AN ECONOMIC ANALYSIS OF TRADITIONAL AGROFORESTRY SYSTEMS IN MHONDA VILLAGE, TANZANIA

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ABSTRACT

This study was carried out in Mhonda village on the southern slope of Nguru mountains Morogoro. The purpose of this study is to analyse the economic potential of agroforestry systems vis-a-vis other farming systems in Mhonda village. The main hypothesis is that agroforestry is more profitable in a sense that it utilizes more efficiently the available resources than other farming systems. Due to constant increase in population, agroforestry is likely to be the most efficient alternative land use towards satisfying social and material needs of local population.The study involve random sampling of 344 households using structured and semi-structured questionnaire. Parameters associated agroforestry were measured, viz., inputs (costs) and output (revenues). These were compared with monoculture. Economic analysis of the data collected from the village was conducted by using cost-benefit analysis (CBA) and return to labour criteria.The results of the analysis indicate that agroforestry, as a farming system is more profitable than other farming using both NPV and return to labour criteria. The system uses low market inputs while producing various outputs on a sustainable basis. Moreover, agroforestry has the potential to solve or at least ameriolate some of the land - use constraints confronting local/rural population.

Keywords: agroforestry, farming system, cost-benefit analysis, return to labour analysis.

INTRODUCTION

Background

In the past, the population of Tanzania and Africa in general was low hence less pressure on the land user. Also, soil erosion, exploitation of natural resources and general land degradation was a less serious problem. Overtime the population has increased tremendously in both urban and rural areas, this resulted in increased pressure on the land to provide various essentials agricultural and forest products. People overexploited natural forest to give room for agriculture fuelwood, construction material, fodder and area for grazing.

The increase in population growth coincides with the increase of these essential land products, hence accelerated deforestation, overgrazing and inefficient lad use practices; which led to environmental degradation (Kaoneka, 1993). Moreover, the practice of monoculture and shifting cultivation hasten soil erosion and other land degradation due to deforestation and frequent and nutrient uptake through farming practices. As population growth is likely to continue hence persistence of pressure on the land which leads to decreased land productivity. In order to mitigate the effect of deforestation and inefficient land use practice, alternative land use system must be explored. Agroforestry is one of such systems.

Agroforestry is a popular concept among agricultural development and environmental specialists and is often worked by scientists and planner as a solution to rural development needs in Africa (Rocheleau et al 1988). The basic aim of agroforestry is to attain ecological stability and at the same time to provide maximum short-term and long-term benefits to the user of the land (FAO 1989). Agroforestry may be defined as a collective name for land use systems in which woody perennials (tree , shrubs) are grown in association with herbaceous (crop, pastures) and/or livestock in a spatial arrangement, a rotation or both and in which there are both ecological and economic interactions between the trees and non-trees components of the system (Young, 1989).

The practice of agroforestry involves the alteration of agriculture, livestock production and/or forestry practice through time on the same piece of land. When the combination of these land uses are implemented on the same piece of land, agroforestry is considered to be practiced simultaneously. Where the land use practice are placed side by side as they are in the case of wind breaks and shelter-belts agroforestry is spatially practiced (FAO 1989).

The utility of the various components in an agroforestry system lies in their capacity to produce multiple products and services (Young and Pinney, 1990). Multiple products of tree component include provision of fuelwood, fodder, fruit and maintenance of soil fertility. The latter function enhances the capacity of the soil to sustain crop production.

Statement of Problem

Agroforestry as a farming system has gained popularity in recent years due to its potential to address a wide range of households needs with low level of market inputs and fairly high outputs on sustainable basis compared to existing traditional systems (Kaoneka, 1993; Swinkels and Scherr, 1994). Moreover, agroforestry has the potential to solve or ameriolate some of the land - use constraints confronting rural societies. However, the economic potential, especially that of traditional agroforestry is less studied. It is a fact that meaningful innovative measures on these systems can be enhanced through case studies. Thus, the purpose of this study is to analyse the economic potential of agroforestry systems vis-a-vis other farming systems in Mhonda village. The main hypothesis is that agroforestry is more profitable in a sense that it utilizes more efficiently the available resources than other farming systems. Due to constant increase in population, agroforestry is likely to be the most efficient alternative farming system towards satisfying social and material needs of local population.

Objective of the Study

The main objective of this study is to assess the efficiency of traditional agroforestry systems over other farming systems. The more specific objectives are to identify and describe the existing agroforestry systems, analyse the inputs or costs and outputs or benefits involved in agroforestry systems, calculate returns to labour and discuss the economic suitability of agroforestry systems relative to other farming systems.

METHODOLOGY

Description of the Study Area

Geophysical features

Mhonda village is located in the southern parts of Nguru Mountains in Turiani Division, Morogoro Rural District. The village lies about 160 km North of Morogoro Municipality covering a total area of 890 km_2. The village is close to the natural forest with four main rivers flowing from it, i.e., Dirua, Dikulula, Mbegele and Mvuga hence adequate supply of water for both domestic uses and irrigation..

Mhonda village receives bimodal rainfall pattern with short rains falling between October and December and long rains falling between March and May. Rainfall amount decreases from east to west with a range of 2100 - 4000 mm per annum on the East and 1000 - 2000 mm per annum on the West. The rainfall intensity can be fairly high especially during rainstorms thereby causing intensive soil erosion on fields without adequate tree cover. Temperature varies with altitude between 12 to 24^{o}C. The period between June and September is the coldest time of the year and rainfall is rare.

Generally, the climate of this area is under the influence of coastal belt especially the Indian ocean and altitude due to its proximity to Nguru mountains. The natural terrain is mountainous with steep slopes, deep valleys, high summit and rock cliffs. The altitude ranges from 2000 - 3000 m above sea level. The western side has high altitude than the eastern side. The area has a wide range of acidic lithosols, feralitic latosols and deeper fluvisols over precambrian cystalline grusses, grancolite and magmatiters found mainly in the valleys. The colour of the soil is reddish - brown. The soil nutrient status of the area has not been studied.

Vegetation

The varying physical conditions, viz., terrain, climate and soil, have resulted in a wide range of vegetation types. The major vegetation types include, lowland forest, montane forest, heath and woodlands. Most of the forest and woodland in the public land have been cleared for cultivation purposes, leaving a small portion on the mountains for watershed functions and along river valleys serving as buffer zones.

Population

The village has a population of 2400 people and a total of 344 households. The average household size 7 people. More than 53% of population is women, about 43% of the population comprises of children aged between 0-14 years, 27% are adults between 15 - 50 years and 20% are old people above 50 years. The population increases at a rate of 1.8% per annum much lower than the national average of 3.0%. Population growth coupled with inefficient farming practices have led to the encroachment of high tropical forests converting them to dry savanna type of vegetation dominated by grass rather than trees. Major tribes dominating the area are Nguru and Zigua, whereas minor tribes constitute of Luguru and Kaguru.

Infrastructure and social services

Mhonda village is accessible by seasonal road system and inefficient telecommunication system. Roads are impassable during the rain season. This poses a serious constraint in crop transportation to local markets. The essential social service present include shops, hospital, clinic, primary school, church, social hall and Mhonda Teacher Training Centre (TTC) which serves also as part-time secondary school

Land use patterns

There are essentially four land use patterns at Mhonda village; natural forest which serves as catchment forest reserve, traditional farming system of intercropping maize and cassava, banana and yam and coffee, monoculture cropping of maize, yam, banana, cassava and rice, and traditional agroforestry of mixing tree species, cocoyams, banana and other farm crops. These could further be classified into three types of farming systems agroforestry, intercropping and monoculture cropping in the order of their intensity of being practiced.

Methods of Data Collection

Research design and sample size

Random sampling design was applied. Farmers were picked randomly using the village register. The sample size was about 60% of the total households in the village

Data Collection

The techniques used to acquire data from primary sources were questionnaires and direct observation. Questionnaire survey was conducted mainly during evenings, because during the daytime farmers were out in the field as the survey was conducted during the farming season. The morning session was used to make direct observations on the farming systems and casual informal communication aimed at gathering general information about the village activities. During the visiting session we were accompanied by either the village chairman or ten-cell leader, locally known as *Balozi*, for the purpose of eliciting reliable responses from the farmers.

Data from secondary source were obtained largely through the review and analysis of records and reports from natural resources office and the village office. The use of various combination of techniques in data collection was necessary due to the existing variations among data components and the village household (Kaoneka, 1997).

Data Analysis

The data were analysed by using two criteria, viz., cost-benefit analysis (CBA) and return to labour.The techniques are described in sections 2.3.1 and 2.3.2.

Data analysis by cost-benefit analysis

There are essentially two categories of cost-benefit analysis (CBA), private and social cost-benefit analysis (Hoekstra, 1985; Kaoneka, 1993). Private cost-benefit analysis has the single minded profit maximizing objective in which the needed data constitute of direct market costs and benefits. In social cost-benefit analysis, the welfare of the society becomes the target such that the data components include both direct, indirect, market and non - market costs and benefits.

This study made use of private CBA with the Net Present Value (NPV) as a decision criterion. In order to conduct this analysis the following aspects were considered; choice of discount rate, valuation of family labour, land and pricing of other farm inputs (costs) and farm outputs (revenues).

Choice of discount rate

The discount rate which was applied here is the Real Rate of Discount (RRD) which is about 10% (Kaoneka, 1993). This was chosen by following the private economic analysis procedures (Gittinger, 1982).

Valuation of the family labour

The opportunity of family labour was valued at the low wage rate paid to the employed labour force to the extent that peasant farmers are unskilled (Kaoneka 1993). The wage rate used was 300 TShs (0.5 US$ according to 1996 exchange rates) per man-day based on government rates.

Valuation of land

The cost of land was not included because it was considered to be one of the fixed family resource and that the same land was used to evaluate all farming systems, i.e., monoculture and agroforestry hence a common factor of production (Kaoneka, 1993).

Valuation of inputs and outputs

Local market prices where used for valuation of inputs (costs) and outputs (revenues)(FAO, 1979; Gregory 1987). The formula which was used to compute Net Present Value (NPV) is:

$$NPV = \Sigma_{t=1} [\frac{B_t}{(1+r)^t}] - \Sigma_{t=1} [\frac{C_t}{(1+r)^t}]$$

where,

NPV	=	net present value (TShs/ha)
B_t	=	annual returns (TShs) which accrue in year t, t = 1...T
r	=	discount rate (%) per annum
C_t	=	cost accrued in year t, t = 1.... T.

Regarding hand-tools they were assumed to have a useful life of 3 years and no scrap value.

The straight line method was used to calculate depreciation:

$$D = (P - S)/L$$

Where

D	=	annual depreciation (TShs/yr)
P	=	purchase price (TShs)
L	=	useful life (years)
S	=	scrap value (shs)

Data analysis using return to labour criterion

Return to labour criterion was used in order to estimate labour time spent under agroforestry system relative to other farming systems. The main premises in using this criterion is that peasant have time preference for family labour. Hence can only commit labour where it is deem profitable. This is because the value of home production is not only large relative to the total family income, it is also produced predominantly by family labour and only in small part by purchased inputs because in low-income societies the purchased material goods that the household can acquire are very high in price relative to the economic value of time of members of the household (Kaoneka, 1993).

The economic indicator used in this study is the return to labour value which was computed using the following relationship:

$$Li = \frac{Ri - Ci}{Mi}$$

where,

Li	=	return to labour for crop i, TShs/man-day
Ri	=	total returns for crop i, TShs/ha
Ci	=	total cost for crop i, TShs/ha
Mi	=	man-days required for crop i

RESULTS AND DISCUSSION

Input Structure under Monoculture Farming Systems

Inputs (costs) for monoculture-farming system is shown in Table 1. Inputs which are required in this type of farming system include seeds, labour and hand-tools. These are basic production factors for most traditional farming systems.

Table 1: Average input (costs) required under monoculture farming system

Inputs	Maize	Cassava	Cocoyam	Banana	Rice
Labour in Shs ha-1	15,000	15,000	18,000	18,000	15,000
Seeds Kgha-1	12	-	-	-	60
Unit cost Shs kg-1	90	-	-	-	1,500
Sub total Shs kg^{-1} ha^{-1}	1,080	-	-	-	90,000
Handtools	5,250	5,250	5,250	5,250	5,250
Total cost in Shs.	21,330	20,250	23,250	23,250	110,250

Source: Own field data.

Input Structure under Agroforestry System

The inputs (costs) incurred under agroforestry system include, labour, seeds and hand-tools. These are summarized in Table 2. It can be inferred from Table 2 that the agroforestry system incorporating maize and cassava has the highest input cost. This could be attributed largely to the purchase of maize seeds.

Table 2: Average input cost incurred under agroforestry system

Input	Maize and Cassava	Banana and yam
Labour Shs ha^{-1}	16,500	16,500
Seed Kgha^{-1}	8	-
Unit cost Shs kg^{-1}	90	-
Sub total Shs $kg^{-1}ha^{-1}$	720	-
Handtools Shs	5,250	5,250
Total cost in Shs.	22,470	21,750

Source:Own Field data.

Seeds of other crops are recycled from one season to another. The few farmers who plant forest trees obtained them from the teak plantation in Turiani free of charge and others were collected from the forest. Fruit trees were established through natural regeneration of seeds. Therefore, no cost of nursery is included in the analysis.

Output structure for different farming systems

The average output (revenue/returns) of monocropping and agroforestry farming systems are shown in Tables 3 and 4. These are based on prices for the 1995/96 season in the open market.

Table 3: Average revenue from monocropping farming system

Crop	Revenues TShs ha^{-1} per household
Maize	50,850
Cassava	208,890
Yam	462,800
Banana	520,000
Rice	122,500

Source: Own field data.

Note: Market prices for 1995/96 season, 1 US$=580 TShs.

Table 4: Average Revenues from agroforestry farming system

Crops	Revenue in TShs ha^{-1}
Maize	37,710
Cassava	204,510
Yam	431,600
Banana	336,000
Coffee	105,840
Coconut	543,900
Fruit	2,476,500

Source: Own Field data

Note: Market prices for 1995/96 season, 1 US$=580 TShs

In addition to the farm crops each household is capable of producing 5000 jackfruits (*Artocurpus heterophyllus*) and each jackfruit is sold at a price of 400 TShs per piece. Other fruits contributing to revenues are monila plum (*Sderocaya binea*), Tangarine (*citrus reticulata*), mango (*Mangifera indica*) and orange (*Citrus sinensis*).

Cost-benefit analysis of the farming systems

The average NPV which indicates the profitability of the various farming systems is presented in Table 5. The decision criteria is that the higher the NPV the more profitable the farming system and that for a system to be profitable the NPV must be greater than or equal to zero.

The results indicate that agroforestry system is more profitable than monocutlure system. This may be due to the fact that under monoculture, crops are produced once per year whereas in agroforestry there is a constant flow of products throughout the year hence steady income. Also production under monoculture is reduced through intermediate harvests such as maize for roasting and boiling especially in times of food shortage or scarcity. Crops under monoculture farming system entail the use of market inputs such as seed hence reduced net returns.

Table 5: Net Present Value for the various farming systems using a discount rate of 10%

Farming system	NPV, TShs
Monoculture:	
Maize	26,840
Cassava	171,490
Yam	399,590
Banana	451,590
Rice	11,140
Agroforestry	
Fruits & Banana & Yam	2,929,410
Coffee & Maize & coconut	

Source: Own field data.

Note: Values deflated using 1995 Consumer Price Indices (CPI)

Agroforestry 1 (fruit +banana + yam) is more profitable than agroforestry 2 (coffee + maize + coconut). The reason behind may be that, agroforestry 1 comprises of crops which are to some extent persistent and produces throughout the year hence continuous supply of economic returns which translates into high contribution to NPV.

In addition to economic returns, agroforestry systems contribute recycling of nutrients which enhances the maintenance of soil fertility and controlled soil erosion. In monoculture where there is a continuous depletion through up-take of nutrient and crop removals which results into a decline in crop production due to decreased fertility (Kaoneka 1993, Young 1989). Thus, agroforestry is more profitable in both marketable and non-marketable values.

Analysis of farming systems using return to labour criterion

The returns to labour values for various farming systems are presented in Table 6. Return to labour criterion was used because labour is the most critical resource besides land. Therefore, a farming system can be more acceptable to a farmer if it is profitable (Kaoneka 1993).

The results presented in Table 6 indicate that agroforestry farming systems have high returns to labour hence more profitable. The return to labour is 53,262 and 12, 622 TAS/man-day for agrofrestry 1 and 2 systems respectively. Hence agroforestry is more profitable system with respect to utilization of labour.

Table 6: Return to labour for the various farming systems

Farming system	Net Present Value (NPV) TShs	Return to Labour TShs/man-day
Monocropping systems:		
Maize	26,840	537
Cassava	171,490	3,430
Yam	399,590	6,660
Banana	451,590	7,527
Rice	11,140	223
Agroforestry systems:		
Fruit + banana + yam	2,929,410	53,262
Coffee + maize + coconut	694,230	12,622

Source: Field data
Note: Values deflated using 1995 Consumer Price Indices (CPI)

It may be noted that labour time, measured in man-days, for different farming activities varies considerably between households due to several reasons/factors including; physical conditions of the family, i.e., the number and health of people involved in production, social obligations such as funerals, vegetation types, form of planting whether random or line planting, distance from home to the farm and type of farming tools used.

CONCLUSION AND RECOMMENDATIONS

Agroforestry was observed to be profiTable in both aspects of quantifiable and non-quantifiable values. Based on the results from this study, agroforestry system is more profiTable using the NPV decision criterion compared to other farming systems and the system is comparatively more labour efficient. These observations indicate that agroforestry practice is economically efficient relative to other traditional farming systems.

Furthermore, agroforestry, unlike other farming systems, plays great role in soil erosion and soil fertility improvement through biological nitrogen fixation, nutrient recycling, organic matter content and micro environment ameriolation for instance moderation of wind speed as in shelterbelt practices.

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