The interactions of human mobility and farming systems and impacts on biodiversity and soil quality in the Western Highlands of Cameroon

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6 General Discussion and Synthesis

The responses of the inhabitants of the Western Highlands of Cameroon (WHC) to an increase in population pressure and economic stress have brought about rural-rural mobility, rural-urban commuting, rural-urban migration, urban-rural migration and occupational diversification. The interaction between the human mobility patterns and farming systems, have effected change in the biodiversity and soil quality in the area. This study has made an attempt to bring into focus the interaction between the driving forces of human mobility, the sustainability of the farming systems and what has impacted on the biodiversity and soil quality in the WHC.

The demographic pressure of the WHC coupled with the cash crop crises prompted the rural population to seek for alternative ways of making a living. This brought about different types of human mobility.

6.1 What are the driving forces, contributions and categories of human mobility in the study area?

My results reveal that a diversification of occupation and income had become widespread in the WHC. One important reason for this was population growth and increased pressure on natural resources. In addition, the difficulties encountered by small-scale farmers in their struggle to make a living out of agriculture in an already risk-prone environment, had been exacerbated by economic reform and this had become an important 'push' factor for diversification. Young men in the WHC had found an occupational niche by offering transport services on motorbikes from the tarmac road and other pick-up points to the hinterlands. Return migration had injected financial resources and new skills into the local economy, but it was generally limited and varied between locations, depending on factors such as success in accumulating capital and skills, which in turn depended largely on educational levels and the income secured while away; the infrastructure and opportunities in home areas and access to local assets such as land, encouraged investment but also provided a safety net to migrants. In this my results support the views of Tacoli (2002) who stated that the contributions made by migrants when urban-rural migration takes place need to be better recognised and supported, as does their need for a safety net, given the often high levels of insecurity in urban labour markets.These migrants bring about significant diversification in the rural environment. Diversification is a key element in the livelihood strategies of most rural inhabitants and education is the most important single factor in determining whether diversification can start an accumulation process, or whether it is part of a survival strategy (Tacoli, 2002). Education would equally influence the understanding and adoption of technological packages.

Substantial information was obtained in order to provide adequate answers about the driving forces and their contributionto the different types of mobility found in the study area. While the low earnings from coffee production and demographic pressure were diagnosed as the most important driving forces on human mobility in the study area, various types of mobility and cropping systems were established as responses to alleviating problems and improvingreturns for the farmer. My research results show that there had been a transformationin the intra-rural mobility trends since the drop in the price of coffee on the international market in the early 90s. During the coffee boom-years, farm plots that were far from the homesteads were dedicated to subsistence crop production mostly through shifting cultivation or long fallow systems. However the end of the coffee boom and demographic pressure orchestrated rural-rural mobility for the production of vegetable crops that had become the replacement cash crops. As a result, farmers had started commuting to designated areas suitable for the cultivation of the vegetable cash crops and the shifting cultivation system subsequently gave way to intensive off-farm input systems. These results are in accordance with the observations of Potts (2006) who postulated that migration patterns can be a sensitive indicator of the spatial expression of economic and social variations in a region or a country. Increasing population and economic stress have acted as driving forces to reshape the lives of the farmers of the WHC. Results obtained from this work also demonstrated that better access to local assets (such as having access to farm plots at the high altitudes with a water supply) reduced the need for rural-urban migration, but non-economic aspects (such as household endogenous factors) were also significant determinants. Traditional approaches to migration focus on 'push' factors (economic hardship in areas of origin) and 'pull' factors (economic opportunities in destination areas) to explain the direction of movement (Lee, 1966). They usually fail to account for specific cultural and social factors, which play important roles in determining not onlydirection, but also composition and type of movement. Access to resources in home areas is a critical factor which is likely to be influenced by gender and age. In the WHC our findings showed that rural-to-urban migration was associated with both the number of household members and the age of the head of the household. The drop in coffee prices in combination with demographic pressure influenced the mobility pattern and land-use in the area.

In the study area, the commuting of rural farmers to the regional urban centres of Dschang where products were sold at higher prices to wealthier consumers was provoked by the costly off-farm inputs (improved planting materials, inorganic fertilizers and pesticides) that they were obliged to use due to the development of intensive cultivation practices; it was only in this way that the farmers could make their smallholding economically viable. The pull of urban markets for vegetable products that characterises the rural-urban commuting by high-input farmers of the WHC diagnosed by this study was also influenced by the level of the existing infrastructure. Given the perishabilityof these crops, long distance transportation without refrigeration facilities was impossible. The absence of appropriate storage and transportation facilities were major handicaps to evolution in theregion. The losses of perishable fruits and vegetables have been estimated at between 40 and 50% in the tropics and subtropics throughout the agro-food chain. This is mostly due to spoilage, physiological decay, and water loss, mechanical damage during harvesting, packaging and transporting (FAO, 1995 a and b). These results contribute to an understanding of intra-rural mobility in Africa which is currently the least studied aspect ofpopulation mobility (Potts, 2006) as opposed to international migration (Stanton *et al.*, 1991; Crush and Wilmot, 1995; Crush and Mcdonald, 2002), both to neighbouring countries and the new interest in the role of the African diaspora far afield (Black & King, 2004). It is useful to note that rural-rural mobility has been identified as the strongest element of internal migration flows in some sub-Saharan African areas, with slightly more people involved than in the other three categories (rural-urban, urban-rural andurban-urban) put together (Potts, 2006). Rural-urban and especially urban-rural types of migration are much studied owing to their impacton urban economies (Potts, 1995, 2004, 2005; Ferguson, 1999; Beauchemin & Bocquier, 2004). Intra-rural movement is relatively neglected, perhaps because it is not associated with a shift in sectoral activity and is deemed to be of less interest in terms of assimilation issues (Potts, 2006). However, the massive movements of 'stranger' farmers within West Africa have been addressed, involving movements from the Sahelian zones to the wetter south to work oncash crops such as cocoa and coffee (Swindell, 1984), and some research has been done onthe return of refugees and internally displaced people to rural areas in their countries of origin (Wilson, 1992; Myers, 1994; Allen & Morsink, 1994; Koser, 1996, 1997). Host-stranger arrangements were widespread and flexible in both urban and rural areas and facilitated mobility in the WHC as in many other regions in Africa (Swindell & Iliya, 1999).

Efforts to maximize their efforts brought about achange in the farming systems with different approaches to the intensification of land use over space and time in addtion to the modification of input use in the farming systems. These new approaches modified the sustainability of farming systems.

6.2 What are the levels of sustainability and the relationship between sustainability and the different factors affecting farming systems in this zone?

During my research, I found that the traditional on-farm input-dependent system characterized by shifting cultivation and intercropping had fallen short of satisfying the demands of the rural population which was greatly concerned with income generation especially after the drastic drop in the market value of the original cash crop, coffee, in the early 90s. My study revealed a pragmatic and measurable format for sustainability relevant to small-scale farming in the WHC in particular, and sub-Saharan Africa in general. My results also revealed that the heavy dependence on off-farm inputs of the commercial vegetable producers of the WHC was a threat to the long-term sustainability of the system. The maintenance of agro-ecosystem function in the face of forces of change is a product of ecosystem properties and management activities. The main factors that influenced the long-term sustainability of the farming system in the WCH were grouped as: land use intensity over space, intensity of off-farm inputs, household adjustment factor and mobility of household, in descending order of importance. In other words, intensive land use was greatly favoured because of the possibility of cultivation during the off-season. In as much as this practice exploited the soil nutritive elements and destroyed the soil structure, it favoured the excessive use of off-farm inputs which were indispensable for the practice of intensive land use in my study area. These negative sustainability approaches in the WHC were found to be promoted by both younger and older farmers with less household residents. The last component in the multiple regression relation involved mobility of the household where favourable practices of crop biodiversity were discouraged by the distance of the farm plots from the homestead. The study showed that the further the farm plots were from the homestead, the greater was the tendency to have fewer crops in the field. The advantages of intercropping systems include yield stability under adverse environmental conditions, efficient use of limited growth resources, biological diversity, and potential control of pests and diseases.

My study revealed the litany of problems faced by the farmers in the WHC as laid out in this document. Smallholder farming systems are undergoing changes which impact on long term sustainability and social differentiation. In terms of livelihoods, many constraints inhibit both high quantity and quality outputs. Access to international markets for smallholder producers in the WHC was nonexistent, while local, national, and to some extent, regional marketing networks were the main outlet for small flows of diversified production. Investment in post-production infrastructure, information, roads and transport networks were found to be essential for the long term survival of these local marketing systems. High-quality land transport infrastructure facilitates economic activity, improves access to health care and education, raises social welfare by bringing consumer goods to rural areas, and facilitates social integration. In my research, I found that in the WHC, long distances, underinvestment in infrastructure, and inefficient trade and transport policies resulted in high land transport costs and low land transport quality. I concluded that this impeded the movement of labour and goods, reduced access to information and technology, and reduced export competitiveness by raising both the prices of imported inputs and the costs of transporting the final products to market, as was also noted by Farrington and Gill (2002). Continued access to farming assets is essential for poor and vulnerable groups in the WHC. Access to the main assets linked to farming (natural resources such as land and water, labour, either unpaid family or waged, credit, and markets) often depend on an individuals' social position (*ibid*). In my study, I noted that constraints over access to farming assets, especially land, were important factors in intergenerational conflict and changes in the pattern of employment. Increasingly, financial dependence on household heads, linked to contributing unpaid labour on the family's farm, was resented by the younger generations. Also Jambiya, (1998) and Mung'ong'o, (1998), found that shrinking natural resource availability and financial constraints on agricultural production strongly encouraged young men's engagement in non-farm employment as noted.

The modified farming systems as well as the extension of the land area for cultivation had greatly impacted the biodiversity of the agro-ecosystems in the area.

6.3 What are the different types of biodiversity of agro-ecosystems in the WHC and how are they influenced by abiotic factors?

The intensive cultivation system and drastic decrease in fallow length were other significant factors in the system which had already reduced plant biodiversity as reflected in the biodiversity ofthe 'sacred groves' of the area. For centuries, the indigenous people of the WHC and natives of other parts of Cameroon have loyally guarded patches of forest and accompanying streams commonly referred to as 'sacred groves' as described by Shonil and Claudia, (2006). They are believed to be the dwelling places of "Gods", and in some areas, are the burial grounds of royalty. I found that certain species of trees were considered sanctified (God's trees) and believed to have healing powers. The sacred quality of other groves derived from reverence for an animal species that lived there, most commonly monkeys or leopards. During my interviews I found that other sacredness originated from a river or stream that was home to a water god; the surrounding woods then became a protected area. Shonil and Claudia, (2006) found that logging, gathering of firewood, fires, hunting and cultivation in sacred groves were routinely banned, and in some groves, entry was restricted for women during their menstrual cycle. I also found that the custodians of the groves held ceremonies and rituals of ancestral worship in the forests. Telly (2006) noted that permission to take certain botanical elements for medicinal purposes from a sacred grove was sometimes granted.

I found that in the WHC, rural-rural mobility accounted for intensive land-use which had completely changed the structure of the native vegetation and caused severe plant diversity losses when compared with the composition of the sacred groves though some useful forage species such as *Pennisetum clandestinum*had been introduced to the area. I suggested that conservation of the sacred groves was important for the provision of certain ecosystem services in the WHC. Jackson et al (2007) already suggested that natural ecosystems provide many services essential to human existence such as water, medicinal plants and fruits. Increased species diversity provides more opportunity for species interactions, improved resource use, and ecosystem efficiency and productivity. It has been shown that intercropping in the grasslands outperforms the best monocultures, resulting in better production and more storage of carbon (Tilman *et al.*, 2002). In general, there is a positive correlation between species richness and productivity, and ecosystem resilience to drought (Tilman, 1997). Intercropping systems in the WHC were nearly exclusively in the production of subsistence crops. Well planned intercropping systems could provide better results in the cash crop systems of the area. Biodiversity in the WHC was strongly related to ecosystems and abiotic factors. I found that the herbaceous α-diversity[1] was significantly higher in the fallows than the sacred groves at low altitude; the tree species richness was higher at low altitude compared to the high altitude with tree ß-diversity[2] increasing with altitude; varying combinations of soil pH, total P, total K, CEC and slope percent were related to herbaceous species richness, herbaceous Shannon index and shrub species richness. In general the sacred groves contained a higher biodiversity, composed of trees, shrubs and herbaceous plants, compared to the fallow vegetation where trees and shrubs were very insignificant.

The different types of cropping and farming systems developed as a result of mobility and land use provoked significant changes in soil quality.

6.4 What is the impact of the modification of the farming system on soil quality at the crop and farm levels of the study area?

A modification of land-use intensity and cropping systems in the study area had a drastic impact on soil quality at the crop and farm levels. I found that nitrogen was the major element drained in the system while there was an excess of potassium and phosphorus in the predominantly sole cropping systems in the study area. This is in agreement with the findings of Matson *et al.* (1999) who noted that in tropical agro-ecosystems, most of the nitrogen is transformed into NO_3^- due to the heat and moisture and the majority is not taken up by plants but leached out of the system. My results show that the highest negative full balance for nitrogen wasto be found in mixed intercropping of bean, maize and potato; the highest negative full balance for phosphorus was in green pepper production;the highest negative full balance for potassium was observed in cabbage production.With the partial NPK balances, except for the mixed intercropping system of beans, maize, potato and yam, all the others were positive for nitrogen while the partial balances for phosphorus and potassium followed trends similar to the respective full balances. With regard to the average results of the research site, the full balances were positive for potassium and phosphorus, which are less susceptible to loss and negative

1 α diversity is the biological diversity at one site or sampling location.
2 β diversity is the change in diversity among various α diversities

for nitrogen while the partial balances were positive for all three. I also found that the yield and gross margins of the cropping systems in the WHC need some particular attention as negative gross margins were identified through my analysis. The negative gross margins for green peppers, leeks and onions indicated that either they were not profitable or the cropping practices were not adequate. Farmers may not be aware of this because the farm records they keep do not generally show such information.

6.5 Conclusion and recommendations

I found that vegetable cash crop farmers use significant amounts of inputs including a multitude of cultivars per crop which excludes them from the theory of involution or non-innovative intensification as outlined by Keys and McConnell (2005). I suggest that population pressure does not work in an unmediated fashion; rather it operates in conjunction with market and other social forces. The response of the inhabitants of the WHC with regard to the main forces that drive our framework can provide a guide when comparing their attitudes with respect to the many theories outlined. The famous models, of determinism (Malthus, 1989), possibilism (Boserup, 1965) as depicted by Gunnel (1997), and involution (Geertz, 1963) which still serve as a subtext to almost every contemporary debate on the environment and economics in the developing world, are cases in point; and yet, while the WHC cannot truly subscribe to environmental determinism (despite some isolated cases of detrimental effects on vulnerable lands) and involution, it does not conform entirely to the coordinates outlined by Boserup (1965). Non-innovative intensification or involution is not in essence, a typical characteristic of the WHC. The results obtained from my study show that demographic pressure does not lead to intensification of land use per se, as farm families employ strategies such as temporary or permanent migration and occupational diversification. This is substantiated by the significant numbers of household members involved in the different types of mobility in the WHC. By the same token, our results do not provide any justification for a Malthusian degradation spiral associated with increasing population in the WHC as suggested by Malthus (1989). Intensive agriculture in this zone is location and crop specific, a change which ocurredt after the precipitous decline in international coffee prices. Being nearly entirely dependent on agriculture, the practice is the farmer's way of coping with the economic situationin which they find themselves. However, no community is in perfect demographic equilibrium, and the number and ability of productive members, and their ratio to consumers, as well as the needs and aspirations of those consumers, are always important factors. Human movement, voluntary and involuntary, is a reflection of the initiatives and responses of people to the changing nature of society and the economy.

The different villages studied in this work clearly underline the necessity to tailor policies to local circumstances and to the specific needs and priorities of different groups in the region. It is crucial that future studies should account not only for internal demographic growth, but also for seasonal, generational, and permanent flows of labour and consumers, and to the knowledge, skills, and other resources carried with immigrants and returned migrants as proposed byKeys and McConnell (2005). No totally isolated agricultural communities can exist. Market signals are pervasive, influencing a broad range of outcomes. While proximate urban markets are seen to encourage the development of gardening and fruit production, distant international markets provide the incentive for planting other crops, particularly stimulants such as coffee, tea, and cocoa. These local or nearby markets encourage farmers to grow higher-value crops on limited landholdings (Eder, 1991). Farmers in the WHC are no exception to the rule as the national and international markets are the major stimulus guiding their farm activities. Apart from the local market in Dschang, the divisional headquarters, the Yaounde and Douala markets which are the political and economic capital cities respectively, in addition to Gabon and Central African Republic, international markets constitute the prime consumers of the farm products from the WHC. Eder (1991) also noted that farmers near Cebu City in the Philippines began cultivating new vegetables in response to increased demands and new taste preferences. A number of cases of horticulture also involved markets that lay farther away from cropping regions. Chilies, produced in southern Mexico, were sold some 1000 km away in Mexico City (Keys, 2004). The vagaries of the demand for stimulant crop products have important implications for the production of crops that take several years to produce fruit (Keys & McConnell, 2005). It would not be a surprise to observe a significant and abrupt change in the WHC if the market prices of coffee become very attractive again. Given the fact that coffee is the world's second most important commodity in legal internal trade after oil (O'Brienand Kinnaird, 2003) and that it is also the developing world's most important earner of capital, many farmers will be tempted to revert to it when the economic conditions become favourable. Improving the infrastructure and marketing channels is indispensable for sustainable production. The quality of land transport infrastructure is correlated with output, productivity, growth rates, land values, and market development (Farrington & Gill, 2002).

Sustainable agriculture is not a single, well-defined end goal. There is the general consensus that less time should be spent defining sustainable agriculture and more time spent on working to achieve it. This is because sustainability is a question rather than an answer or a direction rather than a destination. What constitutes sustainability in environmental, social, and economic terms is continuously evolving and is influenced by contemporary issues, perspectives, and values (Brodt *et al.,* 2011). Agricultural systems are artificial systems and distinct from natural systems as a result of man's purposeful interference and manipulation. The continued disturbance through artificial soil, weed and pest management exacerbated by the harvesting of desired plant and animal products influences the economic and ecological sustainability of the system. In the short term, economic sustainability may not be equal to ecological sustainability but in the long term this is expected to be the case. At the end of this study there will be a need to address the question of the economic and ecological sustainability of the WHC. How close to development are the activities carried out in the WHC that meet the needs of the present without compromising the ability of future generations to meet their own needs? The change from shifting cultivation to intensive land use has brought about modifications, amongst which are biodiversity loss and improved livelihood from vegetable cash crop cultivation. This biodiversity loss is felt both with regard to cultivated crops and important natural vegetation which possess a number of positive ecological functions. Intensive land use around areas with water available for irrigation also contributes to influence the sustainability of the system. It has been shown that natural resource scarcity is often an expression of conflicting relationships between humankind and nature (Farber, 2000). Efforts are required to improve the sustainability of the traditional high biodiversity base system where the yield levels are presently very low. Environmental degradation undermines the economic and societal conditions essential to the well-being of a growing human population (Homer-Dixon, 1994; Scheffran, 1999). However, resource scarcity may not always lead directly to environmental conflicts, though a clear correlation may be hard to prove for complex situations. An increasing number of environmental agreements demonstrate that, under certain circumstances, threatened environmental systems can be improved through well designed approaches. In the case of the WHC, there is the possibility of exploiting natural resources that can improve both the soil quality and structure and promote less dependence on off-farm inputs. Appropriate intercropping systems will also contribute to improving both the economic and ecological sustainability of the area. Expanding the cultivation of the natural vegetation found exclusively in the sacred groves and which is on the verge of extinction, is indispensable for a healthy functioning of the ecosystem. In searching for ways to develop more sustainable agro-ecosystems, several researchers have suggested that tropical agro-ecosystems should mimic the structure and function of natural communities, (a practice followed by thousands of indigenous farmers for centuries), as these systems exhibit tight nutrient cycling, resistance to pest invasion, vertical structure and preserve biodiversity (Soule & Piper, 1992). If such an ecological approach is used, it will be important to ensure that promoted systems and technologies are suited to the specific environmental and socio-economic conditions of small farmers, without increasing risk or dependence on external inputs. I support the ideas of Altieri (1995) who postulates that agro-ecological development projects should feature resource-conserving yet highly productive systems such as intercropping, agroforestry and the integration of crops and livestock. There is thus a great need to conserve the biodiversity of the WHC. Complementary genetic conservation through combining the use of insitu and exsitu technology (Damania, 1996) has been very successful in other areas. In situ conservation is vital because it provides a pathway for preserving complete biological diversity. It provides important basic necessities, such as medicines, fodder, food cosmetics, industrial products, fuel and timber, upon which humankind depends. Wild species, including relatives of cultivated plants, are crucial in cropimprovement programs as sources of genes for disease and pest resistance, environmental adaptability and nutritional qualities. In situ conservation evolves to establish and sustain a broad genetic base, stabilize and maintain populations and present opportunities for expanding agricultural systems (Chang, 1994). Great efforts are required in the WHC to preserve many species and cultivars of spices, food and vegetable crops that have become very rare since the introduction of new production techniques.

The capacity of the soil resource to perform the critical function of a life support system is undergoing unabated degradation of different kinds and deterioration due to nutrient depletion (Surendran *et al.,* 2005). Keulen and Seligman (1992) showed that nutrient deficiencies limited the primary production more than water availability. Changes in soil fertility level should be monitored to provide an early caveat on adverse trends and to identify the problem areas. Understanding the nutrient balance at each crop activity level within the farm and at farm level is essential, in order to accurately guide agricultural policy decisions for planning at these levels, which can help to improve the crop yield and to sustain the production system. Tropical regions and especially the WHC experience this particularly as the NO_3^- is easily available in the dry season but is easily leached when the rains come at the beginning of the growing season before the young plant root systems arewell established. The introduction of nitrogen-rich leguminous species and other organic agriculture techniques can take care of this deficiency as was portrayed by intercropping systems that contained beans as a companion crop in the study area. However, a thorough understanding of farming systems is required in order to develop technological interventions, appropriate to the management of soil fertility (Hilhorst & Muchena, 2000). Chemical fertilizers could be regarded as the technical solution, directly as a supplier of nutrients, indirectly as a trigger for more nitrogen fixation and for more and better organic matter (manure, crop by-products and agroforestry). However, the efficiency of fertilizers is very low in African agriculture, in view of a low nutrient recovery of less than 30% (Van Duivenboden, 1992). Therefore, fertilizer-use must be combined with soil improvement. There is thus a need for research geared to evaluating the quantity, quality and synchrony of introducing different organic sources into the system.

Generally models remain important analytical tools as they organize the temporal evolution of very complex phenomena into different segments, each segment being composed of strikingly different characteristics, offering the means to centre attention on the most prominent aspects of reality. The proposed framework for this study (illustrated in Chapter 1) can be applied to both cross-section and longitudinal perspectives. The framework was applied in this study in a cross-section fashion. It has however, illustrated a clear relationship between the driving forces, responses and impacts in the agricultural production system in the Western Highlands of Cameroon. The scenarios portrayed in the conceptual framework were diagnosed by providing answers to:

- The driving forces and their contribution to the different categories of mobility
- The levels of sustainability, the relationship between sustainability and the different forces driving farming systems
- The different types of biodiversity and the influence of abiotic factors on agro-ecosystems
- The impact of the the modification of the farming system on soil quality at the crop and farm levels

In order for the population in the WHC to adjust to the drastic reduction of revenue from the cash crop of the area, trends in human mobility surfaced that in part transformed the traditional technology of shifting cultivation, to the intensive cultivation of novel species of cash crops based on high dependence on off-farm inputs. This accounted for the modification of soil quality at the crop and farm levels and the biodiversity of agro-ecosystems.

Future studies should explore the validity of the results of this study in other similar areas with pertinent historical data so as to expand and further develop the model presented here. However, the types of mobility claims advanced here are pertinent to the WHC; the quantitative evaluation of sustainability of farming systems reflects the reality on the ground; the constraints expressed by the farmers are contemporary; the nutrient flux evaluated at the crop and farm levels constitute a valuable database to guide future research.

The food challenge will be met using environmentally friendly and socially equitable technologies and methods, in a world with a shrinking arable land base, with less and more expensive petroleum, increasingly limited supplies of water and nutrients like nitrogen, and within a scenario of a rapidly changing climate, social unrest, and economic uncertainty (IAASTD, 2009). Across all farming systems, the efficiency of production or productivity measured in terms of output per unit input, linked to rewarding producers with fair prices and for a range of other environmental and social goods and services need to be emphasized. The only agricultural system that will be able to confront future challenges is one that will exhibit high levels of diversity such as are found in well managed multiple cropping systems, productivity with a positive energy flux, and efficiency in the use of production inputs.The positive indicators found in the study area included high crop biodiversity in most of the farms and the high use of organic inputs that mitigated the cost of production and increased the efficient use of production inputs. However, one of the key challenges in terms of food security is access to and distribution of the food produced.

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