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Effect of market-oriented agriculture on selected agrobiodiversity, household income and food security components

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Abstract

Commercialization of agriculture as a government strategy to eradicate poverty at household level has been envisaged in market oriented agricultural production as a way to negate efforts concerning agro-biodiversity and pause a threat to an insurance for household food security. The research question was whether it is possible to meet the goals and objectives of Plan for Modernization of Agriculture (PMA) through integrated agricultural research for development. The paper discusses aspects of conservation promoting market-oriented production as opposed to conventional subsistence oriented and diversification system. This is an issue subject to investigation through research for development, achievement, and lessons learnt and best practices to establish a reality of policy's possible impacts on agro-biodiversity, food security and improved income. The study was carried out in the districts of Bushenyi and Mbarara, in western Uganda . Methods focused group discussions and household interviews. The selected effect components of the study were number of crops / animal species grown for agro-biodiversity, on farm cash income per annum, as well as number and quality of meals per house hold. Results revealed that market-oriented agriculture increases income, improves quality of meals and accessibility to food, but reduces agro-biodiversity at household level. The study recommends diversification of commercial crops /livestock and popularizing farm enterprises with product that can be utilized locally rather than depending on external market for food security.

Key words: Diversification, farm enterprises, markets, subsistance oriented.

Introduction

Commercialization of agriculture is a Uganda government strategy to eradicate poverty at both household and national levels and is the mission for the Plan for Modernization of Agriculture (PMA). The vision of PMA is "poverty eradication through a profitable, competitive, sustainable and dynamic agricultural and agro-industrial sector". The processes chosen to achieve this vision, as stated in the mission is transformation of farmers and the agricultural sector in general from subsistence to commercial. While the intentions are good and objectives are well stipulated (PMA, 2000), the goal may be difficult to achieve if the possible contradictions in the objectives are not well researched and sorted out. One objective states "improve household food security through the market rather than emphasizing self sufficiency" while another is "to promote sustainable use and management of natural resources". PMA emphasis is that the "farmers must be commercially oriented". However, there is concern that commercialization, which is synonymous with market-oriented production, may lead to specialization and this would jeopardise the efforts to promote conservation and sustainable use of agro-biodiversity. Commercial or market oriented farmers tend to produce what is demanded or profitable on the commercial market thus reducing plant species richness (diversity) on farm in favour of economic gains (Tumuhairw *etal.*, 1999). Agrobiodiversity is shorthand for agricultural biodiversity which means many different crops and livestock species, crop varieties, livestock breeds ,cropping petterns and farming systems.It is a fundamental component of biodiversity, the conservation of which, like poverty eradication, is also a commitment of the Government of Uganda by the fact that she ratified of the United Nations Convention on Biodiversity (CBD). Biodiversity is an important multifunctional natural resource and a major determinant/ indicator of ecosystem resilience. The more species an ecosystem supports, the more resilient it is.

Agro biodiversity is utilized and managed by farmers for the benefit of society at large. A rich agro-biodiversity has for long been an assurance for food security of rural households and also their insurance in case of catastrophic years like drought or pest and disease outbreaks. Loss or significant reduction of agrrobiodiversity would pose risk of degrading Uganda's inherently rich agrobiodiversity resources resulting into unsustainable development.. There is no emperical data to show the relationship discused above. In view of the above concerns, a study was carried out to investigate the effect of commercialization on agro biodiversity and its related household income and food security components. The research question is whether it is possible to have a biodiversity -rich farm that can still meet the goal and objectives of PMA.

The aim of this study was to advocate for integration of agro biodiversity conservation into the market-oriented farming agenda of PMA, for the sake of ensuring

sustainability of our genetic and other related land resources. Findings of this study will contribute to the process of developing appropriate strategies for implementation of PMA and other related policies.

The main objective was to assess the potential effects that market oriented commercial farming might have on the agrobiodiversity resource and its related household income and food security components. the specific objectives were: 1. Assessing commercialization levels of the three farmer categories in two representative rural communities. 2. Assessing the crop and livestock diversity of market oriented commercial and semi-commercial viz. a viz. subsistence farms. 3. Evaluating effects of commercialisation of rural farms on their crop and livestock species diversity, on-farm income, accessibility to food, as well as frequency and quality of meals.

Methodology

The study was conducted in one of the biggest Agro-ecological zones of Uganda; AEZ 4 "Southern and Western tall grasslands" (Jameson, 2002) to ensure relevance for wider applicability. This zone covers most of western region which "faired the worst in terms of welfare indicators despite the fact that it has the second highest income levels" during the 1997 National Household survey. The study sites were two sub-counties, namely Kagango and Mwizi in Bushenyi and Mbarara districts respectively PMA recognizes three farmer categories: Subsistence, Semi-commercial and commercial. Four focus group discussions; (two at district and two at sub county levels) were used to establish farmer categories in the study sites and to develop local indicators for distinguishing the categories and for assessing household food security. Participants included: technical agricultural staff, local councils 1 and 111 Chairpersons, Sub-county Chiefs and farmers' representatives each site. The local indicators given were used to select 250 respondents for the field surveys, targeting 8-12farmers of each of the three farmer categories in each parish. Household interviews were conducted .in eight selected parishes were guided by a structured questionnaire.

Some of the characteristics and indicators listed by PMA and confirmed by the focus group discussion which could be quantified or converted into index values, were used in the survey data collection procedure to be able to develop quantifiable criteria i.e. commercialization index for distinguishing farmer categories. Hierarchical Cluster Analysis was used to group the farmers into the three categories of interest *viz.*, subsistence, semi-commercial and A commercialization index was defined as, the quantity of farm produce sold per total quantity harvested/produced for each enterprise. A mean commercialization index at household level was then calculated by taking the average of all commercialization index values of all farm enterprises, (Govereh and Jayne, 1999).

Species richness was taken as the number of crop types/ varieties grown and animals kept at a particular time within a sample unit (Zarin *et al*, 2002). It is a simplified way of assessing biodiversity at household level.

Agro biodiversity index was calculated and used to show the dynamism in species diversity over a certain period of time in a specific area.

Period was confined to 10 years prior to the study whereas area refers to the current study sites of Kagango and Mwizi sub-counties. Dynamism means change in agro biodiversity.

The change in agro biodiversity ("ABD) was determined as a function of number of current crops grown, number of new crops introduced, number of crops no longer managed and number of crops no longer grown on the farm for the last 10 years. A function for change in ABD was thus formulated according to *Red Data Book of Finland, (1992)* as:

"ABD =fn (Xi) x =1…. n; i =1…. n.

"ABD $=B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3$

Where B_0…. *B3* correspond to the coefficients of the independent variables namely:

X_1 = proportion of new crops introduced.

X_2 = proportion of crops no longer managed.

X_3 = proportion of crops no longer grown on the farm.

It was then drawn from this that the higher the index the greater the change in agro biodiversity.

The agro biodiversity index was divided into crop bio-index and livestock bio-index.

Food security indices were developed by incorporating availability of food throughout the year i.e. accessibility, frequency and quality in a household.

Sufficiency of food throughout the year was used as a accessibility. This is because if food in a household was not sufficient then it meant that accessibility was a constraint either by the household not being able to afford it or it was too far to be reached. All the types of foods taken in the household were noted and a mean index calculated for them in relation to the sufficiency. For example, if a household took only banana and it reported that it was sufficient then it was given score 1. On the other hand if a household diet comprised banana and meat and the meat was reported not to be sufficient then the score was (1 +0) =1. Accessibility here then took into account both the number of different foods and whether they were accessible. Therefore the higher the score the higher the degree of accessibility.

Frequency of meals was defined as the mean of frequencies of all types of foods taken within a given month. For example if a household takes banana 30 days a month and meat once in a month the mean frequency per month for that household would be (30 +1)/2 =15 assuming that the household was confined to only meat and banana.

For food quality, all the types of food taken in the household were grouped into three categories i.e. carbohydrates, proteins and vitamins. There were eight main sources of carbohydrates in the household; banana, millet, sweet potatoes, Irish potatoes, posho, rice, bread and cassava. So each of these foods was assigned a score of one. The same was repeated for proteins and vitamins. Another score was developed for the extent of balanced diet. For example if a household took carbohydrates alone throughout the year it was assigned score one. If the households' diet was composed of carbohydrates and vitamins alone then it was assigned score two.

The above-mentioned indices (proxy indicators) were then used to relate commercialization to agro biodiversity, farm income and household food security. It was not possible to

study all components of agro biodiversity and food security due to time and financial constraints.

Different parametric and non-parametric tests of significance were used to compare means. Cross tabulations, incorporating the Crammers V Chi square tests were used to determine the association between two categories measured at ordinal or nominal level. This was supported by the Spearman Brown correlation coefficient to determine the strength and direction of the association for multidimensional variables measured at the ordinal scale. The curve estimation technique was used to determine association between commercialization, agro biodiversity, and income and food security indices. This was supported by graphical methods to clarify the type of relationship existing between the variables.

Results and discussion

Scio-economic characteristics of studied communities

Social-economic factors were the basis of respondents' characteristics that ranges from gender, major occupation, age, level of education and constraints to commercialization. The average age of group was between 40 in Mwizi and 53 in Kagango (ranging from 20- 65. years .The education level majority of the respondents lie between primary and secondary school. Kagango had more educated farmers than Mwizi.

Farming was found to be the major occupation of most respondents across households in Kagango and Mwizi, over 79% in each. This confirms the views that most Ugandans derive their livelihood from agriculture and that agricultural sector is the biggest employer, over 80% of labor force (MAAIF and MFPED, 2000)

Other occupations in the study sites included being employ in civil service and / or trade. However respondents from the two areas of study participate in farming activity with equal proportion. Kagango has more civil servants 15% than Mwizi 6% most likely due to higher education level among respondents in Kagango but for trade was a reverse. Mwizi and Kagango reported more or less the same agricultural production constraints. Marketing of agricultural produce was reported to be a major constraint in both sites but varying in ranking. In Mwizi farmers reported that unreliable markets (21.8% of responses), lack of transport to the market (11.3%) and low market prices are the major problems similarly the same parameters were ranked third, fourth and fifth constraints respectively in Kagango. The most felt problems during farming in Kagango were lack of capital (cash) and land shortage. All these hinder agricultural development because it promotes conservatism and failure to adopt modern farming practices. Mwizi had started growing wheat 10-15 years ago but abandoned it because of changes in market. Meanwhile the Kagango farmers are hesitant to adopt silk and mushroom growing for which they have received adequate sensitization and training due to fear of risks in marketing of such exotic crops.

Also the farmers reported seasonal fluctuation in prices of milk and bananas have hindered many farmers in both sites from expanding to commercial levels for fear of risks and losses when prices drastically drop.

Farmer categories according to commercialization index

Results in Table 1 by the commercialization index means column shows that the commercial level farmers sell over 80% of their farm produce; semi-commercial sells about 50% of subsistence less than 15%. The level of commercialization in two sites was that Kagango was at higher level than that of Mwizi. Majority of the sample population was semi-commercial of about 78%-80%. Commercial farmers were only 13% in Kagango and 6% in Mwizi while subsistence were 7 % and 13% respectively.

Kagango had more commercial farmers than Mwizi. The commercialization index of Kagango is higher (0.51) than Mwizi (0.47). Implying that on average Kagango sells about 51% of their produce while Mwizi sells about 47%

Crop and Livestock Diversity

Field survey showed that semi-commercial farmers Semi-commercial farmers generally have very rich crop diversity (species richness) with 26 and 24 different species in Kagango and Mwizi respectively and a sequence of the respondents. Both commercial and subsistence farmers grow a much smaller number of crops ranging between 10 to 16 in both sites.

Table 2 shows the common 6 crops grown by each farmer category in the sites. Leading crop in dominance is banana for all categories in Kagango, and semi-commercial of Mwizi while beans took the lead for commercial and subsistence farmers in Mwizi. Other important crops include beans, coffee and Dodo *(Amaranthus spp.)* in Kagango and banana and Irish potatoes in Mwizi for all farmer categories. Generally, Kagango is more pronounced in perennial crops like banana and coffee while Mwizi is mostly growing annual crops like beans and irish potatoes. Eucalyptus is only common and important among commercial and semi-commercial farmers but not subsistence for they are constrained by land shortage. Instead the subsistence farmers commonly grow cereals (maize and millet) and sweet potatoes, known as food security crops. Dodo *(Amaranthus spp.)* is a commercial crop in Kagango. All categories appreciably have various fruit species on their farms.

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Livestock

Livestock species richness follows the same pattern as crop diversity, with semi- commercial farmers keeping more different types of livestock/ domestic animals (10-11) than the rest. However, in this case, commercial farmers keep relatively more numbers (6) than subsistence (4-5).

The possible explanation for the semi- commercial farmers having higher agro biodiversity (species richness) is probably that these are farmers in the transition stage of commercialization. They have adopted new commercially promising species and technologies with a market orientation motive while still maintaining the traditional ones. The commercial farmers have gone beyond this stage and are majoring in few enterprises (specialization) in order to expand for high production levels. This was confirmed by the focus group discussions as one of the criteria, that commercial farmers produce and sell in bulk from few enterprises while semi-commercial farmers have high crop and livestock diversity, selling low quantities but more frequently. Specialization leads to monoculture and its associated economic and environmental problems. For instance South western Uganda is increasingly turning into a banana monoculture which can be damaged by diseases and pests. This may require farmers to use lethal pesticides that eventually may enter water systems and most food chains thus poisoning animals and humans. Such effects have been reporte in apple monoculture of the Hindu Kush- Himalyan Region (Partap and Sthapit 1998).

Relating Commercialization and change in Agrobiodiversity

The effect of commercialization of rural farms on their agrobiodiversity is shown in Table 4, and the model is depicted in Figure 3.

Biodiversity is generally negatively related to commercialization implying that farmers who have adopted this practice (commercial) have reduced the number of species on their farms. The impact is more significant in crops ($p<0.10$) than in livestock. This effect has been felt more in Kagango than in Mwizi, as reflected by the F values (4.61 and 3.74 respectively). The overall trend of the relationship is well illustrated in Figure 1 below. The reason for this difference being the relatively higher commercialization index for Kagango as observed earlier in Table 4.

The dynamism in agro biodiversity is highest at semi-commercial level. This implies that it is at this level that the ecosystem is most resilient and able to survive changes in the environment, be it social, economic or physical environment. This category of farmers stands better chances of surviving any catastrophe than the rest (Brookfield *et al* 2002).

Relating Commercialisation and Income

Results in Table 5 indicate that commercialization has had a very significant ($p<0.001$) and positive impact (b_1) on-farm income for both locations. They also indicate that income increase is more for farmers in Mwizi than in Kagango judging from the higher F value, 11.85 and 8.66 respectively. This relationship of commercialization and farm income for both sites is depicted in model presented in Figure 2 showing the drastic increase in income with increase in commercialisation index. This confirms the theory and expectations on which PMA is based.

Relating Commercialization and Food Security

In Kagango, there is significant improvement in access to food ($p=0.001$) and diet as a result of commercialisation as shown in Table 6 and illustrated in Figures 3- 5. This is probably due to the increased income, which enables farmers to buy food, which the household has not grown whether it is available near or far. Commercialization of farming in Mwizi has not had any impact on accessibility of food despite the significant positive impact on income (Figure 2). This is probably because Mwizi farmers generally consume more of their own farm produce than they sell, as indicated by the lower commercialisation index (0.47). They also grow many food crops (11-24 species). This implies that with or without commercialisation, Mwizi farmers have no problem with access to food.

This also implies that the effect of commercialisation on food security depends on whether the dominant crops are edible or not. Farmers who grow more of non-food crops like coffee are likely to have less access to food than those who grow crops like Irish potatoes that are both for cash and food, irrespective of their commecialisation levels. Domestic needs are met irrespective of market constraints. The significant increase in food security in Kagango is explained by the fact that most farmers have tried to respond to government call for commercialisation and converted some of the under-utilised/non-traditional crops into cash enterprises. For instance *Dodo (Amaranthus spp.)* is a new cash crop in Kagango. The same *Dodo* is abundant but is still disregarded in Mwizi, because there is no commercial market for it there. Kagango being relatively more accessible by highways, have access to urban markets for such crops as *Dodo*, tomatoes *(Lycopersicon esculentum*) and even egg plants (*Solanum melongena).*

Results in Table 6 also indicate that commercialization has a significant reduction effect on frequency of meals in both sites ($p < 0.05$). This is probably because as the farm gets more commercialised; the family members are too busy in farming and selling to sustain frequent meals. The effect is more severe in Kagango than in Mwizi as shown by the higher F value (42.7). This relationship of the variables is illustrated in Figure 6. Similar explanation for the differences between the two sites given above to accessibility applies to frequency of meals, because Mwizi has not changed much from her traditional practices. They only sell surplus of their food crops. In addition, Mwizi is dominated by Bakiga people who traditionally work in field's almost whole day and prepare meals even in the field. So frequency of meals do not change as much as in Kagango, no matter how busy the farmer may be.

It is also observed from Table 6 that quality of food improves in Kagango significantly ($p =0.001$) but not so

Table 1. Characterization of respondents into categories according to commercialization index

Attribute	Status	Kagango				Mwizi			
		Mean	N	Std. Error of Mean	% of Total N	Mean	N	Std. Error of Mean	% of Total N
Commercialization Index	Subsistence	7.300E-02	10	2.427E-02	6.9%	3.143E-02	14	1.378E-02	13.2
	Semi commercial	.4841	115	1.366E-02	79.9%	.5083	83	1.559E-02	78.3
	Commercial	.8989	19	1.275E-02	13.2%	.8322	9	1.222E-02	8.5
	Total	.5103	144	1.898E-02	100.0%	.4728	106	2.262E-02	100.0

Table 2. Ranks of six major crops grown by farmer category and site

	KAGANGO			MWIZI		
Order of dominance	Subsistence	Semi Commercial	Commercial	Subsistence	Semi Commercial	Commercial
1st	Banana	Banana	Banana	Beans	Banana	Beans
2nd	Beans	Coffee	Coffee	Banana	Beans	Banana
3rd	Coffee	Beans	Beans	Irish potatoes	Irish potatoes	Irish potatoes
4th	Millet	Eucalyptus	Eucalyptus	Maize	Eucalyptus	Eucalyptus
5th	S. Potatoes	Dodo	Dodo	Millet	Maize	G.nuts
6th	Mango	Avocado	Pineapple	S.Potatoes	Coffee	Avocado

Table 3. Ranks of livestock kept by farmer category and site

	KAGANGO			MWIZI		
Order of dominance	Subsistence	Semi Commercial	Commercial	Subsistence	Semi Commercial	Commercial
1st	Cattle	Cattle	Cattle	Goats	Goats	Goats
2nd	Goats	Goats	Goat	Chicken	Chicken	Chicken
3rd	Chicken	Chicken	Dogs	Cattle	Cattle	Pigs
4th	Pigs	Dogs	Cats	Dogs	Sheep	Cattle
5th	Dogs	Rabbits	Chicken		Dogs	Sheep
6th	Rabbits	Pigs	Pigs		Pigs	Cats
7th		Sheep			Rabbits	
8th		Cat			Ducks	
9th		Turkey			Cats	
10th		Ducks			Bees	

significant in Mwizi (p=0.14), with increase in commercialisation. The reason for this could be the higher income earned by farmers in Kagango (Table 5) which enables them to get quality food as opposed to Mwizi farmers. Another reason could be that there is a higher crop diversity in Kagango and hence a greater dietary variety. Education is another factor that could have contributed to this better quality, in that respondents who are better educated are more enlightened about the importance of proper household nutrition. based on the results of the study, the following are apparent:

1. Most farmers in Kagango and Mwizi sub-counties are already market-oriented but only a few have reached

Table 4. Commercialisation and change in agrobiodiversity

Dependent Mth	Sub county	Rsq	d.f.	F	Sigf	b0	b1	b2
Crop Bioindex (*Linear*)	Kagango	0.034	131	4.61	0.034	0.149	-0.183	
(*Quadratic*)	Mwizi	0.075	93	3.74	0.027	-0.0736	-0.0084	-0.2141
Livestock bioindex (*Quadratic*)	Kagango	0.018	130	1.21	0.303	-0.089	-0.128	0.0415
(*Quadratic*)	Mwizi	0.032	93	1.52	0.225	-0.0319	0.0918	0.1607

Table 5. Commercialisation and income

Dependent Mth	Sub county	Rsq	d.f.	F	Sigf	b0	b1	b2
Income (*Quadratic*)	Kagango	0.118	130	8.66	0.000	0.378	0.311	-0.2217
(*Linear*)	Mwizi	0.112	94	11.85	0.001	-0.1868	0.2393	

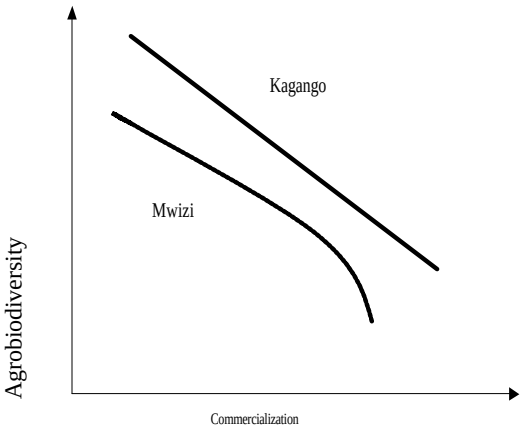

Figure 1 Relationship of commercialization and agrobiodiversity in kagango and Mwizi

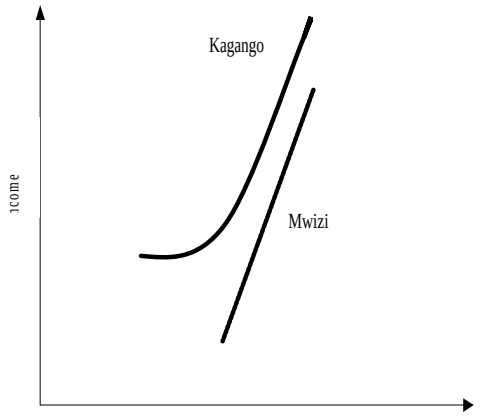

Figure 2. Relationship of commercialization and income in Kagango and Mwizi

commercial levels (selling 80% and above of their farm produce).

2. It is the semi-commercial farmers who conserve and enhance crop and livestock diversity. Subsistence farmers keep low numbers of types crop/livestock because of capital and land constraints but commercial farmers reduce the farm diversity to specialise and reap economies of scale.
3. Although commercialisation significantly increases household income, its influence on the three-food security indicators studied was very variable. While commercialisation increased quality of meals in both sites it only increased access to food in Kagango but not in Mwizi. On the other hand commercialisation of farming generally reduced frequency of meals and food types per given time period. The magnitude of the relationships also varied greatly between the two study sites.
4. The impact of commercialisation on household income is more pronounced in Mwizi than in Kagango but the reverse is true on food security because Mwizi grows more of traditional food crops (beans and Irish potatoes) for both cash and food than non-food cash crops (Coffee and Eucalyptus) in Kagango.

Conclusions and recommendations

Table 6.Commercialization and Food security

Dependent Mth	Sub county	Rsq	d.f.	F	Sigf	b0	b1	b2	b3
Food Access (*Linear*)	Kagango	0.081	131	11.49	0.001	0.224	0.296		
(*Cubed*)	Mwizi	0.024	92	0.77	0.515	-0.3421	-0.1319	0.027	0.088
Meal Frequency (*Linear)*	Kagango	0.246	131	42.77	0.000	0.135	-0.511		
(*Inverse*)	Mwizi	0.053	94	5.31	0.023	-0.1684	-0.0439		
Quality of meals (*Cubed*)	Kagango	0.113	129	5.48	0.001	0.122	0.640	-0.0883	-0.1591
(Inverse)	Mwizi	0.023	94	2.21	0.14	0.003	0.033		

The majority (70-90%) of farmers are at semi-commercial level who sell 47-51% of their farm produce on average and not subsistence as is commonly said and also estimated and documented in PMA. It is recommended here that the yardstick for categorising them be validated in several representative sites across the country.

Semi-commercial farmers have richer and more dynamic agrobiodivesity (crop and livestock species richness) than both subsistence and commercial farmers. It is therefore recommended that, in addition to the subsistence poor, PMA should also target the semi-commercial farmers with special emphasis on sustainable management of land resources including biodiversity in order to fulfill the national commitment to Agenda 21 and UN Convention on Biological Diversity (CBD). This is very important as the study showed that beyond this level, commercialisation leads to specialisation, thus endangering agrobiodiversity, especially when the commercial crops or livestock have large land and labour requirements, thus outbalancing efforts to meet domestic needs.

There was no clear relationship between commercialisation and household food security. This was

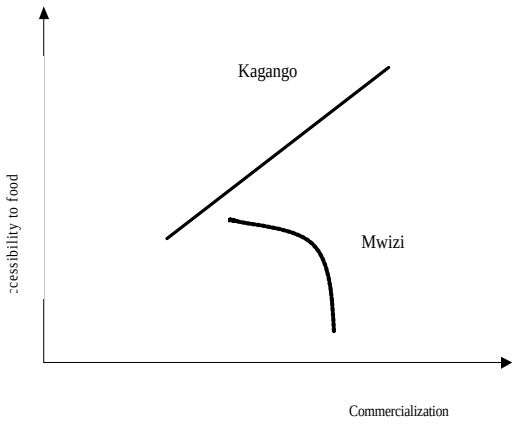

Figure 3. Relationship between Commercialization and Accessibility to food in Kagango and Mwizi

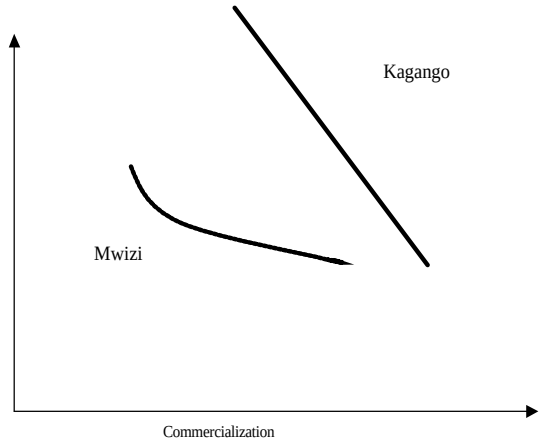

Figure 4. Relationship between commercialization and frequency of meals in Kagango and Mwizi

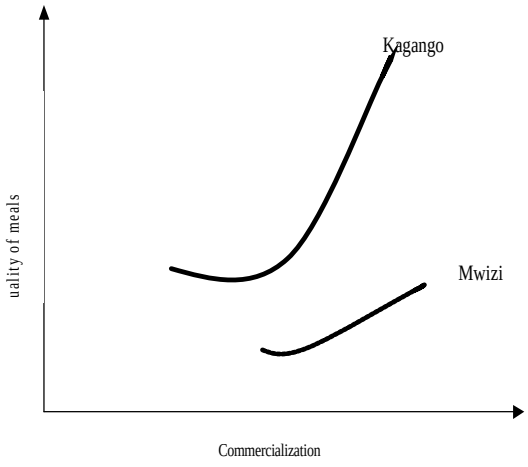

Figure 5. Relationship between Commercialization and Quality of meals in Kagango and Mwizi

partly attributed to the fact that food security indicators were measured qualitatively due to limited funds and time. Further research for longer time and with much bigger funding to permit study of household food security quantitatively is recommended.

Finally it is recommended that mainstreaming agricultural biodivesity conservation and sustainable use be included in PMA strategies and activities at household level. The appropriate target group to demonstrate integretion of commercialisation and agrobiodiversity conservation is the semi- commercial farmers.

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