Overseas assignment report

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REPORT ON A VISIT TO KENYA: SONY WOMEN IN DEVELOPMENT CONSULTANCY

November 21 - December 12 1989

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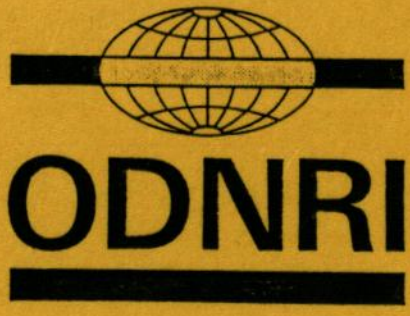

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Project Background and Terms of Reference

Overall Objective

To determine the effects of increased sugar production on the income and diets of SONY outgrowers and their families.

Specific Objectives of the Technical Survey

Soil Scientist

To assist in the selction of sample areas on a physical basis and to determine the proportion of land suitable for food crops and woodlots but unsuitable for sugar cane by sampling at farm level.

To suggest soil conservation and/or water harvesting measures that may improve food crop production security.

Agriculturalist

To determine the current balance of food crops to sugar cane and the practises of food crop production.

To discuss with the Ministry of Agriculture, SONY and Booker-Tate arrangements for developing extension services and make recommendations for food crops and agroforestry.

Executive Summary

LRD was asked by BDDEA to undertake the Women in Development Consultancy in order to fulfil the Project Evaluation Committee requirements to assess the affects of the SONY Rehabilitation plan on women in the area.

It was determined that the average farm size is 4.2 ha and approximately 35% of the average farm is under cane and 25% is under maize. An analysis of the farming system showed heavy reliance on oxen for cultivations. Some possible methods of improvement in the maize yields include early planting, increased plant population density, use of more fertiliser and improved store designs.

Extension can best be implemented by combining the SONY extension service with Ministry of Agriculture technical support. Farmers visits and training courses can be coupled with field plots within the SONY nucleus estate and demonstration farms.

Agroforestry is rarely practised though 88% of farmers plant trees, usually in boundaries or small woodlots. The primary reason for this is to provide building materials and fuelwood. Crop yields (per ha) could be improved by the initiation of agroforestry practices.

There are few signs of dramatic soil erosion in the outgrowers area, but recent reductions in practices of rotation, fallowing and addition of dung as fertiliser create conditions in which the soils are being slowly degraded. Doubts must be raised as to the sustainability of existing yields of both food crops and sugar cane. It is recommended that farmers are encouraged to add organic matter in forms other than cow dung (eg. compost of crop residues), if possible rotate food crops or incorporate planted fallow of nitrogen fixing species.

If limited resources are available to implement the soil erosion recommendations, targeting should be on the basis of an assessment of the erosion hazard of the locality. In the efforts to improve the food security situation of the outgrowers area, the initial focus must be on the soil resource, as it is the foundation on which the agricultural and other systems rely.

Acknowledgements

The technical team would like to thank particularly the following for their help in the project.

Mr R. Harbord General Manager SONY
Mr O. Needham Process Advisor SONY
Mr N. McConnell Booker Tate
Mr Omondi Outgrowers Manager SONY
Mr Oyier Assistant Agronomist SONY
Mr Orlale Divisional Agricultural Officer, Rongo
SONY Outgrowers Supervisors, Superintendents and Headmen
Farmers of the SONY area

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1 The Environment of the SONY Outgrowers Area

The physical environment of the SONY outgrowers area is complex and diverse. The underlying geological variation within the 72,000 hectare core zone (within a 16 km radius of the factory at Sare-Awendo) is the main factor controlling this diversity. The geology influences the soil, both due to the chemical and physical nature of the parent material and also as it controls topography.

The local geology includes both acidic and basic rocks. The soils developed on the acidic parent material are characteristically low in pH and highly leached and have moderate only organic matter content. The soils on the basic rocks are less acidic, typically less intensively leached and higher in nitrogen, organic matter, calcium and magnesium. The lowland areas (valley bottoms) are infilled with admixtures of alluvium, colluvium and volcanic materials, producing fine textured, nutrient rich soils.

Topography is also an important factor in influencing the spatial distribution of soils in the area. This can be interpreted best with reference to the catenary concept. The soils vary consistently from ridge and plateau tops to footslopes and valley bottoms. Crest and upper slope sites support well to very well drained soils of variable depth and stoniness, often prone to erosion due to the steep angle of slope. Lower and foot slopes are characterised by deeper, moderately well drained, darker coloured soils. Valley bottoms and plains are typically covered in deep sedimentary deposits (alluvial, colluvial and volcanic), in which deep soils have developed, which tend to be very poorly drained and frequently highly acidic in reaction.

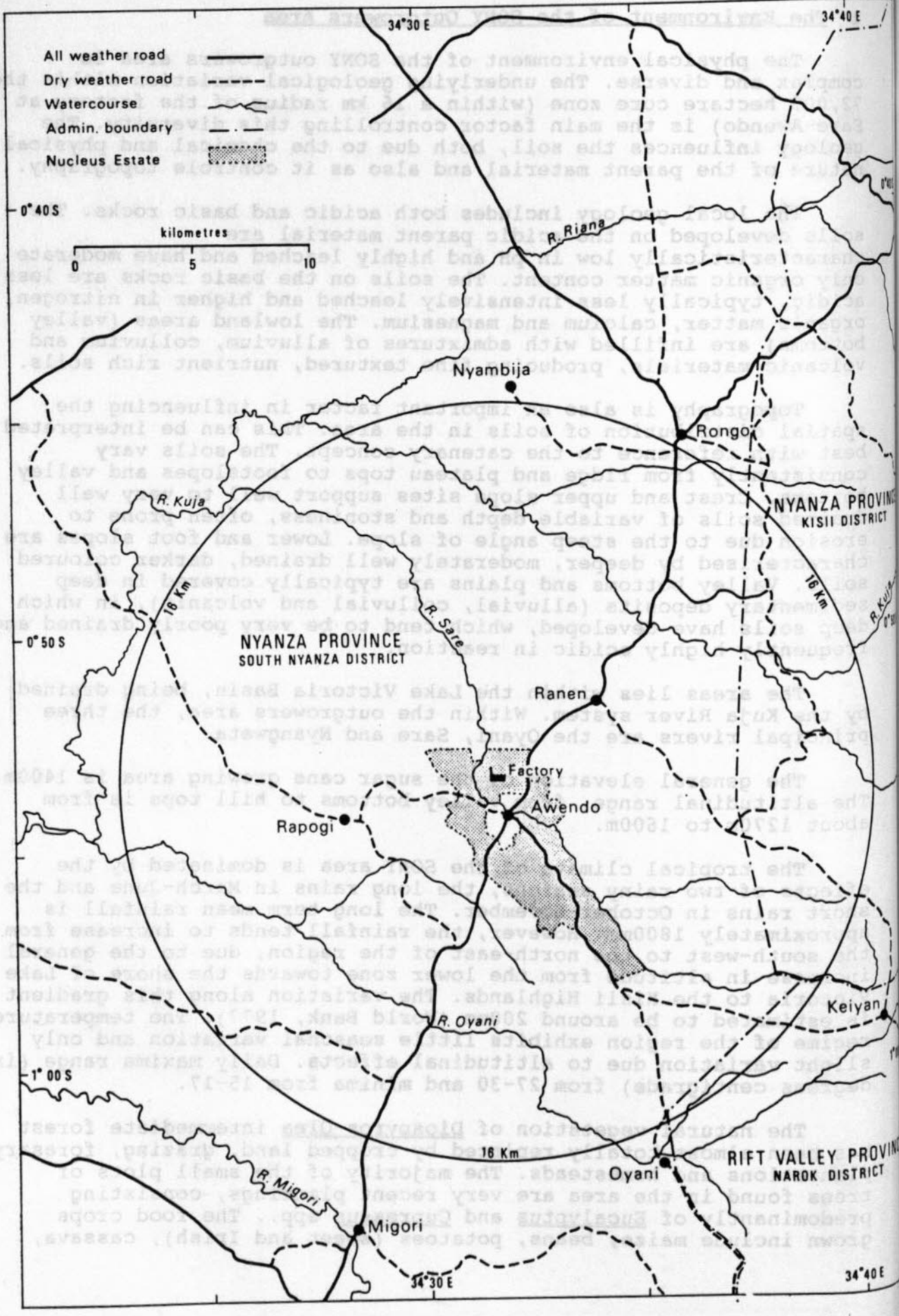
The areas lies within the Lake Victoria Basin, being drained by the Kuja River system. Within the outgrowers area, the three principal rivers are the Oyani, Sare and Nyangweta.

The general elevation of the sugar cane growing area is 1400m. The altitudinal range, from valley bottoms to hill tops is from about 1270m to 1600m.

The tropical climate of the SONY area is dominated by the effects of two rainy seasons, the long rains in March-June and the short rains in October-November. The long term mean rainfall is approximately 1800mm. However, the rainfall tends to increase from the south-west to the north-east of the region, due to the general increase in altitude from the lower zone towards the shore of Lake Victoria to the Kisii Highlands. The variation along this gradient is estimated to be around 200mm (World Bank, 1977). The temperature regime of the region exhibits little seasonal variation and only slight variation due to altitudinal effects. Daily maxima range (in degrees centigrade) from 27-30 and minima from 15-17.

The natural vegetation of Diospyros-Olea intermediate forest has been almost totally replaced by cropped land, grazing, forestry plantations and homesteads. The majority of the small plots of trees found in the area are very recent plantings, consisting predominantly of Eucalyptus and Cupressus spp.. The food crops grown include maize, beans, potatoes (sweet and Irish), cassava,

TEXT MAP 1 SONY outgrowers area



sorghum, millet, finger millet and various vegetables. Cash crops grown include sugar cane, tobacco, coffee, bananas, pineapples and tea.

2 Physical Basis for Sampling the SONY Outgrowers Area

The sampling framework was devised to allow detailed investigation, at farm level, of present conditions in the outgrower area. The framework was devised after reconnaissance field work, which indicated that there are no dramatic changes in the general pattern of agricultural land use in the outgrowers area. This may be attributable to a number of factors, including the primarily subsistence nature of the local food economy, the small farm size, local emphasis on maize as the staple food crop and the broad ecological tolerance of sugar cane. However, the influence of soil type was considered to be of sufficient importance that it should be incorporated in the sampling scheme. Although the same crops were observed growing on different soil types, soil type was anticipated to influence cultivation techniques, limits to cultivation and yields of both food and cash crops.

The framework devised involved sampling along the south-west to north-east agro-climatic gradient, stratified according to the main soil types as they occurred along the gradient. [The soils of the area have been mapped in some detail (Wielemaker and Boxem, 1982).] The individual farms were, as far as possible, randomly selected (within the constraints of lack of up-to-date maps showing the locations of farms), being approached on foot along informal transects running at right angles from tracks. This strategy facillitated the investigation of the role of soil type and also topography on farms in the outgrowers area.

3 Methodology

Three techniques were used at each sampled farm in the main field programme.

(1) guided interviewing of an adult farmer (male or female)

(2) field observation

(3) field measurement

The interviewing of farmers was intended to be the key data source, during which basic information was gathered. This included details of farm size, areas under different crops, woodlots and impressions from the farmers of the limitations/problems of his/her land. Field observation and measurements were used to cross-check the responses to the interviews and to collect technical data on the soils (pH, depth, texture, stoniness and Munsell colour). It was necessary to collect information about soils in the farm level study, in order to fulfill the terms of reference regarding problems at farm level. Existing soil information is at a broad scale (1:100,000), giving no impression of the degree of variability over short distances etc..

The technique of guided interviewing was adpoted in order to try to gain some of the undoubted wealth of local knowledge and insight, within the time available.

Given the time constraints imposed on the technical survey, local assistance was required to locate the pre-selected sample areas and also for translation work. Although the basis of sampling was not by sub-location (the smallest administrative unit in Kenya), the team were assisted on the ground by the SONY outgrowers headman, who are each responsible for one sub-location, and also a SONY supervisor.

4 Fieldwork

A total of one hundred farms were surveyed during the short rains of 1989 (late November to early December). The farms were located in twelve sub-locations (Kanyagwala, Kanyajouk, Kadera Lwala, Kamresi, Kogelo East, Kogelo West, Nyataro, Kawere Rateng, Kakrao, Kawere I Upper, Kawere I Lower and Kawere IIA). Of these, one (Nyataro) is in Kisii District, the remainder are in South Nyanza District.

The distribution of sampled farms by dominant soil type was :

soil type	n
Phaeozem	58
Nitosol	17
Planosol	4
Vertisol	3
Acrisol	7
Cambisol	8
Lithosol	3

The above classification is on the basis of the type of soil which covers the largest proportion of each farm. However, many farms include more than one soil type. This is particularly attributable to the traditional pattern of land holding in the region, which involves ownership of strips of land extending from the top of a hill/ridge to the valley bottom, spanning the catena of soil types and consequently sharing the good and less good soils.

The small number of farms on the five soil types other than Phaeozems and Nitosols was unavoidable - at present very few farms are located predominantly on these soils, particularly Planosols, Vertisols and Lithosols. This pattern indicates that at present there seems to be sufficient land for most farms to include some easily worked, fertile soil. This is considered not likely to be the case in the near future, due to successive subdivision.

5 Soils

5.1 General Characteristics of the SONY Soils

The seven soil types encountered in this investigation have been grouped into three classes which are considered to be valid combinations for the purposes of this study. The groups share common characteristics which are critical to soil management, agricultural practises, limitations and also potential yields.

Phaeozems and Nitosols (Class A)

These red-brown to dark reddish brown soils are characterized by high natural fertility. Their textures vary from very friable, slightly sticky to plastic as they have significant clay content. Phaeozems have a well developed crumb structure which allows fairly rapid moisture percolation - and creates aerobic conditions in the rhizosphere. Nitosols tend have less well developed crumb structure, therefore are less rapidly draining.

Class A soils are considered to be the most favourable types in the outgrowers area, both for sugar cane and for food crop production. They are generally well drained, have good nutrient status, are not highly acidic in reaction and are generally not highly susceptibility to erosion.

Under intensive cultivation, this class of soils tend to become acidic, thus the addition of lime, plus fertiliser to maintain fertility, is generally considered essential to maintain their productivity.

Planosols and Vertisols (Class B)

Both these very dark grey to black coloured soils types are found in areas of flat or depressed topography, typically in bottoms of river valleys. They have high clay contents, thus are only slowly permeable to water. When wet, the water is retained well, making them poorly drained and creating an anaerobic environment which is not favourable for rooting in most crops. In the anaerobic environment, organic matter decomposition is slow and produces highly acidic products. When wet, these soils are very heavy - on drying, vertisols in particular shrink, creating often very deep cracks and also forming very hard surface crusts.

Cultivation of these soil types is very difficult. They are often rendered unworkable at critical times in the crop calendar - being too dry and hard to plough before the rains, then too heavy for jembe or oxen to plough when very wet. Problems such as weeding in the rainy season, when hand weeding (the only option to small farmers) is effectively only transplanting, are solved in the nucleus estate only by the use of herbicides.

It is SONY policy not to allow outgrowers to plant sugar cane on these soil types, although they are often fertile, the high cost of land preparation and problems over harvesting are considered too great.

In areas where drainage is technically possible and economic (eg. in the nucleus estate), the addition of organic matter and lime (to neutralise the pH) can be used to create soils suitable for crop production.

Acrisols, Cambisols and Lithosols (Class C)

These soil types vary in colour from light grey through to reddish brown and grey brown. All tend to be shallow and course in texture, often with many stones. Due to their course textures, this group of soils tend to be very well drained, which from a plant growth point of view means that they may be subject to moisture stress.

Where any of these soils occur on slopes, they are highly erodible due to their weak inter-particle cohesion.

On favourable sites, provided sufficient organic matter and nitrogen are available, these soils can be agriculturally productive.

5.2 Results of Sample Survey

All the detailed results from the sample should be interpreted with a some caution. Due to the small sample size (100 of a population of some 16,000) it is not considered to be statistically justified to make numerical estimates for the entire zone from the results below. However, they are indicative results, which have been discussed with local "key informants", who agree that they are in accord with their knowledge and understanding of the current local situation.

Use of satellite imagery had been planned, as a means of determining total areas under food crops, cane and woodlots. However, it has been found that no recent satellite imagery is available of the area (the most recent SPOT scene is from 1986 - since when major changes, particularly in cane areas, have occurred). A further limit to the usefulness of imagery is that such information could not subsequently be disaggregated to farm level, which is required in the terms of reference.

Soil Depth

The range of soil depths within the outgrowers area is from zero or only a few centimetres, typically on ridge tops and steep slopes, to over 1.5 metres on foot slopes and valley bottoms.

soil depth class	A	B	C	total
1 (0-45cm)	13	0	9	22
2 (46-80cm)	28	2	7	37
3 (>80cm)	20	4	0	24
1-2	8	1	2	11
1-3	5	0	0	5
2-3	1	0	0	1

[sample size A = 75, B = 7, C = 18]

In terms of crop production, it is shallow soils which may be considered to have limitations. (SONY enforce a limitation that the average soil depth necessary for cane is 45cm - see Apendix 1.) Consequently, any farm with all or part of its area having soils less than 45cm may be considered to have limited options due to this factor alone. Of the farms with soils of class A, thirteen have their entire area less than 45cm in depth. Five farms have soil depth ranging from less than 45cm to over 80cm. In class B, soils are generally deeper, with only one farm having any soil of less than 45cm in depth. In class C, nine farms are entirely on soils of less than 45cm in depth and a further two farms include such soils within their area.

Soil Drainage

The drainage classes of the soils are closely related to the soil type, with class A being predominantly very well and well drained, class B being poor to very poorly drained and class C being varying from somewhat excessively drained to moderately well drained.

drainage class	A	B	C
somewhat excessively drained	-	-	1
well drained	22	-	14
moderately well drained	42	-	3
poorly drained	9	4	-
very poorly drained	2	3	-

[sample size A = 75, B = 7, C = 18]

Erodibility

The rainfall in the SONY outgrowers area has been identified by Moore (1979) to be of moderately high erosive capability (10,000 - 14,000 $J/m^2/yr$ on the basis of the KE25>25 parameter). This fact, together with the undulating nature of the local topography, combine to create conditions in which all the soils in the region must be considered to have at least a low erosion hazard.

Impressions about the erodibility of the soils on each farm were obtained from each farmer. These were supplemented by observations around the shambas. The fact that observations were made during a rainy season (the unusually late and heavy 1989 short rains) assisted in the identification of erosion problems; clearly active erosion processes were frequently identified beneath crops, on grazing lands, around homesteads and along roads/tracks. In many cases, however, individual farmers did not mention that their land suffered from accelerated erosion. In the field the evidence was clear, with active sheet wash, channels etc..

erosion hazard	A	B	C	total
high	16	4	4	24
medium	25	2	7	34
low	34	1	7	42

[sample size A = 75, B = 7, C = 18]

Although steep land is generally more susceptible to erosion, farms in the highly erosive category were not confined to those on the steepest sites, as may have been predicted on simple theoretical grounds. The spatial and temporal distribution of the vegetation cover (natural, semi-natural or crop), which is related to soil depth, organic matter content, pH and nutrient status are fundamentally important factors.

Use of Soil Fertility Maintenance Techniques

Practises of adding organic matter, either in the form of cow dung or mulch of maize stalks etc. to cropped land are not universal, as had been expected in the outgrowers area. In total seventy-three farmers mentioned that they actively tried to maintain the organic matter status of their soils.

technique	A	B	C	total
cow dung	41	3	6	50
mulch	3	-	-	3
dung + mulch	13	-	7	20

[sample size A = 75, B = 7, C = 18]

The use of crop rotation or fallowing as a means of avoiding soil exhaustion was only mentioned by twenty of the one hundred farmers interviewed in the outgrowers area.

technique	A	B	C	total
rotation / fallow	16	2	2	20

[sample size A = 75, B = 7, C = 18]

Similarly, only a minority of farmers stated that they to used any form of inorganic fertiliser on their maize crop or other food crops (all sugar cane areas are fertilised using the supplies sold to outgrowers by SONY see Appendix 1).

technique	A	B	C	total
fertiliser	9	1	4	14

[sample size A = 75, B = 7, C = 18]

Use of Soil Conservation Techniques

A variety of conservation techniques have been attempted by outgrowers, some following advice from the Ministry of Agriculture staff, but most entirely individual efforts. In total thirty-six farmers indicated having tried to conserve their soils from accelerated erosion, but of these seventeen farmers had not been successful in solving their problems. Contour ploughing is the most commonly cited conservation technique. In view of the powers which local chiefs have to enforce contour ploughing, the figures below are likely to underestimate use of this simple but effective technique. However, they also indicate that the level of awareness of the purposes of contour ploughing is not high.

technique	A	B	C	total
contour ploughing	13	0	2	15
terracing	3	0	1	4
cut-off drains	4	1	3	8
stone lines	3	0	1	4
tree planting	5	2	2	9
sisal planting	2	0	0	2
agro-forestry*	1	0	0	1

[* World Bank Training and Visit Farm]

[sample size A = 75, B = 7, C = 18]

5.3 Land Suitability

In 1986, Booker revised the Mehta estimates of land suitability for sugar cane in the SONY area (Booker, 1986). The results were:-

	Mehta %	BAI %	BAI ha.
highly suitable	39.7	9.6	6910
moderately suitable	17.8	8.2	5900
marginally suitable	4.1	41.1	29595
unsuitable	38.4	41.1	29595

The present survey indicates that approximately 35% of the land area in the area is at present under sugar cane. Within the outgrowers area, there are now only very limited areas of land not under cane, which fulfill the SONY criteria. It has not been possible to make a quantitative estimate of the relative proportion of food crops to trees/bush in the remaining 65% of the outgrowers area either on a farm basis, or for the entire zone (the latter due to lack of new satellite imagery). However, it is clear from field observations that better use could be made of the land not under cane (see Section 5.4).

5.4 General Recommendations

A co-ordinated soil conservation campaign should be started involving SONY, SOC and the local Divisional Agricultural Officers' staff. This must reach both outgrowers and non-outgrowers. Emphasis should be given to the fact that soil conservation need not involve major construction efforts (although in places these may be essential) - but that small changes in practises may be sufficient to conserve and improve soils. There is a general awareness that soil erosion is taking place, but most people seem to accept this as normal, as it has been going on for as long as they can remember. There is a new urgency in the problem, in view of the reduction in land available for food and also the decreasing possibilities for fallowing etc. should be highlighted.

Soil conservation messages should be incorporated in the extension messages of both SONY and the Ministry of Agriculture. This should involve not only direct contact between extension workers/headmen and farmers but could also make use of publicity materials such as posters and leaflets to spread the message. (Already the Ministry of Agriculture produce a booklet entitled "Soil Erosion and Conservation".) Particularly in areas where the erosion problems are severe, village soil concern groups could be developed to encourage increased awareness of the problems and emphasis that solutions need not involve hard labour.

Serious consideration should be given to setting up demonstration farms and/or plots which can be used to educate farmers, by example, in low cost methods of maintaining and improving soil conditions. Particular emphasis should be given to promoting the soil conservation/improvement capabilities of agroforestry techniques - the value of tree planting for shade, fuel and building materials has already been recognised.

The fundamental aim is to promote techniques which will make the best use of the land, in this zone where pressures on the land are enormous.

5.5 Specific Recommendations

Sugar Cane

In choosing land suitable for cane in future and in checking existing areas before replanting, the minimum depth criteria should be varied depending on the erodibility of the soil. On erodible soils, a greater minimum depth is essential for continuous cane monoculture. On soils of low erodibility, it may be possible to plant cane on soils shallower then 45 cm.

Care must be exercised in the alignment of the furrows in contour ploughing. In many fields, attempts had been made to contour plough but these have not been carefully aligned; consequently furrows are acting as channels for run-off and topsoil is being lost unnecessarily.

The furrows ploughed must be sufficiently deep to prevent 'over-topping', which can lead to serious erosion down slope if even a single contoured furrow is breached.

If land is to be continuously under cane monoculture, the problems of sub-soil compaction leading to impedence of both drainage and root development should be seriously addressed, particularly between cropping cycles. Within the nucleus estate, the problems are overcome by subsoiling using tractors. In the outgrowers area, this is not considered viable, yet the problems are not dissimilar. The present ox-plough technique used in the outgrowers area cannot be expected to be sufficient, especially in areas of deep soils.

The pH of the topsoil in cane areas should be monitored closely and if necessary lime applied prior to replanting. This is likely to be required even on the Phaeozems, which generally tend to become acidic under intensive cultivation.

The organic matter status of the topsoils in the outgrowers area should be monitored. Maintenance of the organic matter status of these soils is essential, as the organic matter not only specifically retains nutrients but also maintains the soil's physical, chemical and biological structure and thereby reduces the risk of accelerated erosion. Additions of organic matter to cane land differ between the nucleus estate (which is said to be the model of how cane should be grown, which outgrowers should try to emulate) and the outgrowers area. On the nucleus estate 80 t/ha of filter press mud is applied prior to planting, but on the outgrowers' fields only the trash from the cane after cutting is available (Appendix 2). Investigation should be made into alternative sources of organic matter for cane in the outgrowers area. An indirect result of a change away from the cane variety CO421 may be a reduction in this problem, cane roots are an important source of organic matter to the soil system, but CO421 is acknowledged not to be a very good rooting variety.

Investigations into intercropping of sugar cane should be continued in the nucleus estate and developed in the outgrowers area. Whereas intercropping of sugar cane is being undertaken

elsewhere, prompted by low world sugar prices, the reasons behind the promotion of intercropping in SONY are rather different. In the SONY context, intercropping will provide a means to produce some food on land which otherwise would have been a sugar cane monoculture, with no reduction in cane yields. Also, as an indirect effect, where the other crop is a legume, intercropping should provide a means of increasing the nitrogen status of the soils, without the need for fertiliser.

The SONY recommended fertilisers should be available to the outgrowers at the correct time for both the plant crop and ratoons in each cropping cycle (Appendix 2).

Other Cash Crops

A number of other cash crops are grown on a much smaller scale then sugar cane. These include tea, coffee and pineapple. Some attention should be given to promoting small scale alternative cash crops (eg. sun flower) within the SONY area. This would enable farmers who cannot grow sugar cane, due to lack of land, or limitations on their land, therefore provide them with a source of cash income. In the absence of this, it appears inevitable that there will be an ever increasing differential in living standards etc. between cane growers and non cane growers, with the latter being at ever greater disadvantage.

Food Crops

Contour ploughing should continue to be encouraged.

In limited zones of the SONY outgrowers area, grass strips are being used successfully on slopes to limit overland run-off of rain water and the resultant topsoil removal. These should be promoted more widely, particularly where, due to the various pressures on land already described, arable cropping is being forced onto steeper slopes.

Emphasis should be placed on the importance of replacing nutrients to the soil after every harvest, particularly where one crop has been grown in monoculture. Sources could be the traditional, including cow dung and maize stalks. However, unless zero grazing 'takes off', the reduction in the local supply of cow dung will limit these options. More novel agroforestry sources including leaves directly from trees or compost made primarily from leaves and branches lopped off fast growing trees (either in alley cropping systems or more likely boundary plantings and small woodlots) should be encouraged.

Inter-cropping practises, for example maize and leguminous beans (thereby increasing the soil niotrogen content), which had been a traditional practise, but at present is only carried out by a small number of farmers, should be promoted as a means of avoiding soil exhaustion where rotation and fallowing are no longer feasible.

Where sufficient land is available to allow continuation of the practise of fallowing, planted fallows of legumes to provide

green manure should be encouraged in preference to simply allowing weeds to colonise, as occurs at present.

Where there is insufficient land to allow fallowing, it may be feasible to promote some form of crop rotation which will avoid the problems of soil exhaustion inevitable where monocultures of maize etc. are being growing in successive growing seasons without fertilisers.

Use of the recommended planting distances between maize should be encouraged: frequently plants are so widely spaced that sheet erosion is occurring in plots irrespective of the soil type.

As an option, inorganic fertilisers (particularly nitrogen) should be made more widely available. This will be achieved by:

(1) ensuring that the fertilisers are sold in small quantities, to make their use at least a possibility to most farmers

and

(2) improving distribution, farmers should not require to go to Rongo or Migori to purchase supplies as at present.

It is suggested that SONY could increase the amount of fertiliser which they have available for sale, and agree to sell this on to any farmer for cash.

Grazing Lands

Emphasis should be placed on the importance of maintaining good vegetative cover on grazing areas, in order to limit the often imperceptible losses which can lead to a serious decline in the quality of the pasture.

Woody Resources

The proportion of woodland areas and trees (boundary etc.) in the SONY area appears to have increased greatly in the past few years, the result of the successful promotion of tree planting by Government and NGOs. Despite the much discussed shortage of land for food crops, the landscape includes significant proportions of woodlands and bush dominated by woody scrub vegetation. However, few of these areas are suitable for cropping under maize etc. Better use could be made of these areas of scrub woodland, by clearing and planting with, for example nitrogen fixing trees. The leaves and branches of these trees could then be harvested and moved directly onto the crop land or stacked to make manure - both soil improvers. Poles and fuel woul also be available from these improved bush areas.

Roads and Tracks

Any work on new tracks and the widening of existing tracks to enable cane cutting operations to be carried out must recognise the potentially damaging effects which such activities are having at

present on farms downslope. (Thirteen of the one hundred farmers sampled highlighted the serious problems they were facing due to run-off from tracks.) SONY freely admit that their present track making activities are rushed and that they should use compacters. However, it is recommended that carefully oriented grass lined cut-off drains are also essential in many situations.

6. Crop Production Systems

6.1 Maize crop production system.

Maize is by far the most common food crop in the SONY outgrowers zone covering about 25% of the farm area. It is cropped twice annually, once in each wet season.

Land Preparation.

The ground is ploughed and harrowed just before the rains using oxen and metal single-mouldboard ploughs.(71% of farmers own oxen, 27% hire oxen and 2% use hoes.)

Planting.

Timeliness of planting is of major importance particularly in the short rains because it affects the length of the growing season, the pest load suffered by the crop and the efficacy of weedings. Hybrid seed is rarely used though rapid maturing varieties are more commonly planted in the short rains. Seed is planted in rows in unfurrowed earth. Spacing between plants in rows is very commonly too great though the spacing between rows is not excessive (ideal spacing is 75cm between rows and 30cm between plants in rows).

Weeding.

The first and second weedings are done using the ox-drawn plough. Loosened weeds are removed by hand. Third weeding is done using hoes. Chemical herbicides are not used. The parasitic weed Striga (compositae) is particularly difficult to control. Couch grass is also a problem.

Fertilisation.

Cow dung is added sporadically both as a fertiliser and a mulch. Chemical fertiliser is rarely used. It is doubtful that the fertiliser used replaces the nutrients lost in whole crop harvest. The majority of farmers leave the trash in the field though some is fed to livestock.

Pest Control.

Common reports of crop losses to birds and mammalian pests (antelope, porcupine, monkeys, moles, rats and cattle) were recorded. The control measures were restricted to use of local traps which were not effective enough to control populations of these pests. Moles are a particular nuisence in maize. Insect pests include stalk borers, termites (microtermitae) and weevils, the latter being important only in storage. None of the insect pests result in heavy losses of yield.

Storage

Maize is partially dried on the stalk in the field and then placed into large storage baskets supported on logs. Some maize is shelled and sold immediately. The majority of farmers do not store sufficient maize to last to the next harvest and so rely on purchasing for a short period.

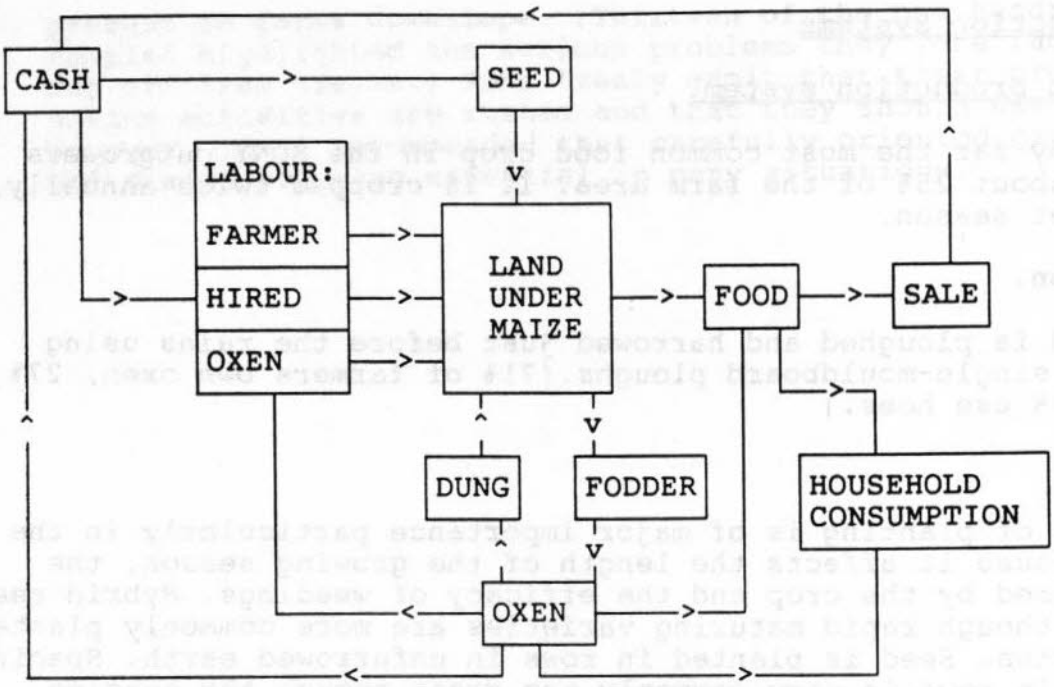


Diagram of the maize crop production system

Rotation

Rotation of cropped land is practised by many farmers but it is limited by plot size. Fallow land is left unplanted and is colonised by weeds. Maize is rarely intercropped with beans and though it is often found in very small plots it is usually monocultural.

Labour

The great majority of labour is supplied by the farmer and her family though rarely some hired labour may be used for weeding. Farmers who hire oxen out accompany their animals because they respond only to their trainer. However, even where the oxen are hired the plough is usually controlled by the land owner or a son. Women find the metal ploughs too heavy to control and the job is done by men.

6.2 Other food crops

Sorghum millet and cassava.

These are grown in the drier areas to the South West though Maize is the preferred crop. Sorghum is the traditional staple and is also used for brewing. The practices of crop production are essentially as for maize with the following exceptions:-

Sorghum and millet seeds are broadcast and this makes weeding with oxen impossible so it is done by hand.

Cassava cuttings are planted in the ridges of ploughed land. The crop is grown as a reserve and harvested as required.

Vegetables.

Usually brassicas and spinaches planted close to the homestead and in small plots.

Beans.

Cropped separately or round the edges of maize plots. It is grown to provide a supplement to the diet of maize.

6.3 Areas of potential improvement in the practices of food crop production.

Timeliness of operations.

During the short rains in particular, it is important to plant maize early. One of the effects of this is to give the maize a longer growing season because water deficit is increasingly a limitation to plant growth once the rains are over. This is particularly important on the sandy acrisols and in the South Western area of lower rainfall.

Maize that is planted early has an advantage over weeds as it can outgrow them if given a few weeks to establish itself. Weedings must be carried out at the right time in relation to the comparative size of the maize and weeds. Weeds begin to grow as soon as the first rains fall and the first weeding is best done when most of the weed seeds have germinated. This will be around two weeks into the rains by which time the maize will be big enough to survive weeding by ox-plough. Maize planted late may not be big enough to survive this operation. Weeds will be most competitive towards the end of the rains when the maize is growing vigourously. The shade cast by the maize plants reduces the growth rates of these weeds but if the maize is planted late it will be smaller at the end of the rains and so less able to shade out the weeds. This third weeding time is commonly put off due to labour demands for other crops making this shading effect more important.

Pest load is increased later into the season, this is most marked for insects but is also true for some mammalian pests. Crops that are still in the field after most of the maize in an area has been harvested attract a higher proportion of pests. Farmers recognise this as a major problem to cropping in the short rains.

Harvesting begins before the maize has dried out. This green maize is boiled or roasted and is harvested early because of the food shortage just before harvest. This food deficit will be longer where maize is planted late. Also the market price will decrease as more maize is available later in the harvesting season.

Reasons for untimely operations.

The main reason why maize is planted late is because of the difficulty of judging the start of the rains. People therefore commonly wait for the first rain before starting to plough. Also, the land is often left to weather for a short time.

Late planting is also caused by the lack of availability of oxen. This is severely restricted for the farmers who are forced to hire oxen as the owner ploughs his own land before hiring out the animals. This problem will be exacerbated as the number of livestock is dropping in the area, primarily due to the shortage of grazing land.

Solutions

The effects of planting early on later operations may not be well understood by farmers and this is seen by the local Ministry of Agriculture as their most important extension message. The availability of oxen could be increased if people could be pursuance to plough before the first rain. The use of single-ox ploughs has been successful in trials and could be introduced.

Plant populations

Most of the maize seen in the outgrowers zone was too widely spaced given an optimum spacing for rain-fed maize of 30cm by 75cm. Competition between maize plants is minimal at this density yet gives suppression of weed growth by shading. Not only is the correct spacing important for maximising yield but also for reducing exposure of the soil to wind, sun and raindrop impact all of which contribute to soil erosion. Maize is commonly planted in unfurrowed land which increases rainfall run-off and a higher plant population would reduce low-level sheet erosion. Wind causes lodging of maize in some exposed areas and this can be reduced by higher plant population densities.

Reasons for low plant populations

Farmers were traditionally practising intercropping with the maize crop usually with beans or other crops such as tobacco or sweet potatoes. This has now almost ceased because of the adoption of monoculture which is seen as a modern cropping practice. The traditional spacing of maize which leaves room for the beans has continued but without the beans. The increasing pressure on land due to rapid human population growth rate in the area has only recently reduced farm sizes to a level where intensive cropping of food has become important. This is evidenced in areas of lower human population density such as the South West of the outgrowers zone where the maize is less intensively cropped.

Solutions

The use of rope to create straight lines of maize is increasing and farmers using this method and optimum spacing claim increases in total yields. The Ministry of Agriculture place plant populations high on the list of extension messages.

With the increasing human population density the necessity to produce more food from small areas of land will lead farmers to adopt more intensive cropping practices including higher plant population densities.

Fertiliser Usage

74% of the farmers surveyed claim to use some sort of fertiliser on the maize crop. The majority use cow dung from their own animals. Very few farmers purchase cow dung or inorganic fertiliser. Mulching with maize stover is common and a few farmers use cow dung as a mulch to control weeds. Undoubtedly from the wide variation in yields of maize and apparent health of the crops the use of fertilisers is sporadic and restricted to small areas of plots.

Reasons for low fertiliser usage

The major constraint on the use of fertiliser is the cost of purchase. It is only recently that inorganic fertiliser has been available in 20kg bags, 100kg being the usual weight and too costly for small farmers. Transport of cow dung is difficult as the region has no ox-carts and even moving dung from the animal enclosure to the field on the same farm requires a major commitment in terms of labour.

It is unlikely that farmers do not know of the value of applications of fertiliser particularly as the SONY extension service have been so successful in promoting its use for sugar cane. In fact it is probable that some of the fertiliser supplied by SONY and bought buy the farmers for the cane is used on the maize. Farmers may not buy chemical fertilisers because they prefer cow dung and are unlikely to substitute a lack of dung with purchased inorganic fertiliser. The decreasing cattle population in the area is a major problem for the supply of dung. Few farmers buy cow dung which has always been seen as a free resource and the labour involved in moving it is restricted.

Solutions

The availability of fertiliser in 20kg bags has made it far more accessible to small farmers and hopefully its use will increase. Demonstration of the effectiveness of fertiliser is readily seen in its affect on sugar cane. The Ministry claim that farmers know they are supposed to use cow dung but more extension effort in this area would confirm this and show farmers the correct application rates.

Acquisition of loans

Farmers in the SONY area need capital loans in order to purchase fertiliser, ploughs, oxen, seed and to hire labour.

Reasons why loans are not available

Farmers loans from the Agricultural Credit Corporation (ACC) and banks are only available if approved by the Ministry of Agriculture. One local Divisional Agriculture office authorised no loans in 1988 due to a poor recovery rate of the 77 loans authorised in 1987.

Possible Solutions.

SONY operates an efficient loan system whereby farmers loans are subtracted from the payment for cane at the harvest. Having a good knowledge of the farmers, the Ministry extension officers and SONY headmen could advise the ACC and SONY on farmers requiring loans. Land title deeds may be one form of security for loans.

Storage

Though the problems of grain storage are not seen to be very important by farmers, there is undoubtedly loss of stored maize due to weevil damage. The traditional crib in which unshelled maize is stored is raised about 1 foot off the ground which is easily accessible to rats. Weevils cause low-level damage to most cobs and no attempt is made to reduce this loss.

Reasons

The experience of farmers in Tanzania dealing with the Greater Grain Borer (Prostephanus) has shown that the major changes to storage design are only adopted slowly even under pressure. Both the availability of insecticides and awareness of their usefulness are at a low level in the area.

Solutions

The Ministry is pushing improved storage designs as part of its food crop extension package and some demonstration cribs have been built. The supply of building materials is not a severe limitation to crib construction and extension work on the appropriate techniques can centre round the existing demonstration cribs. Awareness of the use of insecticides and shelled storage of maize needs to be built up.

7 Discussion

Soil is a complex heterogeneous medium, including a matrix of inert particles, but also chemically and biologically active components (including clay minerals, organic matter, bacteria, fungi, flora and fauna), water and an atmosphere of gases. Within the soil, changes occur in the relative proportions of the different components, for example in the amount of water; but the system is basically in a form of dynamic equilibrium.

Key aspects in this equilibrium are the processes of pedogenesis and erosion, which form part of the geomorphological cycle of weathering of bedrock and removal of detritus.

Accelerated erosion or degradation of the soil by man is a problem which has been widely recognised. In simple terms, it is where the rate of erosion exceeds that of pedogenesis. Soil degradation may mean the removal of all the components of a soil, as is the case of gully erosion. Arguably of greater importance are the progressive and incidious losses of soil material due to sheet erosion, which never gain the attention of often spectacular gully erosion. It is possible that as little as a 1% loss in topsoil particles may result in a halving of the total soil nutrient content. Degradation may not even involve removal of soil material or leaching of nutrients. A change in soil aeration due to impedence of drainage can indirectly affect the entire system and its suitability to sustain crops. Use of herbicides and pesticides may have the desired direct effect, for example of killing a weed species, but indirectly may kill elements of the soil flora which are vital to the maintenance of the integrity of the entire system. A pesticide used to solve insect pest problems in a standing crop may also reduce the population of soil dwelling fauna, which may be crucial to maintaining the soil structure as they create biopores, allowing rainwater infiltration etc.

It is the minimum goal of all permanent agricultural systems that the yield of crop(s) can be maintained - within the range of variation attributable to local climatic variability and other factors (eg. pest outbreaks). The time scale on which this stability or sustainability is assessed may be over a single growing season (eg. the long or short rains in South Nyanza), several seasons followed by rotation or fallowing, or over a longer time scale as in the case of sugar cane, tea, coffee, other perennials and forest systems.

In reality, the goal is to progressively increase yields (which may be quantified per hectare or per man day), by whatever means available and/or appropriate, to satisfy growth in demand, which may be due to increasing population, per capita demand or a decrease in the land available for the crop.

Due to constraints of time and data availablity, it has not been possible to rigorously test the hypothesis that, relying on currently prevailing practises of land management, both for food crops and sugar cane, yields in the SONY outgrowers area cannot be sustained. However, reviewing the current practises and problems

described by the 100 sampled farmers, yields are not even being sustained, far less increasing in pace with population growth.

The sample survey can only provide a snapshot of the situation, but some farmers did indicate that they had noticed a reduction in food crop yields over recent seasons. This reduction comes despite the recent succession of good rainy seasons in Kenya. Use of time series analysis to test the hypothesis on cane yields, which have been accurately recorded, is not appropriate in this context. Recent increases in cane yields are most likely to be attributable to improvements in the management of the SONY operations.

Questions must be raised as to how long crop yield levels can be maintained.

The entire soil/vegetation system in South Nyanza is inherently fragile. This is in part due to environmental factors, particularly the high erosivity of the rainfall. Superimposed on this fragile ecosystem, the rapid rate of population growth and the transfer of the best land in the SONY outgrowers area from food crop production to sugar cane, are placing enormous and ever increasing pressures on the remaining land. Progressive sub-division of the land between generations means that inevitably in future more farms will have to be located entirely on soils which have often severe agricultural limitations (erosion, drainage or stone problems, or shallow depths). With the population of the area growing at a rate of about 4% per year, there will be an inevitable increase in the demand for food, yet a considerable area of land has been put over to sugar cane and more may be converted in future.

Although at present the majority of farmers seem relatively content with the amount of land they have available for maize, they also note progressive reductions in their maize yields. The reasons for this are complex. Traditionally, fallowing and rotations were practised in order to allow soils to recover their fertility following periods of intensive cropping. Recently, the best land in the outgrowers area has been transferred from being used predominantly for food production to sugar cane monoculture. Due to the reduction in the total area of land available for food crops and compounded by the reduction in the land area available per capita (due to the rising population) there has been a severe reduction in the possibilities for fallowing and crop rotation. Effectively more food must now be grown on less fertile portions of the land.

In addition to the practises of fallowing and rotation, the other traditional means of maintaining soil fertility was by the application of cow dung. However, with less land available for grazing, due to pressures to grow more food and loss of land to cane, there has been an enforced reduction in the local livestock population over the past decade. A direct consequence of this is the reduction in the supplies of cow dung.

Most farmers are aware that inorganic fertiliser could be used to improve their soils, but even if it was available and affordable, there seems to be a marked reluctance to accept its

usage. Farmers questioned, maintained that although fertiliser use can double the yields, manure is better (suggesting that in fact it is the organic matter content of the soil which is the critical factor limiting yields).

SONY Outgrowers Company (SOC)

SOC operates in close collaboration with SONY management and is a form of trades union for the outgrowers. All minor questions and complaints are dealt with by SOC and they represent the outgrowers to the factory management. The founding members on the board of SOC include the District Commissioner, District Agricultural Officer, Provincial Cooperative Officer, SONY Agricultural Manager, Kenya Sugar Authority Executive and four elected outgrowers representatives. One woman is elected by the board to represent women's interests.

Soc collaborates with the SONY training courses and has a substantial input in explaining to outgrowers the terms of their contract and the legal aspects of growing cane. SOC does not run any separate course or extension service to outgrowers but provides a useful service as a point of contact with the factory.

Local Non-Governmental Organisations (NGOs)

There are many NGOs working in the SONY area, these include missions such as the Church of the Province of Kenya and the Maranatha mission in Migori. Also Peace Corps and Care Kenya operate in the area alongside the Ministry of Agriculture. Local churches and religious organisations, women's' groups and youth groups are also active in agricultural development. Many of these groups have intimate local knowledge of the farming system which could be very valuable to any extension programme in food crops. The groups are mostly self-motivated and self-funding and function at the grass roots level.

8.2 Proposed structure of food crop extension service to farmers in the SONY outgrowers area.

The basic problem with the present Ministry food crop extension service is the lack of transport. The basic constraint preventing SONY from providing such a service is the lack of technical expertise. It would seem that collaboration between the two services could result in an effective means of reaching farmers with the basic messages outlined earlier.

SONY can provide transport and an extensive network of headmen who know their areas and farmers. The ministry can provide technical support and training for the headmen and farmers in food crop husbandry. Both SONY and the Divisional Agriculture Office stressed that collaboration could lead to more successful extension for food crops.
The detailed mechanics of this collaborative effort will need to be worked out between the parties involved. The following suggestions are intended as a working structure.

Overall Control by:	District Commissioner SONY General Manager
Administrative Supervision by:	SONY Outgrowers Manager District Agricultural Officer

Coordination by:	SONY Training Superintendent and Divisional Agricultural Officer
Headmen trained in food crop extension by:	Ministry Field Staff and SONY sublocation supervisors
Farmers trained in food crop husbandry by:	Headmen and Ministry Field Staff
Transport for headmen to training courses by:	SONY vehicle pool
Identification of farmers by:	SONY headmen
Provision of food crop literature by:	Ministry of Agriculture and inclusion in SONY handouts.
Input into SONY monthly farmers training courses by:	Divisional Agriculture Officer and Technical Staff.
Demonstration food crop plots:	On SONY nucleus estate and one farmer in each sublocation.
Regular visits to demonstration farmers by:	Ministry field staff.
Joint reports to SONY Management and District Agric. Officer by:	SONY training superintendent and Divisional Agric. Officer
Regular review and modification of programme by:	SONY Outgrowers Company General Manager, women's representative

The SONY supervisors presently carry out a limited amount of food crop extension when they are in the field and they are aware of the important messages. However, time constraints prevent them from meeting many farmers and advice given is only in response to farmers questions. The extension system outlined above is suggested as a means of increasing the collaboration between the Ministry and SONY with a view to improving the extension services of both parties. Detailed study of the organisation of such an extension system will be necessary before it can be implemented.

8.3 Agroforestry extension

88% of the farmers in the outgrowers area plant trees on their land. The following is a breakdown of the farmers main reasons why this is done:

Purpose	no. farmers
Building	77
Fuelwood	42
Sale	23
Windbreak	14
Erosion control	9

Many farmers claimed more than one major reason for tree planting and this was corroborated by the Divisional Agricultural Officer for Rongo who pointed out that building and fuelwood species (Eucalyptus and Cupressus) were taken in preference to leguminous species from nurseries. Eucalypts account for approximately 90% of the trees in the outgrowers area. Alley cropping is not practiced in the area, though a few Peace Corps demonstration farms have been set up. With the increasing pressure on land it is unlikely that alley cropping with trees will be widely accepted. It is a subject of controversy that the trees increase the overall yield of maize in intensive alley cropping. A further limitation is the use of ox-ploughs which can damage the tree roots.

As farmers are well used to planting trees in small woodlots and along field and homestead boundaries it would be more appropriate to encourage the use of forage and mulch leguminous trees for agricultural use in these areas. Many NGOs (Peace Corps, Care Kenya, The Green Belt Movement, missions, schools and colleges) and the Forestry Division of the Ministry of Natural Resources are producing tree seedlings for sale. Until recently there was an active market for seeds and missions are not only giving away seedlings but actually paying people to produce seedlings for themselves. Some private individuals have started nurseries and many women's groups have begun to grow trees for their own use.

There are tree planting systems already in place which could be utilised to encourage the planting of agroforestry species such as Calliandra, Leucaena, Gleditsia and Causurina. An extension effort coordinated by SONY would be able to identify small groups in each sublocation to be given tree seeds and encouraged to propagate them for distribution to local farmers. The production of trees need not be coordinated by SONY though the inclusion of an agroforestry seminar in the SONY outgrowers training course would be very valuable. It would also be of benefit for the SONY headmen and Ministry field staff to receive training in appropriate agroforestry practices from local NGOs, for example Peace Corps.

It is somewhat alarming that Eucalyptus species dominate the arboraceous flora of the outgrowers area because they use large quantities of water (to the extent that they can be useful in draining waterlogged land) and because of this they can reduce growth rate of nearby plants. This subject is, however, in contention. The genus has been planted primarily because of the availability of seed, its rapid growth rate and straight bole which is used in building. As an agroforestry tree Eucalypts have little potential and should not be grown within crops. The promotion of leguminous species is already under way at a low level but more extension work is required on methods of integrating tree products into the food cropping system. Agroforestry for soil erosion control may be very important. Land availability is not likely to become a restriction on tree planting given that boundary plantings are common. Ministry forest plantations exist on some hill tops in the area.

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Appendix 1

SONY Criteria for land suitable for Sugar Cane

-field must be > 3.0 ha (may be in multiple ownership)
-topsoil must be at least 45cm in depth
-soil must be fertile
-soil must be freely draining
-soil must not be stony
-plots inaccessible to tractors are not acceptable
-field gradient must be < 15% (for tractor safety)
-each farmer should keep 0.8 ha for food crops

Appendix 2

Chemicals etc. Added to Suger Cane

Inorganic fertilisers added to plant crops and ratoons in both the nucleus estate and the outgrowers area.

diammonium sulphate (DAP) + 18% nitrogen	100kg/ha
urea (46% nitrogen)	80kg/ha

(Urea is applied as a top dressing 3-5 months into the sugar cane growth cycle.)

Herbicides (used only in the nucleus estate)

TCA	8kg/ha
Diuran	2kg/ha
Actril DS	1.5l/ha

Organic Matter

trash is left after harvesting of green cane in the outgrowers area

filter mud (80t/ha) applied to nucleus estate (no trash is left as the cane is burnt prior to harvest - leaving some ash)

PPENDIX 3.1 FARMS ON CAMBISOLS, PLANOSOLS, VERTISOLS ACRISOLS AND LITHOSOLS

arm ode	% area Cane	% area Maize	Total Area	Yield Maize	Length Deficit	Main con- -straints	Ideas to Solve	Trees
46	44	30	5.2	844	1	O	C	3.B,F
47	25	50	.8	n/a	2	O	F	1.B,F
93	20	30	4.0	1125	0	S,P,A	F,C	3.W,K
57	0	60	4.0	1350	1.5	S,W,B,I	E,C,F,L	2.B,W,F
58	33	48	8.4	2250	0	S,W,B,P	F,C	1.B,F
59	18	20	12.0	2250	2	B,I	C	2.S,B
60	0	33	1.8	2092	2	S,W,L	O	1.B,F
61	32	43	2.8	2250	1	A	C	2.S
62	8	8	2.4	2250	1.5	S,W	C	3.B,F
63	40	30	2.0	1333	1.5	A	F	1.K
64	0	21	1.9	2250	1	O	C	2.F,B
1	50	25	2.0	n/a	4	A,B,S	H,C	1.W
2	46	23	3.5	n/a	0	F	F	1.B
6	25	25	3.2	750	1	I,B,W,P	K	3.B,F
10	11	7	19.2	n/a	2	W	H	2.B,F,K
9	44	18	6.8	875	2	L	F,H,K	3.S,E
69	0	38	4.0	800	1	W,B,A	F	0
97	42	34	2.4	3375	0	A	C	1.B
51	0	75	1.6	2000	2.5	L	F	3.K
52	0	50	3.0	3645	n/a	W	F	1.B,S,K
53	0	67	.6	1125	0	B	K,F	1
54	0	50	.4	450	3	F	F	0
55	33	19	6.4	1125	2	B,A	F,M	3.B,F
56	0	86	.7	2500	4	P	B,C	3.W,E
68	19	13	6.4	1781	1.5	F,I.A	C	1.E
verages:-						S = 6 O = 3 P = 4 A = 8 B = 8 W = 8 L = 3 F = 3 I = 4	F = 13 C = 13 O = 1 L = 1 H = 3 B = 1 M = 1 K = 3	B = 14 F = 10 S = 4 W = 4 K = 5 T = 0 E = 3
	#	#	*					
	31	27	4.1	1456	1.5			

.B. # non-cane farmers excluded
* Farms over 15ha excluded

APPENDIX 3.2 FARMS ON PHAEOZEMS AND NITOSOLS

Farm Code	% Area Cane	% Area Maize	Farm Area	Yield Maize	Length Deficit	Main Con-straints	Ideas to Solve	Trees
3	0	100	.8	675	0	B,A	F	1.B
4	80	20	5.0	800	0	N/A	F	3.F,B
5	21	4	14.0	1000	0	W	L	3.F,B,S
7	18	64	5.5	n/a	2	W,B,L	L,F	2.B
8	67	16	22.5	450	0	L	C	1.B,F
11	0	33	1.0	2400	0	I	B	2.B,F
12	29	29	3.5	500	1	O	K	1.W,S
13	0	100	.4	200	4	I	K	0
14	0	100	.4	n/a	4	B,A,W	C	0
15	0	100	.2	n/a	4	B,A	C,F,E	0
16	7	2	160.0	1800	0	W,B	L,E	3.S
17	0	17	6.0	2375	3	L	K	1.B,F
18	40	12	100.0	n/a	0	F	B,C	3.E
19	16	13	12.8	3150	0	W	F,M	3.B,S
20	31	37	3.2	n/a	0	B,W	L	1.B,F
21	19	7	28.0	1350	0	L	C,F	1.B,F
22	15	33	4.8	2700	0	I,S	K	2.B,F,S
23	0	56	7.2	900	4	O	K	3.B,F,T
24	0	75	1.6	1350	1	A,F,S	M,C	2.E,B
25	0	100	1.2	417	0	P,S	B,F	2.B
26	0	23	6.9	1125	3	F,B,W	F	2.B
27	36	6	40.0	2250	2	M,S	F	3.B,S
28	0	71	2.8	n/a	1	F	C	1.F,B,K
29	37	33	6.0	1575	2	P,A,W,L	E	1.S
30	22	44	3.6	2160	3	L	K	1.K,B
31	21	7	28.2	1800	0	W,I	F	1.T
32	48	10	12.0	n/a	0	F	O	3.S
33	25	30	4.0	1125	0	W,P	C	3.B,F,S
34	31	25	3.2	n/a	3	W	E,F	1.B,F
35	0	25	1.6	450	4	I,F,S	O	1.B
36	13	9	14.0	1800	0	S	C,F	3.T,B,S
37	40	40	4.0	1575	6	P	C,L	2.B
38	60	20	2.0	1800	4	O	F	2.W,B
39	22	13	3.2	n/a	1	L,M	F	0
40	30	50	2.0	1800	3	O	M,F	3.B,W
41	19	19	3.2	2250	0	O	F	3.F,W
42	29	14	2.8	1575	4	S	F,C	3.B,F
43	38	60	9.4	968	0	P	K	3.B,F
44	40	50	3.0	1800	4	S,P	C,F	0
45	40	20	1.0	900	1	O	K	3.B,F
48	0	100	.2	225	10	O	L	1.B
49	32	48	2.5	n/a	2	O	F	1.B
50	50	50	3.2	1688	0	O	C	0
65	13	27	3.0	500	2	W,S	F	1.B
66	0	30	4.0	833	0	I,L	F,H	3.B,S,E
67	0	20	4.0	1250	0	P,W	F,C	2.E,B,S
70	30	7	24.0	2250	0	S,W	F	0
71	8	25	16.0	875	1	W	F	0
72	33	17	4.8	2250	3	W	F	1.S
73	29	19	8.6	3750	3	W,F	C,B	2.B,F
74	47	13	6.0	900	2	L,F	C	1.W
75	32	32	7.5	500	3	O	K	1.F,B
76	0	4	20.8	1500	1	S,P	E,F	2.W,K
77	49	9	14.0	750	2	W	F	0
78	0	50	.8	1500	3	M,F	K	2.K,B
79	43	10	12.3	3375	1	W	C	2.B,S
80	63	13	3.2	675	6	F	F	1.B

81	22	13	3.2	900	5	S	C	2.B
82	25	33	2.4	900	8	B,W	L	2.B,F,K
83	45	10	6.0	600	2	F,W,I	M,F	2.K,B
84	25	25	3.2	675	0	M	K	2.B
85	80	10	4.0	1800	1	W,M,P	F	1.B,K
86	58	8	2.4	450	2	W	K	0
87	50	15	4.0	1350	0	I,P	E	3.F,K,B
88	80	20	4.0	2250	5	I	O	1.E
89	50	20	4.0	788	0	B,M	C,F	2.B,S
90	88	5	4.0	n/a	2	F,S	H,F,C	2.E,B
91	0	50	1.6	338	2	M	F	1.W
92	68	14	2.8	2250	0	W	O	2.B,F
94	35	20	4.0	2025	5	I	C,F,K	2.B,F
95	43	29	2.1	2250	0	I	C	1.S,B,F
96	25	20	4.0	2250	2	P	O	2.B,F,S
98	0	34	3.5	1125	2	W	C,F	2.B,F,S
99	0	100	2.4	750	2	W	F	1.B,F
100	56	24	2.5	600	2	W	F	1.B

Averages:-

	#	#	*			P = 11	F = 37	B = 51
	37	23	4.3	1188	1.9	A = 6	C = 23	F = 26
	(1.6ha)	(1 ha)				B = 9	O = 5	S = 19
						W = 27	L = 7	W = 6
						L = 9	H = 2	K = 7
						F = 11	E = 6	T = 3
						I = 11	B = 4	E = 6
							M = 4	
							K = 13	

N.B. * - Farms over 15ha excluded
- non cane farmers excluded
n/a - data not available
see key for definitions

APPENDIX 3.3

Key to symbols used in APPENDIX 3.1 and 3.2

N.B
Farm areas are in hectares.
Maize yields are in kg/ha.
Length deficit is in months/year.

Main Constraints refers to the farmers perceived limitations to increasing maize yields.

Key:
P = Porcupines and moles destroying maize
A = Antelopes, monkeys and squirrels destroying maize
B = Birds destroying maize
W = Weeds reducing maize growth rate
L = Labour limitations
F = Fertiliser supply inadequate (organic and inorganic)
O = No constraints perceived
S = Soil erosion and infertile soils
I = Insects destroying maize

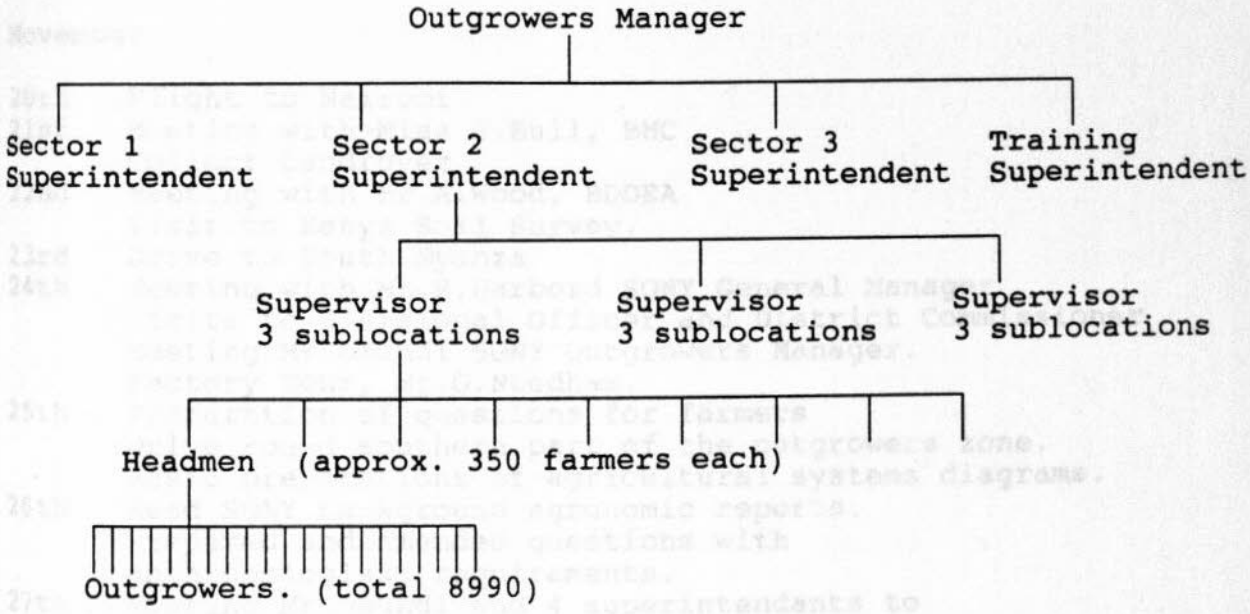
Ideas to Solve refers to the farmers ideas to increase maize yields

Key:
F = Fertiliser (organic)
C = Chemical fertiliser
O = No ideas mentioned
L = Labour
H = Hybrid seed
E = Early planting
B = Biocides
M = Mulch
X = Other ideas such as using rope to produce straight lines, agroforestry etc.

Trees refers to the farmers current reasons for planting trees

Key:
0 = no trees planted
1 = Few trees planted
2 = Some trees planted
3 = Many trees planted
B = Building
F = Firewood
S = Sale
W = Windbreak
K = Shade
T = Tobacco curing
E = Erosion control

APPENDIX 4. **SONY OUTGROWERS MANAGEMENT**



APPENDIX 5.

PROGRAMME UNDERTAKEN.

November

20th Flight to Nairobi
21st Meeting with Miss S.Bull, BHC
Collect Landrover
22nd Meeting with Mr.A.Wood, BDDEA
Visit to Kenya Soil Survey.
23rd Drive to South Nyanza
24th Meeting with Mr.R.Harbord SONY General Manager
Visits to Divisional Officer and District Commissioner
Meeting Mr.Omundi SONY Outgrowers Manager.
Factory Tour, Mr.O.Needham.
25th Preparation of questions for farmers
Drive round southern part of the outgrowers zone.
Basic preparations of agricultural systems diagrams.
26th Read SONY background agronomic reports.
Prepared and amended questions with
anthropologists requirements.
27th Meeting Mr.Omundi and 4 superintendants to
outline the fieldwork programme.
Meeting Mr.Ojow, SONY Outgrowers Company (SOC)
General Manager.
Pilot survey two farmers visited.
Visit to Mrs. Odero, board member of SOC
28th Survey in Kogelo sublocation
29th Kawere 2A
30th Kawere Rateng and Kawere 1

December

1st Nytaro and Kabouro
2nd Kanyajuok and Marongo
3rd Sunday
4th Kamresi and Katieno
5th Kanyagwala and Kagera Lwala
6th Kakrao
Meeting Mr.P.Otieno, SONY Training Superintendent.
7th Visit to Mr. Orlale, Rongo Divisional Agricultural Officer.
Processing survey data.
8th Mr. Omundi, debriefing.
Visit to Migori Division Ministry of Agriculture.
Mr. Harbord, debreifing. Mr.P.Oyier, Assistant Agronomist.
9th Visit to nursery plots and nucleus estate.
Processing survey data.
10th Drive to Nairobi
11th Mr.J.Hansell BDDEA, debriefing.
Visit to Mr.Were, Deputy Director of Agriculture,
Ministry of Agriculture.
12th Fly to U.K.