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Rainfall variability, soils and land use changes in the Ethiopian highlands

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Abstract

Most farmers in the Ethiopian highlands are dependent on rain-fed agriculture. The indigenous cereal tef is the most important crop for the farmers in the highlands. The central highland is an environmentally fragile area and a marginal area of Ethiopia with a recurring problem for the farmers to sustain an adequate agricultural production.

The objectives of this thesis are; to analyse the rainfall change and rainfall variability in time and space and its impact on farmers' potential to cultivate during the short rainy season *Belg*; to analyse the status of soil parameters and its consequences for farmers' food production and; to analyse land-use changes and its consequences for the farmers dependent on agriculture. The geographical focus is on the central highlands and especially South Wollo. The rainfall analysis is based on daily rainfall data from 13 stations and covers the time period 1964-2012. Land use and land cover changes were analysed by interpretation of black and white aerial photographs from 1958 and colour satellite images from 2003 and 2013. All soil samples used in the study were analysed according to standard methods. In addition interviews with farmers and field observations were done during six different field campaigns between 1999 and 2012.

The results reveal a decline in the total *Belg* rainfall since the 1980's in the central highlands. The total amounts of rainfall during the long rainy season, called *Kiremt*, have increased during the same time period. An increase in the rainfall variability over time is also found. The increased rainfall variability is also found when comparing two adjacent places only 30 km apart. It is also found that the synchronicity of rainfall between the two adjacent stations is very low during *Belg*, but higher during *Kiremt* season. A rainfall model for tef cultivation is developed and used as a tool to analyse the impact of rainfall changes on tef cultivation. The model suggests that during the time period 1963-1982 and 1984-2003 farmers were able to have a potential tef harvest every second year during both these twenty-year periods. The model also shows that the possibilities to grow tef at Combolcha after 1996 has



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become more difficult and the possibilities to grow tef during the *Belg* season are very limited today.

A comparison of the soils' nutrient status and mechanical properties in Tehuledere and Wenchi shows that most parameters are found within a normal range however, the organic matter content is very low in Tehuledere, which may explain lower soil productivity compared to Wenchi. This also confirms the farmers' perception regarding the soil productivity in Tehuledere. The study also suggests that different cropping strategies such as enset plantation may have a significant positive effect on the soil status.

An increase in the number of houses and a decrease of farm land during the past 50 years suggest that land is more intensively used today. The fact that the farmers claimed that they not have been able to have land in fallow may confirm this. New techniques such as water harvesting ponds introduced in the study area in 2009, as well as the development of irrigation systems along a creek introduced in 1999, are measures that may increase the agricultural production and enable some farmers to develop and improve their farming strategies.

The findings presented in this thesis shows that there is a need to improve the soil productivity parameters such as organic matter in many areas. The change in rainfall shows that the impact rainfall has on farmers potential to grow tef varies from one place to another. Some farmers having access to larger land, access to irrigation or water harvesting have improved their livelihood situation, but on the other hand some farmers have ended up in a more difficult situation due to changes of rainfall, sometimes in combination with problems with soil productivity. Future studies of the farmers' situation such as analysis of land-use changes, analysis of farming strategies and adaptation due to the rainfall changes are important to understand how to reduce poverty in rural Ethiopia in the future.

Keywords: rainfall change, soil productivity, tef, land-use changes, water harvesting, South Wollo