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Farmer Tree Nursery as a Catalyst for Developing Sustainable Best Management Land Use Practices in Lake Victoria Catchments Ecosystem

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Abstract: Support to farmer nurseries is classified as either hard referring to material inputs (tree seed, water, tools and fencing) or soft (information, training and backstopping advice). Against a background of poor services for smallholder farmers in the Lake Victoria basin, it was hypothesized that a number of support agents operating at the grassroot level together with farmers themselves provide the different support functions needed in the establishment of farmer tree nurseries. Through financial support from Inter-University Council of East Africa coordinated VicReS Project, a collaborative project involving Kenyatta University (Kenya), Kenya Agricultural Research Institute (KARI) and Mulingano Agricultural Research Institute (Tanzania) has been able to initiate reforestation/afforestation activities in Lake Victoria catchments ecosystems of western Kenya and western Tanzania. Through the initial activities, a total of twenty four farmer groups have been identified in western Kenya and supported through capacity building and supply of basic inputs for tree nursery seed bed preparation and management. The groups have been able to set up tree nurseries and are now managing seed beds with a total of 450,000 agro-forestry seedlings, mainly *Grevillea robusta* and *Casuarina* spp. The farmers intend to distribute the seedling among the members for planting on farm boundaries, around homesteads and woodlots within their homesteads and sell the surplus. Preliminary findings show that there is an urgent need to facilitate grassroot level support systems with larger participation from the national extension service for provision of training and backstopping advice. Strengthening the human capital of farmers and service providers emerges as critical in increasing impact. Farmer nurseries are shown to play a number of important and interrelated functions in building natural, human and social capital. Monitoring and evaluating farmer nurseries in catalyzing these three functions should therefore receive proper attention in assessing impact of sustainable land use systems. Policies need to be well articulated to address some of the major constrains identified in the Lake Victoria catchments ecosystem.

Key words: Extension services, germplasm supply, nurseries, human capital, lake victoria, natural capital, social capital, tree transplanting

INTRODUCTION

The unsustainable exploitation and destruction of forests is a serious environmental concern in the Developing Countries (DCs) of Africa (Bewket, 2003). While rising agricultural yields and rural outmigration have allowed forests to regenerate in some of the richer countries of the temperate world, the poor countries of tropical Africa are fast depleting their forest resources. As estimates indicate, by the early 1990s, the rate of deforestation in this part of the globe was about 29 times the rate of afforestation or/and reforestation (Salih, 1992). If this trend continues, then it would not be too long before forests will be completely removed from the African landscape (Bewket, 2003). One of the main driving forces of the deforestation in these DCs is the pressure from the growing population, which uses forests for fuelwood and domestic energy production purposes (Baohene, 1998). Deforestation has, as is widely recognized, manifold environmental consequences: loss of biodiversity and genetic resources, soil degradation, depletion of water resources, disturbance of microclimates, loss of wildlife resources and impediment to the cycling of carbon to mention a few. Some of these effects are more local while others are global.

Since the 1992 United Nations Conference on Environment and Development in Rio de Jeneiro, Community-Based Natural Resources Management (CBNRM) has been increasingly accepted as the privileged solution to the challenges of environmental

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conservation in DCs (Virtanen, 2003; Adams and Hulme, 2001; Wily, 1999). The key message of CBNRM proclaims that if economic development and community participation are not promoted in conjunction with environmental conservation, then local populations will have no interest in protecting resources, which will not survive (Virtanen, 2003). This message has been repeated in scientific publications, policy documents and popular media until it has turned into a mantra of sustainable development (Godwin, 2001).

The type of support needed by smallholder farmers varies widely in most of Sub-Saharan Africa. Support may be related to the technology itself, to inputs, production means, infrastructure, marketing and credit, among others. In the case of farmer tree nurseries, specific material inputs required are tree seed and water, inoculum, tools and fencing. These can be classified as hard support. In addition, there is soft support that relates to information, training and backstopping advice. Until recently the provision of agricultural services to smallholder farmers was still largely in the hands of the government sector in East African countries. National agricultural extension systems have largely failed to provide the support needed by smallholder farmers (Oladele *et al*., 2004). In this regard, the farmer to field staff link has been identified as the weakest one in service delivery. Furthermore, inadequate technologies, high degree of bureaucracy and poor working conditions of field staff are commonly cited as major constraints (Vankatesan and Kampen, 1998). In addition, there is lack of evidence on the contribution of public extension services to the improvement of smallholder farmer livelihoods (Haug, 1999). Overall, current support to smallholder farmers can therefore be considered marginal. As a result, the seed and fertilizer supply sectors as well as the marketing of produce have recently been liberalized as part of economic restructuring in the East African region. These three support components are the most likely targets for privatization because they offer profitable business opportunities, unlike in cases of smallholder farmer training and advisory services, which are likely to remain in the public domain (Vankatesan and Kampen, 1998).

The effectiveness of support systems should generally be measured in terms of what leverage they provide in achieving impact on food security, the creation of wealth and reversing the degradation of the environment. In the context of agroforestry, the extent of tree planting in the agricultural landscape expressed both as area planted to trees as well as numbers of rural households using agroforestry technologies could serve as indicators for assessing impact.

It has been shown that smallholder farmers can play a crucial role in supplying germplasm for development of sustainable land use systems in southern Africa (Boeringer *et al*., 2003). In order to allow a better assessment of this output, it is important to understand the problems farmers face with respect to nurseries, the support systems that are needed for this achievement and, also the impact of tree planting on farms. Given the declining importance of national extension services in East Africa, it was hypothesized that a number of support agents operating at grass root level together with farmers themselves provide the different support functions needed in farmer nurseries.

The overall objective of this study is to assess the role and functions of farmer nurseries in building natural, human and social capital for the development of sustainable land use systems. A secondary focus is on farmers' problems and the role of support systems in facilitating the establishment and operation of farmer nurseries. It further assesses the impact of trees planted from farmer nurseries and discusses policy issues related to germplasm supply for smallholder farmers in the lake Victoria catchment ecosystem.

MATERIALS AND METHODS

Study sites: The study focused on three districts (Kakamega, Busia and Butere-Mumias) in western province of Kenya (Fig. 1). These sites were chosen because they had well established Farmer Field Schools (FFs) that formed part of another project of the Kenya Agricultural Research Institute (KARI). Key land use indicators for the three study areas are given in Table 1. They show marked differences in average population density and hence cropping area available to households.

Survey methods and data analysis: A total of 24 nurseries were sampled in the three districts, i.e., 6 nurseries from each district between November 2004 and December 2005. During field visits, interviews were conducted with farmers to collect information on problems encountered and the nature of support they received. The survey team

Table 1: Selected land use indicators in three study districts of western Kenya

Study area/indicator	Kakamega	Busia	Butere-Mumias
Total land area (km^2)	1,395	1,124.3	939.3
Total population	603,422	370,608	478,928
Persons/household	4.8	4.5	4.4
Av. pop. density	433	330	525
Agric. land/person (ha)	0.83	0.18	0.15
Land area under forest (ha)	161.4	185.2	63.8

Jaetzold *et al*. (2007)

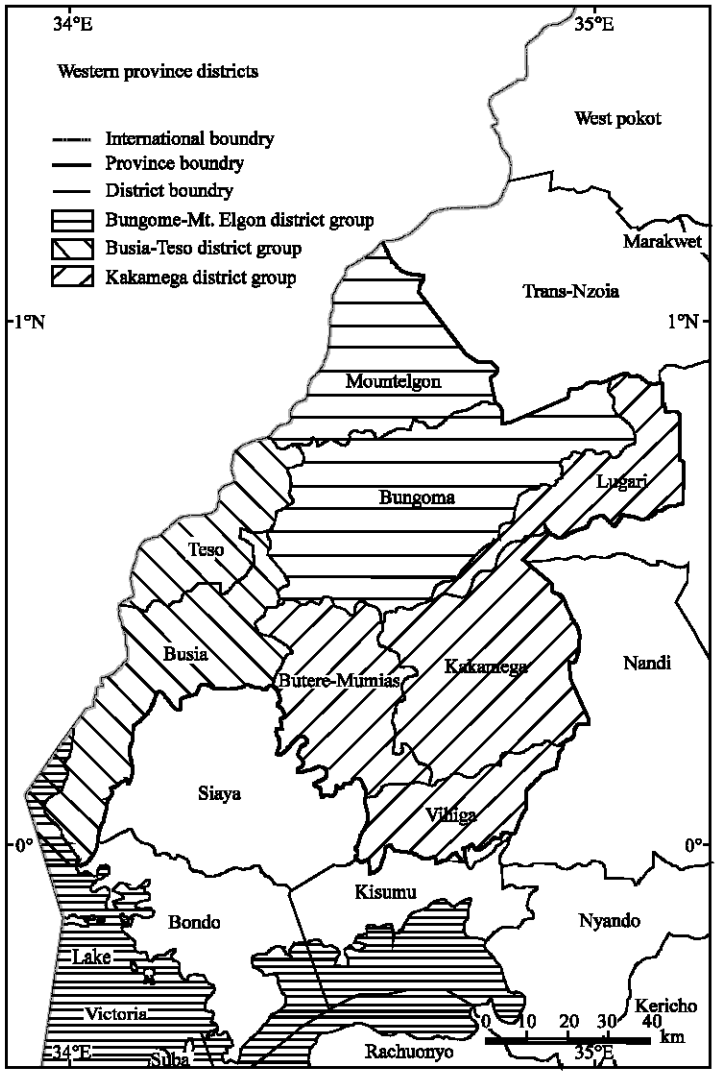

Fig. 1: Study area (Source: Jaetzold *et al*., 2007)

asked open-ended questions and gave the respondents the opportunity to cite up to three major problems associated with their nursery operations. In the analysis, a Cumulative Weighted Score (CWS) was calculated for each problem (Ayuk, 1997). Since a problem one farmer ranks as the most important may be rated as second most important by another farmer or not rated at all, a simple procedure was developed to determine the relative importance of each problem. The most important problem mentioned was assigned a value of 5, the second the value of 3 and the third most important problem the value of 1. The CWS was then calculated by multiplying the assigned weight by the associated number of times the problem was mentioned and then summing across the three most important problems. Thus, for each problem a CWS was calculated and ranked for all the problems mentioned.

Two types of support systems were assessed. The first one related to material inputs used such as seed, water, inoculum for seedbeds, tools and fencing. The second one, which we call soft support, refers to inputs such as information, training and backstopping advice. For each type of support, providers were recorded. In principle these could be farmers, staff of development organizations, government extension staff or VicRes project staff or any combination of these providers.

A follow-up survey was carried out later in September 2005 to determine the extent of transplanting of seedlings from nurseries. The number of tree seedlings transplanted and the field area planted were assessed at the same time. A case study to gain more insight on the impact of tree planting was also carried out in the three districts drawing on a total sample of 36 farmers. This sample was derived from the initial 24 nursery groups that

had been sampled. These nurseries were first stratified according to type, i.e., group or individual and then according to gender composition, i.e., those being operated by women or men. Six nurseries were then selected at random from each of the four strata. One recipient of tree seedlings from each nursery was then randomly selected from the list of all individuals that had received seedlings, based on farmers' records at the time of distribution. Accessibility of villages during the rains and availability of individuals resulted finally in interviewing a total of 36 individuals. Data were collected on gender and age of household head, number of years of household head in formal education, total number of household members and wealth rank so as to characterize the households. The wealth ranking was based on a four-tier system recognized by local communities on the basis of types of asets owned (land, housing, radio, bicycle, tools and livestock). Wealth ranks with original terminology used in luhya language given in brackets were: wealthy (*mapesa manji*), fairly well off (*mapesa matititi*), poor (*mutakha*) and destitute (*mutakha kabisa*). Project staff used open-ended questions to address problems experienced and reasons for expanding tree planting. Regression analysis and independent sample tests (two-tailed t-tests assuming unequal variances) were carried out to determine the statistical importance of the postulated relationships.

RESULTS AND DISCUSSION

Nursery problems: The results in Table 2 show that the majority of farmers experienced no problems. It should be noted here that respondents is not perceive seed availability as an option, since VicRes project provided starter germplasm for initiating farmer nurseries. In the absence of such incentives, availability of tree germplasm is often cited as the key constraint to farmer tree planting (Aalbaek, 2001). The most important problems in this study in descending order were pests damaging seedlings, scarcity of water and lack of adequate space for nurseries. All other problems mentioned received CWC of less than 63 (Table 2). It is worthwhile to note that labour ranked consistently low throughout (Table 2). Overall these results on major problems encountered by farmers, show clearly that establishment and management of nurseries was feasible for majority of farming households, even with their limited resources and capacities.

Support systems: Nursery support could be grouped into two categories: hard inputs such as seeds, water, inoculum, tools and fencing and soft inputs such as information, training and advice. On hard inputs, farmers

Table 2: Cumulative weighted score of three major problems in 24 nurseries across three study area districts in western Kenya during 2004/2005 growing season

Problem	Cumulative weighted score	Problem rank
None	546	1
Pests on seedlings	345	2
Scarcity of water	224	3
Lack of adequate nursery space	220	4
Damage by livestock	46	5
Lack of information	50	6
Limited tree seed	40	7
High labour demand	22	8
Transporting seedlings	10	9
Lack of markets for seedlings	4	10

themselves supplied inputs such as water, fencing and tools. This observation demonstrates that providing these inputs to farmers would be probably counter-productive in making nursery production sustainable. Inoculum was largely not used in farmers' nurseries (80% not using). This low use of inoculum can be explained by two factors: (1) many farmers still lack knowledge about use and benefits of inoculating seed beds and (2) relative high costs for collecting inoculated soil from established stands of trees elsewhere or non-availability of such sources in some areas. This result demonstrates that more investments are required in the future in establishing viable grassroot level seed supply systems in order that VicRes project's role in providing seed can be phased out as soon as possible, if farmer nurseries are to be made sustainable.

On soft support, it was noted that support from government extension services was generally minimal. This is remarkable because this kind of support to smallholder farmers is considered to be the core business of national extension services, which should focus on such public good activities that the market place is unlikely to provide (Van den Ban, 2000). In comparison, support from non-governmental partners was much higher. Here collaboration between VicRes project and non-governmental partners also gained importance in disseminating information and providing technical backstopping and advice. This result, taken in conjunction with VicRes project was playing a dominant role in nursery training, a trend that is similar to the one discussed above with respect to support for tree seeds. There is a clear need for investing more into training of grassroot level trainers in the future in order to allow international and national research and development organizations to move into facilitating the wider process of scaling-up of agroforestry instead of providing large-scale training directly. Overall, the above results on unequal distribution of support services among providers at the grassroot level are far from a desired situation where farmers, researchers and extensionists collaborate

equally as social actors within the social practice of agricultural production (Cornwall *et al*., 1993 after Haug, 1999).

Regression analysis with nursery seedling output per individual as a dependent variable and the above listed types of support as predictors revealed significant effects in cases of support for seeds (t-value = 0.006) and for advice (t-value < 0.001). Independent sample test showed further that there was a difference (t-value = 0.059) between support provided by VicRes project and that by partners, resulting in an average output per individual of 600 and 220 seedlings, respectively. This may also reflect differences in quality of advice given the variation in levels of human resource capacities among service providers. On a broader scale, this result also points to interdependencies between the building of human and natural capital, the latter being exemplified by nursery output.

Tree transplanting impact: From the total number of nurseries surveyed in the three districts, 400 individuals, 60% being women, received and transplanted a total of 180,000 seedlings. Regression analysis showed that number of seedlings transplanted per individual was explained by nursery type and whether recipients of tree seedlings were group members (adjusted R^2 = 0.348). Despite the larger number of trees transplanted from individual nurseries, their overall impact in terms of tree planting at the community and landscape level appeared however small. While nursery location showed no meaningful effect on average number of seedlings transplanted, independent sample tests revealed that home yard nurseries resulted in significantly larger numbers being transplanted (on average 240 seedlings). Since sustainable land use can also be seen as a function of proportion of total area planted to trees, our results clearly demonstrate that counting numbers of individuals transplanting seedlings was not enough in assessing nursery impact but rather that the contribution of different nursery types in transforming land use at a community or watershed level needs also to be taken into account. Furthermore, we also hypothesized that there might be significant interactions between group and individual nurseries in terms of different capital being built, which needs to be assessed in the future. For instance, we observed quite frequently individual nurseries evolving out of group nurseries, the latter providing crucial human start-up capital which later enabled individuals to become more successful in tree transplanting. Such late-benefits from group nurseries need to be evaluated in that respect. This also shows, once again, how the three development functions of building natural resources, human and social capital appear to be closely interrelated with farmer nurseries.

The use of agroforestry on-farm: A total of 36 farmers were interviewed of which, 28 had planted tree seedlings originating from group nurseries and eight from individual nurseries. An interesting aspect here was the fact that 26 individuals out of the 36 sampled had made plans to produce seedlings on their own in the future, while the remainder declared they would continue organizing themselves in groups for raising seedlings. This result underlines the close interrelationships between group and individual nurseries, the former providing a training ground for individuals who operate their own nurseries later. However, there were no significant differences between group and individual nurseries in terms of the size of agroforestry plots being managed eventually by individual farmers.

There were significant relationships between gender and household characteristics on one hand and nursery impact indicators such as area planted to trees and number of trees managed by individuals on the other (Table 3 and 4). Multiple regression analysis of agroforestry land area managed as dependent variable on formal education (t-value = 0.0532) and nursery location (t-value = 0.010) gave an adjusted R^2-value of 0.2101 (F = 0.006). Likewise, number of trees managed could be explained in a meaningful way (R^2 = 0.228, F = 0.017) by age (ns), years in formal education (t-value = 0.111), gender (t-value = 0.003) and nursery location (t-value = 0.064). The majority of respondents (80.8%) planted trees

Table 3: Tree planting as affected by household characteristics among 36 smallholder farmers in western Kenya (expressed in P-values from Leven's Test for Equality of variances)

Household characteristic	Total area (ha) planted to trees	Total No. of trees managed
Tree planter is household head	0.041	0.065
Gender of tree planter	0.680[a]	0.011
No. of yrs in formal education (1 vs 5 years)	0.007	0.008
Wealth rank (wealthy vs fairly well off)	0.030	0.054
Wealth rank (wealthy vs poor)	0.000	0.000
Wealth rank (wealthy vs destitute)	0.030	0.001
Wealth rank (fairly well off vs poor)	0.000	0.360[a]
Wealth rank (poor vs destitute	0.001	0.134[a]

[a]Non significant values, all other values significant

Table 4: Mean total area planted to trees and number of trees managed as influenced by selected household (HH) characteristics among 36 smallholder farmers in western Kenya

	Total area planted to trees (ha)		Total No. of trees managed	
HH characteristic	Mean	STD	Mean	STD
Tree planter is HH head				
Yes	0.46	0.65	140.1	190.5
No	0.05	0.04	65.4	56.8
Gender of tree planter				
Man	0.32	0.51	180.6	190.6
Woman	0.45	0.66	100.4	114.4
Wealth rank				
Wealthy	0.12	0.13	45.6	32.8
Fairly well off	0.30	0.32	120.4	132.4
Poor	0.90	1.00	42.8	56.8
Destitute	0.24	0.20	104.6	110.6

in mixed systems or in a combination of mixed and relay cropping systems in line with the main expected benefit of restoring soil fertility.

Policy issues: A major policy issue emerging from this study is the need for public investment in improving access to water in rural areas. The results of this study show that scarcity of water was the second most important problem facing farmers that wish to establish nurseries. Investments in improving water supply will not only improve human health and increase agricultural production but will also assist in expanding farmer nurseries. Developing and promoting water-harvesting practices can also assist farmers in getting prolonged access to water. Even though this water may not be safe for drinking, it could serve useful functions in other livelihood strategies. The question from an economic standpoint is who should pay for such investments. It can be argued that an increase in expansion of farmer nurseries will translate to increased tree planting that will have direct consequences on the environment. Such benefits extend beyond the farmers' fields and thereby justify public investment. The critical role of water in the establishment of farmer nurseries calls for ingenuity in developing appropriate strategies.

Another aspect that needs the attention of policy makers is that of developing a national strategy for germplasm supply. This study, in agreement with the one conducted by Aalbaek (2001), has shown that germplasm supply remains a major constraint for farmer tree planting. The various actors including government extension services, non-governmental organizations, the private sector and international and regional organizations working in this area need to develop national and regional strategies to address germplasm supply issues. Governments should limit their roles to defining an institutional and policy framework that ensures the smooth functioning of farmer oriented germplasms.

Finally, there is a clear need for policies to articulate strategies for providing support in the form of training and advice. Both elements are critical for building human and social capital as the results of this study show. However, a pre-requisite for such policies will be to conduct a cost-benefit analysis of different types of farmer nurseries in the context of smallholder farmer production and livelihood strategies.

CONCLUSION

Results on support systems for farmer nurseries provided some insights into current service delivery at the grass root level. Support for material came largely from single providers with farmers being able to support themselves for most hard inputs needed. The supply of tree seed was an exemption with the present VicRes project being the main supplier. This function should however be seen as a temporary one triggering the scaling-up of agroforestry impact. There is an urgent need to facilitate the establishment of community-based tree seed supply and distribution systems involving the private sector and community based organizations as much as possible in order to make tree planting sustainable in the region.

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