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Opportunities and Constraints of Small Scale Farms to Adopt Agroforestry Methods in the Western Usambaras of Tanzania

Möglichkeiten und Grenzen der Anwendung von Methoden des Agroforestry in kleinbäuerlichen Betrieben der westlichen Usambara-Berge, Tanzania

by Eckhard Baum*)

1. Introduction

Measures to control erosion and to maintain and improve the natural fertility potential have been adopted by man throughout history. However, their introduction is apparently dependent on an array of factors of which land shortage seems to be one of the most important. For the case of the Western Usambaras, there is a well known example of failure to achieve the obviously rational target. In Mlalo, an area heavily stricken by erosion, the implementation of erosion control measures had to be stopped in the early 50'ies because agreement and cooperation of the people concerned could not be achieved (9).

Since 1980 new attempts are made to introduce soil erosion control practices in the Western Usambaras. The respective package of innovations can be classified as "Agroforestry" or "Eco-farming" and is being described by various authors (3, 8, 2). The practices are rather complex comprising, among others, of contour lines planted with fodder crops (Guatemale grass, leucena) and trees. In some villages a stall fed cross breed heifer is added to the package. In all respect, this introduction of the full set of innovations means a change of the presently prevailing farming system.

Considering past experiences of failure of comparable approaches it is justified to hypothesize that many farmers may face constraints to adopt the full package. This has implicitely been pointed out by Prince, based on informations gained during the planning stage (8). It is the aim of this paper to use available data after three years of implementation in order to assess the scope of possibilities and constraints of farmers in the Western Usambaras to adopt soil erosion control measures in the framework of their present farming practices.

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2. **Development of land use in the Western Usambaras**

Lushoto District in the Western Usambaras is a mountainous area with altitudes ranging between 500 and 2 500 m above sea level. Gradual to steep slopes with waterlogged valley bottoms inbetween are characteristic for the location of farms. Available statistics reveal mean monthly temperatures between 15° and 20 °C and average annual percipitation ranging from 600 to 1 200 mm with a marked peak from April to June (8). The vegetational cover of the mountains originally ranged from rain forest to savannah woodland. However, today only 16% of the area can be classified as forest land (6).

Population in Lushoto District is growing at a rate of 2.8 to 3.2%. The density of population is comparatively high. Whereas the average density is reported to be 77 inhabitants per km^2 this figure may go up to 400 in some parts of the district.

Agricultural production in the Western Usambaras is determined by land shortage resulting from increasing population pressure. This process which went on for many decades resulted in three phenomena, mainly:

- the gradual decrease of fallow periods
- continued cultivation of slopes of increasing gravity
- drainage and cultivation of formerly grazed valley bottoms.

Today little scope is left for leaving the soil fallow in order to improve its fertility, although slight differences can be observed in areas of higher or lower population pressure. Attems in 1967 reports 9% of the cultivated area of being under fallow (1). In 1983 this figure is decreased to 2–6%. The cultivation of steep slopes contributes considerably to soil erosion. Occasionally gradients of 45° and more can be observed without any protection against run-off water.

The prevailing practices are being defined as "destructive exploitation" by some authors (3). In fact they are an attempt to cope with the increasing problem of land shortage in the absence of an adequate adjustment of agricultural practices. To a great extent farmers are still practicing methods adapted to shifting cultivation, although this system had to be abandoned long ago. The urgent need to introduce practices more compatible with present conditions becomes apparent from this argument.

3. **Development of the livestock economy**

Livestock has been for a long time a chracteristic feature of the Usambara Mountains. The livestock complex is firmly established in the Washambaa cultural setting. The existing stock comprises of cattle, mainly, and to a lesser of sheep and goats. According to an estimate given by the District Livestock Development Officer about 70% of the farmers own at least some animals.

Traditionally cattle are grazed in the light woodland areas and on fallow land. The valley bottoms were the principle fodder reserve for the dry season. However, with the gradual encroachment of farm land into the grazing areas opportunities to maintain the herds diminished. In particular the cultivation of valley bottoms resulted

in serious fodder shortages during the dry season. The resultant effect is heavy overgrazing on the remaining slopes and hill tops. Here, soil erosion appears to be even more serious than on the cropped land.

Farmers attempt to match existing problems in two ways, mainly:

- shift of cattle to the low lands (Umba plains, Korogwe, Mlingano)
- keeping of cattle in simple stalls or tethered near the house and practicing the "cut and carry" system of fodder supply.

The shifting of cattle to the lowlands adjacent to the Usambara Mountains where the Washambaa maintain grazing rights appears, at first sight to be an easy solution. However, there are serious disadvantages involved. There are problems of management when parts of the families accompany the herds in the distant areas. More serious is the increased disease pressure in the lowlands. In addition overgrazing is already prevalent in the plains.

Consequently, a lasting solution can only be found in the cut and carry system, and in fact this practice can occasionally be observed in the villages. In most cases it is a combination of grazing and additional fedding. Farmers apparently accept the extra burden of carrying the fodder in order to maintain their herds. Simply constructed stalls can be seen. Normally wild grasses are being cut, but occasionally Guatemala grass has been planted already for quite some time. In addition, crop residues from maize, bananas, sugar cane and vegetables are being utilized.

The strong desire of farmers to maintain their cattle herds by practicing the cut and carry system, and the opportunity to grow the fodder in closer distances on the farm are apparently important factors for the acceptability of contour strips.

4. **Characteristics of project farms**

According to information received in the project area average farm sizes are rather low. This accords with the high population pressure in the Western Usambaras. Literature from 1981 reveals farm sizes between 1.2 and 5 acres (4).

Results of the 1983 evaluation survey show average farm sizes of project farms between 5.4 and 11.5 acres (compare table 1). This accords with the widely accepted fact that better-off farmers tend to adopt new innovations earlier than others, due to the means at their disposal, as well as their ability to bear higher risks.

Parcellation of farms is a aprominent feature in the project area caused by the Shambaa land tenure system. At the same time it enables farmers to spread risks. Project farmers surveyed during project evaluation cultivated 3–4 plots of about 1–4 acres on the average.

All project farmers own cattle herds ranging from 2 to 20 heads, apart from sheep and goats. This is irrespective of the fact wheater they take part in the soil erosion or improved heifer programme. Table 1 gives some selected data on four villages cooperating in the programme (10 farmers each). Though an assessment has to be made with caution the following conclusions can be drawn:

An important difference between Mbwei and Malibwi on one side and Manolo and Viti on the other, lies in a higher degree of land shortage prevalent in the latter two. Consequently, there is almost no grazing land left in Manolo and Viti. This must have a bearing on the livestock situation. In the absence of grazing area farmers will depend on their cropping land for the supply of the bulk of fodder. Hence, livestock can only be kept on larger farms. This apparently is true for Viti and Manolo, whereas in Mbwei and Malibwi livestock keeping farmers do not necessarily have to crop more land than others. This means that here farm sizes are no significant indicator for better-off-farmers. In addition it may be observed that with fodder crops grown on contour strips on the farms the area required for feeding a Livestock Unit is considerably smaller than under grazing on normally poor pasture land.

Table 1: Selected data on four villages cooperating in project activities

Village	Mbwei	Malibwi	Manolo	Viti
annual rainfall (mm)	600	800	600	650
statistical average of farm sizes, whole village [1] (acres)	5, 8	5, 8	3, 3	4, 0
statistical average of forest/ pasture land, whole village [1] (acres per farm)	8, 0	7, 2	1, 5	1, 6
average farm size of 10 project farmers per village [2] (acres)	5, 4	5, 4	10, 6	11, 6
average area per Livestock Unit (farm land + pasture) of 10 project farmers per village (acres)	2, 3	2, 1	1, 7	1, 3
project activities	soil erosion control	soil erosion control	dairy heifer	soil erosion control + dairy heifer

1) Calculated from census '78 and '79 and from land use assessment by air photo interpretation TIRDEP, Tanga 1980

2) computed from (5)

5. The impact of soil erosion measures

With respect to the farming system project measures contribute to the diversification of agricultural production. However, as the majority of project farmers keep cattle and small ruminants the respective innovations lead also to more integration of livestock husbandry and crop production.

Table 2: Opportunity cost calculation for Guatemala grass contour lines based on 40 project farmers in 4 villages

area of mixed cropping excluding valley bottoms		acres	160.2
maize	yield	to	23.53
	price per to	Shs.	4.610.--
	gross return	Shs.	108.472.--
	cost of seed	Shs.	1.499.--
	net return	Shs.	106.973,--
beans	yield	to	11.22
	price per to	Shs.	5.460.90
	gross return	Shs.	61.271.--
	cost of seed	Shs.	2.760.--
	net return	Shs.	58.511.--
In potatoes [1]	yield	to	13.23
	price per to	Shs.	5.000.--
	gross return	Shs.	66.150.--
	cost of seed	Shs.	13.230.--
	net return	Shs.	52.920.--
Net return	total	Shs.	218.404.--
	per acre	Shs.	1.363.32
contour lines 15 % of area [2]		acres	24
net return lost		Shs.	32.760.60
yield of Guatemala grass [3]		to/DM	39.36
Opportunity costs of Guatemala grass		Shs./to	832,33

Source: computed from figures given by (5)

1) grown in one village only (Viti)

2) assumed average area covered by contour strips

3) Calculation is based on an average yield of 1.64 t of dry matter (DM) per acre. This figure has been taken from (10).

Table 3: Cost-Benefit calculation of 4 alternative uses of Guatemala grass based on opportunity costs of 830.- Sh. per t DM

Alternatives (1 ton of Guatemala grass used for:)	Assumption	Returns	C : B-ratio
Sale to neighbours	2.- Shs. per headload of 20 kg.	100.- Shs.	1 : 0,12
Beef production of local steers	average gain of liveweight in 125 days = 34 kg á 11 Shs.	374.- Shs.	1 : 0,45
Milk production from local cows	8 kg DM per day for maintenance and 2 l daily price per l = 7.- Shs. 250 l for 125 days	1,750.- Shs.	1 : 2,1
Milk production from cross breed cows	11 kg DM per day for maintenance and 5 l average daily milk yield, 90 days = Shs. 35.- x 90	3,150.- Shs.	1 : 3,8

Source: calculation based on information received locally

The central element of project activities, i. e. the planting of fodder crops and trees on contour lines has a range of effects. The benefit of the principle aim of the project, erosion control and increase of soil fertility, cannot be quantified for the time being. However, many farmers seem to be aware the effects, though, due to their long-term character they tend to attach less importance to them. The same applies to the utilization of grass for mulching and compost.

The provision of fodder from the farms can be assumed to be the most important effect of the contour lines from the viewpoint of the farmers. The extra labour involved for planting and maintenance of Guatemala strips presumably match the time saved for those farmers who already practice cut and carry over longer distances.

In addition the availability of more and better fodder open opportunities for an improvement of livestock husbandry or the maintenance of the herds, when grazing opportunities diminish. On the other hand it is frequently mentioned by farmers that contour lines decrease the area to be cropped.

In order to assess whether the loss in cropping area is compensated by potential returns from Guatemala grass on the contour strips in the first years, when soil fertility has not improved yet, an opportunity cost calculation is attempted (table 2). The calculation is based on a mixed crop of maize, beans, and Irish potatoes and an equivalent area of Guatemala grass. The opportunity cost calculation of table 2, which is based on data from the evaluation survey 1983 show great variations between the surveyed villages. However, the mean cost of 830.00 Shs. per t of dry matter of Guatemala grass may reflect a realistic situation.

For the direct use of Guatemala grass four alternatives may be assumed. Table 2 shows a rough comparison of these alternatives. Only milk production seems to have a positive cost-benefit ratio. However, the possibility of maintaining the herd may be highly aspired by the farmers at any cost.

It has been mentioned above that a different approach is carried through in some villages. The assumed cost-benefit ratio accrucing to these farmers is given in the fourth alternative of table 3. The principle element is the supply of an improved heifer after a stall has been constructed and 1 500 m of Guatemala grass has been planted in contour lines. This has later to be increased to 3 000 m. The amount required is loaned to the farmer. Furthermore, he is required to contribute labour and some material.

Another important element of this approach is the village bull for which a stall is constructed and Guatemala grass planted. The bull is looked after by an individual farmer on behalf of the village. So far, there is no compensation for it, and servicing of cows is free of charge. The bull as well as the stall remain Government property.

3 000 m contour lines 1.5 m wide can supply about 30% of the fodder requirements of one livestock unit and its offspring. The rest has to come from crop residues or other sources. Secondly, with an average of 15% of farm land covered by the contour lines, a farmer has to cultivate at least 7–8 acres, in order to be able to install 3 000 m of contour lines. The above figures derive from the following calculations:

3 000 m contour lines = 4,500 m^2 = 1,12 acres
yield of Guatemala grass = 1,640 kg DM per acre (10)
3 000 m contour lines yield 1,845 kg DM

Fodder requirement of 1 LU	per day	=	11 kg DM
	per year	=	4.015 kg DM
50% for offspring	per year	=	2.007 kg DM
		=	6.022 kg DM

Hence, availability of farmed land is important in the absence of grazing reserves for those farmers who want to adopt an improved heifer (compare table 1).

Another factor is the economy of the innovation. However, a gross margin calculation does not normally give a realistic picture, as the main bottleneck which farmers face is liquidity. This is improved by the provision of loans to the farmers. The total sum credited is made up the following items

1. materials for cow shed		2,800.00 Shs.
2. transport of material		2,200.00 Shs.
3. craftsman for construction		600.00 Shs.
4. working equipment (whellbarrow, bucket, sieve, etc.)		800.00 Shs.
5. improved heifer (⅓ paid by the project)		3,800.00 Shs.
6. transport of heifer		200.00 Shs.
	Total	10,400.00 Shs.

Table 4: Liquidity Analysis of the Dairy Operation per year (years 2–5)

Variable costs [1]		
drugs	200.-	Shs.
minerals	90.-	Shs.
dip	35.-	Shs.
Subtotal	325.-	Shs.
loan repayment incl. 9 % interest	3,472.-	Shs.
opportunity cost 3,000 m contour lines	1,531.-	Shs.
Total	5,328.-	Shs.
equivalent in milk sold (7.-/l)	761	liter
share of total milk yield per year at 5 l per day - 300 days	50	%

[1] Indicated by District Livestock Development Officer, Lushoto. According to Hauser, 1983 some farmers in project villages mention even higher figures for drugs.

The total of Shs. 10,400,– is loaned to the farmer by TRDB and is to be repaid with 9% interest through years 2–5 in equal installments (= Shs. 3,472,– per year). The feasibility of the operation with respect to liquidity in the repayment years is shown in Table 4.

Table 4 examines the ability of start a dairy operation for a farmer who has no extra resources to invest. It does, of course, not show the total of benefits deriving from the cow. The opportunity to build up a more productive dairy herd is, in fact, the most important benefit, which may inspire better-off farmers even to sacrifice income for a certain period. The fact that some farmers in the project area have bought an improved heifer on cash may prove this assumption.

The net cash flow is positive during the repayment period of the loan, even when opportunity costs of Guatemala grass are considered. Liquidity, therefore, does not appear to be a constraint, when loans are granted with the above mentioned conditions. Nevertheless, the high risk remains of being heavily in depth, when the cow dies, or does not give milk for any reason. In addition, liquidity will depend on the possibility to market at least 50% of the total milk yield. So far, this is not yet a problem, as there is a high demand from neighbours and local tea houses. This demand ensures the relatively high price for the milk, as yet. According to information available in the project area farmers presently market about two thirds of their daily milk yield.

As can be expected, the introduction of an improved heifer has considerable implications on the labour economy. Data on this have been compiled through a study (7). Due to the extra work involved in stall feeding, cut and carry of fodder and fetching water, labour requirements for the improved cow are about twice as high as compared to local cattle. In addition traditional labour division is apparently disrupted as women as well as school age children have to work more in the improved dairy production than they used to in the traditional cow keeping.

6. **Summary**

Since 1980 attempts are made to spread soil erosion control and agroforestry methods into the small scale farms on the Western Usambaras of Tanzania. They are to match evident problems of the environment. While the programme is in general successful, there are factors limiting the diffusion of these practices into the entire farming population. This, in particular applies to very small farms. In addition there is a close linkage between planting of guatemala grass contour lines and the possibility to maintain cattle in the mountains. This is apparently the strongest motivating factor for the adoption of erosion control measures.

Zusammenfassung

In den Usambara-Bergen Tansanias wird seit 1980 die Verbreitung von Methoden der Erosionskontrolle und des Agroforestry betrieben, um den offensichtlichen Umweltschäden zu begegnen. Die Maßnahmen sind im allgemeinen erfolgreich.

Allerdings stehen ihrer Ausbreitung begrenzende Faktoren gegenüber. Diese treffen insbesondere die kleinsten Betriebe. Darüber hinaus besteht ein enger Zusammenhang zwischen der Pflanzung von Guatemala-Gras Contour-Streifen und der Möglichkeit, Rinder weiterhin in den Bergen zu halten. Hier liegt offenbar der stärkste motivierende Faktor zur Anlage der Erosionsschutzstreifen.

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