while about 40 per cent of the cast-iron was imported, mainly from Britain.[116]

Apart from the fact that AB Separator's production in Sweden was integrated vertically, the company from very early on associated factories abroad with the growing business. In most of the countries it was sufficient for AB Separator to have sales offices, but in the most important foreign market areas production was also established. The most prominent example of this was the subsidiary the De Laval Separator Co. which manufactured separators in the USA for the American market. The American factory was set up at the beginning of the 1890s, and thanks to a home market with extensive purchasing power combined with advanced production techniques, it was already able to exceed the production volume of the parent company around 1908. At the same time AB Separator was able to start its own production of separators in Germany through the purchase of Bergedorfer Eisenwerk. At this time it was unusual in Sweden to set up companies abroad. Here AB Separator stands out as the first instance of the country's multinational companies. Of course the fact that the company's transfer of production abroad began in the world's two technically leading industrial

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[116] Linder, E., *Den svenska mekaniska verkstadsindustriens utveckling intill krigsutbrottet*, pp. 14ff. and pp. 99ff.

The information is based on the industrial statistical investigation by the Tull- och traktatkommitté into the consumption of raw materials and semi-manufactured goods. As a whole the material collected was shown to be incomplete, but for the specialised engineering works, including the agrarian technology works, the account is much more reliable. There is no question of absolute accuracy, but the general outcome and the general impression remain intact.

As to the spreading effects within the industry resulting from the orders placed with agrarian technological engineering works, and the latter's orders of raw materials and semi-manufactured goods, see note 7 for a comparison.

nations was especially sensational. This transfer was a necessary condition for the company's exercise of effective control over the situation on important markets. The establishments abroad were probably set up to a lesser degree in an endeavour to avoid the machine tariffs which were in force. It is true that from 1892 Sweden imposed a tariff of 10 per cent on the import value of separators, but the large Swedish separator companies, thanks to their strong position in world markets, were not in need of tariff protection either at home or abroad. For their part they thought it best that all tariffs should be removed. Probably some employment was lost in Sweden as a result of production going abroad. But on the other hand the establishment abroad provided possibilities for increased competitive strength on the market abroad, which in turn led to increased orders in Sweden as well. An excellent instance of this was the pressing of separator bowls, the most complicated manufacturing process, which for a long time was exclusive to the production in Sweden. Before 1905 the De Laval Separator Co. in New York got its separator bowls exclusively from Sweden, and during the whole period AB Separator's production in Germany was supplemented with Swedish-made separator bowls. The most important thing from the point of view of Swedish employment was the fact that AB Separator, through its production abroad on strategically important markets, gained such a hold on the business there that it became really profitable. With these profits behind it the company was able to market its products more boldly on other extensive but more uncertain foreign markets. Because of this the net effect of AB Separator's production abroad from the point of view of Swedish employment was probably positive.[117]

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[117] *Ibid.*, pp. 267ff. and pp. 318f. The tariff protection for Swedish agricultural machines in the years 1892–1910 amounted to 10 per cent of the import value. A readjustment of the rate of duty in 1911 meant somewhat more stringent tariff rates. In contrast to the separator industry, the engineering works producing other agricultural machines were not internationally pre-eminent. Therefore the tariff protection probably had a favourable effect on the development of this part of the industry. International Harvester's establishment for the production of harvesters and mowing-machines in Norrköping, Sweden in 1905 was justified on tariff grounds inter alia.

(*h*) Conditions of financing and ownership

As interest in the present work is mainly focussed on the relations between agriculture and industry the conditions in which the agrarian technology was produced and marketed have been dealt with in detail. The financial aspects will be dealt with in a more summary manner and in close conjunction with the company's production and sales problems.

As far as the parent company AB Separator was concerned it can be established that the growth which occurred up to and during the First World War took place principally within a framework of self-financing. Only during the initial stage was the company provided with a small loan from Oscar Lamm's father for a short time. More occasional loans were taken from Stockholms Diskonto-bank, which had contacts with AB Separator through Ernest Thiel, about which more later. In addition Svenska Handelsbanken gave AB Separator two bond loans in 1899 and 1901 for 1.5 million and 2 million Swedish crowns respectively. The loans were completely repaid within a ten year period. The growth had taken place instead through ploughing back profits, the amassing of capital and increases in the share capital. During the pre-war years the American subsidiary the De Laval Separator Co. contributed the major part of the total net profit, but during the war years the parent company accounted for a large part of the profit. The share capital was increased on various occasions through issues of bonus shares, by revaluation of shares among other methods, and by issues of new shares. All the new subscriptions took place without difficulties. In this connection it can be stressed that it was of importance that the increase in share capital which was carried out to compensate for the assets which were frozen in Russia and Central Europe took place during what was already the latter part of the war. If they had waited a few years a similar new subscription would not have been possible.

In connection with the market expansion of the company AB Separator formed subsidiaries for production or sales or both, and also for steel pressing. In certain cases the financing of these branches of the business required an increase in outside capital. In order to be able to undertake the reorganisation of the De Laval Separator Co. mentioned earlier, AB Separator raised a bond loan of half a million Swedish crowns in 1890, and this was repaid in 1894 when the company once more became totally free from debts. In 1912 AB Separator took a new bond loan of 5 million Swedish crowns from Stockholms Diskontobank in order to get working capital for the extension of the Russian business. Some of the subsidiaries were in debt (bond loans) when they were incorporated into the Separator group of companies. AB Separator allowed some of these loans to remain outstanding, for example as regards Eskilstuna Stålpressnings AB. In order to illustrate the degree of self-financing there is a review in table 55 of the relationship between the group's own and outside capital for the group's various business units in 1915. The table shows the financing situation at a time when the group's first period of expansion had concluded with Alfa-Nobel becoming a subsidiary of AB Separator in 1914. Even as late as 1915 outside capital clearly played an insignificant rôle except as regards Eskilstuna Stålpressnings AB. In the case of subsidiaries the short-term indebtedness consisted mainly of debts to AB Separator.[118]

A consistently good yield during the period in question made it possible for AB Separator to pay large dividends to the shareholders. During the years 1892–1897 dividends of 35 per cent were paid on average, dividends of 50 per cent in 1898–1910, and in the years 1911–1919 about 15 per cent of the share capital on a yearly basis. A comparison between the agricultural machine industries in Sweden and Germany shows that the yearly dividends in 1911–1914 for the industries of both countries constituted on average 9–11 per cent of the share capital. In fact the agricultural machine industry paid larger dividends than most of the other branches of engineering. The war years 1920 and 1921 resulted in lower dividends for AB Separator corresponding to 8 per cent and 3 per cent respectively of the share capital.[119]

During the period in question the conditions of ownership constitute a comparatively complex chapter in the history of AB Separator. They will be dealt with briefly and only to the extent

[118] Steckzén, B., AB Separators historia. Moderbolaget 1895–1921 (manuscript). In table 47 the sales figures are related only to the parent company.
[119] *Technik und Wirtschaft* no. 6, 1921. Linder, E., *op. cit.*, pp. 93 ff.

Table 55. *Percentage distribution of own and outside capital in 1915 for companies belonging to the Separator group*

	Own capital Share capital, profits, funds	Outside capital Short-term debts	Outside capital Long-term debts	Total	Balance-sheet total in millions
AB Separator	92	–	8	100	61.8 Sw. kr.
Eskilstuna Stålpressnings AB	51	–	49	100	5.3 Sw. kr.
Svenska Stålpressnings AB Olofström	86	–	14	100	3.3 Sw. kr.
Svenska Centrifug AB	97	–	3	100	6.6 Sw. kr.
The de Laval Separator Company (Lavalco) New York	100	–	–	100	6.3 $
AG Alfa-Separator Wien	65	33	2	100	5.5 Austrian k.
AG Alfa-Separator Budapest	48	51	1	100	2.0 Austrian k.
AG Alfa-Nobel St. Petersburg	65	35	–	100	3.9 roubles
Alfa-Laval Paris	100	–	–	100	4.3 francs
G.m.b.H. Alfa-Laval-Separator Berlin	31	63	6	100	4.0 marks
AG Bergedorfer Eisenwerk	60	28	12	100	8.6 marks

Note The long-term debts consisted of bond- and mortgage loans, while the short-term debts were to a great extent debts owed by contractors to the principal contractor AB Separator.

Source AB Separators förvaltnings- och revisionsberättelse år 1915.

to which they were directly connected with technical agrarian problems. After Oscar Lamm had left the company in 1886, Gustaf de Laval was able, as chairman of the board and owner of about 30 per cent of the shares for more than a decade, to exert considerable influence over AB Separator in matters which interested him. It was Gustaf de Laval's ambition to unite the rôle of inventor with that of founder of a company. He wanted to see himself as the intermediary link in the life of Swedish industry. With the aid of capital his inventions would make the industrial companies profitable. His economic transactions have to be viewed against this background. He often arranged the raising of capital in an impetuous and unmethodical way, but surprisingly often he managed to inspire and convince the owners of the capital to invest in his projects. De Laval was involved in starting no fewer than 37 companies. The total share capital which was put into the companies which were formed on his initiative and in direct association with his inventions amounted to about 50 million Swedish crowns. In fact most of the companies were short-lived, and only AB Separator, Svenska Stålpressnings AB, Olofström, and AB de Lavals Ångturbin were lasting businesses. Among the better-known companies which were short-lived there were AB de Lavals Laktator for milking machines, de Lavals glödlampfabrik, AB de Lavals Elektriska Smältugn and Trollhättans Elektriska Kraft AB.[120]

In the middle of the 1890s when Gustaf de Laval started to found a series of companies, he still enjoyed financial confidence. Stockholms Kredit- och Diskontoförening with Ernest Thiel as the leading figure acted as financiers for de Laval, and had an interest in the milking machine company AB Laktator. To solve the problem of credit, in 1896 de Laval raised money on his shares in AB Separator to a total of 6 million Swedish crowns from Stockholms Kredit- och Diskontoförening and Stockholms Enskilda Bank. Gustaf de Laval's involvement in the production of milking machines later became of importance for AB Separator's conditions of financing and ownership, and since the spread of the separator produced a demand for milking machines as a result of investing in separators, it is appropriate in this context to pause and consider the development of the milking machine. By mechanically extracting the milk from the cows on the one hand and separating the cream from the milk on the other, milk management became more completely mechanised. It was of course quite natural that the person who had succeeded in the separation of milk by machine would also try to

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120 Althin, T., *op. cit.*, pp. 191 ff.

solve the problem of milking by machine. The spread of separation by machine contributed to the creation of a growing demand for milk. When Gustaf de Laval applied himself to the milking machine industry in 1895 he was by no means a pioneer in the field. Ever since 1862 when the first milking machine was shown at a fair in the USA attempts had been made to solve the practical problems of machine milking technology. In spite of the fact that in the USA with its labour shortage there was a large market—and one with great purchasing power—for the milking machine, as a technical agrarian consequence of investment in the separator, such market incentives did not bring forth a machine which worked practically. Gustaf de Laval did not succeed in 1895 and in spite of the fact that in 1907 AB Separator started a company in a deliberate attempt to develop the milking machine, the endeavour failed here as had those of the other innovators in the USA and Europe. In spite of strong market incentives, the development of milking machine techniques is an instance of many technical appendices preceding the final practical solution of the problem. Not until after the First World War was the problem of machine milking solved through the pulsator, which allowed the milk suction to take place with frequent pauses, thus avoiding the damaging effect of the suction on the udders and teats of the cows. Earlier techniques using interrupted suction had caused injuries to the cattle through blood congestion in the udders and teats.[121]

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[121] Fussel, G. E., *The Farmer's Tools,* pp. 218ff. Juhlin Dannfeldt, H., *Lantbrukets historia,* p. 60. Street, J. H., *The New Revolution in the Cotton Economy. Mechanization and its Consequences,* pp. 99f.

J. H. Street deals with the ability of various sectors of agriculture to introduce and put into practice new technology. He stresses the difference in the use of separators and milking machines in dairying: "The milking machine, unlike the cream separator, failed for a long time to be put to general use even though power-operated models were available by the time of the First World War. The automatic milker came into its own, however, in response to the labor scarcity and acute demand for milk of World War II. There were 175 000 milking machines in use in the United States in 1940 and by 1950 the number had increased to 710 000, an increase of 306 per cent for the decade."

A comparison with Sweden shows a similar development. According to the Swedish census of agriculture in 1944 and 1951 at the former date every tenth farm had a milking machine and at the latter date every third farm. In Sweden

When de Laval's milking machine failed and AB Laktator had to go into liquidation at the beginning of 1897, de Laval was forced after pressure from Stockholms Kredit- och Diskontoförening to redeem the shares in AB Laktator at a premium, and in so doing he lost 1.6 million Swedish crowns. At the same time the Diskontoförening made it clear that Gustaf de Laval was faced with economic collapse. In several quarters there was an interest in holding the crises in check. Both the Diskontoförening and Stockholms Enskilda Bank wanted to support de Laval until their loans were secured. AB Separator was also concerned that de Laval's name should not fall into disrepute, since a large industrial fair was to take place in Stockholm in the summer of 1897 in which the company would be one of the principal participants. To save de Laval, AB Separator at its annual general meeting in 1897 decided on an exceptionally high dividend of 70 per cent of the share capital and on a bonus issue in addition, so that the share capital was doubled. Thanks to a corresponding revaluation of the worth of the De Laval Separator Co. the bonus issue could be made. In 1897 the Diskontoförening acquired the right to dispose of the majority of de Laval's separator shares. Thereafter his influence in AB Separator became negligible. He was, however, more as a matter of form, allowed to continue as chairman of the board for three more years. After the industrial fair Gustaf de Laval's businesses were subjected to a thorough re-financing process. On this account a holding company was formed in 1898, Förenade Separatorintressenters AB, and the Diskontoförening stood behind the formation of the company. The object of forming the company was to avoid a price-cutting bargain sale of the separator shares, and to raise ready cash from the shares for de Laval and the

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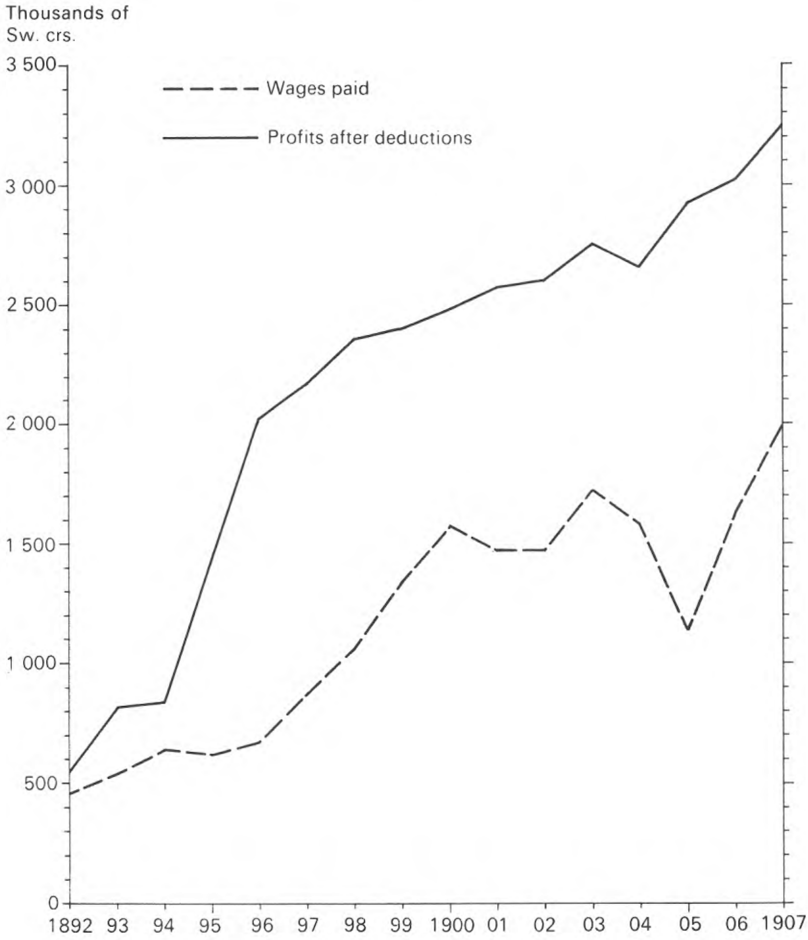
as well as in the USA the 1940s were the time of breakthrough for the milking machine.

See also *Finansman Företagare Förhandlare. Till Jacob Wallenberg på 80 årsdagen.* The chapter on Alfa-Laval, pp. 19f., and also Jansson T., *The Development of the Milking Machine. A Historical Review.*

The explanation for the later mechanisation in dairying and cattle-farming is that cattle require qualified individual attention. Therefore only certain stages in the production of that sector could be mechanised, and complete mechanisation will probably not be possible in the future either.

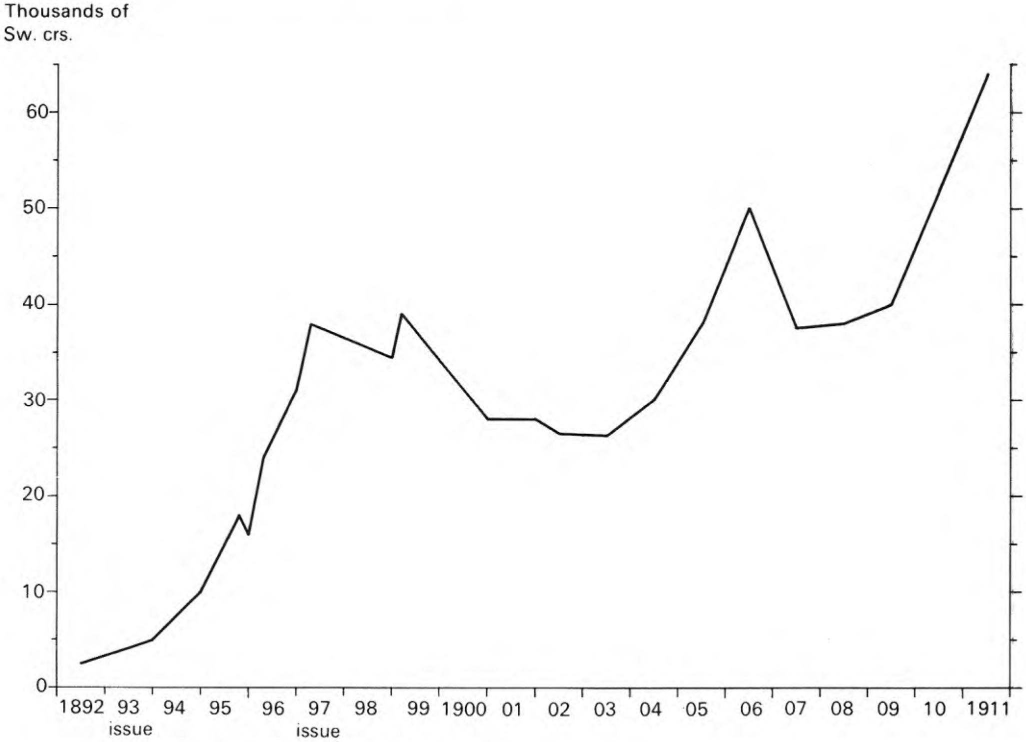
Diagram 16. *The development of wages and profits at AB Separator, 1892–1907.*



Diskontoförening to be able to satisfy de Laval's creditors. In the years immediately following its formation Förenade Separatorintressenters AB and its securities were to feature in Ernest Thiel's financial operations with Gustaf Emil Broms in Luossavaara-Kiirunavaara AB (LKAB).[122]

[122] Fritz, M., *Gustaf Emil Broms och Norrbottens järnmalm. En studie i finansieringsproblematiken under exploateringstiden 1891–1903*, pp. 13 ff. Gasslander, O.,

Diagram 17. *Stock Exchange value of a single Separator share in 1892–1911 (including share issues in 1893 and 1897).*



Source Steckzén, B., AB Separators historia. Cf. table 53.

The Diskontoförening, converted into Stockholms Diskontobank from 1899 onwards, was able to increase its influence in AB Separator during the course of the same year when Hugo Martin, a member of the board of the company, died and the Diskontobank took over his separator shares. At the annual general meeting in 1900 two men from the Diskontobank were elected as new members of the board of AB Separator. John Bernström took the view that these two men

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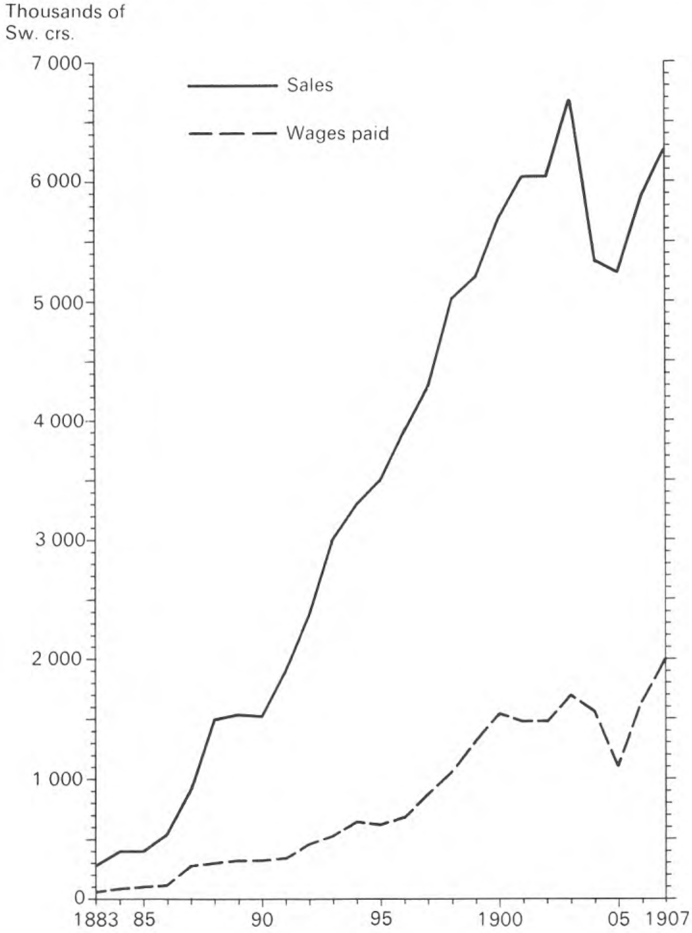
Bank och industriellt genombrott. Stockholms Enskilda Bank kring sekelskiftet 1900, I, pp. 218 ff., 243 ff., II, pp. 91 ff. Steckzén, B., AB Separators historia. Moderbolaget (manuscript).

Diagram 18. *Sales and wages paid at AB Separator, 1883–1907.*



constituted a definit guarantee that no surprising action would be taken against AB Separator by the now powerful group of owners, Förenade Separatorintressenters AB and the Diskontobank. However John Bernström was in a perpetual state of anxiety because of the risk that Förenade Separatorintressenters AB, with its 30 per cent shareholding in AB Separator, would direct AB Separator's financial and dividend policy on a course other than that desired by the management of the company. Therefore at the annual general meeting in 1903 he forced through AB Separator's purchase of Förenade Separatorsintressenters AB's shares.[123]

From an economic point of view AB Separator's share transactions with Förenade Separatorintressenters AB were disadvantageous. However the course of events shows what great importance the company management of AB Separator attached to the condition that no dominant group of owners should get the opportunity to control development against the interests of the management.[124] The high percentage dividends and the extensive bond issues made before 1911 should be regarded as a concession to the owner interests, but a concession which was aimed at pacifying them. It has been pointed out above that the development of AB Separator up to and including the period of the First World War was essentially managed with the aid of its own capital, and from a formal point of view this is quite correct. In reality the structure of ownership was such that large parts of the company's own share capital were regarded by the company management as a foreign element as well as ordinary foreign loan capital. Gustaf de Laval participated to a high degree in the formation of AB Separator but his financial operations led to the company he had created being forced to take part in an economic relief operation for Gustaf de Laval himself, and in consequence in a holding company which for many years caused AB Separator many problems.

(*i*) Summary

In his work "The New Revolution in the Cotton Economy. Mechanization and its consequences" J. H. Street deals with the ability of different sectors of agriculture to acquire new techniques.

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[123] Steckzén, B., AB Separators historia. Moderbolaget (manuscript).

[124] *Ibid.* The problem of Förenade Separatorintressenters AB was to arise again in 1910 and 1912. The purchase of yet another block of shares in Förenade Separatorintressenters AB in 1912 caused a definitive breach in the company management of AB Separator. John Bernström's son Richard refused to endorse the deal and resigned in protest from his newly assumed post of managing director.

The sectors mainly referred to are grain growing, the cultivation of grassland, cattle-farming and cotton growing. Grain growing and the cultivation of grassland were the first and most highly mechanised sectors of agriculture. Implements and machinery for working and preparing the soil were developed and improved during the first half of the nineteenth century especially in the USA. But it was more a question of further technical development to suit a growing commercial agriculture than of pure innovations. However the machines which began to be used in the USA for the protection of the harvest in the middle of the nineteenth century were typical innovations. The harvester, the mowing machine and the threshing machine changed the agriculture in a fundamental way, whereas before the time spent in harvesting and threshing had formed the bottleneck in production. By an enormous increase in productivity and more accurate harvesting and threshing stages above all, American agriculture was able during the latter part of the nineteenth century to produce a growing surplus of agricultural products. The next decisive step on the mechanisation side took place when the tractor and the combination model, the combine harvester, spread during the period between the wars, starting in the USA. By virtue of the fact that by American standards the tractor was cheap and easy to make, it became an example of a "democratic" agricultural machine there. It has been estimated that in 1946 90 percent of the grain of the USA was being harvested by tractor-drawn machines, while two-thirds was harvested by combine harvesters. On the other hand in Sweden in 1944 the combine harvester had not been introduced even on the large estates. However the tractor had been introduced, but only on the big estates. Of all Swedish farms, only 6 per cent were equipped with tractors in 1944. This difference illustrates underlying differences in the size of farms and the purchasing power of the average farm in the USA and Europe.

The corresponding wave of mechanisation in cattle-farming and dairying came much later. The separator made its name in connection with the European agricultural crises in the 1880s and the transition to livestock-orientated production which followed the crises. Not until the period between the wars did machine milking begin to be used to any great extent, but the breakthrough did not come until the Second World War. The problem of using mechanised processes in conjunction with live animals had long baffled the innovators in this field.

However, the breakthrough of mechanisation in cotton growing was long in coming. In fact the first innovation in this sector came very early on. In 1793 Eli Whitney invented the "cotton gin", a machine which separated the cotton fibres from the seeds mechanically. The result was that the USA was able to export cotton from the Southern states to England. The bottleneck in production moved to the working of the cotton fields and also to the harvest. These stages were mechanised very late, however. There were several reasons for this. The pattern of institutional factors in the South was such that it did not invite labour-saving techniques. The slave system was for a long time a corner-stone of the economic and social life of the Southern states. A large part of the capital was therefore tied up in the fixed assets which the possession of slaves represented. The victory of industrial capitalism in the North over the plantation economy of the South meant that after the Civil war the Southern states were held back economically in comparison with the Northern states. But problems of a technical nature also had an effect. In cotton growing it was difficult to standardise the cultivated product and the environment of cultivation generally in the same way as was possible in the growing of grain and the cultivation of grassland. Therefore for a long time the harvesting stage constituted a bottleneck in the cotton economy. International Harvester spent forty years and five million dollars on developing a workable harvesting machine for cotton. Individual models were available on the market in 1942 and there was full-scale production in 1947. Between the first and second technical revolutions in cotton growing 150 years had elapsed.[125]

Street's account is very general but it showed some of the complex patterns and the multiplicity of the technical problems of agriculture. Gustaf de Laval knew something about this when he studied natural science at Uppsala University at the end of the 1860s. At that time he had worked out his future and had decided to put his knowledge into practice and apply it in important

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[125] Street, J. H., pp. 93 ff. *Sveriges Officiella Statistik. Jordbruksräkningen i Sverige 1944.*

economic fields. As he had grown up in and was familiar with the agricultural environment, and as the agricultural sector dominated Sweden's economy, it was natural for de Laval to direct his technical interest towards the mechanisation of agriculture. As shown above and as will be dealt with in greater detail hereafter, the mechanisation of land cultivation in the USA had recently revolutionised the methods of production in this sector of agriculture. On the other hand there had not been any decisive technical innovations in cattle-breeding or in dairying, which was an important sector of the Swedish agricultural economy. With the benefit of hindsight it may seem obvious that de Laval with his knowledge and understanding of the value of a new agricultural technique would have been drawn straight to the technically undeveloped sector of cattle-breeding and dairying. Nevertheless it was more by accident that he introduced the separator onto the market at the end of the 1870s.

It is interesting to study Gustaf de Laval's development in the light of J. Schumpeter's entrepreneur theory. As a young researcher de Laval's thoughts revolved around the economic importance of technical innovations. He says in his diary: "Sweden could take first place among the nations in industrial as well as general well-being if only the right inventions could be made." This interest was combined with a pronounced nationalism, as appears from the phrase "Sweden for the Swedes". His nationalism was so fully realised in his future sphere of activity, the separator market, that it is tempting to parody this as "The world for the Swedes". At any rate at this time (around 1870) he appreciated and remarked to himself upon the need to combine the technical and commercial aspects of an innovation. In his diary the young de Laval had a discussion with himself which was apparently in complete conformity with Schumpeter's model of the entrepreneur: The manufacturer holds the key rôle in society by creating new processes or new combinations of individually known processes. The practical application and diffusion of the innovation are of economic importance. Thus the rôle of the entrepreneur becomes comparatively limited during the process of innovation, while the rôle gradually grows as regards the introduction of the innovation onto the market, and still more as regards its diffusion. When de Laval introduced his separator in 1878 there is a noticeable change in the direction of his interest and activity. The operation of marketing methodically was a limited one and instead it was the further development of the technical possibilities of the invention which occupied him more and more. In addition he was driven by a growing magical enthusiasm to the continual establishment of new companies based on new ideas, but he lacked the patience to see the operation through. Therefore his economic importance became limited except in the case of AB Separator. But there it was the combination of de Laval and Lamm and above all of de Laval and Bernström which approached Schumpeter's ideal of the entrepreneur. De Laval himself failed to live up to this ideal.[126]

Thus the importance of AB Separator lay in the combination of technical and commercial imagination which worked because both the partners could meet and talk the same language well enough. This however was due above all to John Bernström, who showed that he possessed the eye of the visionary and the talent of the entrepreneur in his acquisition of the epoch-making Alfa patent. It is true that Schumpeter says that the manufacturer could fulfil his rôle as an entrepreneur in the introduction onto the market and diffusion of new products on all levels and regardless of the general importance of the innovation. But as Schumpeter sees the manufacturer and his creations as the main cause of the transformation of society, the social range of the innovation determines the degree of the transformation of society. According to this argument an entrepreneur who for example introduced a new lipstick onto the market would not be as great a transformer of society as one who introduced a new agricultural machine, even if the innovations were equally valuable from a technical point of view. An innovation which aims at satisfying more primary requirements of consumption

[126] Schumpeter, J., 'The Creative Response in Economic History' (in *Journal of Economic History*, no. 2 1947).

Schumpeter's entrepreneur theory is probably most applicable to the problems of company formation up to the turn of the nineteenth century. The function of the entrepreneur was usually exercised up to that time by one or very few decision-making men in the company. Later on during the 20th century the rôle of the entrepreneur was often divided up among several hands, while the company was becoming bureaucratic. It is therefore more difficult to apply Schumpeter's theory to the more complex structure of modern companies.

and production of necessity effects a greater change than an innovation which is directed more towards secondary requirements. During the latter part of the nineteenth century and at the turn of that century, not least in Sweden, a succession of industries of genius was created in which the entrepreneur introduced and circulated newly created or newly combined products which were of importance for economic life and in the home. Among other things these included electric motors, special tools, ballbearings, telephones and separators, all of which circulated more or less internationally to a considerable extent. However, the question is whether the separator, as the most outstanding example of Swedish agricultural machines, did not out of all the new creations mentioned above bring about the greatest change in society by virtue of its range. The agricultural machines made a direct impact on the country's most dominant sector, with far-reaching economic and social consequences for most producers in Sweden and many abroad. In countries which were developed at the time the mechanisation process divided agriculture into two parts. One part consisted of those farms which could be mechanised to such an extent that they were incorporated into commercial forms of operation with considerable sales orientation. The other part consisted of all the farms which for various reasons could not be mechanised to an extent which took them above the level of being self-supporting. Even if the separator was perhaps the most "democratic" agricultural machine it also contributed to differentiation in agriculture, as the smaller and cheaper domestic separators were bought mainly by the smaller farmer, while the large farms, especially in the USA, bought larger separators for sales production.

In addition the agricultural technology became of great importance for Swedish industrialisation. As H. Modig has been able to show, the part played by railway building in the industrialisation of Sweden has previously been considerably exaggerated. The railway materials were mainly imported from Britain. On the other hand the mechanisation of agriculture played a much larger rôle in the industrialisation process than earlier research had acknowledged. In the creation of agricultural technology the orders in the whole chain of production from raw materials to finished product were mainly executed within the country. The engineering works of agricultural technology, especially separator works, were ultimately able to export their finished products to farms abroad and thereby account for the main part of the whole engineering industry's income from exports, thus making a further contribution to industrialisation. The rapidly increasing exports of butter from Sweden around the turn of the nineteenth century provide an excellent example of how mechanisation in the form of the mechanical separation of milk led to increased sales production which was sufficient for a rise in domestic consumption as well as in exports. Thus the separator contributed in a readily apparent if indirect way to the further income which came into the country from significant exports. The consumers of food were also affected to a great extent by the new agricultural technology since mechanised farming prevented climatic conditions from having such an unsettling effect on the crop yield as before, and the quality of the final products could also be improved and made more even. The other Swedish industries of genius which have been mentioned were based on ideas and principles which were the equal of those on which the separator was founded, but at the beginning of the twentieth century none of the other innovations had the same impact or the same international diffusion as the separator. For example at the outbreak of the Second World War the majority of Swedish households did not have a telephone, and the telephone only became common for the Swedish working classes after 1950. On the other hand the telephone early on played a large rôle in the economic life and administration of Sweden. The ballbearing is perhaps most like the separator as regards the power of transformation in the techniques in question, but the corresponding importance of the ballbearing did not begin to make itself felt until that sector of industry made a breakthrough and became dominant during the period between the wars.

The breakthrough of the separator in the 1880s—connected with the change-over of European agriculture to production which was more orientated towards livestock when faced with non-European and Russian rivalry in grain—occurred in competition with a method of creaming which was well established in Europe, viz. the so-called ice method. Thus the new separator technology in Sweden was strengthened through facing competition which forced the innovators to develop methods of production which were superior to the old ones. But the ice method offered tough and prolonged resistance, and not until experience of the improved Alfa separators had had time to spread was the machine separation of milk fully able to make its name in Sweden. In countries where there was a shortage of ice it was easier for the Swedish separator technology to make a breakthrough, and the trend was reinforced through the advantage gained by AB Separator over other separator manufacturers from the acquisition of the Alfa patent in 1889. When the period of the patent expired, newly established Swedish separator companies became AB Separator's keenest competitors on the world market. However, AB Separator had the Swedish competitors incorporated into the expanding Separator group of companies in stages.

The formation of the group had begun in 1883 when AB Separator started a subsidiary in the USA. North America was the most important market and the one with the greatest purchasing power, and the profits from the American operation became decisive for the future development of the whole group of companies. AB Separator was gradually able to form a series of subsidiaries on the most important European markets, which had to deal first of all with the sales of the products of AB Separator which were manufactured in Sweden. In other respects the selling abroad was carried out through general agents. The rising demand for agricultural products has already been indicated as the basic explanation of the increased demand for agricultural technology up to the First World War. However the considerable emigration from Europe helped greatly in stimulating the mechanisation of agriculture. In this case the effect of emigration was twofold. First and foremost there was an increase in the demand for agricultural machines in the farming districts cultivated by the immigrants in the USA, Canada, Argentina, Australia and Siberia, but there was also at the same time a decrease in the population of Europe which called for the replacement of labour by agricultural technology to a greater extent than would have been the case had no emigration taken place. The fact that AB Separator was able in the long run to retain its large shares of the market was due partly to the fact that the company moved part of its production abroad to strategically important areas. In a longer term view the departure of the business had favourable effects on employment in Sweden.

By virtue of the fact that AB Separator concentrated its resources completely on producing, developing and marketing a special product, the company became well acquainted with all the problems and possibilities of the business. From this point of view the specialisation was clearly an advantage, but in its struggle to spread its machines throughout the world AB Separator faced another problem. International Harvester, which was the world's largest producer of agricultural machines, operated on the opposite full-line principle. The group of companies had built up a gigantic sales organisation, and when it came to the acquisition of the best salesmen it was a definite advantage to be able to let them sell different kinds of agricultural technology to the farmers. However, in spite of the fact that International Harvester with its wide range of goods was able to get the most prominent agents under contract, AB Separator was able to see to it that International Harvester did not get any real hold on the separator market even in the USA. Apparently the selling of separators could not simply be integrated with the sale of machines for the cultivation of land. But by virtue of the high level of its resources International Harvester was largely able to maintain its full-line programme, which will be dealt with in greater detail in the section which follows.

2. *McCormick-International Harvester Company, Chicago*

The McCormick Epoch

Introduction

When the frontier in the USA around 1860 had passed the Mississippi Valley and had extended halfway into Wisconsin, Minnesota, Iowa, Kansas and Texas, a large part of the prairies south of the Great Lakes had been cultivated. From an international point of view the largest agrarian purchasing power developed and was concentrated here through the many large holdings which were built

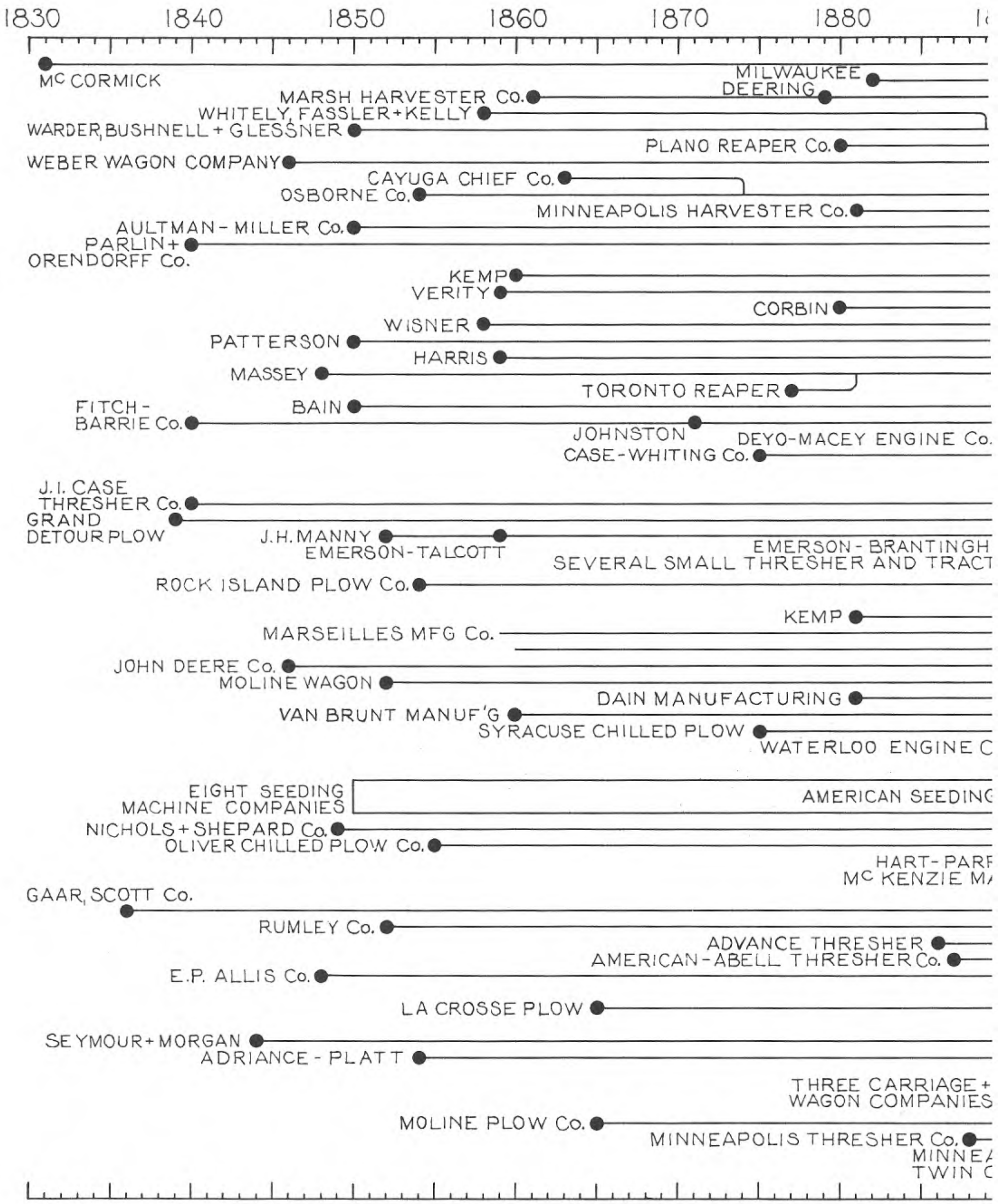
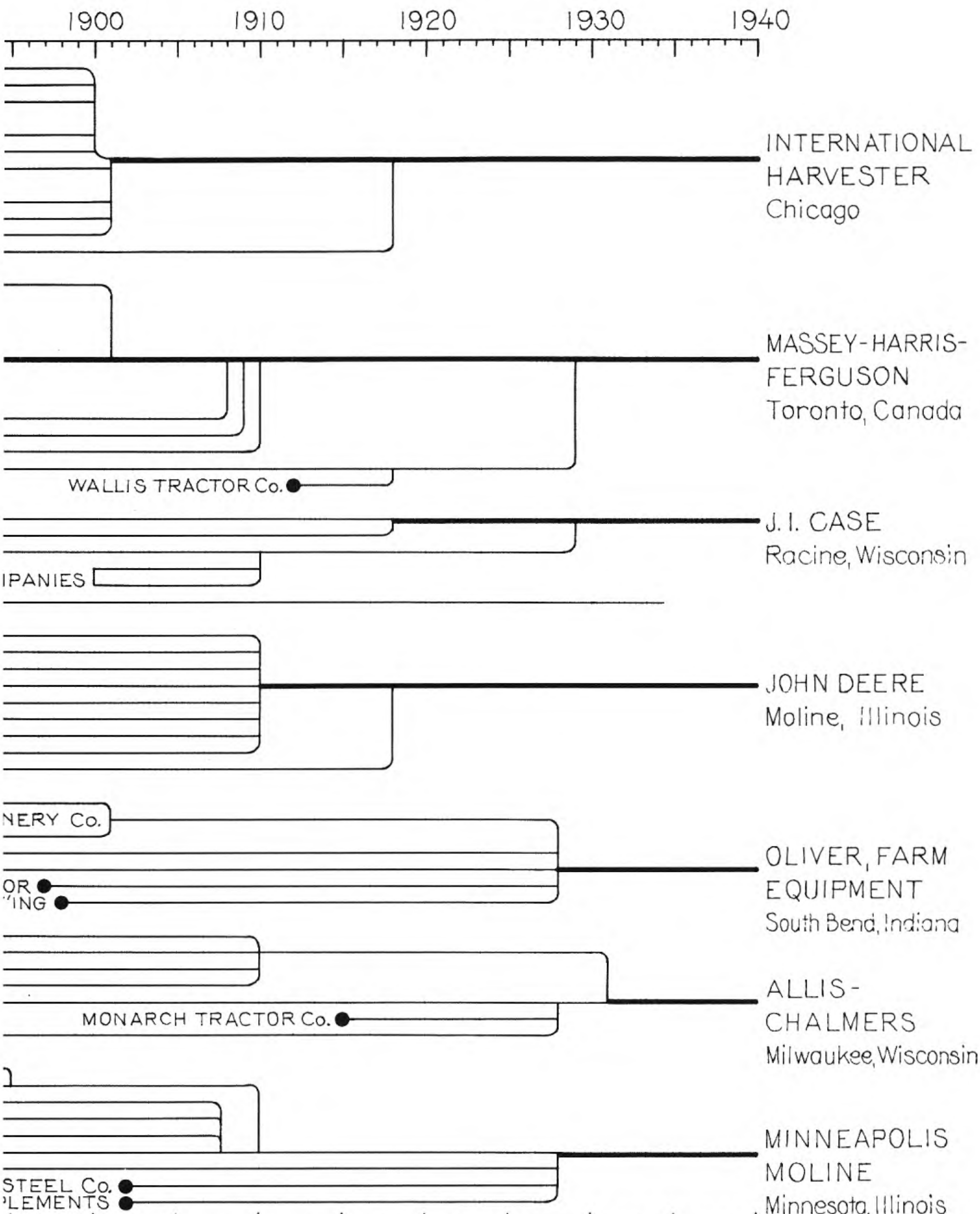
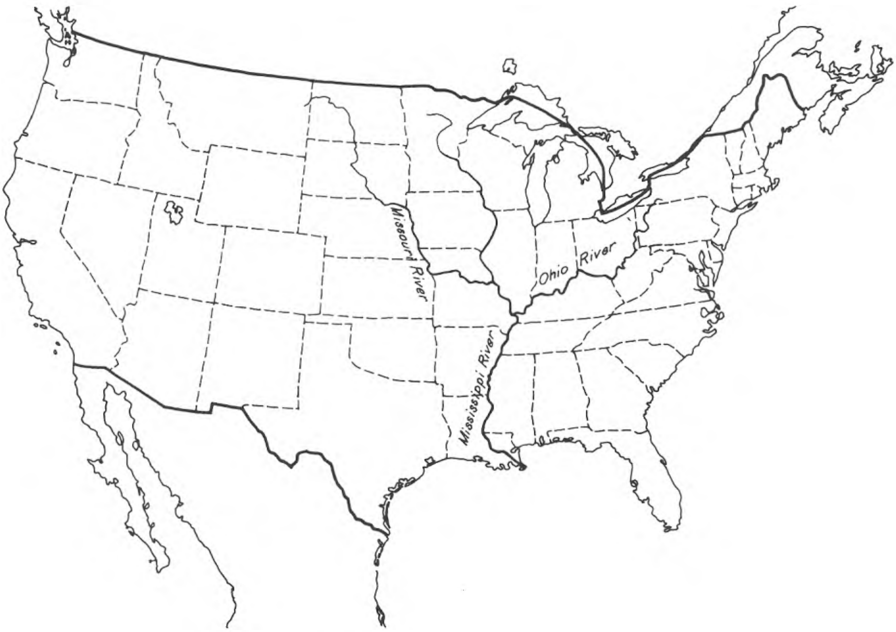


Figure 2. *The more important mergers in the North American agricultural machine*



in 1830–1930. *Source* Phillips, W. G., The Agricultural Implement Industry in Canada, p. 13.

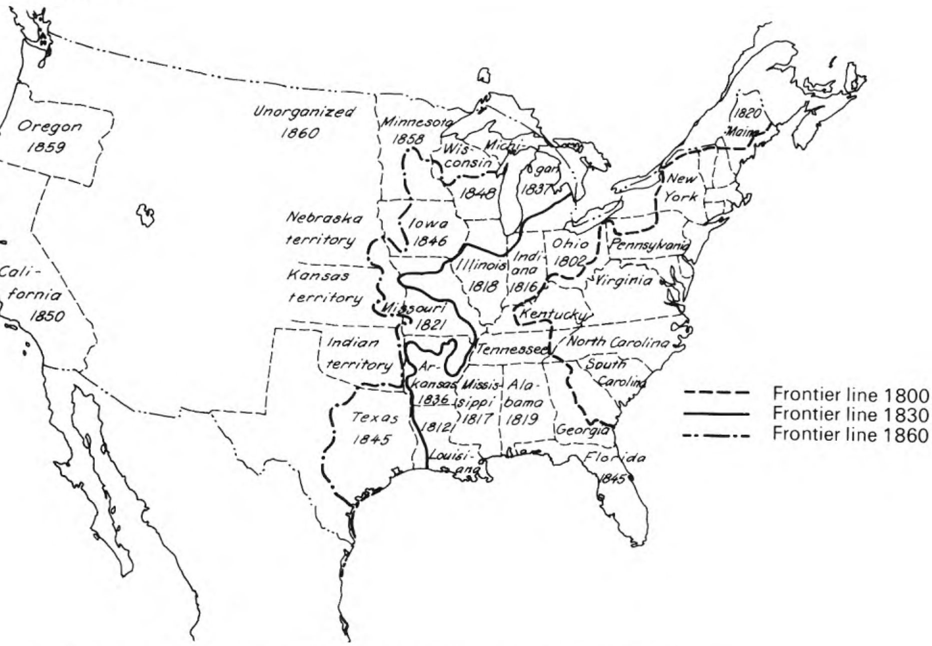
Map 9.



up. The vast supply of land which was topographically extremely suitable for mechanised farming, and the shortage of labour explain why the agricultural machine industry was located and developed in the region of the prairies to an especially high degree.[127] Figure 2 shows the development of the companies in the agricultural machine industry which around the turn of the nineteenth century and in the following decades merged to form seven different groups of companies which were then the largest in the business in North America. All the groups of companies through their predecessors had their roots in the period before 1860. The companies in the Middle-West completely dominated the branch of the industry geographically, and the Canadian Massey-Harris in Toronto can also be included here. In the USA the large units of the agricultural technology industry were entirely located in the

[127] Turner, F. J., *The Frontier in American History*, pp. 126ff. Faulkner, H. V., *American Economic History*, pp. 186ff.

Map 10



The years represent the dates when the states joined the Union.

states of Illinois, Wisconsin, Minnesota and Indiana. The first wave of foundations in the branch of industry had ended around 1860. The next wave came during the 1870s and 1880s when substantial competition began to develop. Among other things as a result of this, around the turn of the nineteenth century in the agricultural machine industry as well as in other American industries a series of mergers began, the largest of which in the agricultural machine industry involved International Harvester. International Harvester, which is the largest manufacturer of agricultural technology, after the merger in 1902 controlled between 80 and 90 per cent of the production of agricultural machines in the USA. McCormick's company, which was the largest component in International Harvester and its oldest and most important predecessor during the nineteenth century, had first started to produce harvesters before all the others in the 1840s. At the end of the nineteenth century McCormick was faced with heavy competition from the Deering Harvester Company, which was also integrated into International Harvester in 1902. After the merger the production programme was gradually changed to the so-called full-line principle from a production which had mainly comprised harvesters before the merger. In the same way the other mergers in figure 2 changed character. After the mergers the groups of companies strove to operate a full-line system whereas the predecessors which had previously been foremost e.g. in Deere and Oliver had specialised in ploughs, in Case in steam threshers and traction engines, and in Massey-Harris in harvesters and mowing-machines. At the turn of the nineteenth century there were in the USA about 700 companies on various levels which produced agricultural machines. The companies in figure 2 were the giants in the field.[128] The most important of these was International Harvester, and this justifies a closer study of this company and its predecessor. McCormick and to a certain extent Deering as the best known predecessors of International Harvester

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[128] In comparison with their Swedish counterparts, American engineering works had a much higher capacity. For example the J. I. Case Company which was the largest American producer of traction engines and steam threshers manufactured more than 30 000 traction engines and 70 000 steam threshers between 1880 and 1914. Munktell in Sweden produced 7 000 traction engines and almost as many steam threshers in 1853–1914. Around 1910 when the sales of steam threshers and traction engines reached their peak both in the USA and in Sweden, Munktell's yearly production was equivalent to only one-tenth of that of J. I. Case. In addition it should be borne in mind that Munktell completely dominated the Swedish market, while J. I. Case, in spite of its leading market position in the USA after the turn of the nineteenth century, met with much keener domestic competition. Thus before 1898 the oldest predecessor in the Allis-Chalmers group of companies, the Gar Scott Company, of Richmond, Indiana, was the leading traction engine company in the USA.

In 1860 the John Deere Company produced about ten times as many ploughs as Överum. Twenty years later the Oliver Chilled Plow Company was able to sell 60 000 ploughs compared with Överum's 5 000. The above information gives an idea of the disparity in terms of volume which the agricultural machine industries in the two countries discovered.

Wik, R. M., *Steam Power on the American Farm*, pp. 99 ff. and p. 257. Clark, N. M., *John Deere. He Gave to the World the Steel Plow*, pp. 39 ff. Ardrey, R. L., *American Agricultural Implements*. Rogin, L., *The Introduction of Farm Machinery and its Relations to the Productivity of Labor in the Agriculture of the United States during the Nineteenth Century*, pp. 32 ff. Holbrook, S. H., *Machines of Plenty. Pioneering in American Agriculture*.

were also during the nineteenth century leaders of the market in harvesters and mowing-machines. The harvester was probably the most revolutionary innovation in American agricultural technology. Therefore the course of McCormick both before and within International Harvester will be followed comparatively closely, and Deering's course will also be traced to a certain extent. A further reason for choosing McCormick-International Harvester is that the sources for the group are both comprehensive and of good quality, in contrast to the material for the other groups of companies.[129]

(*a*) The background to McCormick's harvester

The textile industry was the branch of industry which was best able during the eighteenth century to utilize technical innovations and put them into practice. During the industrial revolution in England the textile industry led the way in the introduction of new techniques of production, and the demand for cotton increased sharply. It was probably not by chance that Eli Whitney's cotton-gin became the first agricultural machine to achieve economic importance. The machine, which was introduced in 1793 and affected the delivery capacity of American raw cotton above all, followed a radical mechanisation of the English cotton mills.[130] Bearing in

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[129] The sources relating to the McCormick Harvesting Machine Company and its founder Cyrus Hall McCormick have been preserved in extensive records, "the McCormick Collection". This collection is kept at the State Historical Society of Wisconsin in Madison, where "the Singer Collection" is also to be found. The McCormick Collection contains among other things a great number of volumes in different series such as Reaper Sales, Reaper Orders, Deliveries, Machine Record (Ledger) and Twine Account for the McCormick Harvesting Machine Company before 1902. However, information for certain years is missing. It is possible in an Order book and/or a Machine Ledger to find information about the salesman's/agent's name and address, the buyer's name and address, and also the year of the model of harvester sold. Thus the information is highly relevant for studies of diffusion of agrarian technology, since it is possible to follow the machines all the way to their place of operation. In addition a very comprehensive business correspondence has been systematised into a special series. Finally the McCormick Collection contains some important sales data about International Harvester during the building-up period from 1902–1913.

[130] The introduction of Whitney's cotton gin had immediate and far-reaching effects. Cotton growing in the South developed rapidly during the first half of the 19th century and between 1800 and 1830 the frontier was moved westwards very much

mind that agriculture had been of great importance in the world economy for thousands of years, it could have been expected that decisive technical changes would have taken place first in agriculture. During the industrial revolution grain was the world's leading staple product, but nevertheless the grain was harvested in the same way as in classical times. Around 1800 the sickle and the scythe were the only available harvesting tools. However the scythe had been improved during the eighteenth century by the attachment of a cradle consisting of a number of wooden sticks which ran parallel with the blade of the scythe. In the USA this improved implement was called the 'cradle', and was able to collect the straw with much greater efficiency, and thus make the binding of the sheaves easier for the farmworkers. However the economic effect on production resulting from this was probably marginal. The fact that the agricultural sector, which was economically dominant later than the textile industry, introduced new techniques was due to several circumstances. The rural population was techni-

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faster and farther in the Southern states than in the Northern states. In 1830 in the South the cotton belt had been stretched out from the Atlantic coast to Texas, but in the North at the same time the reclamation of land for grain had not reached Lake Michigan. The yearly production and exports of American cotton were therefore able to increase sharply as the following series of figures shows:

Year	*Average yearly production in thousands of pounds*	*Percentage production exported*
1791–1795	5 200	33
1801–1805	59 600	56
1811–1815	80 000	53
1821–1825	209 000	73
1831–1835	398 522	83
1841–1845	822 954	84
1851–1855	1 294 423	77

Cotton played a decisive rôle in the American economy during the first half of the 19th century, and in 1810 cotton accounted for 22 per cent of the country's total export income. In 1860 the corresponding proportion had risen to all of 57 per cent. In spite of falling cotton prices up to the 1840s the development mentioned above explains much of the sense of prosperity and confidence of the Southern states when faced with the prospect of the Civil War. At the outbreak of the Civil War the price of cotton had recovered considerably.

Faulkner, H. U., *American Economic History*, p. 187 and pp. 201 f. Hutchinson, W. T., *Cyrus Hall McCormick. Seed Time 1809–1856*, pp. 49 ff.

cally more conservatively inclined than people in towns. The towns offered larger areas of contact and the influx of inventions, technical inventions included, was generally greater there than in the rural areas. To a great extent the upper class lived in the larger towns whence they came into contact with other people and ideas through their opportunities to travel. The whole way of life of the affluent upper class of the urban population was one of receptiveness and curiosity towards innovations. Furthermore, during the industrial revolution the businesses of the towns were able, in spite of their limited importance for the national economy, almost completely to control economic policy. The national dominance of agriculture then resulted in frequent neglect at governmental level because there was the desire to promote the advance of other industries which were at that time still comparatively insignificant.

Another important explanation for the fact that the revolutionary technical innovations were first introduced in the textile industry and not in agriculture was probably the different production structure of the two industries. The leading English cotton mills consisted of large but comparatively few production units, for which the advantages of new working techniques of production must have been plain.[131] Even if the land-parcelling movements in Western Europe during the eighteenth and nineteenth centuries brought about a certain concentration of production, agriculture was still divided into small units and lacked the justification for introducing more advanced techniques of production or the ability to do so. It was above all the critical and labour-consuming stage of harvesting which limited the volume of production in farming. Larger and more integrated farms were formed, above all in England, but because of the good supply of farm labour at the beginning of the nineteenth century the English landowners did not undertake any decisive mechanisation of farming. However there was no lack of technical innovations in agriculture. Between 1786 and 1831, for example, over fifty more or less fully developed harvesting machines were constructed, of which 33 were of British

[131] The new expanding factory-like cotton industry in England was too specialised to involve more than a small part of the population. Even within the English cotton industry it took a long time before the old forms of production disappeared.

and 22 of American origin. In his work *Cyrus Hall McCormick, Seed Time,* W. T. Hutchinson has chronologically dated and schematised what were probably the sixteen most important of these early inventions in the harvesting machine field according to the inventor's place of abode and the technical data of the invention. Thirteen of the sixteen inventions took place in England or Scotland, but the ground gained by these in farming technique was exploited first and foremost in the USA. The most important difference in the pace of progress in agricultural technology between the USA and Britain was that the former had an abundance of land but hardly of labour. In Britain, on the other hand, there was a shortage of land and an abundance of farm labour. H. J. Habakkuk explains the causal connections in the following way in his work *American and British Technology in the Nineteenth Century:* "This work done by machinery in American agriculture is not very much cheaper than it could be done by hand, but the great question is —where are the hands to come from? In Britain, where land was scarce but agricultural labour abundant, farmers were principally concerned with raising output per acre rather than output per man. It is therefore not surprising that America first established an international reputation for her machines, and in this field she ultimately made the most striking advances. A British patent for a reaper was taken out in 1799 ... but the several technical difficulties, particularly the difficulty of making an efficient cutting-bar, were overcome first in America."[132]

[132] Hutchinson, W. T., *Cyrus Hall McCormick. Seed Time,* p. 59. Habakkuk, H. J., *American and British Technology in the Nineteenth Century,* quotation at p. 101. In his report *The Landscape and the Machine: Technical Interrelatedness, Land Tenure and the Mechanization of the Corn Harvest in Victorian Britain,* Paul A. David supports Habakkuk's theory that Britain had a surplus of agricultural labour compared with the USA. Therefore in comparison with the USA the labour force was cheap in relation to capital. But according to David the price relation between labour and capital is far from explaining everything; there is in fact the third production factor, land. David does not so much stress the difference in the supply of land between the USA and Britain, instead he emphasises the difference in topography and suitability for mechanisation. Thus the central theory in David's report is that Britain's slow adoption of the harvester technology was mainly due to her agricultural land which by its nature was badly adapted to agricultural machines which required an even surface.

David, P. A., The Landscape and the Machine: Technical Interrelatedness, Land

As the shortage of labour was great in the USA larger fields could not be harvested before the harvesting machine, even if it had been possible to sow them. If the harvesting time was prolonged there was an increase in the risk that the harvest would be destroyed by unfavourable weather or overripeness. Therefore in practice the harvesting technique dictated the size of the land which the farms cultivated. The average size of the two million American farms which existed before the harvester around 1850 was about 25 acres. Between 1860 and 1910 there was an increase of four million farms, mainly through the cultivation of the prairies in the North and West. The total area of newly cultivated land during those fifty years corresponded to the total area of Western Europe and covered 500 million acres. The average size of the newly established farms was five times larger than that of the old ones, or 125 acres per farm. The development towards larger farm units stimulated the mechanisation of American agriculture which was gradually able during the latter part of the nineteenth century to make up for the shortage of labour and to facilitate farming on a larger scale. Research carried out by the United States Department of Labor (in table 56) shows the consumption of labour in 1830 and 1895 needed to harvest one acre of wheat with an unchanged yield per acre. The figures for 1830 represent an average for the USA and show a consumption of over 57 working hours per acre of wheat. In 1895 in places where the mechanisation had gone furthest, on the large holdings in California, the corresponding working time had fallen to less than four hours, and in Kansas, which is perhaps more representative of the large wheat districts, the corresponding working time then amounted to somewhat more than ten hours. Thus in 1895 the consumption of labour in the western prairie districts had fallen to only 18 per cent of the number of working hours which were required in 1830. The really large saving of labour had taken place during the harvesting stage. Twenty working hours had been needed in 1830 against only one and a half hours in 1895, and so the labour consumption for harvesting in 1895 amounted to only 7

Tenure and the Mechanization of the Corn Harvest in Victorian Britain. In *Essays on a Mature Economy in Britain after 1840* (Ed. D. N. McCloskey).

Table 56. *Man labour time consumed in producing one acre of wheat*

Implement/operation	Motive power	Number of hands	Man labour time per acre	
			Hours	Min.
Hand method 1829–30				
Plow	2 oxen	1	6	40
Sow	hand	1	1	15
Harrow	2 oxen	1	2	30
Total to put crop in			10	25
Reap	hand	2	20	00
Haul sheaves to barn	2 oxen	2	4	00
Thresh	hand	4	13	20
Winnow with sheet	hand	3	10	00
Total to secure crop			47	20
Total to produce one acre of wheat			57	45
Machine method 1894–96				
A=Large farming, California				
Gang plow	12 horses	1	1	00
Seeder	2 horses	2	0	15
Five-section harrow	8 horses	1	0	12
Total to put crop in			1	27
Combine	26 horses	4	1	00
Wagon to granary	8 horses	1	0	52
Total to secure crop			1	52
Total to produce one acre of wheat			3	19
B=Farm in central Kansas producing 100 acres of wheat				
Plow	4 horses	1	4	00
Harrow	4 horses	1	0	36
Drill	4 horses	1	1	12
Total to put crop in			5	48
Binder and shocking	4 horses	1	1	36
Stacking	4 horses	4	2	00
Threshing from stack		10	1	00
Total to secure crop			4	36
Total to produce one acre of wheat			10	24

Source United States Department of Labor, The 13th Annual Report of the Commissioner of Labor (1898). Hand and Machine Labor. Rogin, L., The Introduction of Farm Machinery, pp. 213 ff.

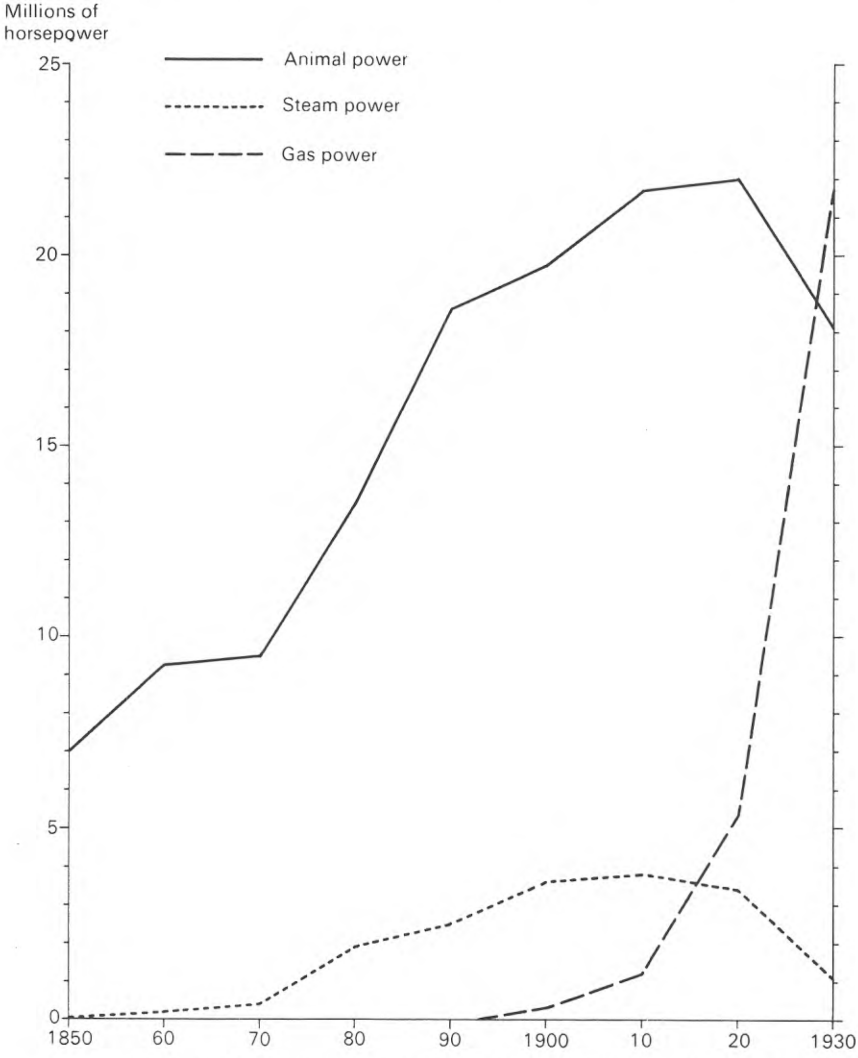
Table 57. *Average man labour time per acre for crop production in various parts of the United States 1925*

Area	Small grain cut with binder (hours)	Small grain cut with combine (hours)
New England	42	
New York	24	
Pennsylvania	24	
Virginia	23	
West Virginia	23	
Ohio	20	
Michigan	19	
Arkansas	16	
Georgia	15	
Missouri	15	
Wisconsin	15	
Indiana	15	
Illinois	15	
Kentucky	12	
Minnesota	12	
Eastern Nebraska	10	
Kansas	8	5
Western Nebraska	7	5
Dakotas	7	
Colorado	7	5

Source United States Department of Agriculture Bulletin 1348: 59 (1925 July).

per cent of what was required to harvest in 1830. Table 57 shows that according to research in 1925 the consumption of working hours varied greatly in different parts of the United States. The Eastern regions show the largest consumption of working hours while the Western prairie districts show the smallest. The variation probably reflects differences in the size of the farms as well in the degree of mechanisation. In 1925 mechanisation and labour-saving on the large farm units in the prairie districts had got just as far as on the most advanced large holdings in California during the 1890s. Instead of increasing the contribution of human energy to any appreciable extent American agriculture increased the contributions of other sources of energy in the most important grain districts (see diagram 19). The first wave of mechanisation, with

Diagram 19. *Amount of power available for farm purposes in United States 1850–1930.*



Source: Courtesy US Department of Agriculture Miscellaneous Bulletin 157, April 1933.

the horse-drawn mechanical harvester to the fore, required a great increase in the number of draught-animals, and above all of horses. The next phase consisted of the arrival of the first non-living source of energy on the farms, steam power, which was used mainly in connection with threshing. Finally at the beginning of the twentieth century the internal combustion engine replaced the draught-animals with the tractor and the steam threshing-machines with the motor threshing-machine. However the internal combustion engine did not become of real importance until the 1920s.[133]

The person who first and most clearly appreciated the importance of these changes in the American agricultural economy of the nineteenth century was the Southerner Cyrus Hall McCormick. It was something of an irony of fate that it was the Southerner McCormick who gave the Northern states their prosperity through the use of his harvester in the grain districts, while the economic growth in the Southern states was due to a large extent to the Northerner E. Whitney's cotton-gin and its contribution to the cotton economy. Cyrus Hall McCormick was born in 1809. He was of Scottish-Irish descent and the son of farmer Robert McCormick of Walnut Grove, Rockbridge County in Virginia. On the father's farm there was also a small forge which was used for the requirements of the farm. Robert McCormick was interested in agricultural technology and as early as 1816 he is supposed to have constructed a simple harvesting machine which could work under favourable conditions. But faced with the difficulties of making it really practical he abandoned machine construction for the time being. The environment in which Cyrus Hall McCormick grew up no doubt influenced his later epoch-making work. According to his grandson, in his youth he was of a somewhat weak constitution and was not particularly suited to strenuous farmwork, which also encouraged him to take an active interest in his father's experiments with labour-saving inventions. Cyrus Hall McCormick's first contribu-

[133] Faulkner, H. V., *American Economic History*, pp. 365 ff. McCormick Harvesting Machine Company extract from catalogue 1899: The end of the century. *US Department of Agriculture. Bulletin 1348:59* (July, 1925), *Bulletin 157* (April, 1933). US Department of Labor. Hand and Machine Labor (1898). Rogin, L., *The Introduction of Farm Machinery*, pp. 213 ff.

tion to agrarian technology was a plough he built in the 1820s which was especially suitable for broken ground. However the revolutionary improvements in the sphere of ploughing were to be made somewhat later by John Deere. John Deere was born in Vermont in the North-East USA and he trained as a blacksmith, but in 1837 he moved to Illinois where in the blacksmith's workshop in Grand Detour he began to experiment with steel ploughs suitable for the sticky mould of the prairies. The cast-iron plough had been introduced into the Eastern states by Jethro Wood in 1817, and there it gradually began to drive out the wooden plough, but the cast-iron plough performed badly in the prairie districts. Mainly because of his improved and polished mould-board made of steel, John Deere was able to start production on a commercial scale in the 1840s. In 1846 the village blacksmith's shop in Grand Detour had reached a capacity of a thousand ploughs a year. So that he could distribute the ploughs better to the prairie districts John Deere moved westwards in 1847 to Moline on the border between Iowa and Illinois, where he could expand sales and production on a really large scale, on the basis of improved models of plough. During the 1850s the steel ploughs of Deere and other newly established manufacturers became widespread in the prairie districts and they replaced the cheaper but less practical cast-iron ploughs. By 1860 Deere alone had reached sales of 13000 ploughs a year. John Deere was more than a skillful blacksmith and an inventor. In addition he had a definite flair for business and the same combination of the entrepreneur's characteristics as his contemporary McCormick, and Henry Ford later. Through the mass distribution of comparatively cheap products these entrepreneurs not only played a great part for their own large companies but became to an even greater degree of importance for the national economy. They constitute excellent illustrations of J. Schumpeter's theory of the entrepreneur as social transformer. It should be mentioned that John Deere's contributions during the 1870s were made more complete by James Oliver, whose chilled-iron plough was well adapted to its purpose. Oliver's ploughs spread generally, especially in the Eastern states, where they replaced the cast-iron plough.[134]

[134] Hutchinson, W. T., *Cyrus Hall McCormick. I. Seed Time. 1809–1856*, pp. 49 ff. McCormick, S., *The Century of the Reaper*, pp. 17 ff. McCormick, C. H., *Memorial*

In 1831 Robert McCormick took up his harvesting machine experiments again, but they failed and he gave up the idea completely. However Cyrus was now able to make use of his father's experience while improving construction at the same time. Amongst other things he added a straw-collecting reel. When Cyrus had completed his construction, he had his machine tested in public near his home in July 1831, when the harvester did well to cut six or seven acres of oats. About the same time as Cyrus Hall McCormick two other Americans, viz. William Manning of Plainfield, New Jersey, and Obed Hussey of Cincinnati, Ohio, tried to build new models of harvesting machine. Most earlier attempts to produce harvesting machines had stopped short at theoretical constructions. The most successful of the earlier constructions was the Scot Patrick Bell's award-winning harvester of 1828. It is not clear what influence Bell's machine had on the American inventions. Therefore the question of who originally invented the harvester cannot be answered unequivocally and completely. Several innovators improved earlier known constructions, and several new models of harvesting machine were built more or less simultaneously. Cyrus Hall McCormick's harvester of 1831 was a combination of seven fundamental parts or principles, of which the most important were the cutting apparatus with fingers and the reciprocating knife with serrated edges, the reel, the collecting platform and also the ground drive wheel which operated the cutting apparatus by means of a gear device. Before 1831 the innovators had used one or more of these fundamental parts and principles, but McCormick was the first to combine them in an effective whole. The importance of McCormick's contribution lay not in any technical originality but in the fact that he made the harvesting machine workable. An invention can also consist of a combination of processes which are already known individually, and this is precisely what McCormick produced.[135]

of Robert McCormick (reprint of a pamphlet, Chicago 1898). International Harvester Co., *Roots in Chicago One Hundred Years Deep 1847–1947*, pp. 7 ff. Clark, N. M., *John Deere. He Gave to the World the Steel Plow*, pp. 39 ff. Thomson, H., *The Age of Invention*, pp. 110 ff. (in The New Industrialisation). Rogin, L., *op. cit.*, pp. 31 ff.

135 Fussel, G. E., *op. cit.*, pp. 115 ff. and 218 ff. Hutchinson, W. T., *op. cit.*, pp. 59 ff. International Harvester. *Roots in Chicago One Hundred Years Deep*, pp. 7 f. and pp. 15 f. Rogin, L., *op. cit.*, pp. 72 ff.

In spite of the fact that McCormick had tested his new machine successfully in 1831, he did not exploit the commercial value of his invention straight away. Meanwhile towards the end of 1833 Hussey was able to obtain a patent for a harvesting machine, which prompted McCormick in the very next year to take out a patent for his harvesting machine from 1831. Hussey was a prominent innovator and technician and like McCormick during the rest of the 1830s he improved his construction through experiments. The comparatively long experimental period meant that the two innovators did not come into any direct commercial confrontation or conflict of interests at that time.[136] While McCormick's model was adjusted for grain cutting, Hussey's model was constructed more like a mowing-machine. The difference between the mechanisms of the harvesting machine and the mowing-machine is related to the difference between the problems of cutting grain and grass. For economic reasons grass must be cut as near the ground as possible, while grain can be cut at a much greater distance from the ground without any unfavourable economic consequences. Therefore the unevenness of the ground makes it necessary to have a more serviceable and tougher cutting mechanism in the mowing-machine than in the harvester. For these reasons the mowing-machine was constructed in a more robust way than the harvester right from the start. Also the whole iron frame of the earlier mowing-machines, for example, was often constructed as a single unit. There was a further difference in the way in which the cut grain was set down. The earlier harvester delivered the grain on the side of the machine opposite to the horse so that the grain would not be trampled down during the following swath. When grass was to be cut there was no need to be so careful.[137]

(*b*) The introduction of the harvester onto the market

Both Cyrus Hall McCormick and Obed Hussey had managed to produce the first practical working mechanical harvesters at the

[136] In fact Hussey sold a total of forty machines during the 1830s. Most of the orders appear to have come from "gentlemen farmers" who used the machines as an experiment. Rogin, L., *op. cit.* p. 73.

[137] Phillips, W. G., *The Agricultural Implement Industry in Canada. A Study of Competition*, pp. 3 ff.

beginning of the 1830s. They had not been influenced by each other's designs because their machines, as has been pointed out, were very different and were intended to an extent for different purposes. However they did not consider the innovations ready to be introduced onto the market as soon as the patents had been taken out.

A process of innovation can generally speaking be said to comprise five stages. The first stage is represented by the more theoretical basis and the shaping of the concept. The next stage comprises the embodiment of the ideas into an actual construction. Thirdly the invention must be made practical from an economic standpoint, and fourthly there is the introduction onto the market. Finally the fifth stage consists of the process of the diffusion of the innovation. The time consumed over these stages can vary greatly for different innovations. McCormick and Hussey's particularly experimental innovatory improvements during the 1830s may be said to correspond to the third stage of the innovation process. As far as the horse-drawn mechanical harvester was concerned, the first two stages which preceded the work of McCormick and Hussey had taken place, so far as one knows, during the period from 1786 to 1830. The fourth stage of the innovation process had started when McCormick and Hussey began to produce and sell harvesters around 1840, and the start of the fifth stage, the diffusion phase, can be dated for the mechanical harvester at 1847 when McCormick began industrial production of harvesters on a large scale in Chicago. It is interesting to compare the stages of the innovation process for the mechanical harvester with those for the milk separator which came about fifty years later. For the harvester the time which elapsed between the first and third stages was somewhat more than forty years (1786–1831) and between the third and the start of the fifth stage sixteen years (1831–1847). Up to and including 1847 American farmers had bought about a thousand harvesters. Thereafter the machines spread at a much faster rate. The corresponding lapse of time was much shorter for the milk separator. Between the first and third stages not quite twenty years elapsed (1859–1877) and between the third and the beginning of the fifth stage five years (1877–1882). Before 1883 about a thousand separators had been sold, thus corresponding to the level of spread for the harvester up to 1847. Gustaf de Laval's intervention in the innovation process from 1877 onwards was the main reason for the fact that the separator could be used more quickly in the agricultural economy. In 1877–1878 both the third and fourth stages took place for the separator, when de Laval first made the separator workable economically and then with Oscar Lamm introduced it onto the market straight away. The development towards a greatly shortened innovation process for later innovations was not peculiar to the two examples mentioned above, but was a general phenomenon during the nineteenth century, a tendency which has continued during the twentieth century with certain isolated exceptions.

McCormick sold his first harvesters in 1840 and sales were able to increase during the years which followed. Production took place at the blacksmith's shop on the family farm in Virginia. Capacity was therefore limited. In 1844 McCormick received his first orders from outside Virginia. The orders came from the prairie states of Ohio, Indiana, Illinois, Missouri and Wisconsin. While the incoming orders were increasing McCormick realised the need to terminate contracts with other manufacturers for the production of his machines. The most important of these manufacturers was the Globe Works of Seymour and Morgan in Brockport, New York State, which was considered to be the United States' first industrial manufacturer of harvesters. The contract was in force until 1848 when McCormick's patent expired. If McCormick found it unexpectedly difficult to get the farmers in Virginia to adopt his new agricultural technology, he found it that much easier to sell his innovation to the farms in the prairie states northwest of the Ohio river. Therefore McCormick decided to analyse the market factors in the new area in the West more closely. In 1844 he went to the prairie states to gain first-hand experience of the newly established market for harvesters. After his journey he summed up the situation: "If reapers were luxuries in Virginia, they were necessities in Illinois, Ohio and on the great plains of the West." In hilly Virginia the farms were like those in most of the states in the East, small on average, which did not stimulate the adoption of new agricultural technology, and McCormick realised after his return that Virginia was the wrong starting-place for producing and selling harvesters on a large scale. It occured to him to move operations to a place which was more suitable from a selling point of view. For McCormick it was also a question of being able to centralise production when the various manufacturing contracts came to an end in 1848. In the summer of 1847 McCormick moved to Chicago, which at that time was a small town with barely seventeen thousand inhabitants. The frontier line had passed Chicago at the end of the 1830s, and the town was situated on the periphery of America in the middle of the 1840s, and Illinois was an undeveloped agricultural state. At that time the centre for the grain market in the USA was in Buffalo in the western part of New York State. However McCormick's business instinct and visionary eye led him to Chicago, which was to be America's new grain centre in the future, and the ideal starting-point for the production and distribution of agricultural technology.[138]

Hussey's production of harvesters in Ohio had in fact already begun during the 1830s, but the annual production at that time did not usually exceed ten machines, and these were ordered more by way of experiment than from the standpoint of agricultural economy. Around 1840 Hussey was able to extend the production of harvesters and begin a more commercially orientated business. This meant that a conflict of interests soon arose between Hussey and McCormick. The first of a series of harvester wars broke out in 1843 when the machines of both innovators met on the same market for the first time. During the years immediately following their two machines were compared on several occasions at agricultural competitions and general fairs in the Eastern states. The rivalry between McCormick and Hussey led to intense advertising campaigns on both sides, with arguments for the excellence of their own products coupled with derogatory verdicts on the competitor's machine, something which undoubtedly gave the two rivals a great deal of publicity and wide advertisement. As the machines of Hussey and McCormick were protected by patents until 1847–48, they accounted for almost all the sales of harvesters in the USA. The sales figures for the harvesters of Hussey and McCormick before 1848 developed as follows:

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[138] Rogin L., *op. cit.* pp. 74 ff. *Roots in Chicago*, pp. 8 ff. Casson, H. N., *Cyrus Hall McCormick. His Life and Work*, pp. 68 ff.

Number of harvesters sold

Year	Of Hussey's type	Of McCormick's type
1833–39	45	–
1840	36	2
1841	22	–
1842	10	6
1843	2	39
1844	11	50
1845	33	123
1846	58	275
1847	60	500
Total up to and including 1847	277	995

Source International Harvester Co., Roots in Chicago One Hundred Years Deep 1847–1947, p. 8. Rogin, L., The introduction of farm machinery, pp. 73 ff. Rogin has based his figures mainly on material from patent disputes which had been decided by Supreme Court of the United States.

The majority of Hussey's machines were sold in the East, while McCormick's went principally westwards to the prairie states.[139] It may seem obvious afterwards that the American agricultural machine industry when it started to take shape in the middle of the nineteenth century would be located in the prairie districts as with Deere and McCormick. This is in fact being wise after the event, since we have seen the result. In actual fact at that time the question was a completely open one even for the inner circle of initiates. The prevalent opinion was rather that it was better and safer to aim at the market where the centre of the population was, viz. in the East. As we have two inventors, McCormick and Hussey, who developed on the whole side by side for a number of years, but thereafter (around the middle of the 1840s) quite divergently, we can compare the entrepreneur characteristics of each of them. Hussey's line of development would then represent something that never happened and McCormick's would represent what really did happen. In spite of the fact that Hussey had the advantage of

[139] Rogin, L., *op. cit.* pp. 74 ff. Phillips, W. G., *op. cit.*, pp. 3 f.

developing and introducing his innovation in the prairie state of Ohio with its agricultural potential, he came to the conclusion, which was perhaps not a completely preposterous one from the viewpoint of that time, that the market absorption of agricultural technology was greater in the densely populated Eastern regions with their many farms than in the West where he himself had worked. He therefore moved eastwards to Baltimore in Maryland, where he continued to manufacture and sell. A contributory cause for Hussey's move was that his mowing-machine-like invention had had greater success in the Eastern grass-cultivating areas than in the grain districts in the West. However, even after his move Hussey did not acquire any great importance in the spreading of the harvester and the mowing-machine. The application of mechanised forms of operation was to take place first and foremost on the farms to the northwest of the Ohio river. At the end of the 1850s McCormick had sold ten times as many machines as Hussey, viz. 23 000 for McCormick and about 2 000 for Hussey. Shortly before his death Hussey sold his business to a mowing-machine syndicate, Aultman and Co., Canton, Ohio and Cayuga Chief Co., Auburn, New York State. From 1860 onwards the syndicate was for a long time the leader on the mowing-machine market before being gradually incorporated into the International Harvester group.[140] The difference between Hussey and McCormick was that Hussey was principally an inventor and not an entrepreneur while McCormick was undoubtedly an inventor but was an entrepreneur to a much higher degree. In the context of economic history the aspect of application is the essential part of the innovation process. Therefore it is less important from this perspective to discuss who actually invented the harvester. It is of more importance to study how the innovation could be made more useful economically, how it could be introduced onto the market, and most important of all, how it could be widely adopted and spread generally. In these respects the entrepreneur played a great part, but he plays his real part when it comes to persuading people to adopt innovations and give them wide currency. Not until an important innovation is in wide circulation can it have economic consequences for both the

[140] Phillips, W. G., *op. cit.*, pp. 4 f. Rogin, L., *op. cit.*, pp. 75 ff.

entrepreneur and society. Thus if Hussey and McCormick did not differ very much as creators of the first practical working harvesters nor perhaps as introducers of the machines onto the market, they really did differ in the ways in which they analysed market factors after the harvester's first introductory stage. Entrepreneur McCormick, with his visionary business instinct and his feeling for agricultural economy and agricultural psychology, aimed at the future while the man who was not an entrepreneur aimed at the present.

Several factors which were favourable for the breakthrough of mechanisation in agriculture had occurred in the United States in the decades immediately before 1850. For the first time in world history there was a combination of trends of development which were favourable for the rise of a commercial agriculture based on mechanised production. Factors such as good transportation, significant markets, an abundance of land which was well-suited for mechanisation, and a shortage of labour, had never previously been combined to the same extent as they were in the American economy between 1830 and 1860. Through the establishment of the Erie canal (completed in 1825) and the first railroads through the Appalachians (construction started 1843) the Western districts, the Ohio Valley and the area around the Great Lakes were able to be linked more and more closely with the East coast states. This was important from a marketing point of view. Before the Erie canal and the railroads the economy of the West had been linked with the little developed Southern states by river traffic. Thus the South could not offer any greater market for the products of the West. When transportation on the canal and railroads was made cheaper and faster in the East-West direction the new transport routes stimulated farming in the West by supplying markets in the more industrially developed states in the North-East. The non-agrarian population's power of purchasing agricultural goods in the North-East became much greater than the corresponding purchasing power had been in the Southern states. The wave of immigration during the nineteenth century reinforced this trend. At the same time new transport routes developed industry in the East by supplying markets in the West, but it should be observed that the agrarian markets in the West were able at the same time to develop a strongly expanding industry in the Middle-West, an industry which for a long time had its greatest area of contact with agriculture. Apart from the up-and-coming food industries, the iron and steel industry in the Middle-West received a significant stimulus from agriculture. The orders from agriculture to the iron and steel industry consisted mainly of agricultural machines but also comprised material for farm construction—buildings, silos, fences and so on, which used up iron and steel to an increasing extent. An excellent example of this is Chicago, with its population which was expanding, particularly after the first direct railroad link with the Atlantic coast in 1853. For agriculture in the West the improved communications eastwards also meant greater possibilities for selling its products on the world market which was extremely important when Britain abolished grain tariffs in 1846. The effect of this action was to bring about an increase in grain prices in the USA, and prices rose further when the European demand for agricultural goods increased during the Crimean War of 1854–1856. The gold rush to California in 1849 also resulted in raised food prices as it enticed labour away from American agriculture. Thus there were plenty of positive market signs for the American farmers to expand farming into large sales production, which could only take place in the newly cultivated areas in the West through extensive mechanisation. The pace of cultivation of new land therefore became rapid: through a constant stream of immigrants the frontier westwards moved forwards at a rate of thirty miles a year. Thus in the new areas, which consisted of the agrarian production region to the north-west of the Ohio river with its abundance of flat country and shortage of labour, mechanised farming made its first breakthrough during the 1840s. Usually it was the harvesting machine which arrived before the railroad when the American frontier was moved westwards. The majority of the railroads were built on account of the wheat and it was money from the wheat trade which financed the building of the railroads.[141]

It can be said that the harvester became America's concrete

[141] *Ibid.*, pp. 76ff. Faulkner, H. U., *op. cit.*, pp. 205–216. Casson, H. N., *The Romance of the Reaper*, p. 43. During the latter half of the 19th century Chicago was the world's fastest growing town. In 1884 Chicago had about 600 000 inhabitants and since 1845, in 40 years, its population had multiplied sixty-fold.

answer to Malthus's somber prediction that man was forever doomed to remain on a subsistence level because the population would always exceed the supply of food. Malthus died in 1832, the year after McCormick had tested his first harvesting machine. McCormick was to become the great innovator in agrarian technology and was to bring about a development in the USA which completely refuted the theories of Malthus. McCormick learned to realise what was happening in the American economy and with the aid of his patented invention he took the passing opportunity and in 1847 laid the foundations of a harvester industry in the right place at the right time.

(*c*) The spread of the harvester before the Civil War against the background of orders from agriculture

When McCormick arrived in Chicago in 1847 he lacked the capital and credit facilities to start a factory for harvesters himself. So he went into partnership in Chicago with a business friend named Charles M. Gray. With the latter's help a plot of land for a factory was bought on the north side of the Chicago River near its mouth in Lake Michigan. The factory was equipped with modern machinery including inter alia a 10 h.p. steam engine, which was supplemented with one of 30 h.p. in 1850. Mayor William B. Ogden, who took over Gray's share, supplied McCormick with starting capital of 25 000 dollars, acquiring a half share in McCormick's business in exchange. McCormick and Ogden both had strong wills and soon they had difficulties in working together. After two years (1849) the business had yielded about 200 000 dollars in sales. After various costs had been covered, half of this sum was enough for McCormick to buy out Ogden's half share of 25 000 dollars. In addition Ogden received 25 000 dollars by way of interest and as part of the profits. In the future the business was able on the whole to be financed out of profits which had been ploughed back, but for short-term and occasional credit McCormick was mainly restricted to various banks in Chicago and New York. During the first years of operation Cyrus Hall McCormick received help in the factory from his brothers Leander and William McCormick, and these two later became partners in the business.[142]

While Cyrus Hall McCormick left the management of the day-to-day work in the factory to his brothers, he primarily devoted himself to sales problems. He made a special study of the reaction of the farmers to the harvester at work, and he proved to have a great flair for farming economy and agricultural psychology. He entered into annual competitions between various rival harvesters in front of the farmers in the fields. Together with the fairs these competitions were popular means of advertising, and made a great contribution to an increase in the volume of sales. But McCormick did more than that. He pioneered the development of new methods of distribution. McCormick not only solved the problem of mass-producing workable harvesters, but above all he created new principles of marketing to spread the machines among the farmers. Already in the 1850s he was the first in the industry to introduce aggressive sales methods, systematised service for the farmers and the hire-purchase system. By the middle of the 1850s McCormick had built up a network of agents covering what was at the time the whole of the wheat district of the USA.[143]

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[142] Hutchinson, W. T., *Cyrus Hall McCormick. I. Seed Time 1809–1856*, pp. 327 ff. 369 f. *Roots in Chicago One Hundred Years Deep 1847–1947*, pp. 11. Casson, H. N., *The Romance of the Reaper*, pp. 30 ff. Casson, H. N., *Cyrus Hall McCormick. His Life and Work*, pp. 68 ff.

Mayor William B. Ogden undoubtedly received a good yield on his capital—100 per cent in two years, but McCormick made a profit which was many times greater by buying out Ogden. By 1851 McCormick's fortune had increased to 100 000 dollars, which proved that it was possible to make large profits rapidly in the harvester trade.

McCormick's short-term loans in Chicago and New York were not equal in value to the outstanding demands which he had from his customers.

[143] *History and Development of International Harvester*, p. 5. McCormick, C., *The Century of the Reaper*, pp. 33 ff. Hutchinson, W. T., *Cyrus Hall McCormick. I. Seed Time 1809–1856*, chapters 14 and 15.

The harvesting competitions between various rivals in the harvester trade sometimes developed into real scandals with bribed judges and appeals over judgments. The net effect of this was that the new agricultural technology received increased publicity resulting in growing curiosity about the new machines.

McCormick's system of agents was an important stage in marketing and he organised a whole army of agents from general agents, to regional, district and local

The first task in the sales programme was to teach and educate the farmers to use harvesters. It took a man like McCormick who was sufficiently strong and dominant to force his machines onto reluctant farmers and farmworkers. To do this he used hard-hitting advertising in vigorously designed advertising campaigns in farming papers. Apart from pure persuasion McCormick used new methods of providing information and service to break down the sales resistance to the new agricultural technology. For example simple and detailed operating instructions for the maintenance and use of the machines have been preserved from 1851. On posters from 1849, which resemble present-day descriptions of merchandise, McCormick set out among other things the comparative costs of the old and new methods of operation. Lists of all the retailers who carried McCormick's harvesters in the sales district usually followed the advertising posters. Such documents as have been preserved show that McCormick was a pioneer in marketing and sales organisation. As a servicing measure he laid the foundations of spare parts production during the 1850s. The hire-purchase system was an important innovation in McCormick's sales methods. McCormick knew from his own experience that the farmer usually has limited working capital. With a down-payment of 10–20 per cent of the total cost of the machine (about $120 in 1850) McCormick's hire-purchase system enabled many more farmers to invest in harvesters than would otherwise have been unable to do so.[144] A descriptive account of the agricultural machine industry was compiled in connection with the formation of International Harvester. The descriptive account is probably more appropriate as a summing-up of McCormick's 'gründer period': "No other manufacturing business [than manufacturing agricultural implements and machines] carries so many risks or includes so many factors. It is the most comprehensive industry in the world. It is the link between

agents. The local agents often consisted of village shopkeepers and ironmongers. With these commercial feelers McCormick was able to have the market situation at his finger tips. International Harvester's efficient network of agents was affected by the development of the De Laval Separator Co. and AB Separator. International Harvester's sales organisation became to a large extent an extension of that of McCormick.

[144] Hutchinson, W. T., *op. cit.*, chapters 14 and 15. *Roots in Chicago One Hundred Years Deep 1847–1947*, p. 12.

the city and the farm. It is both wholesale and retail, ready-made and made to order, local and international. It must make what the farmer demands, and yet teach him better methods. It is at once a factory, a bank and a university."[145]

To those nearest to him McCormick probably did not appear entirely sympathetic. Looked at in a wider socio-economic perspective it must be conceded that the range of his pioneering contributions was enormous. When the French Academy of Science elected McCormick an honorary member it made the following statement, probably with complete accuracy: "He has done more for agriculture than any other man." To produce and sell harvesters became more than a business for McCormick, it became his religion. McCormick was characterised by his competitors as a fighter, a bulldog, a hunting tiger, et cetera. He plainly saw himself as a fanatical entrepreneur and a somewhat one-dimensional human being when he described his life's ambition as follows: "I have one aim in life and only one—to succeed in spreading my machines everywhere. Everything else is of no importance."[146]

Against this background it is easier to understand McCormick's long-drawn-out lawsuit against the Patent Office to safeguard his patent in various connections after it had expired in 1848. The decades immediately after 1848 were a period of patent pooling in the American agricultural machine industry. In 1850 thirty different harvesting machine companies had already been formed, and in about 1880 there were two hundred of them. At the latter point in time there were in all about two thousand companies which manufactured agricultural machines, but the keen competition at the end of the century eliminated most of them (about 1300) before 1900. During the latter part of the nineteenth century almost twelve thousand patents were granted for harvesters alone, and this led to the commencement of hundreds of patent lawsuits and cross-suits during the period. Whether or not a company continued to exist could depend on the outcome of patent arrangements. Conflicts which also led to lawsuits arose when new machines were produced and sold under a licence which had been purchased. A

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[145] Casson, H. N., *The Romance of the Reaper*, p. 101.
[146] *Ibid.*, pp. 35 ff.

pooling of patents meant that competing groups of companies within a pool tried to centralise control over the fundamentally important patents which covered an implement or a machine. In spite of the fact that the individual companies in the pool worked in this way, the pool was in no sense equivalent to a merger. As long as the market was expanding the individual element dominated this branch of the industry completely. Not until the turn of the nineteenth century when the market had been stabilised and had reached a certain saturation point did the first wave of mergers in the industry become apparent.[147]

McCormick kept a close watch over the emerging competition situation around 1850. On the home market front Hussey quickly became insignificant after 1850, but instead John H. Manny of Rockford, Illinois became McCormick's principal competitor in the middle 1850s. For a few years Manny's production exceeded McCormick's. In 1854 McCormick accused Manny of patent infringement. McCormick lost the lawsuit, which lasted five years, in the Supreme Court in 1858.[148] During the 1850s McCormick was able to control about a third of the harvester market. In 1858 McCormick estimated that there were more than 70000 harvesters in operation in the fields west of the Allegheny mountains. Of these he himself had sold 23000, or almost a third. The most challenging competitors during the 1850s were Manny, who has already been mentioned, in Illinois, and Walter A. Wood of Auburn, New York State. Before the Civil War, Illinois was the state which produced the greatest number of harvesters, with Ohio in second place and New York State in third. However it is important to distinguish between the production area and the operating area. Many of the harvesters which had been produced in New York State were sold in the Western prairie district, and so the dominance of the latter area was more obvious as far as the use of harvesters was concerned. In the Eastern parts of the country harvesters had apparently only been in existence to a great extent before 1860 in the states of New York and Pennsylvania. Before

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[147] Phillips, W. G., *op. cit.*, pp. 5f. Hendrik, B. J., *Making the World's Agricultural Machinery*, pp. 160ff. (in The Age of Big Business).

[148] US Supreme Court no. 34. McCormick vs. Manny, 1854–1858.

Table 58. *McCormick reaper sales before, during and after the Civil War*

	1849–1860	Per year	1861–1865	Per year	1866–1872	Per year	1849–1872 Total
Illinois	15 179	1 265	10 594	2 165	15 815	2 260	41 588
Iowa	2 451	205	4 204	840	15 089	2 155	21 744
Wisconsin/Minnesota	1 903	160	3 174	635	9 905	1 415	14 982
Indiana	1 858	155	1 842	370	3 406	485	7 106
Missouri	1 794	150	831	165	3 307	470	5 932
Ohio/Michigan	2 907	240	1 048	210	1 605	230	5 560
Nebraska/Kansas	3	0	426	85	2 745	390	3 174
Others	4 106	340	1 668	335	3 397	485	9 171
Total	30 198	2 515	23 787	4 760	55 269	7 895	109 256
Others as % of total	14%		7%		6%		

Source The McCormick Collection: Reaper Orders and Reaper Sales.

the Civil War, mechanical harvesting was uncommon in the New England states and the Southern states. Apart from Virginia none of the Southern states cultivated a significant amount of wheat. As Virginia was the original area of the harvester and the principal wheat district of the Southern states, it was worked on with particular keenness by various harvester agents. But in spite of this fact Virginia also did not become a market of any significance for harvesters before the Civil War.[149]

If the pattern of distribution of the country's total number of

[149] Rogin, L., *op. cit.* pp. 77ff. According to McCormick's representative in New York State only a small part of the production of harvesters in Brockport, New York was sold inside the state. The rest was sent westwards. Only half of Wood's production in Auburn, New York was sold inside the state. The figures relate to the year 1855. Through Wood's production reaching the same level as McCormick's at the end of the 1850s, the harvester had probably become more common at that time even in New York State.

The harvester was in general introduced late into the Southern states (South Carolina 1856 and Georgia 1858) and during the Civil War no distribution of harvesters was achieved in the Southern states. According to the Monthly Report, Jan. 1867 (US Department of Agriculture) it was reported from Carolina "There is no machinery used in this county for harvesting wheat", from Texas "not more than one-tenth of our [in county] grain being harvested with machinery".

Table 59. *McCormick reaper sales, 1849–1872*

Year	Illinois	Iowa	Wisconsin Minnesota	Indiana	Missouri	Ohio Michigan	Kansas Nebraska	Other states plus Canada	Total
1849	926	237	183	46	67	4	–	6	1 469
1850	753	163	114	38	95	143	–	188	1 494
1851	346	42	49	8	–	81	–	160	688
1852	289	6	17	104	2	291	–	289	998
1853	518	11	11	52	3	196	–	372	1 163
1854	803	26	132	48	96	164	–	493	1 762
1855	1 406	126	225	77	183	174	–	433	2 624
1856	2 013	299	151	176	380	320	–	483	3 822
1857	1 966	357	71	406	346	513	–	299	3 958
1858	2 470	209	199	249	180	412	–	289	4 018
1859	1 920	409	255	286	270	274	–	526	3 940
1860	1 769	566	496	368	172	335	3	568	4 277
1861	2 881	759	847	442	123	310	36	360	5 758
1862	2 338	735	569	382	121	223	59	383	4 810
1863	1 670	632	510	447	161	225	87	203	3 935
1864	2 402	942	666	395	267	191	96	436	5 396
1865	1 303	1 136	582	176	159	99	148	286	3 869
1866	1 999	1 864	1 096	273	307	61	78	460	6 138
1867	2 944	2 151	1 107	474	510	254	408	670	8 618
1868	3 199	2 156	1 319	703	528	325	470	749	9 449
1869	2 294	2 353	1 390	667	690	289	486	579	8 748
1870	1 773	2 334	1 357	434	420	197	436	490	7 441
1871	1 943	2 232	1 878	448	542	295	462	250	8 010
1872	1 663	1 999	1 758	407	310	184	405	199	6 925

Source The McCormick Collection: Reaper Orders and Reaper Sales.

harvesters before the Civil War is compared with the corresponding pattern for McCormick's machines in tables 58–59, the result is that on the whole they do match up. Bearing in mind that McCormick's share of the total number of harvesters during the 1850s came to about a third, this is in itself plausible. In McCormick's sales to 'the other states' Pennsylvania and New York State were dominant during the 1850s. The most important areas in McCormick's sales before 1861 in order of precedence were Illinois, Ohio/Michigan and Pennsylvania/New York State. On the whole this picture tallies with that which L. Rogin gives for all machines. The fact that almost none of McCormick's machines were sold in New England or in the South also corresponds well with the picture of the total distribution of the harvester. On the other hand an adjustment upwards ought to be made in respect of the 14 per cent of harvesters which McCormick's sales show for the area outside the prairie district, if the country's total sales are taken into consideration. Thus there was a comparative over-distribution of McCormick's machines in the prairie area, and, mainly as a result of Wood's competition in the East, a comparative under-distribution in states such as New York and Pennsylvania.[150]

As is evident from the above, McCormick had realised that the technical problems of production in the business of agrarian technology were only the first stage in a wider context. The first stage consisted of the output of the agricultural machine industry, and the second stage assimilation by agriculture of the output in question. As this process of transition did not take place by itself McCormick saw it as his most important task to operate as an intermediary link and as a force exerting pressure in the contacts between industry and agriculture. In a study of the mechanisation of harvesting in the Middle-West before the Civil War Paul A. David stresses the interaction between the development of American agriculture and industrialisation. By the adoption of mechanical har-

[150] L. Rogin's figures for the total number of harvesters delivered and for individual company units in the USA are based on various estimates, business correspondence (McCormick's among others), reports of court rulings and information in agricultural papers. Thus his estimates are often approximate, but for the picture as a whole they provide a valuable complement to the more reliable information from McCormick's sales material.

vesting important links were forged in the chains connecting the agricultural and industrial sectors in the mid-nineteenth century economy. In the North-Western prairie states of Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Missouri, Iowa and Kansas, the agricultural implement and machine industry accounted for four per cent of the total industrial production of the area in 1860. In Illinois the corresponding share was eight per cent, and no other sector of industry contributed such a large share of the processing value. In 1856 the agricultural machine industry in Chicago accounted for no less than eleven per cent of the town's industrial processing value, while the food industries (meat-packing, mills, distilleries and breweries) which are usually emphasised as being typical sectors of industry in Chicago, together constituted only six per cent. The production of harvesters was the really large item in the agricultural machine industry. In Illinois 42 per cent of the production value of the branch of industry came from the harvester production, while the corresponding figure for Chicago was no less than 78 per cent. In 1856 McCormick produced 70 per cent of all the harvesters in Chicago. McCormick's industries and the many other harvester companies which later came to the Chicago area contributed in the highest degree to the fantastically rapid growth of the town. With the aid of the harvesters the wheat wave rolled westwards, with mill industries and towns being established in the whole of the prairie area as a result: Cincinnati in Ohio, Indianapolis in Indiana, Chicago in Illinois, Milwaukee in Wisconsin, St. Louis in Missouri, Des Moines in Iowa, Minneapolis in Minnesota, Kansas City in Kansas and Omaha in Nebraska. By the middle of the 1870s the USA had become the world's largest producer of food. The total value of American agricultural machines in 1880 amounted to 900 million dollars, and the production value of the farming products which were produced yearly thanks to these machines was estimated at the same time at not less than 7 thousand million dollars.[151]

Thus orders from agriculture for agrarian technology generated

[151] Paul A. David., The Mechanization of Reaping in the Ante-bellum Midwest. In *Industrialization in Two Systems. Essays in Honor of Alexander Gerschenkron* (ed. Henry Rosovsky), pp. 4 ff. Casson, H. N., *The Romance of the Reaper*, pp. 43 ff.

enormously vigorous growth in the American economy during the latter half of the nineteenth century. It may therefore justly be asked why the harvester, as the principal manifestation of agrarian technology, began to spread just at the middle of the 1850s. David has studied this question in the essay referred to above, and has come up with something of interest which helps to explain the situation. The fundamental conditions for a transition from harvesting methods involving intensive labour to those involving intensive use of machinery indeed became, as has been pointed out in an earlier context, especially favourable in the North-Western prairie area of the USA from the 1830s onwards. The commercialisation and mechanisation of prairie farming were then promoted by contributory factors sush as rapidly growing markets and improved transport to the market centres, and also rich supplies of land which was well-suited to agrarian technology. According to David, earlier research in economic history has neglected the important task of analysing the specific market forces which did not attract the farmers to adopt the harvester technique to any great extent until the 1850s: "To be sure, virtually all the standard accounts of the development of agriculture in the United States up to 1860 mention the introduction of the machines that Obed Hussey and Cyrus H. McCormick had invented in the 1830s. Yet the literature remains surprisingly vague about the specific technical and economic considerations touching the adoption of these devices by American farmers. We have called attention to the fact that although the twenty years prior to 1853 had witnessed a slow limited diffusion of the new technique, the first major wave of popular acceptance of the reaper was concentrated in the mid 1850s."[152] One explanation for the slow pace at which the harvester was adopted after 1830 could be that McCormick and Hussey, through their patents and limited production capacity up to 1848, blocked the supply of harvesters. But David maintains that the obstacles to the diffusion of the harvester were to be found on the demand side rather than on the supply side in the middle of the nineteenth century, and he sought to explain the increase in the diffusion of the harvester after 1853 by stressing two factors.

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[152] David, P. A., *ibid.*, quotation at p. 9.

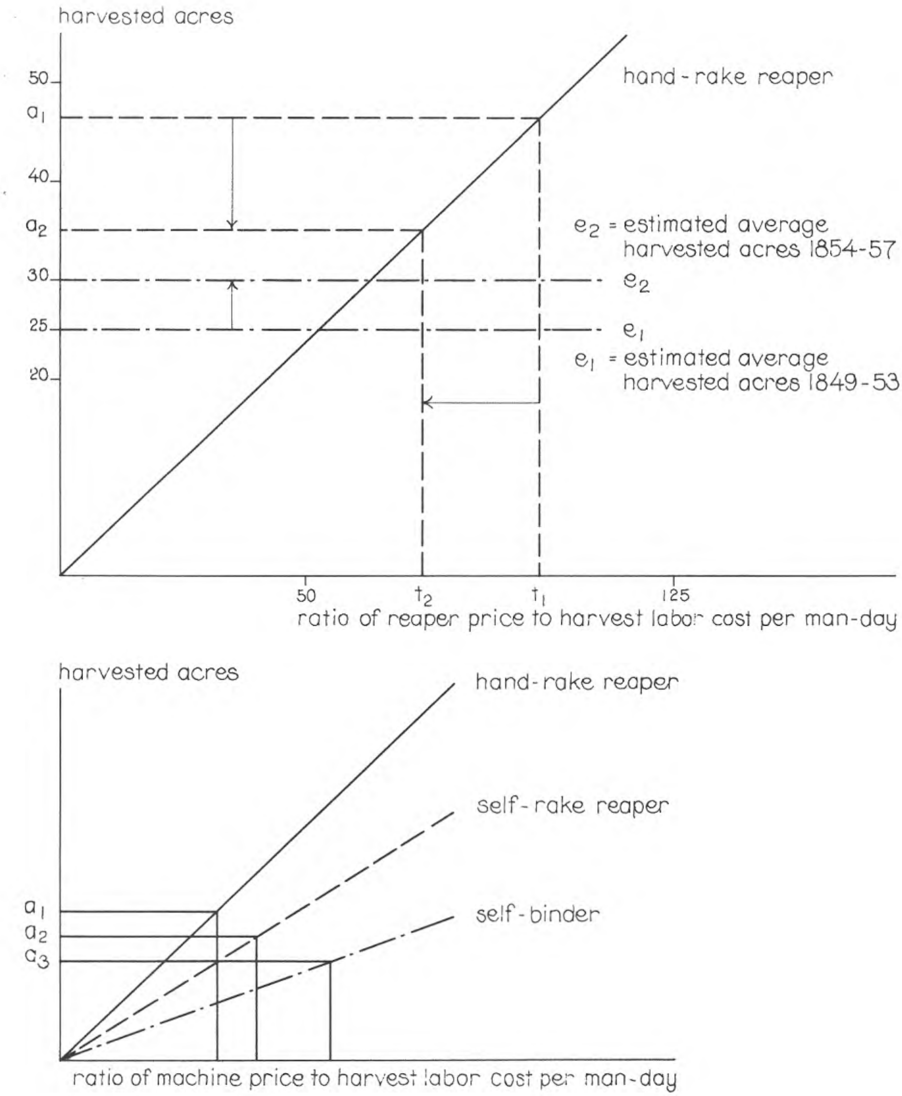

Figure 3

First, the cost of harvesting labour during the 1850s rose faster than the cost of a harvester. During the period 1849–53 the cost of a harvester was equivalent to about 98 working days, while the corresponding cost in 1854–57 was only equivalent to about 74 working days (this applies to Illinois, see figure 3). David has based his calculations here on a depreciation period for a harvester of ten years. In 98 working days in 1849–53 a farmer could harvest up to 46 acres of grain with the manual method as the most profitable alternative, but it was more profitable to harvest by machine when the grain acreage was greater than 46 acres. On the other hand in 1854–57 over 74 working days it had become profitable to harvest only up to 35 acres manually. Thus the threshold value for the farms in Illinois which could profitably adopt the harvester technique fell from 46 acres of land sown with grain in 1849–53 to 35 acres in 1854–57, and it was more advantageous even for smaller farmers to mechanise the harvesting work.

Secondly, the development meant that the acreage sown with grain on average for the farms in Illinois rose from 25 acres at the beginning of the 1850s to 30 acres towards the end of the decade. The possibility of gathering in larger harvests mechanically in a faster and safer way persuaded farmers gradually to sow larger acreages with grain. Thus the adoption of the mechanical harvester before the Civil War was due both to the fact that acreages on the farms sown with grain increased on average and the fact that the lower limit of profitability for harvesting the acreages of the farms by machine during the 1850s was moved downwards. As the average acreage for the cultivation of grain on the farms in Illinois in 1849–53 was 25 acres, it proved to be profitable to mechanise the harvesting only on farms which were more than 20 acres larger than the average. Thus at the start of the 1850s the gap was wide. For the period 1854–57 when the average acreage had risen to 30 acres it had become profitable to mechanise the harvesting stage for all farmers who had grain acreages of only five acres above the average, and so the gap had been sharply reduced.

The comparative development in the cost of the harvester in relation to work resulting in the change in the profitability limit of mechanisation accounts more for the spread of the harvester, according to David, than does the increase in the average grain acreage (see figure 3). David further maintains that the relationship between the explanatory factors mentioned above probably applied to the whole of the Middle-West. In Illinois in fact the average total acreage (i.e. not just the grain acreage) of the farms increased much more between 1850 and 1860 than it did in the neighbouring states. In spite of the fact that the average acreage of the farms during the 1850s increased most noticeably in Illinois, only a small part of the harvester's expansion in the state over the same period was attributable to this. The relationship between the respective costs of harvesting technology and manual methods in Illinois became decisive for the spread of the harvester. If the comparatively modest increase in the acreage per farm in Illinois' neighbouring states is borne in mind, it then seems plausible to David that the development in the comparative cost of machine and manual work was there too the factor which most precipitated the curve of the harvester's spread.[153]

The comparative rise in the cost of labour in the Middle-West during the 1850s was not entirely due to an increase in the demand for farm labour to cultivate the area. The pressure of the demand was also caused by the labour requirements for the construction of the railroads and for town development which finally depended on a constant stream of settlers and on an anticipated growth of the farming capacity of the Middle-West. Since as a rule the contributions of labour gave a much higher yield proportionally in the industrial sector than in the agricultural sector, the replacement of manual labour in the Middle-West by the harvester meant significant profits from the transfer for the national economy.[154]

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[153] *Ibid.*, pp. 19ff. From 1850 to 1860 the average size (total) in Illinois increased from 66 to 91 acres, while the corresponding increase in Indiana was from 53 to 62 acres, in Iowa from 56 to 62 acres and in Wisconsin from 52 to 54 acres.
[154] Bellerby, J. R., *Agriculture and Industry Relative Income*, pp. 232ff. Zimmerman, L. J., *Poor Lands, Rich Lands. The Widening Gap*, pp. 48ff. Martinius, S., *Befolkningsrörlighet under industrialismens inledningsskede i Sverige*, pp. 87f.

The lower contribution by agriculture to the national income per capita was not exceptional for American conditions at the middle of the 19th century. There are corroborative reports from most countries to the effect that labour productivity in agriculture had been consistently lower than in other sectors. The statistical basis for the figures given below is such that it does not permit very far-reaching conclusions to be drawn as far as details are concerned. However the main trend is so apparent and so constant that it seems perfectly reasonable to conclude that agriculture made a much lower contribution to the national income than other sectors of industry.

Around 1850 New York State and Pennsylvania were the leading wheat states, but during the 1850s the Middle-West began to take over the rôle of the granary of the USA. In 1860 Ohio, Michigan, Indiana, Illinois and Wisconsin accounted for half of the country's wheat harvest.[155] If the harvests from Minnesota, Iowa, Missouri and Kansas are also included in the Middle-West's share, this would probably have amounted to 75 per cent at the start of the Civil War. By virtue of the fact that an ever increasing part of the wheat cultivation moved towards the Middle-West, the wheat could be harvested with machines which did not have to be adapted both to the hilly districts in the East and the prairie plains in the West. Attempts were made with the first harvesters to make them suit the needs both of the prairie states and the Atlantic states. The development thus implied possibilities of a simplified and more standardised production of harvesters on a larger scale. Something paradoxical happened in that the tendency towards regional specialisation in the cultivation of grain made it possible to produce farming machines more effectively. Through this the expansion of mechanised farming and industrial development in the Middle-West were advanced.

In his explanation of the adaptation of the harvester David has not taken into account such reasons for the mechanisation as the reduction in harvest losses when the harvesting is carried out mechanically. Because of the harvester the harvests could be brought in more quickly and therefore more safely. The shorter

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Ratio of agricultural to non-agricultural income per capita in United States, Britain, Japan and Sweden

Period	*USA*	*U.K.*	*Japan*	*Sweden(Year)*	
1851–1860	37	44		33	(1860)
1861–1870	39	48		37	(1870)
1871–1880	37	43		40	(1880)
1881–1890	37	43	33	41	(1890)
1891–1900	45	42	39	40	(1900)
1901–1910	46	43	40	45	(1910)
1911–1920	42	44	42	45	(1920)

Source: Bellerby, *op. cit.*, p. 214; Zimmerman, *op. cit.*, p. 51.

[155] *Yearbook of Agriculture 1940*, p. 203. Edwards, E. E., *American Agriculture—The First 300 Years*.

the time for which the ripe grain had to remain on the fields the smaller the risk of wastage due to overripeness or unfavourable weather. The further technical development of the harvester into the self-binder and the combine harvester has lent further weight to such reasons for mechanisation. This means that, irrespective of other socio-economic conditions, areas which use harvesting methods with an intensive use of labour can already secure future profits in changing over to mechanical harvesting by reducing the wastage.

Also in practice the farmers did not react to the new harvesting techniques in strict accordance with a pattern of linear cost functions as David assumed. With regard to the fact that farmers as people carrying on a trade are and have been pronounced individualists, the rapidity with which they adopt new techniques has been due to factors other than those in which purely economic considerations predominated. The farmers came to accept technical innovations in agriculture via the following stages of development: information–awareness–interest–deliberation–attempt–adoption, where adoption signifies the final stage in the acceptance of the innovation. Apart from economic deliberation by the individual farmer, the sum of his personal attributes has determined the speed with which a new technique is adopted. As appears from figure 4, the farmers' inclination to adopt an innovation can be represented schematically by a bell-shaped curve, the pioneers being the first and the laggards the last to adopt the innovation, the shape of the curve being determined both by economic factors and factors of social psychology.[156]

The next figure shows how the most important models of the harvester, when it had been further developed, were distributed among the leading wheat states in the USA during the latter part of the nineteenth century. It was technically possible to develop the harvester in an entirely different way from the mowing-machine. The further development did not involve the actual cutter but mainly concerned labour-saving methods of safeguarding the cut grain. The first type of harvester (the hand-rake reaper) re-

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[156] Metcalf, D., *The Economics of Agriculture,* pp. 64 ff. Jones, G., 'The Diffusion of Agricultural Innovations.' In *Journal of Agricultural Economics,* vol. *15,* 1963.

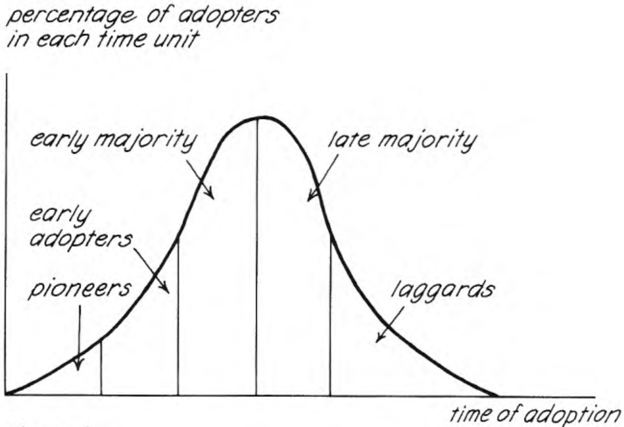

Figure 4

quired that one man with a rake should gather the grain together for the worker who bound the sheaves. The self-rake reaper eliminated the hand-rake. The Marsh Harvester was a forerunner of the self-binder and it rationalised the binding by delivering the cut grain to two binders which bound the sheaves on an accompanying platform at the same pace as the machine cut the grain. Through the application of a binding machine to harvesters of the Marsh Harvester type, the binding process was also automated and the binding workers were rationalised away. The first self-binding models used steel wire in the binding. However, the steel wire caused damage of various kinds, and after complaints from farmers and mill-owners there was soon a change from steel wire to twine. The combination model, the combine harvester, which was the most fully automated machine, already began to be used regularly on the large holdings in California before 1890 and became comparatively widespread there during the 1890s. It is estimated that two-thirds of California's wheat was harvested with combine harvesters in 1900. Thereafter the wheat-producing farms in California split their production into fruit and vegetable cultivation and also dairy production. As a result of this the production of wheat was reduced drastically in California, and therefore the demand for combine harvesters declined rapidly. Outside California there were hardly any combine harvesters at this time and the combine harvester was not again put to use until the period be-

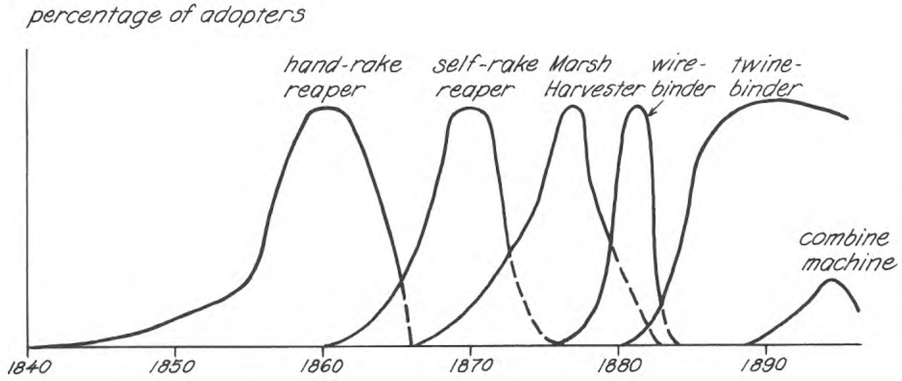

Figure 5

tween the wars, and then in the prairie states to begin with.[157]

If the pattern of adoption in figure 3 is applied to the development in figure 5, the result is that the first type of harvesting machine (the hand-rake reaper) for a comparatively long time—from 1840 to 1855—was only adopted in the leading wheat states of the USA by a small group of farmers, the nearest equivalent to pioneers and early adopters in figure 4. Thereafter harvesting machine technology was disseminated at a significantly increased pace. When newer and more labour-saving variations were later introduced onto the market, they could be ordered with much less hesitation after the breakthrough of the hand-rake reaper. It is reasonable to assume that the pioneers and early adopters of the hand-rake reaper as a rule also became the first to buy the self-rake reaper and the self-binder when these were introduced. However the self-rake reaper and to an even greater extent the self-binder were subsequently adopted by the majority of farmers much faster than the hand-rake reaper. In what was decidedly the wheat

[157] Rogin, L., *op. cit.*, pp. 94–125. International Harvester Co., *Roots in Chicago One Hundred Years Deep 1847–1947*, pp. 15 f.

The development of the rate of diffusion for the improved models of the harvester during the latter part of the 19th century has for the sake of comparison been dealt with at the same time as the pattern of diffusion for the first type of harvester before the Civil War.

district the adoption process showed comparatively large differences as regards time. One must therefore take into account the fact that several of the prairie farmers who were most knowledgeable about agrarian technology for example bought the self-rake reaper before the laggards had yet got the hand-rake reaper, and that the pioneers invested in the self-binder before the laggards had ordered the self-rake reaper. Furthermore it should be remembered that figure 5 shows the development of adoption patterns for different harvesting machines in the wheat district north-west of the Ohio River which was the most progressive as regards agrarian technology. As far as the New England states are concerned, for example, in which farming was mechanised later and to a lesser degree, a time-lag of 10–15 years in the adoption curves and a generally slower rate of adoption should be taken into account. With certain simplifications one could say that the pioneers in the New England states and the laggards in the prairie states adopted the new agrarian technology at about the same time.

As has been pointed out earlier, David has sought to explain the breakthrough in the spread of the hand-rake reaper mainly in terms of comparative cost development for labour and harvesting technology. Even if he has disregarded several possible reasons—mentioned here in part—for a transition to mechanised farming, various data about the sales of harvesters appear on the whole to support David's argument. This of course may be due to the fact that the reasons for the adoption of agrarian technology which David has not taken into account in his explanation pointed in the same direction on the whole as the variables in his explanation. In any case David is right about the breakthrough in the spread of the harvester occurring around 1853–54. McCormick's sales of harvesters showed a tendency to stagnate at the beginning of the 1850s but expanded rapidly after 1853, as is evident from table 59. In addition if one takes into account the fact that J. H. Manny from 1854 onwards and W. A. Wood from 1856 onwards, together with many small, newly established companies contributed considerable and increasing quantities of harvesters during the 1850s, it is understandable that the total figures for harvesters began to shoot up in the middle of the 1850s. In the prairie district the farmers in Illinois were the quickest to adopt the harvester. Before 1860 McCormick sold half of his harvesters in Illinois where the farms on average were larger and had more to gain from mechanisation than those in the neighbouring states (cf. note 153). From Illinois it appears that a more significant adoption of harvesters spread primarily to Iowa and Wisconsin/Minnesota and also thereafter to a somewhat lesser extent to the states of Indiana, Ohio, Michigan, Missouri, Kansas and Nebraska.

As various innovationary improvements of the harvester were gradually being introduced onto the market the farmers' inclination to adopt the new technology was affected. In spite of the fact that improved variations such as the self-rake reaper and the self-binder became more expensive than the original hand-rake reaper for a few decades, the new models nevertheless became cheaper than the old one by virtue of the fact that they reduced labour costs. As appears from figure 3, the self-rake reaper and in particular the self-binder could profitably be used by smaller and smaller farms. Even if the Homstead Law after 1862 to a certain extent laid down the limits for the future expansion of the farms, the average acreage of the farms, especially in the area north-west of the Ohio River, continued to expand during the latter part of the nineteenth century, a tendency which had begun during the 1850s. This further contributed to the fact that the new types of machine, the self-rake reaper and the self-binder, could be adopted so quickly by the many prairie farmers. In the long run the new machines would be cheaper even in terms of their money value than the original hand-reaper had been in the 1850s, while in the long-term the cost of labour rose sharply. As a result the spread of the new machines was also stimulated, as will be discussed more fully below.[158]

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[158] The following prices relate to McCormick sales of various harvesters in the USA.

Type of machine	*1850*	*1870*	*1880*	*1900*	*1905*
Hand-rake reaper	\$120	–	–	–	–
Self-rake reaper	–	\$150	–	\$65	\$50
Self-binder	–	–	\$200	\$110	\$100

The figures for 1905 include not only McCormick's sales but the whole of International Harvester's. Various kinds of rebate were in operation, and in addition the predominant hire-purchase system exercised a modifying effect on the price mechanism.

(*d*) The harvester and the American Civil War

The conflict between America's Northern and Southern states in 1861–1865 originated in the differences in their economic development. The Southern states based their economy on agricultural products such as cotton, tobacco, rice and sugar, with cotton as the completely dominant export product. Even if the majority of the white farmers in the Southern states were smallholders, it was the plantation owners who dominated the economic, social and political life of the South. Before 1860 the Southern states had only been industrialised to a lesser extent, and the need for industrial goods was mainly met by imports. The Northern states on the other hand had developed an industry in the North-East, with New York and Philadelphia as the commercial centres. Through east-west canals and railroads the Middle-West had been more and more integrated with the economy in the North-East before 1860 as far as marketing was concerned. The areas in the North-East and North-West were complementary to each other. In the North-East industry was linked to agricultural development to a lesser extent, while industry in the North-West was firmly anchored to the farming sector. Grain, especially wheat, constituted the core of the Middle-West's agricultural economy.

The divergence in economic development led to conflicting interests in the North and South. On account of the exports of cotton to England and the imports of manufactured goods from there, the Southern states supported the free trade principle. The Northern states, on the other hand, wanted to protect their growing domestic industry behind high tariff walls. The cotton and slave economy in the South constantly demanded newly cultivated land and needed space for a rapid expansion westwards. In addition there was a desire to see the expansion of new slave districts to the West. Therefore during the first half of the nineteenth century the principle of cheap sales of land was in operation in the Southern states. On the other hand the manufacturers in the North, in order to safeguard their markets wanted to concentrate on the population in the East. Before 1860 there was no desire in the North to encourage too large an emigration westwards, and therefore higher land prices and what was on the whole a more restricted land selling policy were being advocated. As a result of this the frontier was being moved westwards faster in the South than in the North before the Civil War. It was not until California joined the group of states opposed to slavery in 1850 that the Northern states began to accept and encourage a more significant emigration westwards as a blockade measure against the expansionism of the South and the slave states. When Minnesota in 1858, Oregon in 1859 and Kansas in 1861 were admitted into the Union as anti-slave states, this constituted a stage in the struggle of the Northern states. The aim of the Homestead Act in 1862, which provided that farmers could get up to 160 acres (quarter section) of land free of charge, was to meet the demands of the free farmers at the expense of the plantation and slave owners. The law which was forced through by industrially interested parties in the North-East signified a formal and definitive change in attitude to the migration westwards. Industry in the Northern states had thought it convenient to establish a union with the free farmers in the North-West in the struggle against the Southern states.[159]

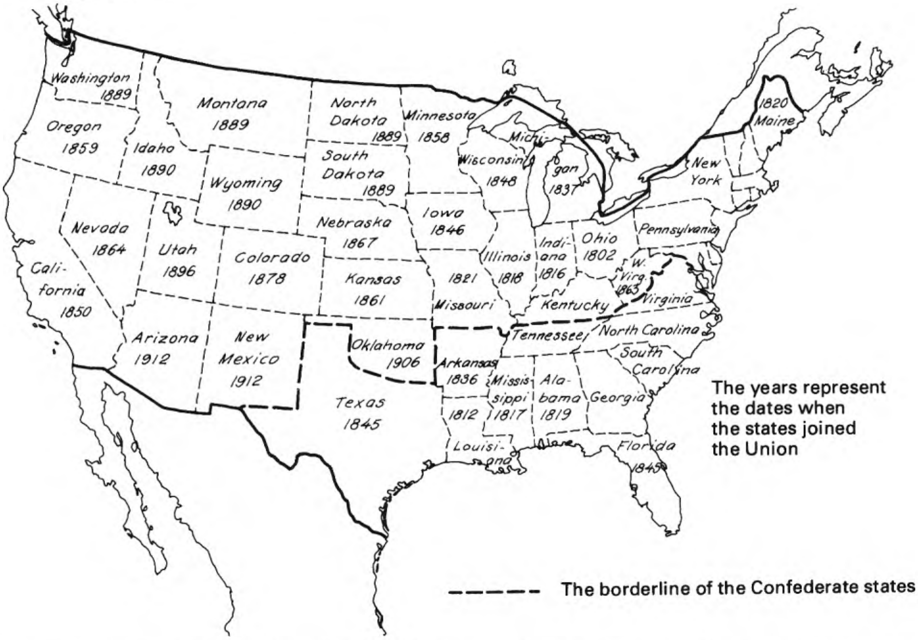
The farms to the north-west of the Ohio River at the outbreak of the Civil War were in the process of developing into the centre of the nation's agrarian economy. Around 1860 70 per cent of the USA's wheat was grown in the Middle-West, and Rogin estimates that at that time 70 per cent of the wheat in the Middle-West was harvested by machine.[160] The 1850s had been a decade of expansion for agriculture in the Middle-West, and at that time the harvesting machine was able to make its breakthrough in the most advanced prairie districts, above all in Illinois. Around 1850 two thousand out of a total of about 76000 farms in Illinois were equipped with harvesters. Out of about 143000 farms which were in existence in 1861 about 40000 had adopted the new harvesting technology.[161] This meant that the distribution of the harvester among the farms of Illinois had risen from about 3 per cent in 1850 to almost 30

[159] Faulkner, H. U., *American Economic History*, pp. 306 ff.

[160] Rogin, L., *op. cit.*, pp. 78 f. David, P. A., Mechanization of Reaping in the Ante-bellum Midwest, pp. 10 f. David thinks that Rogin has somewhat overestimated the level of mechanisation in the Middle-West around 1860, and seeks to modify Rogin's percentage figure to between 50 and 70 per cent.

[161] David, P. A., *op. cit.*, pp. 38 f. McCormick Collection. McCormick alone had sold 20000 harvesters in Illinois up to 1861.

Map 11.



per cent in 1861. It was the third of the farms which gained the greatest acreage which had mechanised the harvesting at the outbreak of the Civil War, and this third accounted for seventy per cent of all the wheat harvested in that state.

In the few years of the duration of the Civil War McCormick sold 24 000 harvesting machines compared with a total of 35 000 before the war. However, McCormick's share of the market decreased significantly during the 1860s. Before the Civil War his share had amounted to about a third, but during the Civil War the demand for harvesters increased so that he could only cover a sixth of the market in spite of the fact that he doubled his capacity. It is estimated that in all 100 000 harvesters were sold between 1833 and 1860, while total sales during the four war years alone amounted to 150 000 harvesting machines. Furthermore there was an addition of a significant number of mowing-machines and combined harvesting and mowing machines.[162] The harvesting machine was also

[162] McCormick Collection: Reaper Sales, Reaper Orders (see table 59). Rogin, L., *op. cit.*, pp. 78 f., pp. 91 ff.

being improved in the middle of the 1850s in a way which became of great economic significance during the Civil War. In 1854 various firms started to sell self-rake reapers on a small scale. However, it was not until 1861 when Wood in the East and McCormick in the West began to produce self-rake reapers that these could circulate on a larger scale. The self-rake reaper brought about an important saving of human labour, as the hand-raker became redundant. The saving of labour, which was always a minor production factor in the North, became of special importance in time of war. The rapid increase in McCormick's production of the self-rake reaper illustrates the development during the Civil War. In 1861 self-rake reapers constituted 0.2 per cent of the total harvesting machine production. The corresponding percentage in 1862 was 4 per cent, in 1863 it was 50 per cent, and in 1864 67 per cent.[163]

It has been estimated that at the outbreak of the Civil War harvesting machines of all kinds carried out work equivalent to that of almost a million harvest workers with hand tools. "Careful estimates determined that the number of reaping machines introduced throughout the country up to the beginning of the great rebellion, performed an amount of labor while working in harvest nearly equal to a million of men with hand implements." Towards the end of the war the harvesting machines would by analogy have been equivalent to two million men in harvest work.[164] In comparison it may be mentioned that in the final stages of the war the Northern states employed a total of 1.5 million soldiers as against 0.7 million for the Southern states. However, the harvesting machine was extremely unevenly distributed in the country around 1860. 86 per cent of McCormick's sales of harvesters were concentrated in the prairies north-west of the Ohio River, and during the Civil War in the area in question an even larger share or 93 per cent of his harvesting machine production was ordered. However McCormick's share of the market decreased during the war,

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[163] Rogin, L., *op. cit.*, p. 79. Rogin refers to an expert on agricultural machines, ment of Agriculture in 1864 there was a large number of companies (187) which together produced 100 000 harvesters and mowing machines.

[164] Rogin, L., *op. cit.*, p. 79. Rogin refers to an expert on agricultural machines, J. J. Thomas, who among other things was editor of the agricultural paper *Country Gentleman*.

since many new agricultural machine companies had been established beforehand. The new companies had mainly been located in prairie states such as Illinois, Wisconsin, Indiana and Ohio, but also in states in the North-East, where New York State produced a significant number of harvesters. Even if a large part of the production in the East was delivered to the prairie area in the West, a comparatively large number of harvesters remained in states like New York and Pennsylvania. Thus if the total number of harvesters is under consideration, McCormick's figures give a somewhat exaggerated picture of the importance of the prairie area as a purchaser of harvesters. As regards the picture of distribution for all machines, a certain adjustment from north-west to north-east ought to be made in McCormick's distribution pattern. But it is only a question of a small adjustment, and almost entirely within the Northern states. Before and during the Civil War the overwhelming majority of harvesters in the USA were ordered for the farms in the North, and the farms in the South accounted for 1 or 2 per cent at the most.

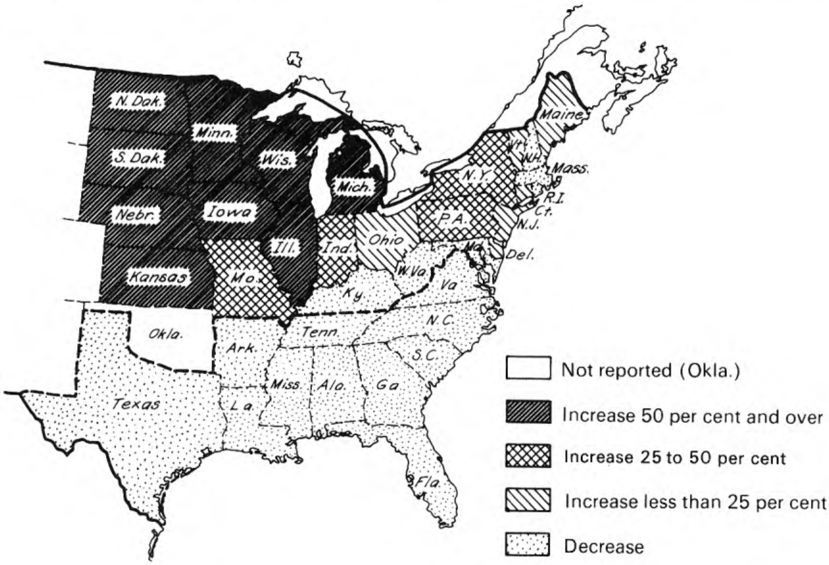
The economy of the South was based on cotton to a large extent. Various attempts were made to mechanise the cotton-growing in the South, and technological progress was not lacking after E. Whitney's cotton-gin. But it was not possible to make the same sweeping profits from mechanisation in the South as on the farms in the North. This was partly due to the slave system and the limited possibilities of slave labour with its incapacity to take and have responsibility for more advanced farming machinery and organise mechanised farming production. Another important cause was that the purely technical problems connected with mechanised cotton growing and other farm production in the South remained unsolved for a long time. The harvesting operation was the bottleneck in cotton production, but it was so difficult to construct suitable cotton-picking machines that no appropriate technical solution was found until well into the twentieth century. Because of the irregular environments for cultivation it proved difficult to construct labour-saving machines for other forms of farming in the South such as on tobacco, sugar and rice plantations. Agriculture in the Northern states was concentrated on grain production and the cultivation could be standardised technically to a far greater extent, and was therefore from a technical point of view more rewarding to mechanise.[165]

The growing interaction between agriculture and industry in the North and above all in the North-West contrasted significantly with the undifferentiated agricultural economy in the South. Before and during the Civil War the interaction between industry and agriculture in the prairie area led to important profits for the national economy. Due to a chain of causation the rise of an agricultural machine industry was promoted by the great purchasing power of prairie farming in placing orders for agrarian technology. The same industry supplied a commercially expanding agriculture with various labour-saving machines. By these means productivity was increased in the farming sector, but in addition the limited labour force could be transferred more rapidly from farming to other sectors of society which were still more productive. In this respect the harvester played the strategic rôle among the agricultural machines, but the process of mechanisation which went on at the same time should also be stressed. Before the Civil War the larger farms in the North had mechanised various stages of operations such as the preparation of the soil, the sowing, harvesting and threshing. During the Civil War the mechanisation spread rapidly even to small farms. Many onerous procedures in the seasonal rhythm of agriculture which had previously had to be carried out by hand were effected in the North instead by a combination of draught animals and machines. Therefore when necessary the remaining less arduous operations could be carried out to a large extent by women and children.

The start of the process of mechanisation in prairie farming should certainly not be regarded as a measure within the framework of preparation for economic defence. The mechanisation had begun on the basis of commercial economic estimates in a peace economy. But during the Civil War the mechanisation brought about an immediately increased state of preparedness. Thanks to the progress of mechanisation the prairie district was better able than the Southern states, and also better able than the North-Eastern states, to economise over the labour force supply in the changeover to

[165] Street, J. H., *op. cit.*, chapters 5 and 6. Cf. note 125.

Map 12. *Percentage of increase of all farm property, by states, 1860–1870.*



Source Statistical Atlas of the United States, 1924.

a war economy. Already in the years of peace immediately preceding the Civil War in the prairie states there had been a commencement of the reduction of the agricultural labour force and a replacement of it with machines, which had resulted in a yield which was unchanged or increased. When in wartime it became a case of putting an army quickly on its feet and supplying it with food, this meant no real process of readjustment for the North-Western states, but rather the continuation of a development which had already begun. It was only necessary to speed up the rate of progress. The harvester was the principal labour-saving farm machine and the introduction of the improved self-rake reaper around 1860 in itself meant that millions of working hours could be saved in the North during the Civil War by virtue of the fact that tens of thousands of hand-rakers no longer had to be used in harvesting. During the war orders for harvesting machines increased rapidly, and during the war years McCormick doubled his yearly sales in comparison with the previous decade. Nevertheless McCormick lost half his share of the market during the war. Compared with the preceding period the total annual sales were quadrupled during the war. Table 58 shows that McCormick's sales increase during the war only took place in the prairie area of the Northern states. In Iowa, Wisconsin and Minnesota the annual sales were quadrupled, while in Illinois and Indiana they were doubled. It is notable that sales to the slave state of Missouri which was neutral in the war fell considerably during the war. After the end of the war Missouri received significant supplies of harvesters from McCormick and the state became one of the largest customers for harvesters in the South-Western prairie area.

In spite of war time the spread of the harvesting machine resulted in grain surpluses, above all on the farms north-west of the Ohio River. In 1860–1862 significant export quantities of wheat were shipped to Britain, whose own harvests at that time fell below the normal figure.[166] In England there were divergent opinions about whether to maintain a position of neutrality towards the Civil War. There were sympathisers with the Southern states in many leading English circles, and there was a desire to see the collapse of the American Republic. However, Britain's trade position at the beginning of the Civil War was such that she stood to gain more from trade with the Northern than with the Southern states. Britain had increased her stocks of cotton through large purchases from the Southern states in 1860. At the same time there was an apparent grain shortage, and when Britain had to choose between cotton and wheat there was only one possible decision. The highly mechanised American agriculture in the North-West could meet England's grain requirements, and thereby contributed to the neutrality of Great Britain in the American domestic conflict. The British balancing act between wheat and cotton during the Civil War has been described by E. D. Fite in the following terms: "It may safely be concluded that while the need of grain would not have prevented England from defending herself from a war of aggression by the United States, it was doubtless one of the factors, and an important one, in preventing aggressive demonstra-

[166] Faulkner, H. U., *American Economic History*, pp. 328 ff. Rasmussen, W. D., 'The Civil War: A Catalyst of Agricultural Revolution.' In *Agricultural History*, October 1965.

tions by England in favor of the Confederacy and against the United States."[167]

The total economic power of the Northern states was superior to that of the Southern states during the Civil War. Various industries in the North were stimulated by the war. The wool, leather and armaments industries received large orders from the army and helped to decide the course of the war. The production of small arms had been rationalised, and they could be mass-produced on the basis of E. Whitney's original principle of interchangeable parts. The outcome of the war—provided that Great Britain did not interfere in the conflict—was therefore plain in the long run. The outcome of the war has usually been accounted for by referring to the industrial superiority of the Northern states. It has also been said that the financially powerful metropolises in the North-East, with New York at their head, were able as middlemen to control the important trade between the Southern states and Europe, a control which the Northern states developed into an economic blockade of the Southern states during the war. These explanations are true in themselves but there is good reason for underlining a further important explanatory factor. The cotton in the South was defeated to the same great extent by the wheat and the harvesting machine in the North-West as by the capital and industry in the North-East. The interaction between industry and agriculture in the North-West generated enormous forces of growth immediately before and during the Civil War by virtue of the fact that agriculture, the dominant sector there, was being mechanised and commercialised. Industry in the North-East certainly also expanded during the 1850s and 1860s, but at that time it was still inferior to English industry. When the Southern states came into conflict with prairie farming in the North-West during the war they had to fight against the world's most efficient agriculture, which was able to adapt rapidly to the conditions of a war economy. The Northern states found it much easier to advance along the Western rather than the Eastern frontier, and even if troops are mobile units the course of the war seems to show that it was easier to meet the

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[167] Fite, E. D., *Social and Industrial Conditions in the North during the Civil War,* quotation at p. 21.

new war situation in the North-West. The fact that it was possible to increase grain production in wartime to such an extent that wheat could be exported to England, who was at that time greatly in need of imported wheat, further underlines the economic and political effects of the new harvesting technology. It probably made an effective contribution to the fact that the conflict was limited to a civil war without interference from foreign powers.

(*e*) The spread of the harvester outside the USA before 1900

The first harvesting machines were constructed in England and Scotland in the years immediately before and after 1800. However, as has already been seen, practical application of the harvester was first made in American agriculture. In itself there was no lack of incentive for the English farmers to adopt the technical innovations in farming in their native land. During the nineteenth century England's consumption of wheat had been supplied by imports to an increasing extent. The proportion of imports grew from a modest 3 per cent, during the twenty year period from 1811 to 1830, to 13 per cent in 1831–1850 and to 30 per cent in 1851–1860. At the end of the nineteenth century the proportion of imports approached 80 per cent. In spite of the fact that the grain producers in England could count on good and secure sales markets, the work of harvesting was still carried out in the world's leading industrial nation in the middle of the nineteenth century in the same primitive way as it had been carried out for a thousand years. At the world fair at London's Crystal Palace in 1851 the harvesting machines of Hussey and McCormick which were exhibited took the English by surprise. The Times wrote lyrical articles about the blessings of the harvester. It was for two main reasons that England adopted the harvester technology later, more slowly and to a lesser extent than the USA. First, the supply of farm labour was larger in England than in the USA, while the supply of land was much smaller in England. Secondly, England had no equivalent to the large, smooth plains of the Middle-West. The rapid spread of the harvester in American agriculture is in clear contrast to the slow spread in England. While only one per cent of the grain in the USA was mechanically harvested around 1850, the corresponding proportion in 1860 had risen to over 50 per cent for the Middle-West and to 80 per cent for the whole nation in 1870. It is estimated that in England only 6 per cent of the grain was cut by machine in 1863. It was not until the middle of the 1870s that the corresponding proportion is estimated to have risen to 40 per cent. It was mainly the comparatively few large English estates which had mechanised the work of harvesting at that time, but together they accounted for a considerable share of the domestic grain production.[168] In contrast to the USA agricultural power in England was thus limited to a comparatively small number of farms. On the whole the purchasing power of the rest of European agriculture during the latter part of the nineteenth century was limited to a

[168] Bairoch, P., *Agriculture and the Industrial Revolution 1790–1914,* pp. 35 f. David, P. A., The Landscape and the Machine: Mechanization of the Corn Harvest in Victorian Britain. In *Essays on a Mature Economy* (ed. D. N. McCloskey), pp. 147 f.

"The progressive Lothians formed a British topographical counterpart to the American Midwest, but—unlike the latter region—carried little quantitative weight on the national farming scene ... One cannot understand the divergence between British and American experience during the third quarter of the nineteenth century without observing that the landscape of Britain's principal grain-producing districts was on balance inimical to the immediate successful introduction of the mechanical innovation that had been suddenly brought to the attention of her farmers through the medium of the Great Exhibition. In the United States the broad, level and stone-free prairies of the Midwest, where grain production was becoming increasingly concentrated even before the Civil War, provided extensive regions whose topography was singularly well suited to the operation of horse-drawn machines in field work. As I have elsewhere shown [Paul A. David: The Mechanization of Reaping in the Ante-bellum Midwest. Cf. notes 152 and 153] so technically hospitable an environment in itself was not sufficient to induce the farmers of the American Midwest to abandon hand methods of harvesting the small grains prior to the 1850s. On the other hand, the favourable physical conditions did mean that during the 1850s—when an alteration of the structure of Midwestern factor prices combined with a rise in average farm acreage devoted to small grain crops, providing a stronger inducement to substitute machinery for labour on the region's farms—the mechanization of the harvest could proceed without the limitations that terrain problems would have imposed, and actually did impose in sections of the Northeast and the seabord South." According to David small and medium-sized farming units dominated English agriculture around 1850. Only about 17 000 farms, equivalent to 7.5 per cent of all the farms in England and Wales, were at that time larger than 300 acres. During the next three decades the relative number of English large holdings remained constant (p. 178).

comparatively small top stratum, and the topographical agricultural environment of the continent of Europe was much more like that of England than that of the American Middle-West. Therefore the American manufacturers of agricultural machines who began selling to Europe from the 1850s onwards were compelled to concentrate their exports on the comparatively narrow market constituted by the top stratum of agriculture. The competition from the growing American exports of grain to Europe subdued the inclination of the European farmers to invest in agricultural technology and acted for a long time as an additional obstacle to a more general spread of mechanised agriculture in Europe. During the latter half of the nineteenth century the USA became the world's largest grain producer, to a great extent on account of lower production costs than in Europe. In spite of the high wage situation in the USA in the year 1870 the production cost per bushel of grain there was more than 50 per cent lower than in France, who was the second largest producer. There was a further sharp increase in the difference in production costs between the countries up to 1890. The production costs per bushel of wheat in India, who was the world's third grain producer, were no lower with her very cheap labour around the turn of the nineteenth century than in the highly mechanised American agriculture.[169]

[169] Bairoch, P., *Agriculture and the Industrial Revolution 1700–1914,* p. 36.

The world's wheat harvest divided among different countries and states in the USA in the year 1880

Country	*Millions of bushels*	*State in the USA*	*Millions of bushels*
USA	459	Illinois	51
France	290	Indiana	47
India	240	Ohio	46
Russia	227	Michigan	36
Germany	121	Minnesota	35
Spain	116	Iowa	31
Italy	108	California	29
Austria-Hungary	105	Missouri	25
Great Britain	105	Wisconsin	25
Turkey	43	Pennsylvania	19

Even though McCormick's harvesters had great success at the world fairs in London in 1851, Paris in 1855, London in 1862, Hamburg in 1863, Paris in 1867, Vienna in 1873 and in Paris again in 1878, he did not achieve any large and rapid sales successes in Europe. European farming, in which the emphasis was on small-holdings, still had a good supply of cheap labour. There were usually few incentives in the prevailing conditions to allow capital of a farming technology kind to replace manual labour in a decisive way. During the decades immediately after 1851 agricultural machines were only exported from the USA to a lesser extent, and in the beginning the harvesters and mowing-machines accounted for a modest proportion of the limited exports of agricultural machines as a whole. McCormick found that it was not profitable to export harvesters to Europe, and he therefore decided to let the English firm Burgess & Key, of Essex, produce and sell his machines under licence and in return for the payment of royalties on the sales figures. Through Burgess & Key McCormick was able to sell more harvesters in England in 1851–1861 than any other producer. After McCormick had opened up the European market other American producers followed suit, of whom the more prominent were J. H. Manny, Seymour & Morgan and W. A. Wood. When McCormick was ready to introduce the self-rake reaper onto the market in 1862 after the experimental phase of development, he went to Europe for the second time to have it tested in various countries. But Burgess & Key were unable in the long run to meet

Rumania	37	Kansas	17
Australia	37	Nebraska	14
Belgium	26	New York	12
Algeria	26		
Canada	23		

Source Peale's Educator and Cyclopedia of Reference. R. S. Peale & Co. Chicago. Casson, H. N., Cyrus Hall McCormick. His life and work. Pp. 203 ff. McCormick Harvesting Machine Co., Chicago, Catalogue 1887.

It should be stressed that the number of farmers in France was about as large as the number in the USA, while the farmers in several other countries such as India and Russia were many times more numerous. A large part of American agriculture was already producing grain for sale and for export in 1880. In Russia only a small proportion of the farms were able to produce grain for export at that time. The grain exports of France and India were negligible.

McCormick's capacity. McCormick therefore got involved in a dispute with Burgess & Key, and had to ship the machines from Chicago to the continental market in Europe himself with heavy transport costs. The events meant a decline in McCormick's competitiveness, and in 1862 he was overtaken on the European market by W. A. Wood. McCormick only sold 4 000 harvesters to Europe before 1876 and the majority of those were delivered before 1866. In the ten year period from 1867 to 1876 McCormick sold no more than a thousand harvesters to Europe while over the same period Wood outstripped the English harvester manufacturers on the Continent. For the sake of comparison it may be mentioned that Wood exported 18 000 harvesters to Europe prior to 1870. Wood's production was located in the North-East of the USA and his transport economic position vis-a-vis the European market was better than McCormick's.[170] The importance of the fact that McCormick had opened the European harvester market in 1851 was not due to the drastic increase in the number of machines which were in operation on the European farms before the 1880s. If anything his successes among technical experts in agriculture in Europe aroused still further interest in the American farmers in purchasing harvesters. Nor were Wood's deliveries to Europe before 1880 anything more than a drop in the ocean, and the value of the total exports of agricultural machines from the USA is shown in table 61.

During the 1880s the character of the American exports of harvesters changed. On the one hand they began to grow in volume

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[170] Hutchinson, W. T., *Cyrus Hall McCormick*. II. *Harvest 1856–1884*, chapter 11. The Rise and Fall of the Transatlantic Market 1856–1876. International Harvester Co. *Roots in Chicago*, p. 17. Wilkins, M., *The Emergence of Multinational Enterprise: American Business Abroad from the Colonial Era to 1914*, p. 29.

For a long time the European market played a completely subordinate rôle in McCormick's sales. Thus in 25 years (1851–1876) a total of 4 000 machines were sold to Europe, while the state of Iowa alone bought more than 4 000 machines in 1875 (cf. table 60).

The Walter A. Wood Mowing and Reaping Machinery Co. played an important rôle both on the American and the foreign harvester markets, and during the 1860s, 1870s and 1880s was one of McCormick's most powerful competitors. Wood himself was the driving force in the company, the importance of which declined rapidly after his death in 1892. In 1920 the company went into liquidation. Phillips, W. G., *op. cit.*, p. 169, note 4.

Table 60. *Number of McCormick harvesters and mowing-machines (including machine parts) sold to various states and countries in 1875–1902*

State/Country	1875	1891	1895	1902
Illinois	3 600	18 162	31 514	30 521
Iowa	4 623	12 831	34 275	35 211
Minnesota	3 273	35 098	37 900	35 734
Wisconsin	858	5 007	10 388	20 065
Indiana	647	9 196	14 441	24 827
Missouri	1 293	34 335	7 595	22 331
Ohio	209	15 319	19 952	17 235
Michigan	394	9 072	11 555	16 944
Kansas	614	4 915	5 600	13 157
Nebraska	1 252	12 493	4 069	6 997
North Dakota	–	6 738	10 166	13 257
South Dakota	–	3 784	7 941	8 480
Pennsylvania	–	2 909	10 224	11 609
New York	–	3 133	9 091	19 054
Oklahoma	–	–	–	4 035
Texas	498	3 420	5 772	4 902
Tennessee	–	4 599	6 279	9 356
Georgia	–	–	–	8 201
Virginia	89	2 701	2 741	4 427
Other Southern states	–	–	920	6 451
Other states	555	3 424	7 599	19 120
Canada	–	1 160	3 725	15 102
Denmark	6	46	556	1 606
Norway	–	–	271	858
Sweden	–	66	430	1 888
Finland	–	–	–	618
Russia	–	1 418	2 741	16 137
Germany	–	289	785	12 211
France	–	189	1 396	14 646
Great Britain	–	964	1 163	6 272
The rest of Europe	–	29	1 122	7 214
Argentina	–	371	720	3 971
The rest of Latin America	–	–	382	708
South Africa	–	–	562	621
North Africa	–	–	38	780
Australia/N. Zealand	–	2 790	530	3 112
Total	17 911	196 175	254 172	417 658

Source McCormick Collection: Machine Ledgers.

at that time and on the other hand they began to be directed towards markets other than the European one. Before 1880 the limited volume of exports had gone mainly to Europe. The new markets were composed of newly colonised areas whose land reclamation was made possible by the European emigrants. Between 1850 and 1930 almost sixty million Europeans emigrated. The emigration was greatest between 1880 and 1914, constituting in fact 60 per cent of the total. During the period 1850–1880 on average a quarter of a million people emigrated each year, while the corresponding number in 1881–1900 was three quarters of a million, and in 1901–1914 a million and a quarter. In the years 1915–1930 emigration declined again to about the same level as during the period from 1850 to 1880. Somewhat over half of the emigrants went to the USA, while about 35 per cent went to Canada, Argentina, Australia and New Zealand, Siberia and South Africa. As a rule all the new areas were like the USA in that there was an abundance of good smooth land and a comparative shortage of labour. Labour-saving machines in the dominant agricultural sector therefore became a key factor in the economic development of the new areas. The new areas lacked any important domestic industry of a farming technology nature. One exception was Canada who had built up her own agricultural machine industry by borrowing agricultural technology from the USA and through the protection of high tariff walls. Therefore American agricultural machine manufacturers were able after 1880 to extend the production series to a greater extent than before, for an enlarged export.[171]

During the latter half of the nineteenth century the domestic agricultural machine industry in Canada had been located south-east

[171] Casson, H. N., *Cyrus Hall McCormick. His Life and Work,* pp. 203 ff. Carr-Saunders, A. N., *World Population,* p. 49. Phillips, W. G., *op. cit.,* pp. 37 ff. The number of emigrants to the following countries has been estimated at:

	Million
USA	34
Siberia	7 (before 1914 alone)
Argentina	6.5
Canada	5
Australia+New Zealand	3.5
South Africa	1

Table 61. *Exports of agricultural machines from the USA in 1870–1900 in thousands of dollars*

Year	A=Reapers and mowers	B=Other machines	C=Total	A as % of C
1870	66	1 002	1 068	6
1880	769	1 477	2 246	34
1890	2 093	1 766	3 859	54
1900	9 943	6 370	16 313	62

Source Statistical Abstract of the United States. Department of Commerce.

of Ontario, with the Toronto district as its centre point. In Canada no significant agricultural innovations of a technical kind were made, and many Canadian producers manufactured harvesting machines under licence from leading firms in the USA. Most prominent in the Canadian industries were the two companies Massey Co. and Harris Co., which based their business on harvesters and mowing-machines and had been founded by Daniel Massey (1847) and John Harris (1859). Protected by virtue of the fact that the tariff rates on agricultural machines were raised to 25 per cent at the end of the 1870s, and further raised to 35 per cent of the import value in 1883, the two firms in question could successfully shut out the large competitors in the USA. However, Massey and Harris did compete with one another for the leading position on the Canadian market especially during the 1880s. Thus in Canada the harvester war was fought out ten years before the equivalent conflict in the USA in the 1890s between McCormick and Deering. The internal struggle resulted in a merger of the companies in 1890 when the Massey-Harris Co. was formed.

But time was on the side of the large industries in the USA. As the frontier in Canada gradually, starting in the 1880s, was moved westwards through Manitoba, Saskatchewan and Alberta, the farmers' dissatisfaction with the high tariffs on American agricultural machines in fact increased, and in 1895 the government was forced to reduce the tariff rates to 20 per cent. The Canadian agricultural machine industry had started in the East, but in contrast to that in the USA it had not followed the market westwards. The whole of the prairie area in the American Middle-West and Western Canada grew together into one industrial geographical unit based on the mechanised farming of large holdings for sales production. The border people quite rightly felt that the border between Western Canada and the USA along the 49th parallel was a mere bureaucratic concept, and from a sales point of view the position of the agricultural machine industries in Illinois, Wisconsin and Minnesota vis-à-vis the market in Western Canada was a much more favourable one than that of the equivalent Canadian industries in the East. Therefore when the protective tariff was reduced, the domestic agricultural machine industry was unable to retain the expanding market in Western Canada. After twenty years absence McCormick returned to the Canadian market in 1887 when the company opened a branch in Winnipeg. The transporting of machines from Toronto in Eastern Canada to Winnipeg in Manitoba, Regina in Saskatchewan or Calgary/Edmonton in Alberta became too expensive to be competitive with the companies in the USA. On the other hand the domestic industry kept hold of the market in Eastern Canada. It may seem paradoxical that it was more natural from the point of view of transport economics for the agricultural machine industry in Eastern Canada to supply other imigration countries such as Australia and Argentina with agricultural technology than the domestic settler farms in the West. The loss of the domestic market in the West was compensated for by aiming at export markets, first in Argentina, Australia and New Zealand, and later also in Europe. Therefore the production value of the Canadian agricultural machines was able to rise from 4.5 million dollars in 1880 to 7.5 million dollars in 1890 and 9.5 million dollars in 1900. In 1880 the production of agricultural machines in Canada was equivalent to just under 7 per cent of that of the USA but in 1900 the ratio had risen to almost 10 per cent. Canada began to export agricultural machines at the end of the 1880s, and in 1890 the exports amounted to 0.4 million dollars or 5 per cent of the production value. During the 1890s exports were more than quadrupled and at the turn of the nineteenth century exports accounted for 18 per cent of Canada's total production of agricultural machines. At the same point in time Canada's exports amounted to one tenth of those of the USA. As in the USA harvesters and mowing-machines accounted for the main part of the production and exports of the Canadian branch of the industry. After the USA Canada became the world's largest manufacturer and exporter of harvesting machines. Outside the USA and Canada there were only a few smaller European companies in this field at this point in time.[172]

It is apparent from McCormick's very extensive correspondence with his foreign agents that the exports of Canadian harvesters on certain foreign markets from the 1890s onwards meant noticeable competition for McCormick. The general agents acted among other things as feelers for the management of the company and informants about the competitors' sales methods and shares of the market. In 1890 for example the agent Morrow, Basset & Co. of Christchurch, New Zealand, reported that Deering was McCormick's keenest competitor in Australia/New Zealand and that Wood's share was smaller and decreasing. At that time there was no mention of Massey or Harris in Canada. However, ten years later (1900) the agent W. P. Postin in Melbourne reported that Massey-Harris and McCormick shared the leading position on the Australian harvester market, noticeably ahead of Deering. At that time Wood only had a modest share.[173]

Towards the end of Cyrus Hall McCormick's life (he died in 1884) Australia and New Zealand became the company's largest and most profitable foreign market. At the same time the railroad opened up new areas for wheat-growing in Western Canada, and in Argentina the Pampas was being developed into Latin America's principal wheat district. A decade or so later Southern Siberia was colonised, and new parts of South Africa. Through these new areas of cultivation and through continuing land reclamation in the USA west of the Mississippi River, the wheat-growing acreage of the world was doubled between 1880 and 1910. The first breakthrough in foreign trade with agricultural machines coincided with the first really important wave of emigration in the 1880s. As is shown in table 60, the new immigration areas of Australia and New Zealand,

[172] Phillips, W. G., *op. cit.*, pp. 37–46, pp. 54 ff., p. 179. Denison, M., *Harvest Triumphant. The Story of Massey-Harris.*

[173] McCormick Collection. McCormick Company Records, letters received, series 2 X.

McCormick's business correspondence for 1839–1904 which has been preserved is very extensive and consists of more than 600 boxes, of which 100 contain letters from foreign agents.

Argentina and Western Canada took more than 4000 machines, or 60 per cent of McCormick's total exports of about 7300 machines. Between 1891 and 1895 the volume of exports was doubled, and at the latter date McCormick sold 40 per cent of the harvesters and mowing machines which were exported to the new areas, including South Africa. McCormick's real export breakthrough occurred at the end of the 1890s, and between 1895 and 1902 the exports were multiplied sixfold. Of the total of 85000 harvesters and mowing-machines which were exported, about 23000 or a quarter went to the new immigration areas in 1902, while at least 60000 or almost three quarters went to Europe including Siberia. The importance of emigration for the development and diffusion of mechanised farming must be underlined. The effects of the emigration became apparent first and foremost in the fact that newly colonised areas were brought under cultivation with the aid of machines. The settler farms in the American Middle-West developed significant purchasing power and became the first big customers numerically and individually of the agricultural technology industry. During the decades around the turn of the nineteenth century a new batch of orders for agricultural technology followed from the settler farms in Australia and New Zealand, Argentina, Western Canada, Siberia and South Africa. Through its exports of farm produce the more effective agriculture in the new production areas dealt a blow to European agriculture, which contributed further to the increase in emigration from Europe. However the accumulated emigration gradually reduced the agricultural labour surplus in Europe, which helped to raise labour costs in farming. Thus the emigration also gradually stimulated the spread of a mechanised agriculture in Europe.[174] In research into economic history the double effect of the emigration in diffusing mechanisation in agriculture has hitherto not been sufficiently stressed.

Before the 1880s the total foreign trade in harvesters was very limited. The USA accounted for the exports and Europe for the imports. McCormick's machines played a leading rôle in these exports during the initial stage from 1851 to 1862. After that McCormick's significance in exports declined, and until the 1880s other

[174] Hutchinson, W. T., *Cyrus Hall McCormick. II. Harvest 1856–1884,* chapter 15. Casson, H. N., *Cyrus Hall McCormick. His Life and Work,* pp. 203–233.

American firms led by Wood delivered the bulk of the harvesters to Europe. Not until the demand on the world market increased from the 1880s onwards did McCormick concentrate on foreign trade and regain his leading rôle in exporting. After 1892 when W. A. Wood died the importance of Wood's firm declined rapidly, and instead new competitors such as Deering and Massey-Harris began to assert themselves on the world market.[175] When world trade in harvesters made its real breakthrough in the 1880s and at the beginning of the 1890s, the new immigration areas succeeded Europe as the principal customer for agricultural technology. Not until later in the 1890s, when the labour force balance began to change and the population pressure in the agricultural sector eased on account of the continuous emigration, was the interest of the European farmers in mechanising the work aroused. In terms of monetary value Europe then became once more the largest customer for North American agricultural machines. At the turn of the nineteenth century 70 per cent of the USA's harvesters and mowing-machines were exported to Europe including Siberia. As Siberia was a settler area which began to be colonised in earnest during the 1890s its imports of machines should not be included among those of Europe. At the beginning of the twentieth century Siberia took a growing proportion of the total Russian imports of machines. For example in 1906 half of the Russian imports of mowing-machines from International Harvester went to Siberia. Therefore Europe's share of 70 per cent of the exports ought to be reduced somewhat in consequence, but in spite of this the absolute increase in imports was beyond dispute. From a comparative point of view however, Europe at the start of the twentieth century was still sparsely equipped with advanced agricultural technology of the harvester kind.[176] In spite of the fact that the number of farms in the new immigration countries (excluding the USA) only constituted a small percentage of the number of European farms at the turn of the nineteenth century, the orders of harvesters from the settler farms comprised almost 50 per cent of the total orders from

[175] Cf. note 170.

[176] *The Foreign Commerce and Navigation of the United States.* Bureau of Statistics, Treasury Department. McCormick Collection. International Harvester Co. Annual Settlement records, Foreign sales.

Europe. Thus at that time in terms of percentages harvesters were more thickly spread many times over on the farms of Australia and New Zealand, Western Canada, Argentina, Siberia and South Africa than on the farms in Europe. Information available about the degree of the diffusion of harvesters in Sweden and in Holland would probably illustrate the situation in Europe at the turn of the nineteenth century. In Holland in 1904 not quite 4 000 out of approximately 200 000 farms—less than 2 per cent—had acquired harvesters or mowing-machines or both.[177] The spread of harvesters in Sweden is shown in the following table:

Year	Percentage of spread
1890	2[a]
1910	16[a]
1944	25

[a] The figures for 1890 and 1910 have been based on 1 700 farms which were examined in 1890 and 1 600 in 1910 from regions in Southern and Central Sweden where the harvesters were more widely spread than in the North of Sweden. The percentage of spread for the country as a whole was therefore smaller than what is shown in the table above. The figure for 1944 is based on the 414 000 farms accounted for by the agricultural census, and shows that as late as at the end of the Second World War three out of four Swedish farms were without any form of harvester.

Source Kuuse, J., Från redskap till maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1910, pp. 103 ff. Jordbruksräkningen 1944 (SOS Jordbruk med binäringar).

As in Britain and Germany, the engineering industry for agricultural technology was continuing to make rapid progress in Sweden around 1900 by European standards. During the first decades of the twentieth century there were comparatively extensive exports from these three countries of harvesters and mowing-machines among other things, mainly to Eastern Europe, since the dimensions of the home market in the respective countries were not commensurate with the production capacity of the engineering works. However there were probably areas in Europe around 1900

[177] van der Poel, J. M. G., *Honderd Jaar Landbouwmechanisatie in Nederland,* pp. 207 ff.

where the harvester was more widely spread than in Sweden and Holland. Examples of such areas were the grain district of East Anglia and the North German Junker farms east of the Elbe. On the other hand at the same time harvesters were still less common in Southern and Eastern Europe than in Sweden and Holland.[178]

Before 1900 foreign trade in harvesters played a modest rôle in comparison with the domestic trade in the USA. This applies to the whole of the USA as well as to its leading company in that sector of the industry, McCormick's. However the 1890s marked the start of a new epoch. Whereas in 1890 the exports from McCormick constituted 4 per cent of the company's total sales, in 1902 the proportion of exports had risen to all of 20 per cent.[179] Of the USA's total production of agricultural machines in 1890 about 5 per cent were exported. In 1900 the proportion of exports had risen to 16 per cent. The difference in the size of McCormick's and AB Separator's export shares clearly illustrates the different conditions of their businesses. In the USA McCormick had access to a significant home market with great purchasing power, and—with the exception of the 1890s—the foreign markets were only marginal for the company. On the other hand, in order to reach an equivalent volume of sales AB Separator from the start had to sell its products mainly as exports, since the Swedish farms clearly constituted an

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[178] Linder, E., *Den svenska verkstadsindustriens utveckling intill krigsutbrottet 1914,* pp. 284 f. McCormick Collection, Received Letters.

The firm of Andersson & Mattson, Malmö, was the sole agent for McCormick harvesters in Sweden during the 1890s. In a letter to McCormick in 1895 the general agent in Denmark, Bröderna Bendix, Copenhagen, expressed a desire for a larger territory for its agents. The Danish general agent specifically mentioned the Swedish market. According to the general agent Swedish manufacturers could sell 1400 mowing machines a year, and because of their low-price policy Deering, Wood and Osborne were able to sell more machines in Sweden than McCormick could. If Bröderna Bendix got the general agency for the whole of Scandinavia, the agent predicted better sales figures, but McCormick did not comply with the Danish agent's wish.

[179] In order to indicate the proportions of the volume of exports it may be mentioned that McCormick's total exports of harvesters in 1902 were equivalent to the total sales in the three prairie states of Indiana, Illinois and Iowa. At the same time McCormick received the same quantity of orders for harvesters from Minnesota and the Dakotas as from the whole of Europe, while the supply to Missouri was equivalent to the supply to the new immigration countries.

Values of the USA's total exports in 1895 and 1900 divided into various export goods in order of precedence

	1895			1900		
Export goods	Order of precedence	Million dollars	%	Order of precedence	Million dollars	%
Grain, animal produce	1	250	32	1	447	33
Cotton (untreated)	2	205	26	2	242	18
Iron and steel goods	4	32	4	3	122	9
Agricultural machines	17	5	1	13	16	1
Other goods		301	37		544	39
Total		793	100		1 371	100

Source The foreign commerce and navigation of the United States. Bureau of Statistics, Department of Commerce and Labor.

insufficient home market. Moreover in all during the years 1886–1921 the Separator group of companies sold more than half of its separators on markets outside Europe.

The composition of the USA's exports shows that agricultural machines made a less significant contribution to the country's total export income. The importance of the agricultural machines and especially the harvesters lay instead in the fact that through their sales, which were principally domestic trade, they contributed to the greatest possible extent to American farming becoming the world's principal exporter of agricultural produce. It is therefore appropriate to trace the development of the further spread of the harvester in the USA after the Civil War.

(*f*) The spread of the harvester in the USA after the Civil War up to about 1900

After the Civil War the mechanisation of American agriculture continued, and the agricultural machines which were in use in the USA more than doubled in terms of value between 1860 and 1890. In 1890 the agricultural machines were equivalent in value to five hundred million dollars. When the world demand for agricultural produce increased after 1890 the pace of mechanisation in farming quickened, and the value of the machinery was multiplied sevenfold between 1890 and 1930. The mechanisation of agriculture required a much greater power consumption than had been the case earlier. Therefore alongside the spread of mechanisation the available sources of power on the farm increased both as regards living horse-power and steam power. Around 1900 the combustion engine started the later phase in the development of mechanisation with the motorisation of agriculture. Instead the tractor became agriculture's universal source of power and the importance of draught animals and steam power declined after 1920 (see diagram 19).

Before the First World War the majority of machines purchased by agriculture were harvesters, and between 1860 and 1880 the production of wheat was increased by more than 250 per cent. The increases both in the volume of investment and in the yield of the harvest were partly due to the fact that new farms were established and new prairie land was cultivated. The frontier was moved further westwards through Kansas, Nebraska and the Dakotas. However the main reason for the increase was the fact that the farms' average productivity was boosted through the use of more and improved machines. In fact the production per capita of wheat rose from 5.6 bushels in 1860 to 9.2 bushels in 1880.[180] The harvesters were the key factor in this improvement in productivity. The further development of the harvester during the second half of the nineteenth century has been dealt with briefly in an earlier context. The predecessor of the self-binder was the Marsh harvester. Already in 1858 the brothers C. W. and W. W. Marsh, of Kalb County, Illinois, had patented a harvester which by means of a conveyor belt system delivered the cut grain to two binders, which bound the sheaves on an attached platform at the same pace as the machine cut the grain. However the Marsh harvester was of no economic importance for agriculture until the 1870s when it began to be produced on a larger scale. In fact the harvester devel-

[180] Hogan, W. T., *Economic History of the Iron and Steel Industry in the United States*, vol. 1, pp. 150f. Faulkner, H. U., *American Economic History*, pp. 369ff. Rogin, L., *The Introduction of Farm Machinery*, pp. 94f.

oped rapidly and within a short time the Marsh harvester was replaced by the self-binder, which made the binders unnecessary. The first self-binders had a mechanism which bound the sheaves with wire. The wire-binder was adopted in agricultural circles far more rapidly than the Marsh harvester. This was partly due to the fact that several of the largest manufacturers such as Wood, McCormick, Deering, D. M. Osborne and Co. and also C. Aultman and Co. concentrated more consciously on the production and marketing of the wire-binder than they had as regards the Marsh harvester. But the farmers' demand for the increased supply of self-binders was not entirely due to the fact that the machine would keep down labour costs. With the self-binder the farmer could do the harvesting himself when necessary and in a completely different way he could be independent of agricultural labourers who were constantly attracted by the Homestead Act to move westwards in order to establish their own farms there. The popularity of the wire-binder became intensive but short-lived. In fact the wire caused some damage for farmers and mill-owners. Therefore when in 1878 John Appleby of Wisconsin took out a patent for a binding-machine which used twine instead of wire, Deering immediately recognised the importance of Appleby's patent. Deering bought the right to use Appleby's binding mechanism in conjunction with a machine of the Marsh harvester type. Appleby says in a letter that it was thanks to Deering that his twine binder quickly became widespread and replaced the wire binder: "In William Deering, of Chicago, Illinois formerly of the firm of Gammon & Deering I found a man far-sighted enough to see the importance of my invention. To him belongs the credit of forcing my binder onto the market with sufficient energy to convince the farmer of its practicability. His demonstration of the practicability of the invention soon led other manufacturers to adopt it."[181] The new twine binder became such a success that other prominent producers of harvesters hastened to obtain the right to use Appleby's patent. Thus Appleby's twine binder began to be used by Deering in 1878, by McCormick in 1881, by Champion in 1882 and by Osborne in 1883.[182]

[181] William Deering presented by E. P. Korecz, Chicago 1914, after the death of Deering in December 1913. Rogin, L., *op. cit.*, pp. 107 ff.

[182] Rogin, L., *op. cit.*, p. 115.

Table 62. *McCormick's sales of twine in 1890–1900 and the profits from these sales*

Year	Sales: Thousand pounds	Sales: Thousand dollars	Profits Thousand dollars
1890	13 586	1 728	370
1891	16 480	1 572	152
1892	23 064	2 104	340
1893	21 216	1 835	361
1894	19 662	1 353	–156
1895	18 657	1 064	195
1896	25 333	1 528	263
1897	24 001	1 408	209
1898	27 713	1 798	378
1899	24 217	2 211	724
1900	25 185	2 301	193
1901	50 000 (twine contracts)		

Source McCormick Collection: Twine Accounts.

The breakthrough of the twine binder at the beginning of the 1880s immediately led to a great increase in the demand for Manila hemp and sisal hemp which were used to make twine. The raw material was brought in part from the Philippines, and in part from Southern Mexico, Central America and the West Indies, and a significant twine industry developed in the USA. McCormick among others built a large twine factory as an extension to his other factories in Chicago. During the 1890s McCormick alone sold more than 200 millions pounds of twine worth a total of 19 million dollars. During the 1890s the profits from the sales of twine constituted almost 10 per cent of the profits from McCormick's total sales.[183]

Bearing in mind the conditions of production it was natural enough that the attention of the inventors of agricultural technology was particularly directed towards methods of speeding up the harvesting process. In the wheat districts of the Middle-West the climate necessitated rapid harvesting when the grain was ripe, and

[183] McCormick Collection, Twine Ledger, Twine Stock Book and Twine Account.

the amount cultivated was directly dependent on the ability of the farmers to harvest before the grain was destroyed. Harold Faulkner summarised the effect of the innovations in the field of harvesting technology in the following way: "The Marsh harvester almost doubled the amount of grain that could be harvested in a given time. Even more important was John F. Appleby's invention in 1878 of a twine binder, a machine which took the place of the crude and unsatisfactory wire binders in use and increased eightfold the speed in harvesting. In other words [says Professor T. N. Carver] it was the twine binder more than any other single machine or implement that enabled the country to increase its production of grain, especially wheat, during this period."[184]

The USA's growing grain surplus stimulated the expansion of a large flour-mill industry, which followed the wheat wave westwards. At the end of the nineteenth century Minneapolis took over Chicago's rôle as the centre of the flour-mill industry. At the same time the new railroad and steamboat connections improved the opportunities of the surplus areas to sell to the deficit areas. The Wheat Exchanges in Chicago and in London/Liverpool also played an important part in the distribution of the wheat. The Chicago Exchange was the world's big seller and the London/Liverpool the world's big buyer.[185] Thus more rational methods of distributing flour and grain contributed to the rapid expansion of the grain market, which stimulated to a high degree American agriculture's orders for harvesters from industry.

Cyrus Hall McCormick had laid the foundations of the harvester industry in the USA and it was the most important branch of the agricultural machine industry in the country before the First World War. Before the Civil War his company had a third of the total market. An expansion in the formation and development of companies due to a growing demand for harvesters during the Civil War meant that McCormick's share of the market then began to decrease in spite of increased production in absolute terms. Apart from the factor of uncertainty to which Rogin's calculations of the nation's

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[184] Faulkner, H. U., *op. cit.*, quotation at p. 369.

[185] Casson, H. K., *Cyrus Hall McCormick. His Life and Work,* chapter 12. *The Reaper and the World,* pp. 203 ff.

Table 63. *McCormick's sales of harvesters in relation to the country's total sales in 1855–1899 (in thousands of machines)*

Year	A=McCormick	B=USA[a]	A as % of B
1855	2.6	10	26
1862	4.8	33	15
1863	4.0	40	10
1864	5.4	50	11
1865	3.9	90	4
1866	6.1	80	8
1869	8.7	163	5
1875	17.9	160	11
1878	18.4	150	12
1885	54.8	250	22
1899	214.0	667	32

[a] In many cases Rogin's figures for the total sales of the USA in 1855–1885 are based on assessments and estimates, and so the column of figures for the USA should be approached with a certain caution. The figures for the year 1899 relate to harvesters as well as mowing-machines both for McCormick and the whole of the USA.

Source McCormick Collection: Reaper Sales McCormick Harvesting Machine Co. Catalogue 1899. Rogin., L., The Introduction of Farm Machinery, pp. 72ff. Census of the United States 1910, Manufacturers: 1899, 1904 and 1909, Statistics for the agricultural implement industry, Department of Commerce.

figures are subject, the fact is that McCormick's share of the market decreased during the Civil War, and remained comparatively modest during the rest of the 1860s and during the 1870s as well. Thereafter McCormick regained his lost share of the market and towards the end of the century he was also able to acquire a further share.

During the 1860s and 1870s more orders were placed for the self-rake reaper than any other kind of harvester. At the start of the 1860s McCormick and Wood were the leading manufacturers of the self-rake reaper, but after the Civil War they were overtaken by B. H. Warder and W. N. Whitely, who had started working together in the harvester industry in 1867 in Springfield, Ohio. In 1850 Warder had founded a firm in Springfield with a variety of partners to begin with. In 1879 the firm took the name of Warder, Bushnell, Glessner. In the middle of the 1850s Warder had launched a self-rake reaper which was produced under licence from Seymor & Morgan, but the machine could not be marketed on a larger scale until the 1860s. In Springfield another firm in the industry had been founded in 1856 by Whitely, whose firm operated as a partnership under the name of Whitely, Fassler, Kelly. In 1867 the competitors Warder and Whitely started to cooperate in a venture for which Warder provided the main part of the capital.[186] The harvesters from the cooperating firms became known under the Champion label, and in 1879 the association between the firms grew closer. The Champion machines were sold in great numbers and during the 1870s little Springfield became known as "the Reaper City". When the annual sales of the Champion machines were at their greatest they amounted to more then 100 000 machines, and for a time put the volume of McCormick's sales in the shade. After 1880 Whitely made an unsuccessful attempt to free himself from his partners and the sales of the Whitely group declined. In 1887 the Whitely group of companies was bought up by the Warder, Bushnell, Glessner group. Thereafter there was a decline in the comparative importance of the Champion machines, but Warder, Bushnell, Glessner became one of the five large groups of companies which formed the International Harvester Company in 1902.[187]

The widespread fire in Chicago in October of 1871, which reduced a large part of the town including McCormick's factories to ashes, meant that for a time there was a halt in McCormick's production. Nettie Fowler McCormick, who had married McCormick in 1857, was the driving force behind the rebuilding of McCormick's factories. McCormick is said to have wanted to retire after the fire. As the factories got more practical and modern equipment

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[186] Rogin, L., *op. cit.,* p. 96. Casson, H. N., *The Romance of the Reaper,* pp. 48 ff. Phillips, W. G., *op. cit.,* p. 168.

According to Casson, Whitely received a decisive advertising puff in 1867 when he became known through a reporter from the *Cincinnati Commercial* who covered a machine trial in Jamestown, Ohio. On this occasion Whitely, who had enormous physical strength, is supposed to have attracted a lot of attention when he pulled his own harvester along the field by himself. In any event, Warder, who was powerful financially, began to collaborate with Whitely during the same year.

[187] Casson, H. N., *op. cit.,* pp. 48 ff. Phillips, W. G., *op. cit.,* p. 168. Cf. figure 2.

and could also be built in such a way as allowed for future expansion, the fire probably had the long-term effect of raising rather than lowering capacity.

As a result of the expansion after the fire McCormick's firm was transformed in 1879 into a limited company, the McCormick Harvesting Machine Company. The share capital was set at 2.5 million dollars and the founder Cyrus Hall McCormick accounted for 75 per cent of this sum and his brother for the balance. The formation of the company had more of a formal significance as far as the spread of ownership was concerned, since the company remained within the family. However, the cooperation in the company between Cyrus Hall McCormick and his brothers had not taken place without friction and at times had prejudiced the earlier business. The formation of the company strengthened the founder's position in the family firm. Mrs Nettie Fowler McCormick was very active in the business, especially after the fire in 1871. Even though she had no official position in the company in reality she contributed greatly to the moulding of the company's future development. When Cyrus Hall McCormick died in 1884 he was succeeded by his son (who bore the same name) who had received technical training in the McCormick company and had studied business methods in Europe. However, continuity between the founding generation and the following business generation was preserved by the widow Nettie Fowler McCormick. She died in 1923 and survived the founder of the company by almost 40 years.[188]

The harvester's potential development in terms of production technology meant that various manufacturers in turn could secure new and growing markets in the USA. When the hand-rake reaper had been adopted at the start of the 1860s by "the early majority" in the most advanced agricultural districts, the self-rake reaper was introduced onto the market and spread first of all to those who had earlier adopted the hand-rake reaper. When the self-rake reaper had been in circulation for a decade the Marsh harvester could begin to be sold in larger numbers, partly replacing the self-rake reaper. However the Marsh harvester did not have

[188] Casson, H. N., *op. cit.* pp. 35 ff. Hutchinson, W. T., *Cyrus Hall McCormick. II. Harvest 1856–1884*, pp. 636 ff. *Roots in Chicago*, p. 18.

enough time to become widespread since at the end of the 1870s it was in its turn replaced by the wire binder. The twine binder was already able to find a new market around 1880, and it rapidly outdistanced other types of machine. The twine binder had come to stay and, with the exception of the development in California, it faced no new competition until the combine harvester began to be marketed during the period between the wars. At the end of the 1880s about 85 per cent of all the harvesters produced in the USA were of the self-binder type.[189] As the types of machine from the hand-rake reaper to the self-binder gradually reduced the labour costs of harvesting, it became more profitable from the point of view of the economics of production even for farms with smaller grain acreages to invest in harvesters. Therefore the new markets for the later types of machine became potentially larger than the earlier markets had been for the older types of machine. (See figure 5.)

During the 1860s McCormick's market area had been concentrated to an even higher degree than before on the prairies north-west of the Ohio River. During the years 1866–1872 only 6 per cent of McCormick's harvesters were sold outside the prairie district, and the sales for the year 1875 show exactly the same pattern of distribution. Around 1880 when McCormick, after the formation of the company and the introduction of the self-binder onto the market, began in earnest to rebuild his lost market position, the prairie farms were still his largest customer. However, during the 1890s enormous competition began to develop, mainly for the orders for self-binders from the prairie farmers, and at the end of the 1890s tendencies towards market saturation were noticeable in the prairie states. In this situation McCormick sought new markets, partly abroad and partly in the USA in the South and also in the coastal states in the East and West. In 1891 the prairie farms accounted for 86 per cent of McCormick's harvester orders, while deliveries to the rest of the USA and abroad together only constituted 14 per cent. In spite of the fact that the deliveries to the prairie area between 1891 and 1902 increased numerically in absolute terms, the area's comparative importance for McCor-

[189] Rogin, L., *op. cit.*, pp. 118 f.

mick's total sales declined. In 1895 the prairie farms took 78 per cent, the rest of the USA 17 per cent, and the farms abroad 5 per cent of McCormick's harvesters. In 1902 domestic orders outside the prairie area and exports each accounted for as much as 18 per cent of McCormick's supply, while the share of the prairie states had fallen to 64 per cent. From an international viewpoint the farmers in the East and South of the USA and those in Europe and the countries overseas corresponded to "the laggards" and "the late majority" in the harvester's adoption process.[190]

The volume of harvester orders is also reflected in the development of McCormick's profit and work force. During the 1870s the annual net profit varied between 300 000 and 600 000 dollars, as against 100 000 dollars in the 1850s. At the beginning of the 1880s the yearly net profit amounted to about one million dollars, in 1890 to 1.5 million dollars and in 1895 to 2.4 million dollars. During McCormick's years of extreme expansion from 1898 to 1901 the net profit rose to an average of almost 5 million dollars a year. The expansion of McCormick's business during the 1880s and 1890s was mainly financed by ploughing back the profits.

On the whole the employment capacity at McCormick's factories developed in step with the size of the profits. The number of employees increased from 120 in 1850 to about 300 in 1860. During the 1860s and 1870s the number of employees varied between 400 and 600, and rose to about 800 in 1880. McCormick's did not become a large-scale company until the 1890s, and at the turn of the nineteenth century it employed about 3 000 workers.[191]

Around 1880 the production of self-binders inaugurated a new phase in the development of the harvester in the USA. The efficiency of the self-binder in relation to the cost of acquiring it made it remunerative even for many small farmers. Therefore during the 1880s and 1890s the market for harvesters in the USA became potentially considerably larger than it had ever been between 1850 and 1880, and the market expansion after 1880 led to keener competition between the manufacturers. The competition

[190] McCormick Collection, Reaper Orders and Reaper Sales, Machine Ledgers. See table 60.

[191] Ozanne, R., *Wages in Practice and Theory. McCormick and International Harvester 1860–1960*, pp. 25ff. and 116ff.

became especially fierce during the 1890s when what was popularly known in agricultural technology circles as the harvester war took place. More than 200 harvester companies were established in the USA during the latter part of the nineteenth century but as a result of the fierce competition during the harvester war most of them were ruined, and in 1902 there were only 14 of the larger companies left. During the harvester war the fight for the market became mainly a contest between the two large ones in the business, Cyrus Hall McCormick II and the new competitor William Deering.[192]

William Deering was born in the state of Maine in 1826. Unlike Cyrus Hall McCormick he had no agricultural background, and Deering entered the harvester industry direct from the textile industry. Moreover Deering made a further contribution to textiles, since his introduction of the twine binder brought about the breakthrough of the twine industry. As a manufacturer Deering developed the same entrepreneur's qualities as McCormick I. However Deering was no inventor, but simply an entrepreneur with extremely good business instincts. His competitors said of him "there is a business compass in his brain". Deering entered the harvester industry relatively late and in a passive way. In 1870 Deering put 40000 dollars into E. H. Gammon's production. Gammon was a business friend of Deering, and a former Methodist minister who in 1864 bought a licence to manufacture Marsh harvesters, which had been patented by the Marsh brothers of De Kalb, Illinois in 1858. As Gammon lacked capital, the capacity of his business had been limited. In 1870 the capacity amounted to not quite a thousand machines. When Gammon became very ill in 1873 he made over part of the business to Deering who somewhat reluctantly was meant to take charge of production. After the agreement with Appleby in 1878 Deering wanted to concentrate on production on a larger scale, and he moved the business to Chicago. When Gammon objected to this he was bought out of the firm by Deering, who moved to Chicago to develop Appleby's twine binder.[193]

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[192] Casson, H. N., *op. cit.*, pp. 82 ff.

[193] Ibid., pp. 43 ff. McCormick, C., *The Century of the Reaper*, pp. 73 ff.

In the struggle for the growing self-binder market a large number of strategies were used to increase sales. As a sales argument to defeat competitors each and every one tried to argue that the producer himself had gone furthest in the continuing improvement of products within the industry. The catalogues of both McCormick and Deering show tough methods of advertising in which one's own product is lauded to the skies and the competitor is vilified.[194] Furthermore they kept a close watch on one another when

[194] The McCormick Harvesting Machine Company's catalogue for the year 1898, p. 11, is one example of comparative advertising methods which consistently put forward the merits of the company's own product. The following statement may serve as an illustration. "McCormick has 30% more durability than "Bonnie", just 25% more than the 'Pony' Deering, more than 20% more than 'Plano', 15% more than Massey-Harris and 'Adriance' and 10% more than 'Osborne'. The McCormick is worth $20 more than any other binder." In support of the statement reference is made to a brand competition which took place in 1897 at Aas Agricultural School in Norway where the competing harvesters received the following points for working capacity and construction:

Brand/Producer	*Total points*
1. McCormick, Chicago	34.77
2. 'Osborne' D. M. Osborne & Co. Auburn, New York State	32.73
3. Massey-Harris, Toronto	31.96
4. 'Adriance' Adriance, Platt & Co., Poughkeepsie, New York State	31.30
5. 'Pony' Deering Harvester Co. Chicago	29.99
6. 'Plano' Plano Mfg. Co., Chicago	29.11
7. 'Bonnie'The Johnston Harvester Co., Batavia, New York State	28.68

Furthermore, it was pointed out that expert judges "of the Mechanical College of the Russian Empire tested the McCormick binder in the field with seven American-made binders to determine which used the least twine in binding a given amount of grain. It was found that nineteen balls of twine from the McCormick bound more grain than twenty balls on any of the other machines. McCormick's simple knotter saves 5 balls of twine in 100."

"We know of more than 200 binder trials in America where McCormick binders met and defeated the cheap, flimsy 'Pony' Deering machines and replaced them."

As appears, it was commonplace for trial and competition results favourable to the company's own product to be used in advertising. At the same time it should be pointed out that McCormick's, and, to a certain extent, Deering's machines managed de facto to gain top place in most of the domestic and international competitions, trials and fairs in which they participated.

it came to patents and licences, and McCormick in particular had a large battery of lawyers who handled patent actions and other company disputes. At times the price mechanism was put out of action when the harvester war was at its peak. The hire-purchase system and also the granting of rebates and credits were taken to absurd lengths, and for many salesmen it was apparently more important to sell a large quantity rather than at a reasonable price.[195]

Deering tried yet another method to outdo McCormick on the market. Vertical integration became an important principle in Deering's company organisation. By gaining control over ore fields, coal mines, forests, foundries and ironworks Deering secured suitable raw materials. Deering's base of raw materials helped to reduce the cost of materials for his machines, and he became less dependent than McCormick on sub-contractors. Deering became superior to McCormick as an industrialist, while McCormick had the best sales contacts with the farmers and was superior in marketing.[196]

The price war and the inflated sales costs of the harvester companies raised the question of a certain measure of cooperation and more uniform prices within the industry. Several of the smaller companies were keen on cooperation, but the large companies were led by individualists who were less interested in joint ventures. Nevertheless a half-hearted attempt at a merger was made when the American Harvester Company was formed in 1890. Without any great enthusiasm McCormick and Deering shared the leading positions in the American Harvester Company. However, when they failed to receive financial backing from the banks in New York the trust was dissolved on their own initiative after being in operation for only a few months. The trust had met with general opposi-

[195] One episode during the harvester war illustrates the consequences which the price war between different harvester producers could have. When one of McCormick's agents passed through an isolated part of Nebraska he noticed a large number of unused Milwaukee self-binders. The agent knew that the farmers in the district did not have any grain to cut and so he inquired about the reason for purchasing the machines. The farmers replied that they had been in need of hammers and tools, but had no money and had been refused credit in the village shop. On the other hand it was easy to get credit if one bought harvesters, which were always well equipped with toolboxes. McCormick, C., *The Century of the Reaper,* pp. 105f. Hayter, E. W., 'Mechanical Humbuggery Among the Western Farmers 1860–1890'. In *Michigan History,* March 1950.

[196] McCormick, C., *The Century of the Reaper,* pp. 111ff.

tion as it was considered that it violated the recently passed anti-trust law (the Sherman Act), and even McCormick and Deering are supposed to have been relieved when the occasion arose for them to dissolve the trust. In any event, the competition between McCormick and Deering continued more keenly than ever after the dissolution of American Harvester. The reason why during the 1890s the larger companies such as McCormick and Deering were uninterested in merging, even in the future, was that they were established on the growing international market. They never saw that they were trying to sell more machines than the market could absorb. On the other hand the smaller manufacturers who only sold within the USA saw a certain saturation of the market, and were therefore more willing to cooperate.[197]

Thus in the years just before the turn of the nineteenth century the harvester spread in the USA at a tremendous pace. The inflated competition where the salesmen vied in undercutting each other obviously helped to increase the rate of spread. It could be said that the foundation of overmechanisation in the agriculture of the USA already began to be laid in the 1890s. The development towards mechanised and commercialised agriculture in the USA was not a purely harmonious process. To the farm workers the new agricultural technology must have appeared in many cases as an anonymous enemy which caused them anxiety and uncertainty in their employment, even though as a rule the demand for labour was heavy in the USA during the nineteenth century. On the other hand the agricultural machines eliminated many laborious stages in the work of the labour force which did remain in agriculture. But even within farming circles there was dissatisfaction with the new forms of operation which developed in modern agriculture, and this sometimes led to open revolt. The farmers were mainly dissatisfied with the middlemen who organised the trade in agricultural products (the railroads) and also the food industries. According to many farmers the middlemen took far too large a share of the profits from the goods which were produced in an agriculture orientated more and more towards sales.[198]

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[197] *Ibid.*, pp. 106 ff.

[198] Hicks, J., *The Populist Revolt*, pp. 80 ff. Faulkner, H. U., *op. cit.*, pp. 366 ff. Breen, D. H., 'The Canadian Prairie West and the 'Harmonius' Settlement Inter-

It has often been asserted, not least in manufacturing circles, that the harvester helped to strengthen democracy in the USA, since the harvester reached the average American.[199] The statement is perhaps accurate if it is considered from the perspective of the Middle-West at the turn of the nineteenth century, but hardly for farming in the rest of the USA where the farms were on the whole smaller and where the landscape was usually less suited geographically to mechanisation than the prairie plains. The mechanisation and commercialisation of agriculture tended to concentrate the profits among the larger farms whose economic base was suitable for mechanised operation and production for marketing.

Similar tendencies have been noted for Sweden. In research into the spread of mechanisation and commercialisation in Swedish agriculture between 1860 and 1910 it has been possible to establish that agriculture was more and more divided into two parts during the period in question. One of the parts consisted of the larger farms and estates where mechanised and commercialised forms of operation for production for marketing were introduced to an

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pretation'. In *Agricultural History* no. *1*, January 1973. Another distinction was drawn between farmers who on the one hand carried out cattle-farming (graziers) and who on the other hand carried out arable farming (farmers). To an extent in contrast to earlier agricultural research into settlements in Western Canada, Breen maintains that the same kinds of difference also applied to Western Canada, even though the differences did not lead to the same violence as in the USA. "The classic struggle between grazier and farmer so familiar in American history was, on a lesser scale, repeated on Canada's southwestern plains. From the moment of his arrival, the cattleman, for obvious economic reasons, has attempted to stem the advance of the farming frontier, and by 1896 it seemed that the struggle had been determined in his favor. It was another decade before the farmers, growing in number were able to break the hegemony. The struggle was continuous through the entire territorial period and it was often vicious, but at no time did it break to open violence. In this sense the traditional homily on the peaceful settlement of the Canadian West must stand. But in drawing this contrast with the American West, Canadian writers have been negligent on two counts. Noting that armed violence between rancher and farmer is nowhere recorded in the Canadian experience, they have assumed that such contending groups and their related problems did not exist in the northern setting. Second, and more important, such fallacious assumptions come mainly from the inclination of many Canadian scholars to view the Canadian prairie west as a homogeneous unit."

[199] Casson, H. N., *The Romance of the Reaper*, pp. 158 ff.

increasing extent. The total value of the actual agricultural machines on these larger farms increased tenfold between 1860 and 1910. The other part consisted of smallholdings and smaller farms which certainly improved the standard of their implements between 1860 and 1910 but did not invest to any appreciable degree in actual agricultural machinery, and did not produce above the level of self-sufficiency to any great degree. This second group of smaller farms which were examined in 1910 constituted about 85 per cent of the total number of farms which were examined. Thus in Sweden the profits of mechanisation accrued to the smaller part—about 15 per cent—which consisted of the larger farms. According to the Swedish census of agriculture in 1927 the larger farms (of 40 acres and above) accounted for approximately 54 per cent of the country's total arable land and for 75 per cent of the cereal grain harvest, but for only 16 per cent of the number of farms in the country. Thus the mechanisation of Swedish agriculture at the beginning of the twentieth century had taken place only on a small proportion of the farms, and this minority was able among other things to produce the majority of the agricultural products through the power of its efficient machines.[200]

Bearing in mind the character of European agriculture with its emphasis on smaller farms, there are compelling reasons for assuming that the mechanisation in European agriculture had not reached a greater percentage of farms at the start of the twentieth century than it had in Sweden. Certain areas of Europe were probably comparatively better equipped than Sweden in terms of agricultural technology, but in comparison with Swedish farming there were most probably still fewer agricultural machines on the farms of most of the countries in Europe.[201]

On the other hand the majority of the farms in the USA's main

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[200] Kuuse, J., *Från redskap till maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1910,* pp. 67 ff. *Sveriges Officiella Statistik,* Jordbruksräkningen 1927.

[201] In Europe agricultural machinery was mainly produced in Britain, Germany and Sweden. Imports of American agricultural machinery were comparatively extensive at the beginning of the 20th century in Russia, France, Germany, Britain and Scandinavia. Nevertheless, for the many Russian and, to a certain extent, French farms these imports of machines were only a drop in the ocean.

farming area—the Middle-West—had been able to mechanise the work for several reasons which have already been mentioned. This applies to the harvesting work to a particularly high degree. In the rest of the USA where the cultivation of grain became less important—in the East and the South—the pattern of spread of the mechanisation of agriculture was more like that of Europe. The majority of farms outside the prairie area in the USA had definitely not mechanised the harvesting process at the beginning of the twentieth century. The number of prairie farms at the beginning of the twentieth century amounted to approximately one-third of the total number of farms in the USA, but these accounted for two-thirds of the USA's wheat harvest and, for example, for two-thirds of the USA's tractors in 1920.[202]

Therefore the harvester, like the other agricultural machines, served rather to widen than bridge the gaps between farmers. However, the difference between the USA and Europe was plain. In the USA the harvester became more "democratic" than in Europe in the sense that it could be adopted by a significantly larger number of farmers in the USA, above all in the prairie district. The real importance of the harvester lay in the fact that it made an effective contribution to raising the level of grain production and reducing the earlier fluctuations in this production. In the areas to which the harvester had more or less spread, the cereal harvest in the years before the turn of the nineteenth century began, for the first time in world history, to reach such a capacity that the population no longer needed to go without bread in peacetime. This was the case in the USA and in other countries of immigration such as Canada and Australia, and in large parts of Europe too.

The International Harvester Epoch

(g) Mergers: their formation and problems

In competing with Deering, McCormick had expanded the business and it is estimated that McCormick had produced about one-third of all the self-binders in the world around 1900. McCormick's

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[202] *United States Census of Agriculture.*

efforts at expansion also included plans to establish a raw material base like Deering's. In order to obtain the necessary capital to establish this McCormick applied to the finance house of J. P. Morgan in New York in 1902. George Perkins handled the negotiations on Morgan's behalf. He first wanted to test the possibilities of the branch of the industry before any investments were made. Within a month Perkins had gained an insight into the market position of the agricultural machine industry through confidential contacts with the leading companies in that industry. Perkins found that the aggressive price war which had taken place had led to supersaturation of the domestic market for the time being. The militant sales methods had led the farmers into buying more machines than they really needed. A machine which would work very well for ten years was declared obsolete and unusable after five. According to Perkins, conditions were basically unsound, and on behalf of the Morgan bank he suggested a merger which would bring about peaceful working conditions in that part of industry.

In comparison with the farmers in America the foreign farmers were remarkably under-equipped with agricultural machines. Therefore a future merger ought to be orientated more towards the international market. J. P. Morgan suggested that the new amalgamation should be called the International Harvester Company, in accordance with the market expansion, and this was accepted. Thus the International Harvester Co. was formed in 1902 by an amalgamation of the two leading firms in the business, the McCormick Harvester Machine Co. and the Deering Harvester Co., both of Chicago, and in addition the Plano Manufacturing Co. of West Pullman, outside Chicago, the Milwaukee Harvester Co. of Milwaukee, Wisconsin, and the Warder, Bushnell and Glessner Co. of Springfield, Ohio. In 1903 International Harvester bought yet another three groups of companies, viz. D. M. Osborne & Co. of Auburn, New York State, the Aultman-Miller Co. of Akron, Ohio, and the Minnie Harvester Co. of St. Paul, Minnesota. In spite of the fact that International Harvester through the merger in 1903 controlled 90 per cent of the harvesters which were made in the USA during the group's first ten years of business, a few less important company units were bought in addition. Serious negotiations about an amalgamation were also started with W. A. Wood, of Hoosick

Falls, New York State and the Massey-Harris Co., of Toronto, Canada, but they proved fruitless.[203]

By having control over the larger part of the harvester market it was thought possible to achieve the principal aim of the amalgamation, viz. to create a balance in the USA between supply and demand by moderating, at least temporarily, the sales volume on the home market in order to increase the sales abroad instead.[204] Another advantage of large-scale production was that it was better able than smaller companies to make use of new domains conquered by technology. Furthermore it was intended that International Harvester would form an effective group by uniting under the same roof Deering's well-developed production organisation and McCormick's superior sales organisation. The Deering branch supplied International Harvester with a broad raw material base founded on the principle of vertical integration, and Deering's principles continued to be developed within the group. In 1903 International Harvester built a factory in Hamilton, south of Toronto, as a counterweight to Massey-Harris on the Canadian market. The factory was built on a plot of land which Deering had bought a few years before while in fierce competition with McCormick. Apart from factories for the actual production of agricultural machines, in 1907 the International Harvester group owned about 100 000 acres of forest in Missouri, Arkansas and Mississippi, 20 000 acres of coal country in Kentucky, orefields with a capacity of 40 million tons of ore in Wisconsin and the Mesabi Range north of Duluth in Minnesota, as well as a number of ironworks, foundries and twine industries. The vertical integration on the production side was almost complete. On the distribution side more individualism was being practised at the beginning, and for several years after the amalgamation the machines were sold under

[203] Hendrick, B. J., Making the World's Agricultural Machinery, pp. 167 ff. In *The Age of Big Business*. McCormick, C., *The Century of the Reaper*, pp. 111 ff. Phillips, W. G., *op. cit.*, p. 14.

[204] International Harvester, in spite of its increased control of the market, did not make any increase in the price of harvesters after 1902 (cf. note 158). The fact that price fixing did not function during the harvester war, due to discounts and credit facilities, was a different matter. After 1902 price fixing was able to operate again as a market mechanism, and so discounts and credits in the industry again assumed more normal proportions.

different brand names such as McCormick, Deering, Champion and so forth.[205]

It is not completely clear whether it was the Morgan bank or the individual harvester companies who took the initiative in the International Harvester amalgamation and carried it through, even though this later constituted an important legal question. The Bureau of Corporations in Washington, which was a federal body controlling the operation of trusts, emphatically asserted that Morgan had merely carried out the wishes of the companies. For its part International Harvester contended that Perkins as a representative for Morgan introduced the idea of an amalgamation, and conducted and concluded the negotiations for it. The various companies which made up International Harvester regarded the amalgamation somewhat differently. Deering wanted the merger to comprise more company units than McCormick did. McCormick wanted to preserve a certain degree of competition within the business: "We are big enough now. It is not safe for one company to have a monopoly. What we want to do is to regulate competition, not to destroy it." Deering was in favour of a monopoly but McCor-

[205] Phillips, W. G., *op. cit.*, p. 53, p. 62, pp. 80ff. Casson, H. N., *The Romance of the Reaper*, pp. 90ff. The Massey-Harris merger did not achieve the same control of the market in Canada as International Harvester acquired in the USA. In contrast to International Harvester, Massey-Harris did not come formally into conflict with the anti-trust legislation. During the decade after the Massey-Harris merger in 1891 the group never controlled more than 60 per cent of the Canadian market, excluding imports. Since International Harvester accounted for a large part of Canada's imports of agricultural machinery and for a relatively important production within Canada at the factory in Hamilton, International Harvester became a serious rival to Massey-Harris in supplying machinery to Canadian agriculture. On the whole International Harvester and Massey-Harris each accounted for one-third of the agricultural machine sales in Canada during the first decades of the 20th century. International Harvester's operations in Canada started with a capital of one million dollars in 1903, but the capital increased with the expansion of the subsidiary, and at the end of the First World War the capital amounted to 15 million dollars (1918).

The principle of vertical integration was pursued much further in International Harvester than for example in the Separator group. However, AB Separator integrated foundries and steel-pressing factories into the business and became relatively self-supporting on the semi-manufactured goods side. On the pure raw materials side the Separator group in fact became more dependent on sub-contractors than International Harvester was.

mick wanted to stop short at a sort of price-controlling oligopoly, and it was McCormick's view which prevailed.[206]

The formation of International Harvester in 1902 was not a unique phenomenon in American industrial life. In spite of the introduction of the anti-trust law in 1890, the largest wave of mergers in the history of the USA occurred between 1897 and 1904. This was partly due to the fact that the scope of the law was greatly limited in practice by the interpretation of the anti-trust law in a test case in 1895. Several of the mergers were amalgamations, that is to say mergers in their most complete form. An amalgamation involves a business company, as distinct from a holding company, which owns property and all the associated companies and their assets are gathered into a single group, whereas the holding company is a company which holds the shares of the subsidiaries. Apart from International Harvester, among the leading amalgamations which took place around the turn of the nineteenth century were Allis-Chalmers, American Tobacco, Bethlehem Steel, Du Pont de Nemours & Co., Eastman Kodak, United Fruit and the United Shoe Machinery Company. However, some of the really big merg-

[206] Casson, H. N., *The Romance of the Reaper,* pp. 90 ff. Hendrick, B. J., *op. cit.,* pp. 167 ff. McCormick, C., *The Century of the Reaper,* pp. 111 ff. Phillips, W. G., *op. cit.,* pp. 14 f.

It has been asserted on McCormick's part, and even in works of a company economic history nature, e.g. by Hendrick, that the formation of International Harvester was a shotgun wedding. The leading people in the individual companies were great individualists and entrepreneurs with a period of intensive competition and experience of failed co-operation behind them, and it has been stressed that the idea of a merger was accepted with reluctance. The final agreement is supposed to have been concluded in an atmosphere which betokened anything but a willingness to co-operate. The four great men, McCormick, Deering, Glessner and Jones, could not even be persuaded to sit in the same room when the final agreement to the merger was going to be concluded, and instead they had to be placed in four different rooms. Perkins had to run between the rooms with the necessary documents in order to form a basis for the merger. The whole situation was unique and was more like a comic opera than a business transaction. In any event, McCormick's aim was probably not to start negotiations for a merger when he first went to see Morgan about the question of capital. The visit was brought about by the competition situation with Deering. One factor which indirectly confirms that the Morgan bank participated in the formation of International Harvester is that the bank played an active and important rôle in many other important mergers in the USA at the turn of the century.

ers such as the Standard Oil Company and the United States Steel Corporation involved holding companies.

The technological development in the USA was without a doubt the strongest driving force behind the process of concentration in economic life. It was not possible to legislate against such developing forces. The technology and its profits especially from mass-production made the development of the large-scale companies possible to a greater extent than the newly established large-scale companies made possible the development of technology.[207]

In order to avoid coming into conflict with the provisions of the anti-trust law, Perkins's legal experts arranged the business transaction for International Harvester in such a way that the companies' corporeal assets such as mines, forests, factories, machines, salesrooms and stocks were pooled. International Harvester's share capital was originally fixed at 120 million dollars, and in contrast to the United States Steel Corporation, for example, International Harvester did not become over-capitalised. The method of inflating the book value of the assets with fictitious capital unrepresented by actual property, "watered stock", which was so common in amalgamations around the turn of the century, was not practised in International Harvester. The original assets of International Harvester were assessed at 110 million dollars by the Bureau of Corporations, and since this figure did not include the goodwill value the Bureau did not consider that the estimate of the assets was too high.

In spite of the amalgamation International Harvester became a typical family-owned company. The McCormick family received 43 per cent of the shares, the Deering family 34 per cent, and the rest hardly a quarter. During International Harvester's first ten years the company's policy was in the hands of a voting trust consisting of Cyrus H. McCormick II as President, Charles Deering as Chairman of the Board of Directors, and George Perkins from the Morgan group as the representative of the smaller parties. The object of the voting trust was to keep the control of the company safe "in the hands of the old harvester families". Even though the voting trust in theory gave the same voting power to each of

[207] Faulkner, H. U., *op. cit.*, chapter 21, pp. 420–448.

the three representatives, the Bureau of Corporations found in 1913 that the McCormick interests had had a dominant influence on the development of the company.[208]

In spite of all the legal measures taken to avoid it, International Harvester did not escape conflict with the anti-trust legislation. In actual fact the first twenty-five years of the company's history were characterised by a more or less intensive battle against various authorities over the interpretation of the anti-trust law. The state authorities in Kansas, Arkansas, Missouri, Kentucky and Texas accused International Harvester in 1906 and 1907 of violating the anti-trust law. For a number of years the company was forbidden to trade in certain states. The actions of governments of individual federal states in fact had limited effects even in the state in question. In 1912 the battle was removed to a higher level. By a resolution of the Senate the Bureau of Corporations was given the task of investigating the case of International Harvester and the trade in agricultural machines. On the basis of its investigation the Bureau found that International Harvester in restricting competition was acting contrary to the spirit of the anti-trust law, and the Bureau found that International Harvester had forced its agents under threat of dismissal to sell the machines which were newly introduced by the group. "There is no doubt that the principal motive for the formation of the International Harvester Company was to eliminate competition and to secure a dominant position in the trade."[209] In the same year, 1912, the federal government considered that on the basis of the Bureau's investigation it had enough material to start legal proceedings against International Harvester for violating the anti-trust law, and very extensive proceedings then began. According to the judgment of the court which followed in 1914 and completely endorsed the government's view, International Harvester was ordered to divide the group into three equal, separate and independent units. International Harvester appealed to the Supreme Court, where the case had not been decided in 1918.

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[208] McCormick, C., *The Century of the Reaper,* pp. 111 ff. Phillips, W. G., *op. cit.,* pp. 15 f. *Report of the Commissioner of Corporations, 9* (1913).

[209] McCormick, C., *op. cit.,* pp. 166 ff. Phillips, W. G., *op. cit.* p. 171. *Report of the Commissioner of Corporations, 20, 66* (1913).

Pending the decision of the Supreme Court, International Harvester suggested a provisional compromise solution in front of the Attorney-General. The compromise proposal was accepted and meant that International Harvester would part with the three units Osborne, Champion and Milwaukee. On the other hand the two big McCormick and Deering branches would remain intact. The compromise, which nullified the decision of 1914, was a setback for the government, who had aimed above all at having the McCormick and Deering branches separated. During the 1920s the government continued the proceedings against International Harvester through the Department of Justice. However, in 1926 a lower court decided the case in favour of International Harvester, and gave as its reasons inter alia the facts that International Harvester's sale of the Osborne, Champion and Milwaukee branches had reduced International Harvester's share of the market, and that other groups in the industry had expanded more rapidly than International Harvester. According to the court, as a result of this International Harvester's share of the harvester market had fallen from 85 per cent in 1902 to 64 per cent in 1926. The government appealed against the decision to the Superme Court which, however, finally upheld the judgment of the lower court in 1927.[210]

An important aim in the amalgamation and formation of International Harvester was to slow down at least temporarily the sales of agricultural machines. As table 64 shows, the companies which together formed International Harvester also reduced their domestic sales of harvesters by 35 per cent and mowing-machines by 16 per cent during the first four years after the merger, as compared with the four-year period immediately before the amalgamation. The

[210] Phillips, W. G., *op. cit.*, pp. 19ff.

The lower court's reference to increasing competition for International Harvester applied mainly to the John Deere Company. At the turn of the 19th century the John Deere Co. was the largest producer of ploughs in the USA, and when in 1903 International Harvester extended its business to include the production of implements, the Deere Company retaliated by developing a full-line system which was fully-fledged in 1915. Deere expanded not least on the harvester side, and became the largest producer next to International Harvester in the whole of the agricultural machine industry in the USA. Therefore, according to the lower court, International Harvester was not able to dictate or control price development on the harvester market.

Table 64. *Number of machines sold (thousands) before and after the merger of the company units which formed International Harvester*

Year	Self-binders	Other harvesting machines	Mowing-machines	Horse hay-rakes
1899	159	22	215	64
1900	127	35	198	78
1901	146	55	236	113
1902	168	42	245	149
merger				
1903	106	25	208	155
1904	87	21	187	114
1905	98	20	181	123
1906	103	24	176	119

Note Sales means total domestic sales, i.e. the USA+Canada.

Source McCormick Collection: International Harvester Co. Annual Settlement Record.

reduced profitability which affected parts of the amalgamation during the initial years of operation, according to table 64, shows that International Harvester on top of general teething troubles had certain difficulties in effectively coordinating the different parts of the business.

Table 65. *Amount of sales in millions of dollars of the company units forming International Harvester in 1904–1906*

Company unit	1904	(in %)	1905	(in %)	1906	(in %)
Champion	3.2	(9)	2.4	(6)	2.3	(5)
Deering	13.4	(40)	15.0	(38)	17.5	(38)
McCormick	13.0	(39)	15.2	(38)	18.3	(39)
Milwaukee	2.0	(6)	1.7	(4)	1.9	(4)
Osborne			3.3	(8)	3.4	(7)
Plano	2.0	(6)	2.4	(6)	3.3	(7)
I.H. total	33.6	(100)	40.0	(100)	46.7	(100)

Note Sales means total domestic sales, i.e. the USA+Canada.

Source McCormick Collection: IH Co. Annual Settlement Record.

Table 66. *International Harvester's sales in millions of dollars divided into various sales areas in the years 1904–1912*

Year	USA	Canada	Domestic USA+ Canada	Foreign excl. Canada	Total sales Domestic+ Foreign
1904	30.7	2.9	33.6		
1905	36.2	3.8	40.0	13.2	53.2
1906	41.9	4.8	46.7	15.7	62.4
1907	46.2	5.7	51.9	19.0	70.9
1908	42.0	5.6	47.6	19.0	66.6
1909	49.1	7.1	56.2	20.6	76.8
1910	55.2	10.0	65.2	24.2	89.4
1911	55.5	13.8	69.3	28.5	97.8
1912	62.8	14.7	77.5	36.2	113.7

Source McCormick Collection; International Harvester Co. Annual Settlement Record; Annual Reports.

In spite of the fact that the acreage under cultivation and the grain production continued to increase in the USA at the beginning of the twentieth century, International Harvester's domestic sales of the original production (old-lines) of parts of the company stagnated, above all as regards harvesters. On the other hand after a few years of consolidation International Harvester was able to compensate for this stagnation on the home market by expanding internationally, and the group's foreign sales of old-line products increased 2.3 times from 1905 to 1912. However the factor which in the long run gave International Harvester growing sales markets was the new agricultural technology, mainly in the form of tractors, trucks and combine harvesters.

(*h*) International Harvester and the new agricultural technology

The driving power of the tractor, which was a by-product of the motor-car industry, was, like that of the car, ultimately based on the gas engine constructed by the German Nikolaus Otto in 1876, which was shown for the first time at the world fair in Paris in 1878. The first petrol-powered tractors were manufactured at the beginning of the 1890s, and when they began to be manufactured industrially from 1902 onwards they gradually replaced the steam-powered "tractors" which had been in use since the latter part of the nineteenth century. It was above all the intricate problems surrounding carburation and ignition which held up the practical application of the petrol engine during the last quarter of the nineteenth century. R. Wik divides the development of the petrol-powered tractor in the USA into three stages:

1876–1902 Experimental state of tractor development
1902–1913 Manufacture of large gasoline and kerosene tractors
1913–1924 Development of the small gasoline tractor to the advent of the all-purpose sow-crop tractor in 1924.

When the Hart-Parr tractor was introduced onto the American market in 1902 the last phase in the development of mechanised agriculture began. Charles W. Hart of Iowa and Charles H. Parr of Wisconsin had studied technology at the same time during the 1890s at Madison in the University of Wisconsin, and they had been especially interested in the combustion engine. In 1900 they moved to Charles City, Iowa, where in 1902 they started the first petrol powered tractor industry in the USA. During the next five years a total of about 600 tractors were produced of which Hart-Parr accounted for one-third. In order to distinguish the petrol powered machines from their steam powered rivals, Hart-Parr adopted the name "Tractor", a name which was gradually accepted by the public. When in 1906 International Harvester included tractor manufacturing in its production programme there were about ten companies in the business. However, with International Harvester's entry the capacity of that part of the industry increased considerably. In 1912 International Harvester produced more than 3 000 out of a total of approximately 10 000 tractors manufactured in the USA.[211]

The construction of the first tractors was robust, but heavy and clumsy, and the shape was very much like that of the gigantic

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[211] McCormick Collection, International Harvester Annual Settlement Record. International Harvester Annual Reports. Wik, R. M., *Steam Power on the American Farm,* pp. 200 ff.

steam powered machines. To begin with the producers tried to create efficient tractors by making them as large and giving them as great a horse-power as possible. During the tractor's introductory stage the farms in Western Canada became the most important customer of the tractor industry. The early big, heavy and comparatively expensive tractors could most easily be adopted by the really large Canadian prairie farms in Manitoba, Saskatchewan and Alberta, and to the same extent in the USA in the Dakotas and Minnesota. At the end of the nineteenth century and the beginning of the twentieth century the large plains in the USA's North-Western prairie area and in Western Canada had permitted steam ploughing on a comparatively large scale. Tractor ploughing, which replaced steam ploughing in these districts after 1910, became just as important as mechanical harvesting had been on the prairies west of Chicago, and a series of tractor ploughing demonstrations started, the first of which took place in Winnipeg in 1908. In the same year International Harvester was able to export the first tractors to Europe, Argentina and Australia.

Economic trends during the First World War prompted the American farmers to invest in tractors and during the war an increasing number of tractor models were shown at national tractor demonstrations in Minneapolis, Madison, Indianapolis, St. Louis, Dallas and so on. In 1917 the production of tractors in the USA had risen to 62 000, of which a quarter were exported, especially to countries at war in Europe such as Britain, France and Italy. During the war International Harvester was still the leader on the tractor market. Even though tractor orders in the USA increased rapidly under the influence of wartime conditions, only about 1 per cent of the USA's farms had tractors in 1917. The limited spread of the tractor up to the end of the First World War was mainly due to the fact that it was too heavy and too expensive for most of the farms.[212]

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[212] McCormick, C., *The Century of the Reaper*, pp. 145 ff.

One of International Harvester's tours de force at various demonstrations around 1910 was to synchronise three tractors which together pulled 54 ploughs, which ploughed furrows in a band of more then 20 metres in width. The display was of course an advertising stunt, but it demonstrated the manufacturers' view that the new agricultural technology worked best on the massive level. Hart-Parr's first

As a result of Henry Ford's decision to supplement car production with the production of tractors in 1917, the character of the tractor industry changed immediately. Ford's object was to produce simpler and lighter tractors which could be adopted by the majority of farmers. Through this tractors could be mass-produced in the same way as cars, the production costs per tractor could be reduced and the tractor would become considerably cheaper. In 1917 Ford received his first big order, consisting of 6000 tractors, from the British government, and in the following year Ford introduced his tractor (Fordson) onto the American market. The USA more than doubled its production of tractors in 1918 when approximately 200 manufacturers produced 133000 tractors. In one year Ford exceeded the sales volume of International Harvester, and Ford's sales totalled 34000 tractors in 1918 and 54000 in 1919. Ford's share of the American tractor market rose from 25 per cent in 1918 to 33 per cent in 1920, and went up to a total of 70 per cent at the beginning of the 1920s. The explanation for the great popularity of Ford's tractors was largely that he transferred the new production and sales methods of the car industry to the production and selling of tractors. Ford could also apply the principle of standardisation, combined with mass-production which had developed in the car industry, to the tractor industry, and this resulted in smaller and more adaptable tractors, reduced production costs and substantially lower prices. Ford reduced the price of tractors in various stages from about 900 dollars in 1919 to 400 dollars in 1922, at the same time transferring advertising and publicity campaigns from car selling to tractor selling, and having the tractors sold by his car salesmen. As an entrepreneur Ford helped to give a fresh lease of life to the agricultural technology industry through the motor-car industry.[213]

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tractor was a gigantic machine which weighed over 10 tons and International Harvester's first 45 horse-power tractors of the 1910 model weighed 11 tons. When the Oliver Farm Equipment Company extended its business to include the production of tractors, the group bought up the Hart-Parr Co. Phillips, W. G., *op. cit.*, pp. 25 ff.

[213] Phillips, W. G., *op. cit.*, pp. 27 ff. Sorensen, Ch. E., *My Forty Years with Ford*, pp. 217 ff. *The Yearbook of Agriculture, 1960. Power to Produce*, pp. 36 f.,

Ford's successes on the tractor market were a challenge for International Harvester, the largest manufacturer of agricultural machines in the USA. In reply to Ford's price reduction, International Harvester lowered the price of its Titan tractor from 930 dollars to 700 dollars in 1922 and in 1923 International Harvester brought out two new lighter models, the McCormick-Deering 10–20 and 15–30. International Harvester's new tractor models embodied technology borrowed in part from the Fordson tractor and the group now began to integrate its implements with the tractor to a higher degree. Thereafter a tractor sales war broke out between International Harvester and Ford which resembled the harvester war between McCormick and Deering in the 1890s. In 1924 International Harvester was again able to increase its tractor supply and in 1927 was able to exceed Ford's tractor sales for the first time since 1918. Ford stopped producing tractors in the following year and International Harvester regained its leading position on the tractor market as well.

The fact that International Harvester was able to win the tractor war in the 1920s was probably due to a great extent to Ford's inadequate insight into agricultural economy and agricultural psychology. For a short time Ford was able to sell a large number of tractors through his car salesmen. The Fordson tractors were certainly advanced products technically, but in the long run Ford's car salesmen could not maintain the same sales and service contact with the farmers as International Harvester's dealers who were more experienced in agriculture. In addition tractor production was not as vital for Ford as for International Harvester. Therefore when

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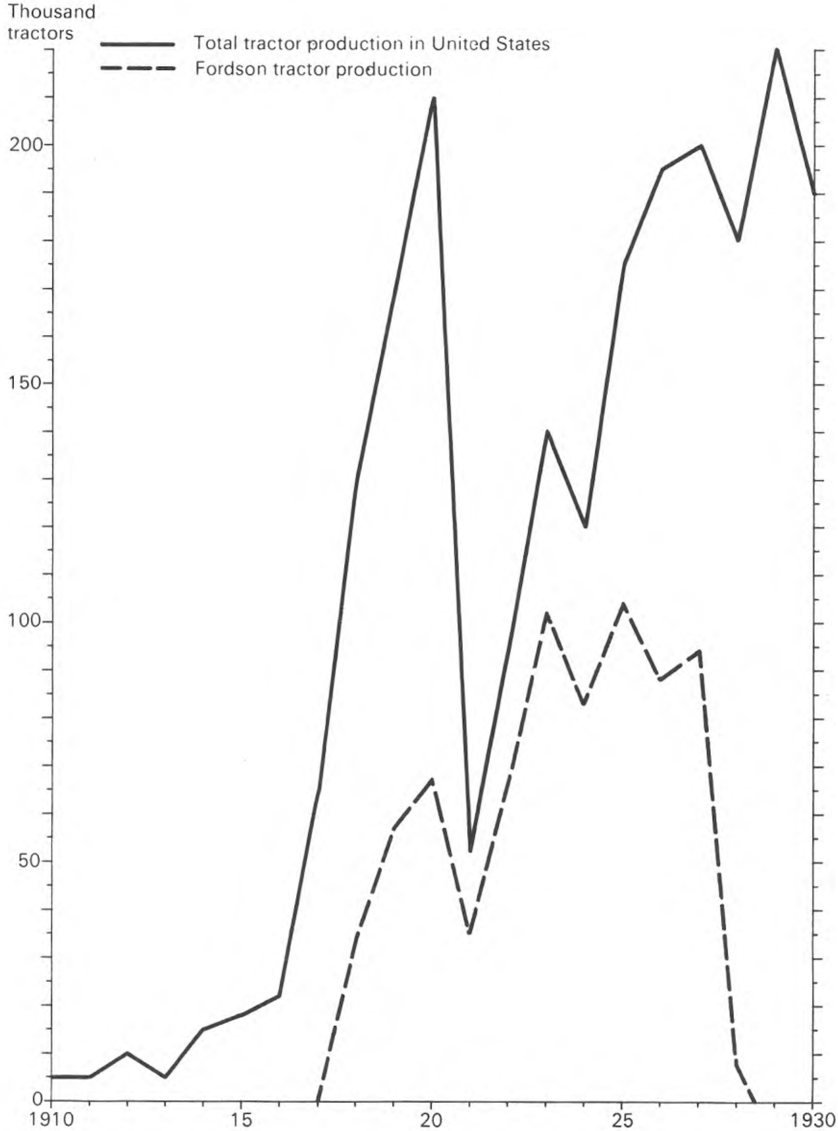
pp. 42f. Wik, R. M., 'Henry Ford's Tractors and American Agriculture.' In *Agricultural History,* April 1964. Fraser, C., *Harry Ferguson, Inventor and Pioneer.*

An important improvement in agrarian technology resulting from the tractor were the implements and machines which were made to be fitted directly to the tractor. The best-known was the Irishman Harry Ferguson's tractor plough which was specially constructed for the Fordson tractor at the beginning of the 1920s, and his tractor plough became a completely integrated part of the tractor. At the end of the 1920s Ferguson further developed a hydraulic system for the tractor, which enabled the implements to be operated and controlled in a revolutionary way. In 1953 Harry Ferguson Inc. merged with Massey-Harris when Massey-Harris-Ferguson was formed. In 1958 the group changed its name to Massey-Ferguson and the name 'Harris' was dropped.

Diagram 20. *Tractors manufactured in the United States 1910–1930 and Fordson tractor production 1917–1928.*



Source The Yearbook of Agriculture 1960, p. 38, Phillips, W. G., The agricultural Implement Industry in Canada, p. 175.

Ford during the 1920s noticed increased competition from International Harvester and other full-line groups with long experience of agricultural technology, he preferred to quit and concentrate on the car industry. Before the First World War the producers of various kinds of agricultural technology such as implements, sowing machines, harvesters and threshers had as a rule formed four separate branches of industry which were not in direct competition with one another. After the First World War full-line groups of companies of the International Harvester type, the J. Deere Co., the J. I. Case Co., Oliver Farm Equipment and Massey-Harris became typical company units in the agricultural machine industry, an industry which was to consist of a small number of multi-producing groups all in direct competition with each other.[214]

Ford thus made a concrete and decisive contribution to the spread, over a decade, of tractors to the pioneers and early adopters in the USA, but his most lasting contribution to the mechanisation of modern agriculture was to show the way to other tractor manufacturers. It was natural for the experienced agricultural machine firms to try and approach the tractor problem by providing the tractor with the same strong, rugged, robust and heavy features which had previously been given to ploughs, harvesters and threshers. With the earlier agricultural machines there was not the demand for flexibility that there was with the tractor. Technologically the tractor resembled the car more than other agricultural machines and it was because of this that the established companies in the agricultural machine industry had difficulties in developing a suitable tractor construction. Ideas from outside were needed. In comparison with the production of cars the manufacture of harvesters had called for a relatively simple production technique, and therefore companies such as International Harvester in fact had no advantages in the development work on the tractor.[215]

In spite of Ford's efforts in 1918–1928 to persuade the smaller farmer to adopt the tractor, it was very unevenly distributed within the USA. On the large holdings in the Great Plains the

[214] McCormick, C., *The Century of the Reaper*, pp. 190ff. Phillips, W. G., *op. cit.*, pp. 29ff. Gray, R. B., *Development of the Agricultural Tractor in the United States*, part II, pp. 18ff.

[215] McCormick, C., *op. cit.*, pp. 155ff.

tractor in 1930 was ten times as common than on the farms in the Southern states, and three to four times commoner than on the farms in the North-Eastern coastal states with the exception of New Jersey. With an interval of fifty years the pattern of spread in the distribution of the harvester was roughly repeated. The tractor pioneers, like the harvester pioneers in their time, were to be found in the most recently cultivated areas in the extreme North-West. The extreme North-West had in fact been moved from Illinois to the Dakotas and Montana in the USA and also to Manitoba, Saskatchewan and Alberta in Canada.

In North America the tractor was adopted by the pioneers and early adopters approximately twenty years earlier than in Sweden. According to the census of agriculture in Sweden, 6 per cent of the farms had tractors in 1944 as against 18 per cent in 1951. These figures correspond most closely to the figures from the official statistics for the USA in 1925 and 1930 respectively, when 8 per cent and 15 per cent respectively of the farmers had adopted the tractor. The domestic regional differences behind the official figures are also comparable. In the USA 20–22 per cent had adopted the tractor in the most advanced districts in 1925, and in Sweden in 1944 25 and 17 per cent respectively of the farms in prominent arable counties such as Uppsala and Malmöhus län had tractors. In 1925 the tractor had only spread to 1–2 per cent of the farms in the American South, which was equivalent in Sweden in 1944 to a county such as Kronobergs län, which was rich in forests and where the farms tended to be small, where only one per cent of the farms had adopted the tractor at that time. In 1930 the tractor had spread to 40–48 per cent on the Great Plains as against 54 per cent and 35 per cent respectively in Uppsala and Malmöhus län in Sweden in 1951. In the South in 1930 the tractor was to be found on 4 per cent of the farms on average, as compared with 5 per cent for Kronobergs län in Sweden in 1951. The difference in time between the breakthrough of the tractor in North America and in Sweden is probably a reflection of the difference in time as between North America and the continent of Europe generally.[216]

[216] See table 71. *Sveriges Officiella Statistik (SOS).* Jordbruksräkningarna 1944 and 1951.

The farmers' inclination to adopt the tractor was dependent to an even higher degree than the decision to adopt the harvester on the economic basis of the individual farmer. Economic factors such as the cost of the tractor in comparison with the cost of horses and labour and also the size of the arable area and the volume of production played a decisive rôle in this respect, even though different acquisition motives of social psychology could modify the pattern. At the outbreak of the Second World War almost two-thirds of the farms in the USA were so-called low-producing farms with a yearly production below 1 000 dollars. On the whole these low-producing units did not rise above the self-sufficiency level, and in 1939 they only accounted for 20 per cent of the total production value of the agricultural sector. Only 9 per cent of these two-thirds of the farms in the USA had a tractor in 1939. In the group of farms which produced between 1 000 and 2 000 dollars worth, constituting 19 per cent of the nation's farms, 37 per cent had tractors, and for the farms with a production of a value greater than 2 000 dollars, constituting the remaining one-sixth of the farms, the equivalent figure was 66 per cent. Even though most American farms were not highly mechanised in 1939, the minority which were highly mechanised in the USA proved to be very large in an international comparison.[217]

International Harvester's new-line products increased much more rapidly in terms of volume than the company's old-line production. According to table 67 the domestic sales of new-line products increased sevenfold between 1905 and 1912, while the corresponding foreign sales increased 25-fold over the same period. Tractors, trucks and lorries for transporting farm produce accounted for the main part of the new-line production. In 1914 International Harvester extended the new-lines programme with the production of combine harvesters. The combine harvester had already been developed during the 1880s, and for a short time during the 1890s had achieved a certain distribution, which had however been limited to the large holdings in California. Due to the changed character of farming in California after 1900 the combine harvester

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[217] *United States Department of Agriculture* Misc. Publication no. 630, October 1947. Progress of Farm Mechanization, pp. 48 ff.

Table 67. *International Harvester's sales of old-line products and new-line products in millions of dollars in 1905–1912*

Year	Old-lines		New-lines		Total	New-lines as % of total
	USA	Foreign	USA	Foreign		
1905	33.3	15.6	2.9	0.6	52.4	7
1906	34.5	17.9	7.4	1.2	61.0	14
1907	35.4	21.3	10.8	2.0	69.5	18
1908	30.9	21.2	10.6	2.5	65.2	20
1909	34.6	22.9	15.5	5.2	78.2	26
1910	37.7	25.2	18.8	9.0	90.7	31
1911	37.5	29.0	19.3	13.3	99.1	33
1912	42.0	35.7	21.9	15.1	114.7	32

Old-line=harvesting machines, implements etc.
New-line=tractors, motorwagons etc.

Source International Harvester Annual Reports.

disappeared. In spite of the fact that the combine harvester was no innovation in agricultural technology, during the period between the wars it was not adopted to the same extent as the tractor. In 1940 only about 3 per cent of the farms in the USA were equipped with combine harvesters, whereas at that time every fourth farm had a tractor. The reason for this was that the tractor was more versatile than the combine harvester. The self-binders and threshers were alternatives to the combine harvester and for a long time formed a barrier to its rapid spread.

Tractors and lorries were the forms of agricultural technology which increased most rapidly, comparatively speaking, during the period between the wars in American agriculture. This kind of agricultural technology replaced the draught animals and steam power. The rôle of the horse declined comparatively quickly as regards transport work but comparatively slowly as regards work in the fields. In spite of the fact that in 1945 there were almost 2.5 million tractors on the farms in the USA, it is estimated that only about 400 self-binders or sowing machines were drawn by tractors. It is estimated that about 75 per cent of the sowing machines and self-binders were drawn by horses at that time. On

Table 68. *Number of machines in use on farms in the USA in 1910–1946 (in thousands)*

Year	Farm tractors	Farm motor-trucks	Farm automobiles	Grain combines
1910	1	0	50	1
1920	246	139	2 146	4
1930	920	900	4 135	61
1940	1 545	1 047	4 144	190
1946	2 585	1 550	4 100	415

Source Miscellaneous Publication No. 630, United States Department of Agriculture, October 1947, p. 32.

the other hand advanced machines such as grain combines and corn pickers were to be developed to a greater extent side by side with the tractor, and they were practically all tractor-driven at the outbreak of the Second World War.[218]

Table 69. *The value of the agricultural machines and draught animals on the farms in the USA, 1910–1946. Amounts given in millions of dollars in prices for the years 1935–1939*

The figures in parentheses indicate the values as percentages

Year	Tractors	Motor-trucks	Farm auto-mobiles	Other farm machinery	Horses and mules	Total
1910	1 (0)	0 (0)	13 (0)	1 876 (42)	2 564 (58)	4 454 (100)
1915	12 (0)	7 (0)	123 (3)	2 025 (41)	2 813 (56)	4 980 (100)
1920	123 (2)	40 (1)	558 (10)	2 055 (37)	2 748 (50)	5 524 (100)
1925	274 (5)	133 (3)	854 (16)	1 647 (31)	2 386 (45)	5 294 (100)
1930	460 (8)	261 (5)	1 075 (20)	1 634 (30)	2 019 (37)	5 449 (100)
1935	524 (12)	258 (6)	947 (21)	1 043 (23)	1 728 (38)	4 500 (100)
1940	772 (16)	304 (6)	1 077 (21)	1 364 (27)	1 503 (30)	5 020 (100)
1946	1 292 (20)	450 (7)	1 066 (17)	2 296 (37)	1 168 (19)	6 272 (100)

Source Miscellaneous Publication No. 630, United States Department of Agriculture, October 1947, p. 84.

[218] *Ibid.*, pp. 32, 36 f., p. 84. *International Harvester Annual Report 1912*. McCormick, C., *op. cit.*, pp. 145 ff.

Table 70. *The development of sales, profits, wages and number of employees at International Harvester in 1902–1921. Amounts in millions of dollars*

Year	Sales	Net profits after tax	Wages paid	Number employed	Wage as % of sales
1902		9.6[a]			
1903		0.8			
1904		5.7			
1905	55.7	7.5	16.9	22 980	30
1906	67.6		19.7	26 560	29
1907	78.2		21.8	28 680	28
1908	72.5		19.7	25 679	27
1909	86.6		22.9	28 493	26
1910	101.1	17.2	29.2	35 743	29
1911	108.0			41 690	
1912	125.4	16.4		42 979	
1913	118.4[b]			39 650	
1919	212.7	15.0	63.0	40 483	30
1920	225.0	16.7	89.9	48 280	39
1921	121.2	4.2			

[a] Net profits 1902 covers the total profits from the five company units which were later to form International Harvester.

[b] In 1913 International Harvester was divided into one domestic and one foreign part. International Harvester Company of New Jersey was formed on half of the share capital—70 million dollars (the share capital was increased in 1910 to 140 million dollars)—and took over the production in the USA. All production and sales abroad together with certain production of new-line products in the USA were taken over by International Harvester Corporation which was founded on the other half of the share capital. Of the total sales in 1913 of 118.4 million dollars I.H.C. of New Jersey accounted for 66.7 million and I.H. Corporation for 51.7 millions. In 1918 the two parts of the group were reunited.

Note The sales amounts above show somewhat larger values than equivalent amounts do in the other tables. The reason for this is that an outstanding item "other sales" has been included here.

Source International Harvester Annual Reports. Ozanne, R., *Wages in Practice and Theory*. McCormick and International Harvester 1860–1960.

International Harvester's new-line production was developed in an attempt to achieve a full-line system. In 1903 the new-line production constituted 5 per cent of the whole of the business, in 1908 20 per cent, in 1912 32 per cent, and in 1916 the new-lines

Table 71. *The spread of tractors to the farms in various states of the USA in 1920–1930. Numbers of farms and tractors in thousands*

State	A=Number of farms			B=Number of tractors			C=B as % of A		
	1920	1925	1930	1920	1925	1930	1920	1925	1930
1 North Dakota	78	76	80	13	17	38	17	22	48
2 South Dakota	75	80	83	13	17	34	17	21	41
3 Montana	58	46	47	8	7	19	14	14	40
4 California	118	136	136	14	30	44	12	22	32
5 Kansas	165	166	166	17	31	66	10	19	40
6 Illinois	237	226	214	23	43	70	10	19	33
7 Iowa	213	213	215	20	37	66	9	17	31
8 Nebraska	124	128	129	11	19	41	9	15	32
9 Minnesota	178	188	185	16	27	48	9	14	26
10 Arizona	10	11	14	1	1	3	9	11	18
11 Colorado	60	58	60	5	7	13	8	12	22
12 Wyoming	16	16	16	1	1	4	7	9	26
13 Nevada	3	4	3	0	0	0	7	8	10
14 Oregon	50	56	55	3	6	10	6	11	18
15 Wisconsin	189	193	182	9	30	50	5	16	27
16 Ohio	257	245	219	10	31	53	4	13	24
17 Indiana	205	196	182	9	24	42	4	12	23
18 New York	193	189	160	7	26	40	4	14	25
19 Washington	66	73	73	3	4	8	4	6	12
20 Idaho	42	41	42	2	2	5	4	5	11
21 Michigan	196	192	169	6	19	34	3	10	20
22 Pennsylvania	202	200	172	6	20	34	3	10	19
23 Missouri	263	260	256	8	13	25	3	5	10
24 Oklahoma	192	197	204	6	11	26	3	6	13
25 New Jersey	30	30	25	1	4	8	3	15	32
26 Maryland	48	49	43	2	4	7	3	8	17
27 Texas	436	466	495	9	17	37	2	4	7
28 Louisiana	135	132	161	3	3	5	2	3	3
29 Massachusetts	32	33	26	1	2	4	2	7	15
30 Connecticut	23	23	17	0	1	3	2	6	16
31 Vermont	29	28	25	0	2	2	2	6	10
32 Delaware	10	10	10	0	1	2	2	7	16
33 Rhode Island	4	4	3	0	0	1	2	8	18
34 New Mexico	30	32	31	0	1	2	2	3	8
35 Utah	26	26	27	1	1	1	2	3	5
36 North Carolina	270	283	280	2	8	11	1	3	4
37 South Carolina	193	173	158	1	3	3	1	2	2

State	A=Number of farms			B=Number of tractors			C=B as % of A		
	1920	1925	1930	1920	1925	1930	1920	1925	1930
38 Virginia	186	194	171	3	7	10	1	3	6
39 Kentucky	271	259	246	2	5	7	1	2	3
40 Tennessee	253	253	246	2	5	7	1	2	3
41 Georgia	311	249	256	2	4	6	1	2	2
42 Arkansas	233	222	242	2	3	6	1	2	2
43 Florida	54	59	59	1	3	6	1	5	10
44 West Virginia	87	90	83	1	2	3	1	2	3
45 Maine	48	50	39	1	2	3	1	4	9
46 New Hampshire	21	21	15	0	1	1	1	3	7
47 Mississippi	272	257	313	1	2	6	0	1	2
48 Alabama	256	238	257	1	2	5	0	1	2
USA	6 448	6 372	6 289	245	505	920	4	8	15

Source United States Census of Agriculture. United States Census Bureau, Census of Tractors on Farms 1920, 1925, 1930.

accounted for half the production value. Around 1930 the new-lines accounted for 90 per cent of the total business. When in 1918 International Harvester acquired the third largest plough factory in the country through the purchase of the Parlin and Orendorff Company, the last step towards the full-line principle had been taken, and as a result International Harvester was able to produce any implement or machine which a farmer required. The full-line system carried various advantages for the producer of agricultural machines. On the one hand it was easier to persuade the agents to sell a full-line range than more specialised machines, and on the other hand the full-line principle meant that the earlier seasonal demands could be replaced by a more even distribution of the orders during the year, which gave a more even annual rhythm to the production.[219]

International Harvester's company policy differed in this respect from that of AB Separator. The Separator group concentrated its production and limited it to cream separators and other dairying

[219] McCormick, C., *op. cit.*, pp. 185 ff.

machines. At the end of the 1870s milk production had been less mechanised than other processes in farming, and this had given AB Separator an opportunity to develop a new domain in agricultural technology in which it later became the international market leader. It may seem remarkable that the Swedish AB Separator was able through its subsidiary in the USA, the De Laval Separator Co., to control a large part of the American separator market. The USA was in fact the world's leading industrial nation and she had 'know-how' of long standing as regards agricultural machines which was quite overwhelming, and as far as tractors were concerned not even a powerful company such as Ford was able in the long run to stand its ground against the domestically established companies in the agricultural machine industry. The Separator group's ability to maintain its position on the American separator market seems to have been due in part to the fact that it concentrated on a type of agricultural technology of which it acquired supreme mastery, on the production side as well as on the distribution side. It should be borne in mind that the separator production was not as vital as the tractor production within the framework of International Harvester's full-line system. The sales of separators in 1909, for example, in terms of value constituted only 4 per cent of the total sales of machines in the USA and Canada. At the same time the sales figures for International Harvester's old-line products such as harvesters and mowing-machines were thirteen times as great as those for separators. Twine alone had a sales value for International Harvester which was five times greater than that of separators. It was obvious to International Harvester early on that the tractor as an exponent of the new agricultural technology would represent very large sales values in the future, and so it was more profitable for the company to fight for the tractor market rather than, for example, the separator market. Thus the fact that AB Separator succeeded with separators when Ford failed with tractors was due to a great extent to the fact that International Harvester deliberately offered much tougher resistance to Ford than it had done to AB Separator. In fact International Harvester tried to increase its separator business in various ways, but was forced to acknowledge that the Separator group's hold on the market was generally such as to foil the attempts. From the point of view of

International Harvester, it was doubtful whether it was profitable to make great efforts in order to begin to compete with the limited but efficient Separator group for a part of the market which was less vital for the former company. In International Harvester's overall view of competition the business of the Separator group could hardly have ranked as a serious threat. At the outbreak of the First World War the value represented by International Harvester's total sales figures was about 25 times greater than that of the whole Separator group.[220]

Since AB Separator had a small domestic market basis it was reasonable for it to specialise in and limit itself to a particular agricultural technology. It may be said that the Separator group reached its position of world pre-eminence within the mechanisation of milk production at the expense of having to forgo competing in other market sectors of the agricultural machine industry. Certain of these other sectors were more important as far as quantity was concerned, but for this reason they were also exposed to keener competition. International Harvester, on the other hand, had access to a large domestic market with great purchasing power, which made it easier to build up in a profitable way really long production series of various kinds of agricultural technology. By virtue of the amalgamation International Harvester was supplied with significant financial resources and resources of production technology which enabled the company to meet the main part of the domestic market's demand for all the more important kinds of agricultural technology and at the same supply a not insignificant part of the foreign market with various kinds of agricultural machine.

(*i*) International Harvester and the domestic market

During the nineteenth century the orders from domestic agriculture had given the decisive potential resources to International Harvester's predecessors, the McCormick and Deering companies. In the decade before the merger in 1902, as has already been pointed

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[220] McCormick Collection, International Harvester Annual Settlement Record. Alfa-Laval's Records, Sales statistics. Steckzén, B., The De Laval Separator Company, AB Separators historia (manuscript).

Table 72. *Sales of the more important types of machines by the companies which merged to form International Harvester. Applies to domestic sales (USA+ Canada) in units of a thousand in 1904–1912*

	McCormick				Deering				Others				Int. Harv.
Year	B	M	R	Total	B	M	R	Total	B	M	R	Total	Total
1904	38	80	49	167	38	61	38	137	25	46	27	98	402
1905	43	81	52	176	45	60	39	144	21	40	32	93	413
1906	47	81	52	180	50	59	38	147	21	36	28	85	412
1907	48	92	60	200	49	68	43	160	20	37	29	86	446
1908	37	81	51	169	38	61	36	135	10	27	24	61	365
1909	51	88	53	192	50	65	38	153	14	24	23	61	406
1910	58	89	56	203	57	69	42	168	17	24	21	62	433
1911	67	76	47	190	69	62	37	168	18	21	18	57	415
1912	71	84	50	205	72	72	39	183	20	23	19	62	450

B=binders, M=mowers, R=rakes.
Note Of the self-binders about 17 per cent were corn-binders.

Source McCormick Collection, International Harvester Annual Settlement Record.

out, foreign orders for agricultural technology began to play an ever increasing part for the leading American agricultural machine producers. McCormick, which was also the leading firm on the export market, sold for example approximately 20 per cent of its machines abroad in 1902 as against 4 per cent in 1890. During the years after the merger in 1902 and up to the First World War the foreign market's importance for International Harvester continued to increase. In 1909 sales abroad represented about 36 per cent and in 1912 as much as 45 per cent of the value of International Harvester's total sales. Even though the home market immediately before the First World War accounted for somewhat more than half of International Harvester's output, its comparative importance for the development of the company had been significantly reduced. The tendencies towards supersaturation after the harvester war in the 1890s, which were mentioned above, continued to make themselves felt in the USA and slowed down the market expansion of agricultural technology before the First World War.

The prairie states were the most important sales areas for International Harvester. The relative change in the home market from the prairie farms to the other farms in the USA which had taken place in McCormick's sales before 1902 also continued during the International Harvester epoch. Nevertheless the prairie farms in proportion to their numbers continued to order much larger quantities of agricultural technology than the farms in the South and East did. This applied particularly to the newly introduced agricultural technology represented by the tractor. Since the middle of the nineteenth century the localisation of the agricultural machine industry had been concentrated in the prairie district. The establishment of International Harvester rather strengthened the prevailing localisation pattern of the industry. In 1909 65 per cent of the production of harvesters in the USA took place in Illinois, and as far as the whole of agricultural technology was concerned the production value was divided between the leading states as follows:

	Per cent
Illinois	47
Indiana	9
Ohio	9
Wisconsin	6
Michigan	4
Prairie states, total	75
New York State	11
Other states	14

Source Census of the United States 1910. Department of Commerce. Manufacturers 1909, Statistics for the Agricultural Implement Industry.

The two families of McCormick and Deering proved to be completely dominant within the International Harvester group, both as far as the home and the foreign markets were concerned. Together McCormick and Deering accounted for between 80 and 85 per cent of International Harvester's total sales before the First World War.[221]

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[221] McCormick Collection, International Harvester Annual Settlement Record. See tables 65 and 77–78.

Table 73. *Sales of various agricultural machines in units of a thousand by International Harvester divided into various regions within the USA in 1909–1912*

	Central		Northwest		Southwest		Northeast		South		USA	
Type of agricultural machine	1909	1912	1909	1912	1909	1912	1909	1912	1909	1912	1909	1912
Grainbinders	17	19	31	40	19	33	12	13	7	6	86	111
Cornbinders	4	6	3	9	6	12	3	3	0	0	16	30
Other harvesting machines	0	0	3	3	3	4	1	1	0	0	7	8
Mowing-machines	20	22	34	33	54	47	27	34	28	28	163	164
Horse hay-rakes	11	11	22	21	34	30	17	16	19	19	103	98
Harrows+cultivators	19	20	9	20	13	21	51	46	26	24	118	131
Cream separators	4	4	4	5	4	5	4	6	0	2	16	22
Tractors	0.1	0.3	0.4	0.9	0.1	0.4	0.1	0.2	0	0.2	0.7	2
Fertilizer distributors	9	9	8	5	8	5	10	10	1	2	36	31

Note The South has a somewhat inflated sales volume, as part of the agent's areas in southern Indiana, Illinois and Missouri has been attributed to the South in the sales tables. The sales volume for the Central and Southwestern prairie districts are correspondingly too low.

Geographical division: Central= Illinois, Indiana, Ohio, Michigan
Northwest= Wisconsin, Minnesota, the Dakotas, Montana, Wyoming, Idaho, Oregon, Washington
Southwest= Missouri, Iowa, Nebraska, Kansas, Colorado, Oklahoma, Utah, New Mexico, Arizona, Nevada, California
Northeast= coastal states north of Virginia and also Vermont and Pennsylvania
South= Florida, Georgia, the Carolinas, Virginia, West Virginia, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Texas.

Source McCormick Collection, International Harvester Domestic Annual Settlement Record.

Table 74. *The value of International Harvester's sales of agricultural machines in millions of dollars divided into various regions within the USA in 1909 and 1912*

	Central		Northwest		Southwest		Northeast		South		USA	
Type of agricultural machine	1909	1912	1909	1912	1909	1912	1909	1912	1909	1912	1909	1912
Grainbinders	1.9	2.0	3.4	4.3	1.9	3.3	1.2	1.3	0.7	0.6[a]	9.1	11.5
Cornbinders	0.4	0.7	0.3	0.8	0.6	1.0	0.3	0.4	0.0	0.0	1.6	2.9
Other harvesting machines	0.0	0.0	0.3	0.3	0.3	0.5	0.1	0.1	0.0	0.0	0.7	0.9
Mowing-machines	0.7	0.8	1.2	1.1	1.9	1.6	1.0	1.1	1.1	0.9	5.9	5.5
Tractors	0.1	0.6	0.5	1.6	0.2	0.8	0.1	0.2	0.0	0.2	0.9	3.4
Fertilizer distributors	0.8	0.7	0.8	0.4	0.7	0.2	0.9	0.7	0.1	0.2	3.3	2.2
Other machines	1.9	2.2	2.3	2.9	2.3	3.3	2.0	3.1	1.8	2.3	10.3	13.8
Machines total	5.8	7.0	8.8	11.4	7.9	10.7	5.6	6.9	3.7	4.2	31.8	40.2
Twine	1.4	1.6	2.8	3.8	1.7	3.0	0.9	1.0	0.4	0.4	7.2	9.8
Other	1.4	2.0	2.3	3.4	2.9	3.3	1.7	2.1	1.8	2.0	10.1	11.7
Total	8.6	10.6	13.9	18.6	12.5	17.0	8.2	10.0	5.9	6.6	49.1	62.8

[a] Including rice-binders. Of the grainbinders, which were sold to the South about two-thirds went to Texas. In the Northwest the prairie states Minnesota, Wisconsin and the Dakotas were completely dominant and in the Southwest the prairie states Iowa, Missouri, Kansas and Nebraska were completely dominant.

Source McCormick Collection, International Harvester Domestic Annual Settlement Record.

Number of farm units in thousands in the various regions in the USA in 1910 according to US Census of Agriculture

Central	Northwest	Southwest	Northeast	South	USA
947 (15%)	656 (10%)	1 191 (19%)	718 (11%)	2 849 (45%)	6 361 (100%)

The market situation altered on account of the First World War. Domestic orders for agricultural technology increased in the conditions of wartime, while foreign sales, apart from exports to Canada, declined.[222] In the wartime conditions which were favourable to agriculture the tractor was definitively adopted by the farmers in the USA and Canada, but Ford's efforts as a product developer also played a great part in this connection. The economic situation was favourable to agriculture up to 1920, during which time significant domestic and Canadian orders were placed. In 1920 domestic sales of agricultural machines which were entirely produced in the USA amounted to 470 million dollars. Altogether 583 companies contributed to this production, but International Harvester alone accounted for approximately 40 per cent of the sales within the USA and the other 582 companies for the remaining 60 per cent. The sales value of various kinds of agricultural technology for the whole industry was distributed in the following way in terms of percentages in 1920:

	Per cent
Tractors	35
Harvesting=threshing machines	18
Ploughs, harrows and others	12
Farm trucks	9
Planting=cultivating machines	8
Others	18
Total =471.4 million dollars	100

Source US Department of Agriculture, Department circular 212 Washington D.C. 1922. The manufacture and sale of farm equipment in 1920.

[222] During the First World War the regular orders placed by agriculture with International Harvester were supplemented to a certain extent by government war orders. The government orders for war materials played an important part for International Harvester during the Second World War. The production of agricultural machinery was drastically curtailed on instructions from the government, and several of International Harvester's factories had to change over to the production of war materials. During the Second World War International Harvester produced significant quantities of military lorries, tractors, trucks and jeeps, and also torpedoes and arms. So that the existing agricultural machine park might continue to function, International Harvester kept up a certain production of spare parts for agricultural machines at the same time.

International Harvester's share of the home market varied according to the type of agricultural technology. In 1920 the biggest share of the market was for harvesters, but it was considerably lower for tractors, where Ford was leading on the market.

After 1920 the American economy was hit by a post-war depression which became especially troublesome for the farming sector. Several expanding new industries in the United States such as the car industry, the electrical engineering industry and the building industry experienced a boom period for the whole of the 1920s after the depression year of 1921. This was not the case with agriculture. The exports of farm produce to Europe had been significant during the First World War and the years immediately after it, but after 1920 American agriculture lost a large part of her overseas export markets. The reason for this was that competition for the European market in farm produce stiffened from countries such as Canada, Argentina and Australia after 1920. During the 1890s and at the beginning of the twentieth century these new competition areas had mechanised their farms in connection with the immigration after the majority of the American prairie farmers had mechanised the farm work. In addition, as regards the increased tariff rates in the USA after the war and the surplus of industrial and farm products resulting from the country's economic superiority, Europe found it easier to trade with countries which were economically inferior such as Canada, Argentina and Australia. Besides, European agriculture had already started to be mechanised before the turn of the nineteenth century because of the reduction in the agricultural labour force surplus through emigration. Mechanisation had continued on the larger farms at the beginning of the twentieth century and had accelerated during the First World War. Therefore Europe, once it had overcome the immediate aftermath of the First World War, became more self-sufficient as regards farm produce after 1920 than it had been around 1900, and this particularly affected the American farmers who had got used to Europe absorbing the surplus production of the highly mechanised American farming. In spite of the fact that the number of farmers in the USA decreased after 1920 in response to the decline in the total demand for farm produce, the production volume of American farming did not decrease. The mechanisation which was in progress in agriculture led to increased efficiency, and the result was overproduction and reduced prices. The farmers in the USA were hit hard by this, and land values fell during the 1920s.[223]

The development in American agriculture was naturally enough reflected in agriculture's orders for agricultural technology. In terms of results the depression year of 1921 became the worst in International Harvester's history up to that time. The company's volume of the sales in 1921 amounted to only 54 per cent of that of the year 1920 and the net profits fell by 75 per cent from 1920 to 1921. The total tractor production in the USA declined by 75 per cent in all between 1920 and 1921. Thus the diminishing orders from agriculture had immediate consequences for the employment potential in the agricultural machine industry. In 1920 International Harvester had laid off 48000 employees, of whom about 8000 had just been taken on in the previous year. The production labour force had to be drastically reduced in 1921. The sales organisation was also affected, and almost 40 per cent of the distributors were dismissed in 1921.[224]

On the whole the situation of the 1920s was a novel one for the agricultural machine industry. Earlier tendencies towards super-saturation of agricultural technology within farming had in fact been noticed, but the problem after 1920 was that American agriculture was not so plainly able as before to find foreign customers for farm produce. With the new limitations of the market, farming in the USA was utterly over-mechanised and too efficient. A state of chronic overproduction had been reached. An article from the National Association of Farm Equipment Manufacturers demonstrated and commented on the decline in the production of agricultural implements and machines in the USA from 1914 to 1922 (in actual fact from 1920 to 1922), see table p. 330.

At the same time a comparison was made with the expanding car industry and the result was that the production of cars had increased by 340 per cent over the corresponding period. In the magazine the producers' association appealed to the farmers to utilise the

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223 Faulkner, H. U., *op. cit.* pp. 625ff. McCormick, S., *op. cit.* pp. 175ff.

224 Cf. tables 70–71 and diagram 20.

full capacity of the land and not to let it lie fallow, as had been happening lately. As an argument in favour of continued investment in farming machinery the association relied on lower production costs and higher production within agriculture.[225]

Implements/machines produced, in thousands

	1914	1922	Percentage decrease
Ploughs	1 335	431	68
Harrows	765	254	67
Corn-cultivators	379	90	76
One horse cultivators	254	59	77
Grain drills	89	17	81
Corn planters	115	21	82
Cotton planters	101	18	82
Mowers	275	80	71
Grain binders	215	41	81

According to the article the figures are based on US government figures.

The agricultural technology which, according to the producers' association was hit by sharply reduced orders in the 1920s was the older variety of agricultural technology which had been developed and adopted in the nineteenth century. In this respect the pessimism in producer circles was well founded. Against a background of prevailing overproduction in agriculture the producers' association could hardly count on getting a hearing for its proposals. On the other hand the new heavy agricultural technology represented by the tractor, the lorry and to a certain extent the combine harvester, became a great success in the USA during the period between the wars. The depression year of 1921 constituted an important but in fact short-lived exception. The curious thing was that the new agricultural technology was adopted to a high degree during a period in which the economic trends in the agricultural sector of the USA were weaker than ever and made the problems of the overproduction which already prevailed even

[225] *The Harvester World*, Jan. 1924. Article composed by the National Association of Farm Equipment Manufacturers, Chicago.

worse. In any case the connection between the inclination to adopt the new agricultural technology and positive market signs, which had been so apparent during the spread of the harvester in the nineteenth century, was in any event very slight during the spread of the tractor in the USA between the wars. What actually happened during the period between the wars shows instead how technology which had developed within one sector of the economy "spilled over" into other sectors, even though the market conditions within the sector receiving the technology had not directly indicated a need for the technology in question. In the present case the modern tractor was developed rather as a by-product of the motor-car industry than as a product of established companies in the agricultural machine industry. As the production of the new heavy agricultural technology required greater resources and access to an advanced production technology, it was above all the big company mergers in the agricultural machine industry which were able during the period between the wars to compensate for the loss in production of the older types of agricultural technology. However, for the many smaller and medium-sized producers of agricultural machines who were restricted to the production of the older types of agricultural technology the period between the wars was a time in which the foundations of the market shook.[226]

(j) International Harvester and the foreign market

Before the First World War International Harvester's foreign markets were expanding more than its home markets. While the sales on the

[226] Gray, R. B., *Development of the Agricultural Tractor in the United States*. Part II, pp. 27 ff.

In 1933 90 per cent of the USA's tractors were produced by nine companies in the following order of precedence: (1) International Harvester, Chicago, Illinois, (2) the J. Deere Co., Moline, Illinois, (3) the J. I. Case Co., Racine, Wisconsin, (4) Massey-Harris, Toronto, Canada, (5) Oliver Farm Equipment, Chicago, Illinois, (6) the Minneapolis-Moline Power Implement Co., Minneapolis, Minnesota, (7) the Allis-Chalmers Co., Milwaukee, Wisconsin, (8) the Cleveland Tractor Co., Cleveland, Ohio, (9) the Caterpillar Tractor Co., Peoria, Illinois. As far as all kinds of agricultural technology were concerned, during the period between the wars International Harvester was completely dominant on the home market as well as the international market. On the home market Deere took second place, while Massey-Harris held the corresponding position on the foreign markets.

Map 13. *The spread of International Harvester's agent network in 1912.*

Source International Harvester Annual Report 1912.

home market doubled in terms of value between 1904 and 1912, the sales to Canada over the corresponding period increased fivefold, and threefold to the other countries abroad. The most important foreign markets remained the same as they had been during the McCormick era. In 1906 Russia, Canada, France, Britain, Argentina and Australia accounted for more than 80 per cent of International Harvester's total sales abroad. A certain change in the foreign sales areas occurred by virtue of the fact that Russia and Canada ordered agricultural technology from International Harvester to an especially great extent. Almost half of International Harvester's total sales abroad in 1906 went to Russia and Canada.

The Canadian farming in the West was younger than the American, but otherwise showed great similarities with the prairie farming in the USA from which it was an offshoot. Therefore it was particularly natural for International Harvester in Canada to extend the shop counter once a large part of the domestic prairie farming had been supplied with agricultural technology. In order to avoid customs duty on agricultural machines International Harvester founded its first factory abroad in 1903 in Hamilton, Canada, which expanded rapidly and in 1912 employed 2 500 workers. International Harvester's operation in Canada should also be regarded as a counterweight to the Canadian Massey-Harris group.[227]

Agriculture in Russia as compared with the rest of Europe was under-equipped with agricultural machinery, but in the years after the turn of the nineteenth century Russian orders for farming machinery rose rapidly. In this connection the colonisation of Siberia and the construction of the Trans-Siberian railway played a great part. The topography of the land in Southern Siberia resembled that of the prairies in the USA and Canada, and the shortage of labour in the newly colonised Russian East stimulated the adoption of agricultural technology there. Apart from the cultivation of grain, milk production and the dairy industry were developed in Siberia, as was shown earlier when discussing AB Separator. Siberia was a very important sales area for AB Separator's cream separators, and as is shown in table 75, both harvesters and mowing-machines and also horse hay-rakes played a great part in International Harvester's Russian sales in 1905 and 1906. Half the number of mowing-machines which were ordered in 1906 were sent to Siberia. In fact the orders for agricultural technology were considerably reduced in 1904–1905 on account of the disturbances of the war between Russia and Japan and domestic political unrest, but after Stolypin's agricultural reforms in 1906 the development altered. In one year from 1905 to 1906 International Harvester increased the number of mowing-machines sold to Russia by 70 per cent, and the number of horse hay-rakes by 50 per cent. It was Siberia which accounted for the main part of this increase, which shows that the expansion of grass cultivation and cattle-farming developed there side by side with investments in agricultural technology.[228]

[227] Cf. notes 202 and 205.

The operations in Canada occupied an exceptional position among International Harvester's business abroad. The Canadian market was regarded more as an extension of the domestic market than as a foreign market, and in International Harvester's accounts the sales in Canada were referred to as 'Domestic sales'.

[228] McCormick Collection, Annual Settlement Record. Casson, H. N., *The Romance of the Reaper*, pp. 130 ff.

One episode during the Russian-Japanese War illustrates the importance which was

During the latter part of the nineteenth century Odessa on the Black Sea was the most important port of entry for American agricultural technology. The smaller quantities which were exported to Russia before 1900 were mainly used on the farms in the black earth area in Southern Russia. In connection with the development of Siberian agriculture, Odessa's relative importance as a Russian port of entry for American agrarian technology declined, which was shipped in an increasing volume during the twentieth century, partly to the Baltic ports of St. Petersburg and Riga, and partly, from 1908 onwards, to Vladivostock via the Trans-Siberian railway to the plains of Southern Siberia. Thus the Siberian market was supplied with American technology both from the West and the East, and American agricultural technology was largely synonymous with agricultural machines from International Harvester.[229]

International Harvester's expansion on the Russian and European markets raised the question of establishing companies on these markets in the same way as in Canada. In 1905 International Harvester took the first step in Europe, when a Swedish factory in Norrköping primarily producing mowing-machines was purchased, and the subsidiary Aktiebolaget International Harvester, Norrköping, was formed. In connection with International Harvester's plan to form further companies in Europe, an American envoy, R. Dennis, was sent on behalf of the Department of Commerce and Labor in 1908 on a trip to Europe, Asia and Africa in order to get to know the basis for the USA's market for the agricultural machine industry. On his return home Dennis handed in a written report, "American agricultural implements in Europe, Asia and Africa", which gives a good picture of the market situation in the years

attached to the new agricultural technology in government quarters. Several trains carrying Russian troops on their way eastwards were directed onto a siding on government instructions, to await a goods train carrying American harvesters which was also travelling eastwards. The generals were displeased and sent a telegram to Witte in St. Petersburg, but he replied: "The goods trains must pass. They are carrying American harvesters. That means bread."

[229] The direct trade in harvesters between the West coast of the USA to Vladivostock was mainly bound for Eastern Siberia. However, some of the harvesters were sold in Nikolayevsk and in Blagoveschensk in the Amur province, and also in Harbin in Manchuria.

before the First World War, and so it is worth while pausing to consider the report.[230]

As far as the Russian market was concerned Dennis particularly stressed the importance of the Trans-Siberian railway in spreading agricultural machines to an area which was underdeveloped as regards agricultural technology and therefore offered potential markets: "It is generally admitted by all who are conversant with the conditions now controlling the agricultural implement trade of the world that Russian Siberia presents today the finest virtually underdeveloped field that exists. The completion of the Trans-Siberian Railroad has made hundreds of thousands of acres of tillable land accessible to the would-be settler, and also provides him a means of getting the products of his labor to a market."[231]

In order to make the emigration to Siberia easier the Russian government opened about forty depots in various parts of Siberia to sell agricultural implements and machines to the settlers with generous credit facilities. The government's purchasing depots handled significant quantities of agricultural technology and so substantial deals were made over American reapers, binders and mowers, German ploughs and Swedish cream separators. In the report Dennis urged American manufacturers who, apart from International Harvester, had been inactive in getting a hold on the Russian-Siberian market, to do so before the activity of the Germans in the area precluded future possibilities. In addition Dennis stressed the double effect of the Siberian migration on the demand

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[230] Dennis, R. R., *American Agricultural Implements in Europe, Asia and Africa.* Department of Commerce and Labor, Statistics for the Agricultural Implement Industry. Washington D.C. Government Printing Office, 1909.

[231] *Ibid.*, quotation at pp. 71 ff.

The centre of activity in Siberia was Omsk, and Dennis saw in this town a parallel with Kansas City. "Omsk is the best point of the whole line of the Trans-Siberian road. It may well be called the Kansas City of Siberia. For 150 miles north of the line of the railroad and hundreds of miles to the south and southeast, stretching away down to the Chinese frontier, are millions of acres which only need a modicum of working to produce wonderful crops. Following Kansas City's example, Omsk is becoming a distributing point for this immense territory and it sounds almost like a fairy tale when one is told the money values of the implements already being sold from there. When one considers the possibilities for the future, it is amazing." Quotation at p. 78.

for agricultural technology. Apart from increased demand in Siberia, the new producer area, the migration of labour from European Russia also stimulated new investments in agricultural technology there.[232]

In the rest of Europe France, Germany, Britain and Scandinavia constituted the most important sales areas for American agricultural technology. In 1907 the French farms ordered about 80000 harvesters and mowing-machines, more than 70 per cent of which were imported from the USA. Since Canada as a most-favoured nation had special customs tariffs with France, Massey-Harris was the most powerful rival to the American manufacturers on the

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[232] *Ibid.*, pp. 71 ff. Volin, L., *A Century of Russian Agriculture: From Alexander II to Kruschev*, quotation at pp. 108 ff.

Through Stolypin's agricultural reforms among other things the migration from the more densely populated areas in European Russia to the thinly populated areas of Siberia was stimulated. Between 1896 and 1913 about 5 million Russians moved to Siberia. As a result the population pressure in the agricultural sector was reduced in European Russia. "The rôle of migration in draining off surplus population will be best appreciated when it is remembered that it most affected precisely those most densely populated areas and those strata of the rural pupulation which experienced the shortage of land most acutely. The average land holding of families migrating to Asiatic Russia was only ten acres before migration, as against an average of thirty acres for all peasant holdings in European Russia, according to the census of 1905.

A correlative aspect of the resettlement movement was its tremendous influence on the agricultural development of the great open spaces of Asiatic Russia. Thus the crop area of western and central Siberia and northern Kazakhstan, for which continuous statistical data are available, more than doubled between 1905 and 1914, increasing from 11.5 million acres to 24 million acres. Moreover, the productivity of peasant labor was higher in the new regions, with a consequent favorable effect on the whole national economy." The reason for the greater efficiency of Siberian agriculture was mainly that conditions for a mechanised agriculture were more favourable there than in the rest of Russia.

One factor which further stimulated investments in agricultural technology in Russia was the unusually quick seasonal changes, especially in Siberia and southern Russia. In Siberia the sudden autumn cold causes great problems with the harvest for the farmers, and in southern Russia the sudden summer heat can destroy the crops if they are too frail. Thus the agricultural machines for harvesting and sowing could play a particularly large part in Russia during the most critical stages of the seasonal rhythm of agriculture. These processes could be carried out in a much shorter time through mechanisation, and important quantities of crops could thus be saved from destruction.

Table 75. *International Harvester's sales abroad of the various types of harvesting machines in units of a hundred and divided into the various company units within International Harvester.*

	Binders		Mowers		Reapers		Rakes	
Company unit	1905	1906	1905	1906	1905	1906	1905	1906
1. Canada								
Deering	47	61	72	71	0	0	45	46
McCormick	38	48	65	66	0	0	47	50
Others	4	1	3	3	0	0	3	3
I.H. total	89	110	140	140	0	0	95	99
2. Russia								
Deering	15	19	31	45	71	79	36	48
McCormick	29	32	32	58	71	88	44	77
Others	17	17	23	42	54	60	49	70
I.H. total	61	68	86	145	196	227	129	195
3. Germany								
Deering	–	–	–	–	–	–	–	–
McCormick	5	7	52	74	20	26	5	5
Others	2	3	17	23	3	4	2	2
I.H. total	7	10	69	97	23	30	7	7
4. France								
Deering	–	–	–	–	–	–	–	–
McCormick	–	–	–	–	–	–	–	–
Others	10	13	32	39	4	5	8	9
I.H. total	10	13	32	39	4	5	8	9
5. Great Britain								
Deering	4	6	15	15	0	0	6	6
McCormick	6	9	12	13	1	1	6	6
Others	4	6	12	9	0	0	7	7
I.H. total	14	21	39	37	1	1	19	19
6. South America								
Deering	28	18	38	43	2	4	28	29
McCormick	16	22	23	33	4	5	15	19
Others	11	5	14	22	1	1	7	16
I.H. total	55	45	75	98	7	10	50	64

Table 75. (*Cont.*)

	Binders		Mowers		Reapers		Rakes	
Company unit	1905	1906	1905	1906	1905	1906	1905	1906
7. Australia with New Zealand								
Deering	3	5	2	4	0	0	2	3
McCormick	4	4	2	1	0	0	1	1
Others	4	5	3	2	0	0	2	2
I.H. total	11	14	7	7	0	0	5	6
8=the total of 1–7								
1 Deering	97	109	158	178	73	83	117	132
2 McCormick	98	122	186	245	96	120	118	158
3 Others	52	50	104	140	62	70	78	109
4 I.H. total	247	281	448	563	231	273	313	399
5=1 as % of 4	39	39	35	32	32	30	37	33
6=2 as % of 4	40	43	42	44	42	44	38	40

Source McCormick Collection, International Harvester Annual Settlement Record.

French market. Canadian harvesters and mowing-machines accounted for fifteen per cent of the total market, while France's own production amounted to about thirteen per cent of her total requirements. The situation was similar in Germany and Britain, where the USA accounted for approximately 80 per cent of the countries' total imports of agricultural machines, but the British and German domestic production was more significant than the French equivalent. Germany's imports of agricultural machines were dominated by harvesters and to a certain extent cream separators. Of the 52 000 harvesters imported by Germany in 1907, 83 per cent came from the USA, 12 per cent from Canada and 4 per cent from Britain. According to Dennis the Germans had been the best in Europe at adopting American technology, and he predicted that Germany would become the USA's new competitor on the production side. In several European countries at the beginning of the twentieth century active campaigns were started against all foreign sales, against a background of strong waves of nationalism. Such tendencies were apparent not least in Russia and Germany, and in order to avoid high tariffs and also a confrontation with such moods of industrial nationalism, International Harvester decided to go the whole hog as far as the establishment of companies in Europe's most important market areas was concerned. In fact in 1909 International Harvester opened a factory in Neuss near Düsseldorf in Germany, another in Croix near Lille in Northern France, and a third in Lubertzy outside Moscow.[233] Thus International Harvester created new opportunities of employment in Europe but the companies were able to negotiate in their own favour tariff exemptions for their American-made machine parts. So the establishment by International Harvester of companies in Europe also meant a continuing stimulus for production and employment in the USA. In actual fact International Harvester's direct exports of agricultural machines to Europe continued to expand side by side with the group's production in the European factories.[234]

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[233] Dennis, R. R., *op. cit.*, pp. 23 ff. McCormick Collection, Diaries of Cyrus Hall McCormick (II) Nov. 24, 1909; Oct. 19, 1911; Jan. 29, 1912.

Cyrus Hall McCormick II personally started the negotiations which preceded International Harvester's establishment of a company in Europe, and through several visits to Europe he became familiar with market conditions. In spite of the fact that the Russian market held out the greatest temptation for International Harvester, McCormick explained at a discussion with the Russian finance, trade and agriculture ministers in St. Petersburg in 1909 that he was particularly hesitant over company investments in Russia since the market conditions there seemed more uncertain than on other European markets. The ministers there gave him every assurance, and promised full support for the company's operations in Russia.

To supplement his initiative and his contacts abroad McCormick also maintained close contacts with leading foreign diplomats in the USA. McCormick appears to have become particularly close to the Russian Ambassador Boris Bakhmetev and the French Ambassador Jules Jusserand, who were often McCormick's guests at dinner. International Harvester's largest European markets were in Russia and France. In the USA McCormick, as President of International Harvester, was one of the country's most influential men. In his circle of friends there were several people who were perhaps more widely known such as W. Wilson, J. P. Morgan and J. D. Rockefeller. Cyrus's brother Harold F. McCormick, who succeeded Cyrus as President of International Harvester in 1918, had married J. D. Rockefeller's daughter in 1899. International Harvester's close relationship with two such important finance houses as Morgan and Rockefeller provided the group with specially large financial resources, through favourable loans, so that it could extend its business both on the domestic and foreign markets. Cf. *Farm Implement News*, Jan. 18, 1912.

[234] Dennis, R. R., *op. cit.*, pp. 50 ff.

However, Dennis expressed certain fears that International Harvester's produc-

In 1890 the exports of agricultural machines from the United States had begun to reach a certain volume, and from then until the First World War they expanded much more rapidly than before 1890. As is shown in diagram 21, harvesting machines played a significant rôle in the total exports. International Harvester was responsible for most of the USA's exports. In fact the columns in diagram 21 indicate International Harvester's total foreign sales, and thus include both the company's direct exports and sales from the business abroad. The sales from the American subsidiaries' production abroad have not been included in the export statistics for the USA, which explains why International Harvester's columns show higher figures than the graph of the country's total exports of agricultural machines. Before 1906 International Harvester's production abroad was limited to Canada. If the Canadian market in 1905 is excluded International Harvester's foreign production is eliminated. The result then is that the group's direct exports constitute 65 per cent of the total exports of agricultural machines from the whole of the USA. In 1909 International Harvester's share of the country's total exports of agricultural machines (excluding Canada) had risen to 80 per cent, and as regards harvesters the

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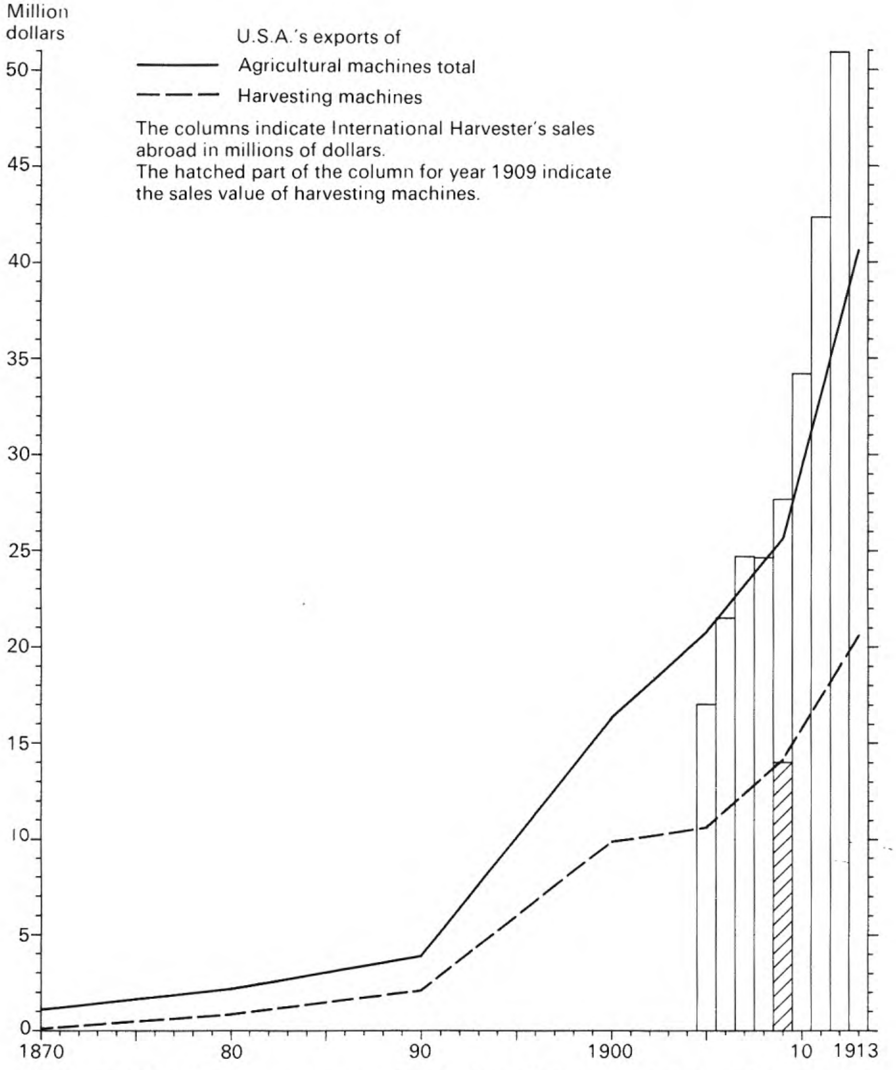
tion of agricultural machinery in Europe would have negative consequences for the USA's exports of agricultural technology. As an example Dennis cited the development in Sweden, where the USA had been hit by export losses after International Harvester had opened the factory in Norrköping in 1905. According to Dennis it was unwise to establish an American-owned factory for agricultural technology in Sweden, as Sweden and Germany were the European countries who were most eager to adopt new technology for the production of agricultural machinery. Moreover, Sweden like Germany had started active campaigns against foreign sales of agricultural machines, and Dennis pointed out that three Swedish factories were producing imitations of American mowing machines and reapers for the 1908 season. At that time the largest Swedish factory had a yearly capacity of 7 000 machines.

Dennis's fears were exaggerated, but they proved to be not entirely without foundation. The German and Swedish engineering industries which concentrated on agricultural machinery became the largest borrowers of American agricultural technology at the beginning of the 20th century, and these loans of agricultural technology in the long run undoubtedly brought about a certain reduction in the need for imports. Earlier Canada had been the large borrower, and later, in connection with the collectivisation of agriculture during the first five-year plan, the Soviet Union became the large borrower of American agricultural technology, especially as regards tractors.

Diagram 21. *Exports of agricultural machines from the USA in 1870–1913 compared with International Harvester's sales abroad in 1905–1912. Amounts in millions of dollars.*



Source The foreign Commerce and Navigation of the United States, Bureau of Statistics, Treasury Department.
McCormick Collection, International Harvester Annual Settlement Record.
International Harvester Annual Reports.

Table 76. *Exports of harvesting machines (binders, reapers, mowers) and other types of agricultural machines from the USA in 1900–1913 in millions of dollars*

Land/Area	1905	1909	1913
Russia	2.6	4.4	6.9
Germany	1.0	1.4	3.1
Sweden	0.2	0.2	0.3
Holland	0.2	0.6	0.4
France	2.6	3.0	3.0
Great Britain	0.4	0.6	0.8
The rest of Europe	0.8	1.7	2.9
The whole of Europe+Siberia	7.8	11.9	17.4
Canada[a]	0.5	0.2	0.5
Argentina	1.5	1.2	1.7
The rest of America	0.1	0.1	0.2
The whole of America	2.1	1.5	2.4
Australia	0.5	0.3	0.4
Africa	0.1	0.2	0.3
Asia excluding Siberia	0.0	0.0	0.0
Harvesting machines total	10.6	14.1	20.6
Ploughs+harrows total	2.9	3.8	7.7
Other agricultural machines total	7.3	7.8	12.3
Total	20.8	25.7	40.6
Harvesting machines as % of total	(51)	(55)	(51)

[a] In Canada International Harvester started a factory for the production of agricultural machines in 1903. The sales from these operations are not included in the export statistics. In 1909 for example International Harvester's sales of harvesting machines in Canada amounted to 2.1 million dollars. International Harvester first started its own production of agricultural machines in Europe in 1905 in Sweden, then in 1909 in Russia, Germany and France and the sales from this production are not shown as exports either. One of the most important motives for setting up companies abroad was that in so doing it was possible to avoid the high import tariffs on agricultural machines.

Source The Foreign Commerce and Navigation of the United States, Bureau of Statistics, Treasury Department.

company accounted for 84 per cent of the total number exported (excluding Canada) from the USA. Furthermore diagram 21 shows clearly the result of the extensive establishment by International Harvester of companies in Europe in 1909. At the same time as

Table 77. *International Harvester's sales abroad divided into various countries and areas in 1905–1906. Amounts in millions of dollars*

Land/Area	1905	1906
Russia	3.7	5.0
Hungary	0.2	0.4
The rest of Europe including an unknown amount to Russia	1.1	1.7
The whole of East Europe+Siberia	5.0	7.1
Germany	0.8	1.0
Scandinavia and the rest of Central Europe	0.2	0.5[a]
The whole of Central Europe	1.0	1.5
Western Europe	2.9	3.1
The whole of Europe+Siberia	8.9	11.7
Canada	3.8	4.8
Mexico	0.1	0.1
South America (mainly Argentina+Uruguay)	2.7	2.2
South Africa	0.1	0.1
Australia with New Zealand	1.4	1.7
Total	17.0	20.5

[a] The sales by International Harvester's factory in Norrköping, Sweden, which was started in 1905 are not included in the figure of 0.5 million dollars. The value of the factory's production in 1906 only amounted, however, to a few tens of thousands of dollars.

Source McCormick Collection, International Harvester Annual Settlement Record.

sales from the factories abroad were increasing after 1909, International Harvester's exports, especially of spare machine parts, were growing. Thus through International Harvester's establishment of companies abroad, the spread of American agricultural technology was still greater than directly appears from the export statistics of the United States.[235]

The organisation of International Harvester's production at home and abroad during the years preceding the First World War is illustrated by the list of the group's factories in 1912.

[235] *The Foreign Commerce and Navigation of the United States.* McCormick Collection, International Harvester Annual Settlement Record. International Harvester, Annual Reports.

Table 78. *International Harvester's total sales in 1909 in millions of dollars and thousands of machine units.*

	Sales amounts				Number of machines sold			
Products sold	USA	Canada	Others	Total	USA	Canada	Others	Total
1 Grainbinders	9.1	1.4	3.9	14.4	86	11	32	129
2 Reapers	0.1	0.0	2.7	2.8	2	0	40	42
3 Corn binders	1.6	0.1	0.0	1.7	16	1	0	17
4 Other harvesting machines	0.6	0.0	0.7	1.3	5	0	5	10
5 Mowing-machines	5.9	0.6	4.6	11.1	163	15	115	293
6 Total items 1–5	17.3	2.1	11.9	31.3	272	27	192	491
7 Horse hay-rakes	1.8	0.3	1.2	3.3	103	11	57	171
8 Harrows+cultivators	1.3	0.3	0.5	2.1	118	13	28	159
9 Separators	1.3	0.2	0.0	1.5	16	4	0	20
10 Working machines	3.1	0.3	0.6	4.0	19	1	2	22
11 Tractors	0.9	0.4	0.0	1.3	0.7	0.3	0	1
12 Fertilizer distributors	3.3	0.2	0.0	3.5	36	3	1	40
13 Other machines	3.2	0.8	0.3	4.3				
14 Machines total	32.2	4.6	14.5	51.3				
15 Twine	7.2	1.0	2.3	10.5				
16 Repairs	4.2	0.2	1.6	6.0				
17 Other	5.5	1.3	2.2	9.0				
18 Total	49.1	7.1	20.6	76.8				

Source McCormick Collection, International Harvester Annual Settlement Record.

International Harvester manufacturing plants 1912.

	Employes	Annual capacity
A. Domestic plants		(in thousands)
International Harvester Co.		
McCormick Works, Chicago, Ill.	8 500	375 harvesting machines
Deering Works, Chicago, Ill.	7 000	300 harvesting machines
Plano Works, West Pullman, Ill.	1 300	80 manure spreaders, wagons, etc.
Champion Works, Springfield, Ohio	1 800	85 harvesting and seeding machinery, hay presses, etc.
Milwaukee Works, Milwaukee, Wisc.	5 000	75 gasoline engines, cream separators, tractors
Osborne Works, Auburn, New York	3 000	275 tillage implements, harvesting machines
Akron Works, Akron, Ohio	1 250	5 auto-wagons, commercial cars
Keystone Works, Rock Falls, Ill.	500	100 harrows, rakes, etc.
Newark Valley Works, New York	170	7 manure spreaders
Tractor Works, Chicago, Ill.	1 500	5 tractors, engines
Weber Works, Auburn Park, Ill.	700	45 wagons
McCormick, Deering, and Osborne Works together		96 tons twine
International Flax Twine Co.		
St. Paul Works, St. Paul, Minn.	300	5 tons twine
B. Foreign plants		
International Harvester Co. of Canada, limited		
Hamilton Works, Hamilton, Canada	2 500	175 harvesting and seeding machines, tillage implem.
Chatham Works, Chatham, Canada	300	18 wagons
Paris Works, Paris, Canada	250	20 tillage implem., manure spreaders
Compagnie Internationale des Machines Agricole		
Croix Works, Croix, France	700	47 mowers, rakes 3 tons twine

(*Cont.*)

	Employes	Annual capacity
International Harvester Co. m.b.H.		
Neuss Works, Neuss, Germany	700	45 reapers, mowers, rakes 4 tons twine
International Harvester Co. in Russia		
Lubertzy Works, Moscow, Russia	2 500	50 lobogreikas, harvesting mach.
Aktiebolaget International Harvester Co.		
Norrköping Works, Sweden	300	35 mowers, rakes

The production volume in all seven of International Harvester's factories in Canada and Europe in 1912 did not quite reach the same level as the group's largest factory in the USA, McCormick Works, Chicago.[236] In fact International Harvester's production of agricultural machines abroad was an important contribution to the more small-scale agricultural technology engineering industry in Canada and especially in the European countries mentioned above. International Harvester developed the largest factories abroad in

[236] International Harvester, Annual Reports. Casson, H. M., *The Romance of the Reaper*, pp. 150ff.

At the same time the group was divided commercially into eight world regions around 1910:

	Commercial head office
1. Domestic department USA and Canada	Chicago
2. Central Europe, Scandinavia, Russia+Siberia	Hamburg
3. Western Europe and North Africa	Paris
4. Great Britain	London
5. South America	Buenos Aires
6. Mexico	Mexico City
7. Australia	Melbourne
8. New Zealand	Christchurch

Cf. the map of the spread of the agent network in 1912.

Canada and Russia. Most of the foreign-owned factories in Russia were English or German, and were located in Southern Russia where the demand for agricultural machinery had been greatest. Examples of such factories were John Grieves in Berdjansk and A. J. Kopp in Alexandrovsk for harvesters, R. T. Elworthy in Elisavetgrad for sowing and harvesting machines, and Höhn in Odessa for ploughs.[237]

By virtue of the very fact that International Harvester started its own production in Russia on a large scale, the relative importance of the English and German harvesters in Southern Russia declined. In addition International Harvester's Moscow factory benefited more from a sales point of view than the factories in Southern Russia from the expansion of Siberian farming and the resultant increase in the orders for agricultural technology. At the factory in Lubertzy the aim at first was to produce self-binders and other varieties of the late models of harvester. However, the demand for *lobogreikas*—a simpler Russian form of non-self-rake harvester—was so great that the production came to consist mainly of *lobogreikas*. The *lobogreika* required a special hand-raker to follow the machine and rake the grain off the machine platform, but nevertheless this cheap machine was popular in Russia.[238] Such

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[237] Essay on the development of the Russian agricultural machine industry during the years 1843–1913 (in *Kommersiella Meddelanden. Konsulers och handelsattachéers berättelser år 1915*, pp. 325 ff.). Volin, L., *op. cit.* pp. 110 f.

The period 1905–1913 was one of expansion in the development of Russian agriculture and both the production and the exports of agricultural products increased. The growth in the agricultural sector also led to a rise in the real standard of the agricultural proletariat. In 1913 the daily wage for farmworkers was between 23 and 64 per cent higher than during the period 1901–1905, and over the same period food prices only rose by 10–16 per cent. According to Volin the investments in agricultural technology which took place during this time played a decisive rôle in economic growth in the agricultural sector. In terms of value, orders of agricultural machines from Russian agriculture increased 3.4 times over from 1900 to 1913. During the same period imports of agricultural machines increased 2.6 times, while domestic production increased 4.7 times. Around 1900 imports accounted for 62 per cent of the consumption, whereas by 1913 the proportion of imports had shrunk to 47 per cent. Thus the domestic agricultural technology industry received an ever increasing share of the order for agricultural machines from Russian agriculture, but a large part of the more important industries were foreign-owned.

[238] *Konsulers och handelsattachéers berättelser 1915*, pp. 330 ff.

a simple form of agricultural technology was well suited to Russian farming which usually had a good supply of labour. It is noteworthy that the hand-rake reaper, which had its breakthrough on the prairie farms in the USA in the 1850s and was beginning to be replaced there by other more efficient harvesters before 1870, had its boom period in Russian agriculture about fifty years later.[239]

International Harvester's big investment in the Russian market should be looked at against the background of the hopes, which were not completely without foundation, which the group entertained at the time about the millions of Russian farms which were under-equipped with agricultural technology as a substantial future market. At the start of the twentieth century many manufacturers of agricultural machinery in Europe concentrated their foreign trade on Eastern Europe to a particularly high degree. In the years before the First World War the potentially extensive Russian market appeared especially desirable to International Harvester, since American farming showed signs of supersaturation in agricultural technology. A certain modernisation of Russian agriculture did in fact take place, and after Stolypin's agrarian reforms it is noticeable that the orders from Russia for agricultural technology increased, and Siberia in particular developed into a significant surplus area for agricultural produce.

International Harvester ploughed back the profits from its sales in Russia into factory buildings and new sales offices for future expansion. But the political administration in Russia was weak, and because of the revolution in 1917 in practice the company's Russian investments were lost. The course of events during the First World War also meant serious disruptions of International Harvester's sales and production in the rest of Eastern Europe and in Central Europe. However, the growing demand in the USA and Canada, where farming went through a boom period during the war, more than compensated for the market loss in Europe during the First World War up to 1920.[240]

After 1920 International Harvester and the whole of the American

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[239] Cf. figure 5.

[240] McCormick, C., *op. cit.* pp. 170 ff.

agricultural machine industry were hit by the heavy reduction in the domestic demand for agricultural technology. After the peacetime depression during the inter-war period the big groups of companies in the industry were partly able to make up for the loss by orders from American agriculture for the new heavy agricultural technology, but the final loss of the Russian-Siberian market caused serious damage to International Harvester.[241] During the period between the wars the American producers and exporters of agricultural machines regained a large proportion of their former European customers, apart from the Russian farmers. After the peace treaty France became the biggest customer in Europe, and when the German economy had recovered from the after-effects of the war and the hyper-inflation of the early 1920s, Germany also started to order considerable quantities of American agricultural machinery. Furthermore, during the period between the wars Canada constituted International Harvester's large foreign market. On the important Canadian, French and German markets International Harvester was able to sell its agricultural machines partly through direct exports, and partly through its own production in the market areas in question. Argentina and, to a certain extent, Australia were other significant export areas for the group. During the period between the wars International Harvester tried to find replacement markets abroad to make up for the loss of the Russian market. In fact a study of the group's internal monthly reports on foreign market conditions during the 1920s shows that International Har-

[241] However, there were significant imports by the Soviet Union from the United States, in which International Harvester played an important rôle, under the NEP policy and in connection with the collectivisation of Soviet agriculture during the first five-year plan. Towards the end of the first five-year plan the agricultural machine industry in the Soviet Union had developed its own tractor production on the basis of the agricultural technology represented by the imported American tractors. In 1931 the largest tractor factory in Stalingrad was completed, and after that the Soviet Union no longer needed to import any more tractors. Somewhat later large tractor factories were established in Kharkov and Chelyabinsk. The question of the importance of the American tractors for Soviet agriculture has been discussed in more detail in some articles by D. Dalrymple: 'The American Tractor Comes to Soviet Agriculture: The Triumph of Technology' (in *Technology and Culture,* April 1964), 'American Technology and Soviet Agricultural Development, 1924–1933' (in *Agricultural History,* July 1966). Cf. note 2.

vester did not pin any great hopes on this. There were two market areas in which the company showed a certain interest. The first was Mexico, and the second was Manchuria and the Japanese Hokkaido in the Far East, but it was quite clear to International Harvester that these markets could not replace the Russian-Siberian market to any great extent.[242]

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[242] International Harvester, Department Managers Conferences No. 76, Oct. 10, 1922; No. 99, Oct. 2, 1923; No. 160, April 20, 1926; No. 189, July 26, 1927. Market reports from E. A. Brittenham, Foreign Sales Department on Mexico 1922, the Far East 1923, Europe 1927, and also from H. F. Perkins, First Vice-President, on South America 1926. According to Brittenham's report an increase could be expected in the exports of American agricultural machinery to Mexico, which was otherwise a large customer for US products. In order to give the management of the group an idea of the dimensions of the Mexican market, Brittenham pointed out that Mexico's cultivated acreage, 38 000 square miles, was equivalent to the area under cultivation in an average state in the Middle-West. In Mexico an area just as large was waiting to be reclaimed or recultivated, but this reclamation or recultivation was partly dependent on how the problems of irrigation could be solved. In 1921 Mexico came directly after Australia and was sixth in order of quantity among the countries importing American agricultural machinery.

As to the market situation in the Far East, Brittenham pointed out that at the beginning of the 1920s there was no market for agricultural machinery. However, agriculture in Manchuria was in the process of being developed, and for several reasons offered the best conditions as a sales area for the agricultural technology industry. The transport system was comparatively well-developed, and this would favour the establishment of new markets for agricultural products and investment in agricultural machinery. The River Amur in the north, and the southern branch of the Trans-Siberian railway in the east, from Chita in Siberia through Harbin in Manchuria to Vladivostock on the Pacific Ocean, and the railway from Harbin to Dairen on the Yellow Sea constituted the most important transport systems. "There is no existing market in the Orient for modern agricultural machinery, so my [Brittenham] remarks will deal principally with the peculiarities and possibilities of the market in the countries and places visited on my Oriental journey. Our greatest present hope for a market lies in the Plains of Manchuria, where we now have an office located at Harbin, and are making one supreme effort to break down the old customs and traditions of the Chinese Nation and choke agricultural implements down their throats whether they want them or not.

Manchuria consists of a fertile plain approximately 360 000 square miles. In area this matches well our five lake states with the addition of Iowa and Missouri.

When regarding the Orient as a possible market for our agricultural machines, we are inclined to overlook the fact that, by far the largest per cent of farm labor is man power. There are vast areas under cultivation where animal power does not exist, and, as far as China is concerned, we can regard the standard as excellent

(*k*) Summary

Agricultural technology had admittedly developed from the agriculture of the old river cultures and classical times up to the agriculture of the industrial revolution, but the technological changes had

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where animal power is used. Our efforts to introduce modern machinery in Manchuria are aided materially by the fact that horse and mule power are in common use, and the farmer in that section knows how to handle animals and make use of them. This can no doubt be explained by a better economic condition among the farmers, which permits them to own and use animal power. The section is sparsely settled, permitting of larger individual holdings, and with it the necessity for some power other than man. A home-made plow is the main tool for the Manchurian farmer. Crops are harvested and threshed mostly by hand, and very little thought has been given to the use of machinery in this connection."

In order to break down the resistance to the adoption of agricultural technology which various traditions in Eastern community life constituted, the agricultural machine salesman in the Far East also had to act as a kind of agricultural missionary. In addition, it was the custom in foreign trade to engage a comprodore as a middleman between the Chinese state and the foreign firm. "Into this much talked of potential market for agricultural machinery we have entered, and with sufficient courage to open a sales office in Harbin and the staff in charge was recruited from our former office at Vladivostock. Most of their time is devoted to field demonstrations and educational work. The process is slow when trying to convince the Chinese farmer. Each sale is an individual sale, resulting usually from a demonstration of the machine combined with the persuasive influence of a Chinese Comprodore. We have adopted the comprodore system at Harbin, which is one of the old established customs peculiar to the country, but is an entirely new phase in our sales operations."

In Japan the farms which were on average very small did not constitute any potential market for modern agricultural machinery. Intensive campaigns by the Japanese government to persuade the farmers to adopt modern agricultural technology have met with no response except from the farmers on Hokkaido.

"Before Japan can become an interesting market for our modern farm machinery, it will be necessary to change her entire system of land holdings and create an economic condition among her farmers which will make individual purchases possible ... The north island of Hokkaido has an area of approximately 23 000 square miles, and, contrary to the condition in the balance of the Empire, most of this area is open and permits of cultivation by machinery. The government has offered every inducement to aid the settlement of this land. Holdings are comparatively large, and the cultivation is conducted very similar to the methods in the United States. Unless the surplus population eventually overruns this Island, then it is likely that cultivation will be conducted, in the main, by machinery; but the market for us will be very restricted, due to the small area and strong tendency in Japan to manufacture their own requirements."

been comparatively marginal from the point of view of the economics of production. The standard of implements had improved throughout the centuries, but the critical stages in the harvest and sowing of arable farming which constituted the bottlenecks in production had hardly been affected by the development in agricultural technology, and these critical stages were decisive for the volume of production. A series of decisive innovations in agrarian technology for sowing and harvesting had already appeared in England and Scotland during the seventeenth and eighteenth centuries, but these innovations had not been adopted by the farmers. Instead it was on the prairies of the USA that the decisive innovations in agrarian technology began to be put into practice in the middle of the nineteenth century for the first time in world history, and thus the mechanisation there had consequences of a completely different magnitude than previously for productivity and the volume of production. The fact that the mechanisation of farming originally spread in the USA was due to a series of concurrent factors. On the prairies there were large resources of level land on which it was easy to operate machines, and as the density of the population was low, the farms as a rule were able to consist of large acreages. The agricultural sector in the USA had to compete with industry for labour of which there was a comparative shortage, and the development during the latter part of the nineteenth century meant that the cost of agricultural technology became lower and lower in comparison with the cost of labour. Around 1850 canals and railroads finally linked the prairie district around the Great Lakes with the industrial area in the North-East of the USA, which on account of the immigration which was current after 1850 constituted a continually expanding sales market for prairie farming.

Through favourable conditions prairie farming in the USA developed significant purchasing power, and as a natural consequence of this an extensive agricultural machine industry was located in the Middle-West. The interaction between agriculture and industry in the Middle-West gave great vigour to the economy. Through the mechanisation of farming the labour force could be transferred to other branches of the economy with higher economic productivity. The pace of industrialisation and urbanisation grew rapid in the Middle-West after 1850, and Chicago was the world's fastest growing town during the latter part of the nineteenth century. Like several other industries in the USA, because of technological development inter alia, the agricultural machine industry was concentrated among a comparatively small number of large company units. At the turn of the nineteenth century the largest and best-known industries were to be found in the area around the Great Lakes: Deere and Oliver for ploughs, and J. I. Case for threshers, as well as McCormick, Deering and Massey-Harris for harvesters.

The harvester represented the most important agricultural technology during the nineteenth century. The harvesting stage constituted the biggest bottleneck in production, and the spread of the harvester after 1850 was the most important factor in the development of productivity in American agriculture. The foremost name in the harvester industry was that of Cyrus Hall McCormick. Between 1840 and 1860 he was the supreme manufacturer of harvesters. During the Civil War the demand for harvesters increased, and a lot of producers then entered into competition with McCormick, whose share of the market was considerably reduced during the years 1860–1880. The harvester was improved in several important details during the latter part of the nineteenth century, and when the self-binder was introduced onto the market around 1880, McCormick was able to regain his prominent market position in competition with Deering. The really big company merger in the agricultural technology industry of the USA took place in 1902 when International Harvester was formed, and the McCormick and Deering companies became the two dominant companies in the group.

McCormick was probably the most important example in the nineteenth century of the confirmation of Schumpeter's entrepreneur theory of the manufacturer as the most prominent transformer of society. McCormick embodied in one and the same man the innovator as well as the inventor on the market. McCormick's entrepreneur characteristics stand out with perfect clarity in comparison with those of Hussey. In AB Separator it was the combination of Gustaf de Laval and John Bernström which represented something of Schumpeter's ideal of the entrepreneur. McCormick introduced and marketed an agricultural technology which had an even wider range and greater importance for the economics of agriculture than that of de Laval and Bernström in combination. The agricultural technology which McCormick offered for sale was to have technological, economic and social consequences for the formation of society and was to affect more people than any other form of technology at that time. The following McCormick generations extended the founder's achievements, and because of the continuity the giant International Harvester became to a large extent a McCormick company.

The technique of receiving the cut grain was improved on the harvester on several occasions during the latter part of the nineteenth century. When investment in labour was reduced with the new models, the American farmers became more and more inclined to adopt the harvester or replace an older model. For the producers of agricultural technology this meant that they faced a demand which grew like a wave. However, when the self-binder was introduced onto the market around 1880 the technique of harvesting had been developed to such a point that no further development of the harvester was possible for the time being. Not until the combine harvester started to spread during the period between the wars could the self-binder be replaced by more modern agricultural technology. Since the self-binder, as a result of intensive sales campaigns, was sold to American agriculture in large quantities at the end of the nineteenth century and no definitively new models could be marketed, certain tendencies towards supersaturation began to appear on the harvester market in the USA around 1900.

From the 1890s onwards American agricultural technology also became of interest to other immigration countries, above all Canada, Argentina, Australia and Siberia. The conditions in these new farm production areas were in many cases the same as they had been in the USA in the middle of the nineteenth century. More rapid transport and the development of refrigeration techniques had since then permitted farm produce to be carried longer and longer distances to the large sales areas. The emigration from Europe which was taking place reduced the labour force surplus and so increased the inclination to invest in agricultural machines. At the beginning of the twentieth century Europe became the biggest customer of American agricultural technology in terms of monetary value. In fact in relation to the number of farmers the new agricultural technology became far more widespread in the new immigration countries than in Europe. Thus the emigration from Europe stimulated the spread of new agricultural technology in two senses. It was important for International Harvester and other American manufacturers of agricultural machinery to find new markets when the important home market began to show tendencies towards supersaturation. An important stage in International Harvester's market expansion was the group's establishment of companies in Canada and Europe. This facilitated the diffusion of advanced agricultural technology to existing agricultural machine industries in Canada and Europe.

Tendencies towards supersaturation of agricultural technology which had already appeared in American agriculture around 1900 became quite plain when the farmers of the USA lost significant sales markets after the First World War. In spite of the lack of positive market signs, a new form of heavy agricultural technology became a success in the agriculture of the USA during the period between the wars. The car industry lent technology to the established agricultural machine industry in the development of the new agricultural technology. Thus the tractor as the most prominent exponent of the new agricultural technology was an example of the transfer of technology from one sector of industry to another. Even though market conditions in the sector receiving the technology did not show a direct need for the technology in question, its spread could not be prevented. For the agricultural technology industry in the USA which did not have the resources for the production of the new agricultural technology the period between the wars was a time of receding trade. International Harvester and other big groups in the industry which were able to concentrate on the new agricultural technology and extend the business in conformity with the full-line principle, were able to some extent on the home market to make up for the reduced demand for the older agricultural technology.

Through the revolution in 1917 International Harvester lost its important Russian-Siberian market, and during the foreign sales resistance of the 1920s the group tried to find new markets to replace it in Mexico and also in Manchuria and Northern Japan. International Harvester sought the new substitute markets amongst the most advanced of the underdeveloped countries, and they could be regarded as offshoots from the markets in the USA and Eastern Siberia.

III. SUMMARY OF CONCLUSIONS

The expanse of time from the old river cultures six or seven thousand years ago to the beginning of the industrial revolution two hundred years ago was certainly not a period of technological standstill. A series of significant inventions took place especially at certain times such as the Hellenic period and the Renaissance. Nevertheless production techniques in the completely dominant agricultural sector were on the whole the same at the beginning of the industrial revolution as during classical times. Agricultural implements had certainly been improved before 1800, but these improvements had mostly had only marginal economic effects. No decisive new technology had been introduced into the bottlenecks in agricultural production such as harvesting, threshing and sowing. More advanced innovations in agricultural technology, such as sowing and harvesting machines, had in fact emerged during the seventeenth and eighteenth centuries, but they had not been adopted by the farmers at that time.

During the first stage of the industrial revolution the new technology was making the production process more efficient, above all in the textile and iron industries. For a long time the new technology of industrial production had comparatively little effect on the national economy because of the limited capacity of the industrial sector. In fact agriculture still remained the important sector of the economy during the whole of the industrialisation process of the nineteenth century, except in England, and agriculture accounted for the greatest total purchasing power. Therefore industrialisation became dependent on progress in agriculture, even though a smaller but growing industrial sector helped to re-shape farming to an ever increasing extent. Therefore it is important to stress this interdependence in development in this context.

Before 1850 the production volume in arable farming had been able to expand above all through land reclamation and increased manual labour. As the bringing in of the harvest required the largest supply of labour, this stage was a bottleneck in the work of the farm. It was not profitable to cultivate or sow larger acreages than could with certainty be harvested. Therefore production technology in harvesting work was in reality to limit the extent of the production volume and a large part of the productivity in arable farming. Through a series of interacting factors a mechanised agriculture developed for the first time in the middle of the nineteenth century in the American Middle-West. There was a great abundance of even land which suited the agricultural machines very well, while the supply of labour was less good. In addition the farmers in the Middle-West had access to large and growing domestic markets, and through the revolution in the transport service they were also able to sell their products on foreign markets. Thus favourable market forces developed an agriculture with particularly great purchasing power in the Middle-West, and it made additional profits by ordering agricultural technology which became relatively cheap in comparison with manpower. As a result of this an agricultural technology industry developed in the Middle-West. Contacts between agriculture and industry took several forms, partly through agriculture's orders from industry, especially the engineering industry, partly through agriculture's supplies to industry, above all the food industries. Chicago became the centre of this interaction between agriculture and industry, and was the world's fastest growing town during the latter part of the nineteenth century. Productivity in American farming increased many times over during the latter part of the nineteenth century, and in grain cultivation mechanisation alone—particularly as regards harvesters—accounted for more than half of the profits from productivity.

The emigration from Europe was an important factor in the economy during the latter part of the nineteenth century. The immigrants contributed to the move westwards and created a new agrarian production area which through its efficiency and sales direction became a competitor of European agriculture. On the whole the same factors which had favoured the establishment of a mechanised and commercialised agriculture in the Middle-West after 1850 existed a few decades later in the new immigration areas of

Canada, Argentina, Australia and Siberia. Here too a mechanised and commercialised agriculture of the Middle-Western type developed, starting around 1890. The supply of arable land was good in relation to the sparsely populated areas, and there was a shortage of labour. In addition there was access to growing domestic markets and markets abroad. The domestic market was in fact considerably smaller than that in the USA, and so the mechanisation of agriculture in the new immigration areas did not become as extensive as that in the USA in terms of monetary value. In Canada a domestic agricultural machine industry developed on the basis of American agricultural technology, but Argentina, Australia and Siberia were dependent on imports of American agricultural technology. Gradually, as the emigration from Europe reduced the surplus of manpower, the inclination of the European farmers to mechanise farming also increased. Thus the extensive migration during the latter part of the nineteenth century and at the beginning of the twentieth century played an extremely important rôle in creating and spreading a mechanised and commercialised agriculture. The migration had a double effect on the diffusion of mechanisation in agriculture, first in the immigration areas and later also in the emigration areas.

Agriculture in Europe at the start of the process of mechanisation was dependent on imported American agricultural machines. After borrowing American agricultural technology, countries such as Germany, Britain and Sweden freed themselves gradually from dependence on the USA, and developed significant domestic engineering industries for agricultural machines. At the beginning of the twentieth century the Russian agricultural machine industry also expanded, and reached a not insignificant capacity, but the industry was mainly developed by foreign companies which had established themselves in Russia. It was above all leading American companies in the agricultural machine industry which tried to face the growing European agricultural technology industry by establishing subsidiaries in strategic countries such as Germany, France, Sweden and Russia.

What has been said above relates first and foremost to the mechanisation of arable farming. Furthermore it should be remembered that it was a comparatively small number of farmers in countries with advanced agricultural technology who mechanised farming in a decisive way before the First World War. In Europe probably only 10–15 per cent of the farms had introduced advanced agricultural machines into their production at the beginning of the twentieth century, while the corresponding proportion in the USA was perhaps 30 per cent. On the other hand this minority accounted for a significant sales production of farm produce. Cattle-farming was mechanised later and to a lesser extent than arable farming. Mechanisation took place first in milk production, and for a long time the machine separation of milk on the farms was the only form of mechanisation in operation in cattle-farming. The machine separator was first introduced in Scandinavia at the end of the 1870s, and it played an important rôle in European agriculture's partial changeover to livestock production which began in the 1880s under pressure of competition from foreign grain. The development of refrigeration technology during the latter part of the nineteenth century also extended the transport possibilities and the markets for overseas livestock production. Dairy production made its greatest progress at the beginning of the twentieth century in Scandinavia, Central Europe, Siberia, Australia and New Zealand and North America, the principal surplus areas being Scandinavia, Siberia and New Zealand. In spite of the fact that the demand for milking machines as a natural investment following on from the separator was large, for a long time it proved difficult to adapt it to agriculture on account of technological circumstances. Only when the pulsator was connected to the milking machines could the suction take place with frequent pauses, so that the damaging effect of the suction on the udders and nipples was avoided. The electrification of the rural areas during the period between the wars definitely contributed to a certain extent to the solution of the problem of machine milking and brought about a certain spreading of the milking machines, but it was not until the demand for milk products increased on account of the Second World War that the milking machine made its breakthrough, starting in the USA.

In the present research the reaction of agriculture to the increased demand for agricultural products after 1850 has been studied by analysing the degree of mechanisation and commercialisation of agriculture. The mechanisation and commercialisation of agriculture have directly contributed to industrialisation, and a special analysis of these processes in the pattern of interaction between agriculture and industry has been made. Of course each factor has not acted in isolation but several factors have acted together in some form in larger fields of force. The growth of the agricultural sector was not achieved simply by the mechanisation of arable farming and cattle-farming but could also be brought about by improved farming methods, the introduction of more rational rotation of crops, and more intensive methods of cultivation with larger harvests, resulting in an increased number of harvests. New forms of soil improvement such as drainage and the systematic introduction of fertilizers began to be practised when the land reclamation expansion was drawing to an end. From the nineteenth century onwards scientific discoveries regarding cultivation and improvement by breeding became of ever increasing practical importance for the production capacity of agriculture. After the land reclamation expansion it was of greater importance to invest in forms of soil improvement, mechanisation and more intensive cultivation rather than to make any striking attempts to extend the existing acreage with new marginal land. Furthermore, the extended education in the nineteenth century in the forms both of general mass education and of more practically orientated teaching in agronomy contributed to the growth of the agricultural sector in Europe and the new immigration areas. The processes in agriculture mentioned above mostly developed side by side with the process of mechanisation, and their importance is stressed mainly in order to give a certain balance to the large field of force which caused the expansion of the agricultural sector. In fact a large proportion of the inventions which were engendered by the new situation were closely linked with the mechanisation of agriculture, and as the mechanisation aspect is considered fundamental its rôle has been deliberate subjected to intensive study.[243]

When society has been studied in sectors the agricultural sector's various contributions to the growth of the economy have usually

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[243] Gould, J. D., *Economic Growth in History*, pp. 95 ff. Kuuse, J., *Från redskap till maskiner. Mekaniseringsspridning och kommersialisering inom svenskt jordbruk 1860–1910*, pp. 17 ff. and also pp. 31 ff.

been pointed out. First, an increased productivity in agriculture has led to a greater volume of agricultural production and has brought about a direct increase in national production. Secondly, emphasis has been placed on the importance of the agricultural sector as a customer for capital goods and consumer goods, the farmers thus constituting an important and growing market for other sectors of society, especially in times of agricultural expansion. Thirdly, an increase in agricultural production has been able to provide transfer profits for the national economy when the possibilities of transferring labour to other sectors of the economy with greater productivity were facilitated and speeded up. The first and third contributions mentioned above seem quite plain, but as regards the aspect of agriculture's contribution to development via the market, it would probably be more appropriate to link it with the concept of balanced growth. According to this concept development is considered more from an intersectoral point of view, and parallel growth in agriculture and industry is advocated as the best strategy for development. The market for industrial products must in the main be sought in domestic agriculture, as the agricultural sector is large, but if farming is to be stimulated to higher productivity, industry and the urban population must buy agricultural produce and offer consumer goods to the farmer in exchange, as an incentive for further agricultural expansion. The best-known attempt at industrialisation contrary to the principle of balanced growth was made by the Russian state during the 1890s, when industrialisation was forced forwards at the expense of the farmers, who constituted about 80 per cent of the population. However, the attempt at industrialisation was halted on account of Stolypin's agricultural reforms after the revolution in 1905, and economic development was linked more closely to the principle of balanced growth. In contrast to the Russian experiment countries with a more even industrialisation such as North America, large parts of Europe and Japan, experienced a plain expansion during the course of early industrialisation, even though the paths taken by the individual countries to attain this expansion varied according to the economic conditions.[244]

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[244] Gould, J. D., *op. cit.*, pp. 100 ff. Higgins, B., *Economic Development. Principles, Problems and Policies*, pp. 327 ff.

Mechanised agriculture's orders from industry were thus a key factor in the early industrialisation in several countries. Agricultural technology orders became of particular importance to the engineering industries in countries such as the USA, Canada, Germany and Sweden. Furthermore, the mechanisation and commercialisation of agriculture led to the development of a lot of food industries, as agriculture was able to improve and distribute its produce in a more rational way through the food industry. Flour-mills, bakeries, dairies, slaughterhouses, sugar refineries and breweries became on the whole machine-intensive sectors of industry. The extensive orders for machinery by the food industry from the engineering industry were therefore significant chain reactions from the commercialisation process in agriculture.

Most of the engineering works which supplied farming with agricultural technology were comparatively small company units whose business was based mainly on a local market. They are represented by Lilla Harrie and Skurup in Scania among the workshops studied in the present work. The sales contacts between the many small workshops and the farms became more direct than such contacts as the larger companies, which aimed at covering regional and national markets, were able to develop. For many of the smaller farmers, who hesitated about making an investment, the opportunity of direct contact with the supplier was a valuable psychological asset. The larger engineering works, with middlemen as special distributors, concentrated perhaps primarily on farmers who were more aware of agricultural technology, and a hesitant buyer might regard them as anonymous sellers of agricultural implements and machinery. Therefore many smaller engineering works found the local market a suitable base, affording them sufficient 'lebensraum' in which to work and develop. With their special aim of sales and service, the smaller engineering works were complementary to the larger ones in agricultural technology. Most of the smaller engineering works which produced farming implements and machinery were to be found in rural areas. Industrialisation in Sweden was for a long time a rural phenomenon, and agricultural orders placed with the small workshops contributed to a high degree to the industrialisation of the rural areas in Sweden. The same tendencies were not as pronounced in the USA, where the concentration of companies at the beginning of the twentieth century was carried much further than in Sweden. Some of the largest American manufacturers of agricultural technology developed into giants in the industry, with far-reaching vertical and horizontal company integration. These multinational companies, of which International Harvester was the most prominent, achieved an enormous market range. AB Separator was the only multinational company in the agricultural technology industry in Sweden before the First World War, and it achieved its position by concentrating on the foreign market and limiting its production to separators to a great extent. Through far-reaching integration the large groups were able to act comparatively independently of the sub-contractors of semi-manufactured goods and raw materials. However, medium-sized and smaller producers of agricultural implements and machinery usually became dependent on a network of sub-contractors. The establishment of these sub-contractors constituted another example of an industrial chain reaction through the mechanisation of agriculture.

The fact that the expansion of agriculture during the nineteenth century was not just caused by mechanisation has already been pointed out. In several modern industrial countries mechanisation did in fact play a significant part and stimulated the establishment of a domestic engineering industry. The clearest case is that of the USA. Britain, and Japan are examples of countries in which orders for agricultural technology played a somewhat smaller part in the development of the domestic industry. Britain's progress in agriculture was due more to organisational changes, soil improvement and more intensive cultivation. Furthermore, the industrial revolution had been in existence in England for more than a hundred years before orders of a more significant size from farming for agricultural technology could affect the English engineering industry.

In Japan the production capacity of agriculture was increased at the end of the nineteenth and the beginning of the twentieth centuries mainly through intensive farming methods, and the system of double harvests in each year spread northwards in Japan. The conditions for the establishment of a mechanised agriculture were few in Japan as compared with the USA. In Japan there was a shortage of arable land and the population density led to an abundance of cheap labour. Nevertheless the technology was adopted in Japanese agriculture, but it was a question of small-scale technology which could be suitably combined with a plentiful supply of labour. In Japan first the American and then the European technology was borrowed, but it only proved suitable in a small number of cases, and in this situation the Japanese, with technological assistance from Americans and Europeans, created a small-scale agricultural technology which could raise the productivity on the many small farms. At the same time Japanese agriculture made use of European and American experience of soil improvement, plant breeding, planting seed selection and animal breeding which opened the way to more intensive farming. Industrialisation in Japan took place through good contact with agriculture. Agriculture's orders for less advanced agricultural technology certainly favoured the establishment of small engineering works, but as the demand for more advanced agricultural machinery was limited, these effects were less extensive from the point of view of industrialisation than they were in many other places. Instead the most outstanding example of contact between agriculture and industry in Japan was the expansive development of silk culture and the silk industry. A large part of the silk could be sold abroad. To a high degree it was the export income from the silk which enabled the Japanese to import goods which were important for the industrialisation of the country. Gradually Japanese industry was also able to diversify.[245] Otherwise the export income from agriculture usually played a great part for a long time in the industrial development of the countries which are now industrialised. For example, goods from the primary sector constituted almost 75 per cent in value of the USA's exports as late as the 1890s, when the country had become the world's leading industrial nation.[246]

The trade in agricultural implements and machinery which developed at the end of the nineteenth and the beginning of the twentieth centuries took place almost exclusively between the countries which are now industrialised. This is particularly apparent when one

[245] Higgins, B., *op. cit.*, pp. 617 ff.

[246] Gould, J. D., *op. cit.*, p. 108.

compares the sales areas of the large groups International Harvester and AB Separator with one another. They show remarkable similarities, and the complete absence of the underdeveloped countries from the market is striking. It was the effects of the extensive population transfer which to a high degree created at that time conditions for a mechanised agriculture in the industrialised countries of today. It is hardly possible for similar effects to arise today, and for mechanisation to solve the problem of agricultural productivity for today's underdeveloped countries.

The continuation of mechanisation in Western capitalist agriculture has gradually increased the productivity of the agricultural sector. In many cases high efficiency has now created more or less chronic surplus problems. Agriculture in the Soviet Union and China and to an even higher degree in the underdeveloped countries is forced to live with deficiency problems, and to appear to be more sensitive than agriculture in the Western world. Industrial technology does not vary much in the industrial countries and in the underdeveloped countries, whose industry insofar as they have one is based to a great extent on foreign investment, or in capitalist and socialist countries. The comparative difference in productivity between industrialised and underdeveloped countries therefore seems to be somewhat smaller in the industrial than in the agricultural sector. Thus the difference is great between the agricultural productivity of the industrial countries and that of the underdeveloped countries, and apparently also between that of the industrialised capitalist countries and socialist countries, and it is the agricultural sector which, in terms of employment, is still dominant in the underdeveloped countries and still fairly large in the socialist countries.[247]

An increase in the productivity of agriculture in the underdeveloped countries therefore stands out as the only realistic solution to the world's hunger problem. However, the underdeveloped countries are faced with a conflict between problems of economic efficiency and social problems of employment. By the introduction of a small-scale agricultural technology it would be possible to achieve a significant increase in productivity without at the same

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247 Higgins, B., *op. cit.*, pp. 202 ff. and also pp. 303 ff. Gould, J. D., *op. cit.*, pp. 71 f.

time making the employment situation worse, and to make profits by reducing the wastage which arises mainly in connection with harvesting and the stocking of harvests. Japan, who built up something of an early mobilisation economy during the Meji period, has shown one way to agricultural expansion by combining work-intensive farming methods with a small-scale agricultural technology, thereby creating a significant growth in the agricultural sector in spite of the fact that the conditions were not the most favourable. The adoption of work-intensive farming in combination with small-scale agricultural technology appears to constitute a reasonable way to economic development in the underdeveloped countries under existing conditions. The success of this development will depend on the possibilities of devising an agricultural technology which in great measure is no longer relevant for the more advanced agriculture in the industrialised countries. In this respect the underdeveloped countries have to bear the main responsibility, and combine in a realistic way work-intensiveness and borrowed technology.

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