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Land-use Intensity in the Tree Cropping Homesteads in Kamuli, Eastern Uganda

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Abstract: A farm-level study on the adoption of community forestry was conducted in Kamuli district, Uganda between July and September 2007. Total 223 farmers were surveyed in fourteen villages. The 2 zones have distinct agro ecological characteristics. From each selected villages, lists were developed with respect to all farmers who had been exposed to community forestry and those without such exposure. A random sample of farmers was taken from each of the 2 groups of farmers. The results revealed that the traditional homegardens are a complex farming system with a number of interdependent components. The tree crop component was well developed largely due to the high land/man ratio and the low intensity of cultivation. Smaller holdings are generally more intensively cultivated than the large and very large holdings. About 29% of the former showed low to very low agricultural copping intensity, while about 75% of the large holdings belonged to the low intensity class. Fragmentation of land eventually makes some of the holdings too small and uneconomical and in a situation where non-agricultural opportunities exist, farming ceases to be the main source of income. In spite of their known ecological stability, homegardens are on the decline, mainly due to social and economic pressures. A better understanding of the dynamics of home garden system is essential to formulate ecologically sound, economically appropriate and socially relevant farm forestry programmes.

Key words: Tree planting, smallholdings, land-use intensity, land dependency

INTRODUCTION

Farm forestry, or the cultivation of trees in close association with agricultural crops, is a major component of the community forestry programme being implemented in Uganda. Supply of seedlings of selected species and providing necessary know-how on planting and tending trees have been the main focus of the programme. Although, ecological, economic and social conditions vary markedly between regions and localities, non-availability of seedlings and lack of technical know-how have been documented as the major constraints in the cultivation of tree crops in farm lands (Carswell, 2002).

Acceptance of such technological packages, however, depends on a number of social and economic factors, extending far beyond the simple cost-benefit calculations. Land allocation among the different components in the farming system food crops, cash crops, tree crops and livestock is primarily determined by a complex of social, economic and cultural factors. Most of the study hitherto done on the economics of social forestry is focused on simplistic financial profitability calculations (Buyinza, 2008) while, important issues like land tenure, size of land holding, dependence on land, farm labor availability and the whole dynamics of these are neglected or at best dealt with superficially.

Traditional homestead cultivation found in the humid tropics provides an interesting example of farm forestry or agroforestry, in which agriculture and tree cropping are closely integrated. Architectural similarity of the homegardens with that of the tropical rain forests has been cited to be an important factor contributing to their ecological stability (Buyinza and Nabalegwa, 2007). However, this could be undermined by a number of social and economic factors leading to a drastic change in the structure and composition.

Typically, home gardens are used for cultivation of perennial crops like coffee and seasonal and annual crops like banana, tubers (cassava, sweet potato, yams and ginger) and vegetables (beans, peas and soybeans). In addition, a number of trees are also grown along the boundaries or in intimate mixtures with agricultural crops. Even small holdings <0.20 ha contain a large number of trees providing timber, fuelwood, fodder, fruits and green manure to the household (Buyinza *et al*., 2008).

Although, the homegardens appear to be a bewildering mixture of trees, shrubs and herbs, a certain general pattern seems to exist. Wide variation in the intensity of tree cropping is noticeable between home gardens situated in the same agro-climatic region. This is largely, due to differences in the socio-economic conditions of the household and how they respond to

externally determined changes, particularly prices of inputs and products, dependence on land and tenurial conditions. This study was initiated with the objective of identifying some of the important social and economic factors that influence homestead tree cropping. The methodology adopted for the study and preliminary conclusions was based on the household survey conducted in 2 villages.

Homestead tree cropping in kamuli district: Kamuli district situated on the South Western part of Uganda (8°17-12°57' N and 74°51-77°24' E) is one of the most densely populated rural regions in the world (654 persons km^{-2}). In the coastal and midland regions forming the old settlement areas the density often exceeds 1500 persons km^{-2}. The hot humid conditions (annual rainfall: 3000 mm, temperature 20-30°C) permit the cultivation of a large number of crops. Although, over time the contribution of the agricultural sector shows a relative decline, it still accounts for about 42% of the district domestic product (Buyinza and Nabalegwa, 2007). The low lying wet land in the valleys is primarily used for rice cultivation. The other arable areas, known as dryland, accounting for about 70% of the net cropping area, consists of homesteads and estates.

MATERIALS AND METHODS

Survey: A farm-level study on the adoption of community forestry was conducted in Kamuli district, Uganda between July and September 2005. Total 223 farmers were surveyed in 14 villages: 142 in the southwest, 81 in the southeast. The 2 zones have distinct agro ecological characteristics. While, the southwest is in the forest-savanna transition zone with average annual rainfall of about 1252 mm, the southeast is in the humid forest zone with average rainfall of about 1800 mm. The survey was done in 2 stages. In the first stage, focused group discussions were used to obtain background information on adaptations as well as adoption of community forestry. This information was used to design a structured questionnaire administered to respondents during the second stage of the survey.

Selection of the survey villages was accomplished through a stratified random sampling procedure (Boffa *et al*., 2005). A complete list of villages where community forestry has been previously introduced was available. Sample villages were selected based on the number of years of community forestry practice, number of farmers exposed to community forestry and an informed assessment by key informants on the extent of adoption of community forestry in each village. From each selected villages, lists were developed, of all farmers who had been exposed to community forestry and of those without such knowledge. A random sample of farmers was taken from each of the 2 groups of farmers.

Table 1: Lowland and highland village characteristics

Village characteristics	Namasagali	Buzaya
Location	Lowland	Highland
Area	960 ha	496 ha
Terrain	Flat	Moderately undulating
Soil	Sandy	Lateristic
Population*	17168	9303
Population density	178	194
Main occupation	Agriculture, fishing	Agriculture and cottage industry
Distance to forest	50 km	20 km
Number of households	2954	1524
Oldest settlement	Very old	Very old

* = Buyinza and Naguula, 2007

Table 2: Households according to landholding size (%)

Size of holding (ha)	Namasagali	Buzaya
<0.020	4.8	4.2
0.021-0.0972	38.4	46.7
0.097-0.1983	21.6	22.4
0.198-0.4006	18.5	18.9
0.407-0.8053	11.7	5.6
0.8054-1.2100	3.2	1.8
1.2101-2.0194	1.2	0.4
>2.0195	0.6	-
Total	100.0	100.0

Household survey: The study was primarily based on a detailed household survey conducted in selected villages in Kamuli. On the basis of altitude, the district was divided into 2 natural regions, namely, lowland and highland. The first 2 form the old settlement areas with along tradition for intensive homestead cultivation. Colonisation of the highland region is of recent occurrence and is largely due to the migration from the midland and lowland regions. Villages in the district were stratified adopting the above categorization and one village from each of the above regions was selected randomly for detailed study. Some of the general characteristics of the selected village in the lowland and midland regions are given in Table 1.

The villages in Kamuli district are generally very large, sometimes consisting of >2000 households, sub-units of the village, census units were taken as the sampling unit in each of the selected villages.

The size of landholding appeared to influence the social and economic status of the household and this could directly affect tree cropping intensity. Before the households were selected randomly, they were stratified on the basis of the size of holding. The distribution of households in the census unit according to different land holding classes in given Table 2.

While, selecting the households randomly, the number of households from each stratum was fixed a priori

taking into account the total number of households in the strata. A strict application of permanent sampling plots will, however, lead to over representation of the smaller holdings and under representation of the larger ones. Hence, taking into account the probable variation in tree cropping, the number of households from each stratum was limited to 20 or 50% of the total households, whichever is less.

Each of the households was visited by a team of investigators and with the help of a questionnaire, information on the household (location, type of house, number of members, principal and subsidiary occupation, year of settlement, possession of land income from different sources, indebtedness) and land use was collected.

Agricultural crops were grouped into: seasonal and annual and perennials. Their number and occupied, duration of cultivation were collected. Based on end uses, trees were grouped into: multiple use; timber; firewood; fruit; ornamental and miscellaneous. For each of the species under the above categories the stem diameter and crown radius were estimated. General information on type of soil, slope irrigation, fertilizer application, soil working, labour use, livestock, timber use in construction, firewood consumption and willingness to plant trees were also, gathered.

Estimation of land-use intensity: In the case of sequential multiple cropping, estimated land-use intensity is not different. However, in respect of the multi-tiered cultivation employed in home gardens, cropping intensity estimation is complicated. Productivity and area occupied by crops are 2 important criteria adopted for estimating cropping intensity. Land equivalent ratios derived on the basis of productivity is a very useful indicator of multiple cropping intensity (Kwesiga *et al*., 1999). However, unreliability and difficulty in getting information on outputs limits its applicability. Taking the area criterion, multiple cropping intensity is estimated as:

$$MCT = \frac{TCA}{TCA} \times 100$$

where:

MCT = Multiple Cropping Intensity
TCA = Total Crop Area
TCA = Total Cultivated Area

In the present study, a variant of the above is adopted to estimate land-use intensity index:

$$TCI = \frac{100}{A}\left[\frac{1}{12}\sum_{g=1}^{m} S_g D_g + O_h + ... >> T_{ij}\right]$$

where:

TCI = Total Cropping Intensity
A = Total area of the land for agricultural activities of the selected household
S_g = Area occupied by the 'g'th seasonal or annual crop
D_g = Duration in months of the 'g' th seasonal or annual crop
O_h = Observation of trees of the 'h' th perennial crop
P_h = Optimal number of trees of the 'h' th perennial crop per unit area
T_{ij} = Area occupied by the 'j' th the 'i' the species

In the case of seasonal and annual crops, data on area occupied and their duration in months were collected. For perennial crops like coffee, Tea. the optimum number per unit area based on space requirements of the species was used to derive the intensity from the number of plants actually observed in the homesteads (Buyinza, 2008).

In the case of tree crops, no data is available on the optimum density at different stages. Crop area was calculated from the crown radius and this was used to estimate intensity of tree cropping. This also, helps to take into account the varying space requirements between species and between different stages in growth of the same species. The data were tabulated and for each household total cropping intensity as well as the intensity of cultivation of different components were calculated.

RESULTS AND DISCUSSION

Traditional homegardens are a complex farming system with a number of interdependent components. The tree crop component was well developed largely due to the high land man^{-1} ratio and the low intensity of cultivation. In addition to those, which could be utilized by the household as fuelwood, fodder, timber and green manure, a large number of trees, which germinate and grow naturally were retained, although they had no direct role in the farming activity. Sacred groves, which were important because of cultural and religious reasons, were a common feature of the homestead landscape. The cross sectional data obtained during the household survey gives some interesting general indications for the changes that are taking place in tree crop cultivation. A brief description of the changes and the factors that are possibly bringing about these changes.

Size of holding and tree cropping: Since, land availability is an important factor that determines development of each of the components in the system, variation in the size of holding could affect the tree cropping intensity. Two factors have been primarily responsible for

a reduction in the size of holdings Kamuli. First and foremost, is the growth of population and the decline of the joint family system. Of the total households sampled, 62% indicated inheritance as the mode of possession of land, invariably involving partitioning of family property, while only 23% obtained ownership through purchase. Implementation of land reforms, involving fixing a ceiling on the size of holding and assignment of excess land to the landless, is another important factor regularinsing occupation has benefited about 4% of the surveyed households. Reduction in land availability has affected the home garden system on the lines indicated.

Intensification of agriculture: The general response to a decline in the size of holding is the increase in intensity of cultivation primarily through utilizing the uncultivated area. Smaller holdings are generally more intensively cultivated than the large and very large holdings. Only about 29% of the former showed low to very low agricultural copping intensity, while about 75% of the large holdings belonged to the low intensity class. Existence of this inverse relationship has important implications on tree cropping intensity as discussed below. However, an interclass comparison shows that both tree cropping intensity and number of trees per hectare is higher in the small holdings. A high proportion of the large and very large holdings has low tree cropping intensities while, a sizeable proportion of the small holdings had high intensities. As the size of the holding declines, there is a marked increase in the number of trees per hectare. Two factors seem to be responsible for this occurrence (Buyinza, 2008). Firstly, an extension of cultivation of tall perennial crops such as fruit trees permits a judicious combination of a number of tree crops permitting the better utilisation of the vertical space. Thus, in a multi-tiered cropping system, intensification of cultivation of both forest crops and agricultural crops is possible up to a certain limit. Secondly, most of the tree crops cultivated have multiple uses and they form an integral part of farming system. An increased intensity of cultivation would enhance the direct and indirect demand on tree crops, as a source of fodder and green manure and as standards for pepper, betel leaves and other climbers.

A larger proportion of trees in the smaller holdings consists of multiple use species like jackfruit (*Artocarpus integrifolia*) mango (*Mangifera indica*), tamarind (*Tamarindus indica*), Cashew (*Anacardium occidentale*) and pawpaw (*Carica papaya*). In contrast, the larger holdings have a higher proportion of time species such as teak (*Tectona grandis*) and Rosewood (*Dalbergia latifolia*) than the smaller holdings. Such a marked preference for the few multiple use species is quite logical considering that almost all parts of these are utilisable in one form or another.

To summarize, during the first phase of transition a reduction in the size of holding has led to an intensification of cultivation and this has resulted in the replacement of miscellaneous trees species. Although, this has reduced species diversity, the intensity of cultivation of the few multiple use species has increased considerably. Interestingly, even this model of a self-contained intensively managed home garden is not stable and further changes are taking place. During the second transition phase, which seems to be in vogue now, in addition to population growth, there are a number of other factors, which also tend to influence homestead tree cropping. While, some of these favour tree cropping, others tend to adversely affect it and hence, from the limited number of sample households, no discernible trend can be identified.

Land dependency and tree cropping intensity: Fragmentation of land eventually makes some of the holdings too small and uneconomical and in a situation where non-agricultural opportunities exist, farming ceases to be the main source of income. A reduction in dependency on agriculture favors natural tree growth on account of keeping the land fallow. Land dependency index for each household was calculated and the distribution of households in the different land dependency classes.

About 59% of the households in the two villages belonged to the low dependency class, while only 24% depended on agriculture for the major source on income. Census data show that the number of cultivators and agricultural laborers, the 2 main land-dependent classes, registered a decline between 1990 and 2000 (Buyinza and Naguula, 2007). Increase in the number of available workers has been absorbed by the secondary and tertiary sectors. Most of the current cultivators and agricultural laborers belong to the older age group while, the younger generation has very little interest in agriculture. In the packing-case industry, facilitating a shift in the occupational structure. Growth of fishing and allied activities and the inflow of remittances from migrant workers in the European countries have led to rapid development of the tertiary sector in the coastal village of Namasagali. A reduction in the dependence in land generally favours a higher tree cropping intensity. This is not due to a deliberate shift in favour of trees, but incidental to the neglect of agriculture, permitting the retention of wild tree growth.

Prices of farm inputs and wood: In contrast to the households whose dependency on land has declined, those who continue to rely upon farming attempt to increase the intensity of cultivation by resorting to the use of purchased inputs like fertilisers, pesticides and weedicides. Especially, in the context of increasing wages, these inputs become attractive in comparison with those organic fertilizers collected locally. This drastically reduces the relevance of multiple use species so that instead of being treated as complementary to farming, they are considered as competing with agricultural crops for space. This provides sufficient justification for their removal.

The pace of tree cutting has accelerated further due to the increasing price of timber and firewood. The real price of all construction timber species has registered a phenomenal increase from the year 2000 onwards (Gombya-Ssembajwe *et al*., 2007) due especially to the declining supply from forest sources.

With the fodder, fruit and green manure values of the multiple-use species becoming redundant, most of the trees in the homesteads are likely to be cut and sold as timber. Such a general trend is already evident in both the villages surveyed.

Most of the intensification, however, takes place by replacing the other trees with, which is one of the best available multiple-use species. Almost all products (leaves, fruits, wood) are utilisable in one form or another. Eucalyptus forms the major source of fuelwood in Kamuli, however, since it does not provide fodder and green manure, farmers have to rely upon markets as sources for these.

Land prices: Increasing land price is another important factor that influences tree cropping. In both villages, land value has increased phenomenally, due partly to population growth and partly to the willingness of the purchasers to pay high prices. Inflow of remittances from workers in the urban areas has led to increased purchasing power and escalation of land value (Maxwell, 1995). Economic and social compulsions force some of the low income households to sell land and this immediately brings about a conspicuous change in the land use pattern. Most of the purchasers resort to commercial cultivation of cash crops, relying heavily on purchased inputs. Tree crops cease to be of any relevance from the point of the new owners, unless they are able to command high market prices. If tree crops are grown at all, they are usually of short rotation and aimed at meeting specific market demands.

Thus, the transition from the intensively managed, self-contained, homestead system with a large number of multiple-use species to the intensively managed commercial farms is progressing. Pauperization of some of the small holders, who continue to rely upon agriculture on account of their inability to find suitable employment openings in other sectors, leads to distress land sales and migration of sellers to the highland region for encroachment into the forests; the whole cycle is then repeated (Maxwell, 1995). It is difficult to visualize the future of commercial farming. Even if the terms of trade are favorable, which is quite unlikely, the ecosystem is highly unstable and productivity could in the long run decline, necessitating the reintroduction of tree crops to improve soil fertility.

CONCLUSION

In spite of their known ecological stability, homegardens are on the decline, mainly due to social and economic pressures. They are being replaced by commercial farming, which, in the long run, is neither ecologically stable, nor socially and economically desirable. Disappearance of the homegardens would not only imply the loss of an ecologically stable and genetically rich system, but would also amount to the loss of valuable cultural heritage associated with it. This study has proved that Community forestry should try to preserve and improve the home garden system by protecting it from the instability of the market place. A better understanding of the dynamics of home garden system is essential to formulate ecologically sound, economically appropriate and socially relevant farm forestry programmes.

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