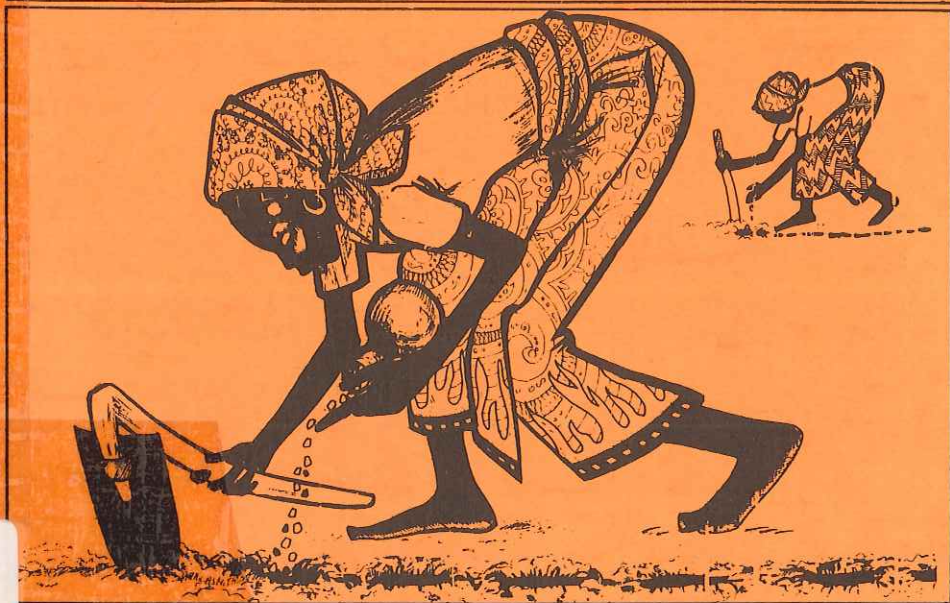
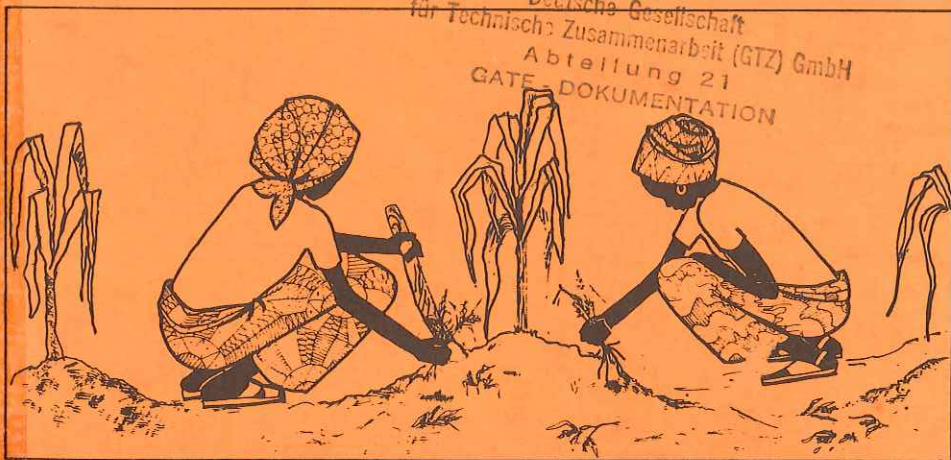


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PRIMARY SCHOOL AGRICULTURE Teacher's Manual Part Three

Farming Methods

Deutsche Gesellschaft
für Technische Zusammenarbeit (GTZ) GmbH
Abteilung 21
GATE DOKUMENTATION



PRIMARY SCHOOL AGRICULTURE

Teacher's Manual

Part One	Pedagogy
Part Two	Crops
Part Three	Farming Methods
Part Four	Crop Storage
Part Five	Land Tenure

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Postfach 5180, D-6236 Eschborn 1	
Inventar-Nr.	Standort
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by Herbert Bergmann and Richard Butler
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PRIMARY SCHOOL AGRICULTURE

Teacher's Manual

Part Three

Farming Methods

by Herbert Bergmann

Published in August 1980 by the
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Note to readers:

This documentation is based in part on research done by the Environmental Studies Section of IPAR-Buea in the years 1973 and 1974. The research approach has been documented elsewhere. Our text fairly often refers to types of communities which differ in important respects. These community types are:

(1) Isolated Rural Communities

They are inaccessible to vehicles and require one or several days of walking or long water transport, most of them are situated in the South-West Province.

(2) Remote Rural Communities

They are inaccessible to vehicles but are less than a day's walk away from motorable roads or places with basic service facilities.

(3) Marginal Rural Communities

They are either on poor roads which can be used only part of the year, or not far from main roads along footpaths; they have poorly developed cash crop farming, and marketing requires transport to a co-operative store elsewhere.

(4) Poorly Served Rural Communities

They are along roads with a firmly established cash crop agriculture but far away from government and non-government services.

(5) Well Served Rural Communities

They all lie on motorable roads and have rather good access to government and non-government services.

(6) Urban and Semi-Urban Areas

These are administrative centres and their immediate surroundings; they are on tarred roads or earth roads motorable throughout the year. Many of them have large markets or are in their immediate neighbourhood so that food crop farming becomes an income earning activity.

1. Objectives

Farming is an art which has developed slowly over centuries of human existence. It is based on very long experience and continuously adjusts to changing conditions. Every people, every group have their own way of going about farming, and individual farming women and men often have their own special skills. It is with these ways or methods of farming that the following section is concerned. Terms used in this connection are farming methods, farming techniques, and land-use systems to denote a whole combination of methods and techniques. One of the general aims of primary school agriculture is to prepare the way for improved farming in order to raise agricultural production or to reduce the work-load of the farming women and men. Teachers therefore need a fair knowledge of the most important techniques suitable for the different Cameroonian environments.

We shall start this section with some information about traditional farming methods in Cameroon. Significant agricultural progress may be possible by improving traditional farming methods. Progress might also require something entirely new, a break with tradition. In both cases, however, it is necessary to know what is happening at present and why things are as they are.

"Before any consideration can be given to possible developments on African smallholdings and the means by which these can be brought about, it must be determined what farmers are now doing, what factors govern their actions, and what pressures there are to change the pattern of agriculture that results."
(Cleave, J.H. 1974, p. 31)

There are several good reasons for carefully examining traditional farming methods:

- Traditional land-use systems are adjusted to local conditions in the best possible way under prevailing

circumstances since they are the outcome of centuries of learning.

- A lot of experience based on long observation and practice has accumulated which should be made available to as many people as possible.
- The inferiority of traditional agriculture is by no means established. There are sound reasons for mixed cropping, and there are local systems of crop rotation and crop sequences that have proved their value.
- Farming techniques are as much part of a people's culture as are its religion, its language, its history, and its arts.
- Therefore, traditional farming is embedded in a way of looking at the world and life in general. Ideas about cause and effect governing traditional farm operations will inevitably be applied to new, "modern" techniques. In order to take them into account it is necessary to know them. If, for example, people believe that fertility can be stolen from a farm by means of magic this might influence their outlook on organic and chemical fertilizers.

After this we shall briefly examine so-called modern or scientific agriculture which is still prescribed in current Rural Science syllabuses. The section will end with some information about recent developments in research in tropical agriculture. These developments seem to agree much more with traditional African agriculture than the approach to modernizing agriculture favoured so far.

A number of major objectives can be pursued in teaching about farming methods. The following list spells out a few of them. A summary table will show which parts of the section may be most useful in planning units with one

or several specific objectives.

- 1) Pupils will acquire basic knowledge and skills concerning farming techniques.
- 2) Pupils will systematically acquire basic knowledge about traditional farming techniques in their area and in other parts of Cameroon.
- 3) Pupils will develop pride in African tradition by discovering the advantages of traditional farming methods.
- 4) Pupils will be able to assess critically different farming methods.
- 5) Pupils will learn the logic and skill of observation and experimentation in an elementary form by comparing traditional and non-traditional methods of farming the same crop(s).
- 6) Pupils will develop at an elementary level the capacity to select farming methods adapted to local conditions.
- 7) By dealing with traditional agriculture and the body of knowledge and beliefs supporting it, schools will be able to document local knowledge about crops, farming techniques, soil and other related topics that up to now have only been handed down orally.
- 8) Teaching about farming methods may lead to links with the extension service and nearby agricultural research institutions. The school will receive up-to-date information on research findings and in turn will provide the extension service and research institutions with feedback on the local relevance of their proposals and findings.

The last two objectives are beyond the reach of the usual classroom but are intimately linked with generating new knowledge and making such knowledge available. Pursuing them will certainly enhance the effectiveness of classroom teaching and school farm work.

2. Traditional Agriculture

2.1. Traditional land-use systems - from shifting cultivation to degraded bush fallow

In Cameroon there are four types of traditional land-use system: shifting cultivation, rotational bush fallow, grass fallow, and continuous cultivation.

Shifting cultivation is a system where a few years of cultivation are followed by very long fallow periods. Fallowing is so long that trees and bushes can grow up again to form a secondary forest. In this way, fertility is completely restored to the soil after it has been farmed. But it means that fallow periods must be longer than ten years. Less than ten per cent of a community's land could therefore be farmed at any one time.

As fallow periods have become shorter, shifting cultivation has give way to rotational bush fallowing. Here, too, the time that the land lies fallow exceeds the time the land is under cultivation. Provided the fallowing period is long enough, bush fallowing also restores soil fertility:

"... when the time period between each cycle of cutting and burning was always in excess of seven years ... the Bush Fallow developed as a stable ecological system."
(Obi, J.K., and Tuley, P., 1973, p. 1)

"It can be seen that Bush Fallowing has many merits in the preservation of soil fertility. The soil is exposed for a minimum period of time by mixed cropping, the root system of the fallow is largely left intact, the fallow recovers quickly ..."
(Obi, J.K., and Tuley, P., 1973, p. 5)

"The stability of the system depends on the number of years that the land remains under fallow. NWOSU mentioned a 'basic rotation' with a fallow period of seven years:

1st year: yams, early maize and vegetable, cassava
2nd year: cassava followed by bush fallow
3rd - 9th year: bush fallow
(Lagemann, J., 1977, p. 9)

With further shortening of the fallow periods, the land-use system develops into a degraded bush fallow system. Fallow periods are too short to fully restore soil fertility.

When the fallow period is reduced to just one or two years, shrubs and bushes no longer grow again after farming but are replaced by spear grass. The bush fallow system turns into a grass fallow system. On the compounds, immediately surrounding the houses, there is continuous farming. The compound area is fertilized with a variety of materials, e.g. household refuse, animal droppings, grass and twigs for mulching. Fertility here is very high and is conscientiously maintained.

"Compound farming is not a special land use system found only in Eastern Nigeria; it can be found world-wide in tropical regions where land scarcity has forced farmers to intensify production on small fields."
(Lagemann, J., 1977, p. 30)

"Compound farming is ... a type of land use which is of general importance in the humid tropics."
(Lagemann, J., 1977, p. 31)

In Cameroon, all four systems can be seen in operation. The average period of fallowing in a sample of 201 farm plots for which data on fallowing were available was four years. The fallowing table shows the frequency with which the different land-use systems occurred in a survey of the two anglophone provinces (compound farms excluded):

length of fallowing		land-use system
1 year	7.6%	grass fallow
2 years	28.8%	grass fallow
3 years	30.3%	degraded bush fallow
4 years	4.5%	degraded bush fallow
5 years	6.1%	degraded bush fallow
6 years	3.0%	degraded bush fallow
7-8 years	7.6%	bush fallow
9-10years	4.5%	bush fallow
more than 10 years	7.6%	shifting cultivation

The areas with long bush fallow shifting cultivation are remote areas with plenty of unoccupied land. By and large, periods of fallowing are tending to grow shorter whereas periods of continuous cropping remain the same or become even longer. If one compares the length of the farming period to the length of fallowing, the following picture emerges:

Fallow and farming periods compared	frequencies	
	absolute	%
the <u>fallow period</u> is two or more years <u>longer</u> than the <u>farming period</u>	33	25.4
the <u>fallow period</u> is one year <u>longer</u> than the <u>farming period</u>	16	12.3
the <u>fallow period</u> is as long as the <u>farming period</u>	20	15.4
the <u>fallow period</u> is one year <u>shorter</u> than the <u>farming period</u>	20	15.4
the <u>fallow period</u> is two or more years <u>shorter</u> than the <u>farming period</u>	41	31.5
	130	100.0

The length of the farming and the fallowing period is not left open to the choice of the local farmers but is the result of differences in local conditions. This is borne out by the way the length of the fallow period is affected by the general level of development of a community. The fallow period becomes increasingly shorter as one moves from isolated areas into urban or semi-urban communities.

At the time of the survey conducted by IPAR-Buea, food-crop farming in the South West Province was already much

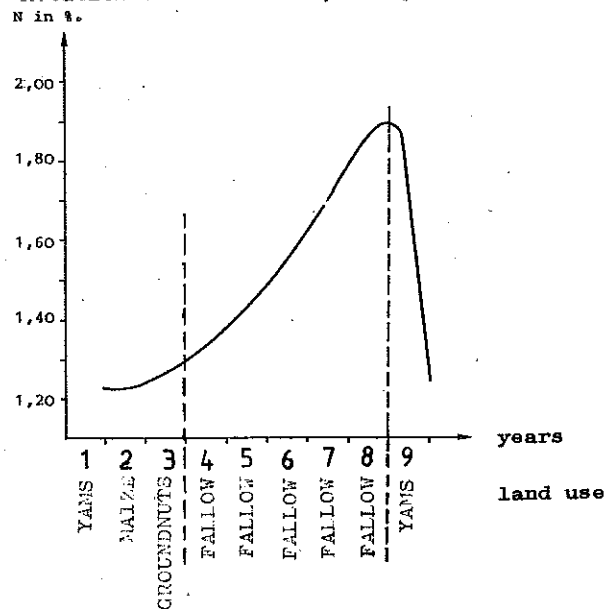
more market-oriented than in the North West Province. Consequently, fallowing periods were shorter in the South West than in the North West Province; this is true for nearly all zones with different levels of development and accessibility, as can be seen from the table below:

Average number of years of fallowing according to community type

Community type	South West Province	North West Province
isolated	3 - 4 years	3 years
remote	3 - 4 years	4 years
marginal	2 years	4 - 5 years
poorly served	2 - 3 years	3 years
well served	0 - 1 year	1 - 2 years
urban/semi-urban	1 - 2 years	1 year
Total per province	2 - 3 years	3 years

In order to understand clearly the importance of fallowing in traditional agriculture, let us look at the following graph. It takes the percentage of available nitrogen in the soil as an indicator of soil fertility. Three years of farming are followed by five years of fallowing. After the nitrogen content has reached its lowest level under maize cultivation in the second year, it increases after the cultivation of nitrogen fixing groundnuts. It rises steeply during the fallow period, but most of it is used up by yam farming in the first year after the fallow.

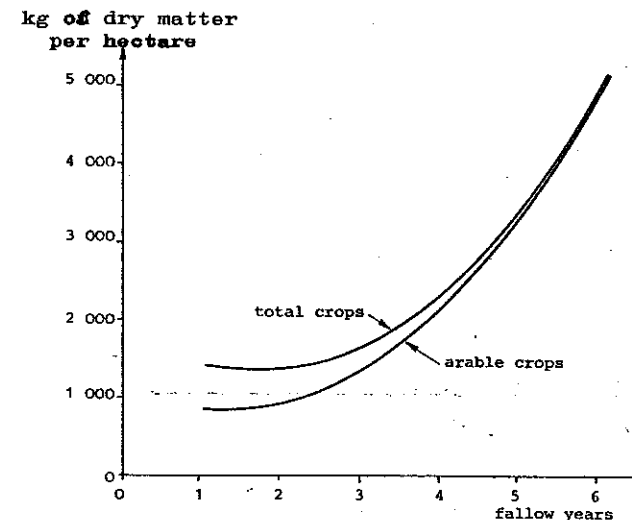
Development of Nitrogen in the Soil in the Traditional Rotation of the Baoulé, Ivory Coast



Source: adapted from Cadillon, M.: Evolution du sol sous une rotation Baoulée traditionnelle, IRAT, Bouaké, (undated),

How dramatically the length of the fallowing period can affect yields may again best be seen from a graph. It portrays the relation between yields as measured in dry matter per hectare and the number of years a plot is left fallow. It is taken from an area with light or sandy soils in Eastern Nigeria; the author of the study thinks, however, that the effect of lengthening the fallow period would be less pronounced in heavy or clay soils.

Relationship between Output of Crops and Length of Fallow Period Prior to Cultivation



Source: Lagemann, J., 1977, Fig. 15, p. 67

Further statistical analysis showed that 60 per cent of the increase or decrease in yields was most probably due to changes in the fallow periods.

Shortening fallow periods are a sure sign of pressure on land. As the fallow periods shorten, soil fertility is restored only imperfectly:

"The length of the fallow cycle depends upon the fertility of the soil and the availability of land. Where land is scarce the fallow cycle is short, and as population density increases fallow cycles ... become increasingly shorter. ... the abbreviated fallow cycles result in the steady depletion of soil fertility and a continuous decline in crop yields." (Smock and Smock, 1972, p. 73)

This means that schools and the agricultural extension service alike should stress the maintenance of soil fertility through fertilizers, manuring, and erosion control especially when they are operating in better developed and densely populated areas.

2.2. Traditional Farming Methods

Traditional farming is characterized by:

- the use of fire for clearing a new farm plot (slash-and-burn agriculture)
- superficial tillage by hand
- often planting on mounds or ridges
- mixed cropping using a number of carefully composed crop associations
- the lack of any inputs for fertilizing and crop protection on the fields away from the compound.

2.2.1. Clearing

Especially clearing by fire has been heavily attacked for destroying the soil. For a detailed analysis of what burning does to the soil, see the section on soil, especially the comparative analysis of three soil samples from a trial plot near Buea. Here, in less technical terms, are the advantages and disadvantages of burning:

"Burning of the bush has the following advantages:

- It kills most grasses and weeds, so that the first weeding needs to be done relatively late.
 - The alkaline ash raises the pH⁺ and availability of cations⁺ in the surface soil
 - Nutrients like P, K and Ca⁺ are made available in soluble form, which stimulates the growth of plants during the early growing period.
- On the other hand there are some disadvantages inherent in the system:
- The carbon, nitrogen and sulphur in the fallow and litter are lost in the burn (but not the amounts in the soil humus).
 - The fire damages trees like oil palms, raffia palms, etc.

⁺ For an explanation of technical terms see section on soil.

- There is a build-up of fire-tolerant, low-productive species.

Burning is, however, still an indispensable part of the system. Crops in bush fallow rotations depend on the pH⁺ effect of the burn, and in grass fallow systems the burning of the grass is still considered to be more advantageous than composting - in particular in terms of return on labour."

(Lagemann, J., p. 48/49)

- clearing in the forest zone

Burning of grass and undergrowth is very common, even more so the burning of the taller trees. In most cases, the dead trees are left standing on the farms, though sometimes the trees are allowed to continue growing as they are used for shade.

We may distinguish between the following systems of bush clearing in the forest zones:

- 60% of all farmers in the survey in the forest zones burned the grass and trees
- 17% of all farmers in the survey in the forest zones used grass and undergrowth as manure but burned the trees
- 23% of all farmers in the survey in the forest zones used grass and undergrowth as manure and felled rather than burned the trees

Burning is the only way of bush clearing in the isolated rural areas and it predominates in the remote and marginal rural communities. Among these communities is not a single one where it is not practised, but there may be some farmers who refrain from burning the grass.

In the poorly served rural communities, the pattern changes and you find farmers no longer burning the grass. This change becomes more pronounced in the well-served rural communities, and in the urban or semi-urban communities, only a few farmers seem to continue the practice of burning. Here, trees are more often felled

than burned, perhaps because of their relatively higher value as firewood and building material.

Farmers in the low-lying forest areas of the North West Province, all isolated or remote areas, do clearing by burning. The communities in the transitional zone between forest area and the grassland savannah, those that are not yet urban or semi-urban always burn grass and trees.

- clearing in the grassland area

In the grassland areas, we have identified four distinct methods of farm clearing.

- 40.4% of the farmers in the survey in the grassland zone burned grass and shrubs
- 16.3% of farmers in the survey in the grassland zone operated the nkara-system
- 18.3% of farmers in the survey in the grassland zone covered the grass with soil and thus used it as manure
- 25.0% of farmers in the survey in the grassland zone left the grass on top of the soil for manure

The nkara-system consists of cutting the grass down, covering it with soil to form a ridge, and then burning the grass. This keeps all the ash in the soil and makes a slow burning fire. It is on nkara ridges that egusi and Irish potatoes would be grown in the first year after clearing. There is a variant of nkara which consists of making ridges immediately after burning so that little of the ash is lost. But this is not as effective as the nkara system since the fire burns much faster, and the greater amount of smoke takes away more of the ash particles.

The nkara- system is especially common in the high altitude zones: throughout Bui Highlands, the neighbouring lower areas (Nkor, Lassin, Tabenken), the

Kom-highlands, the Baligham are, but also around Bamenda itself (Bafut, Bambili etc.). Although clearing by burning decreases as the level of development of a community improves, this tendency is weaker than in the forest zone and burning remains fairly common throughout. This may be due to the fact that, the nkara-system is a rather sophisticated approach to farm preparation.

Also, in most communities there is a wide range of practices. Good farm clearing without resorting to fire can be found even in remote and marginal communities.

Some areas of the South-West Province also use grassland methods of clearing, e.g. Fontem - Fotang area, which is a transitional zone and grassland savannah, some areas on the coastal strip where most forest trees have disappeared long since - Mudeka, Idenau - and communities where substantial food crop farming is going on in coffee and cocoa plantations like the area south of Tombel and around Nyassosso. Burning disappears as one moves from the isolated to the poorly-served rural and the urban or semi-urban communities.

The incidence of burning in farm clearing

Community Type	<u>South West Province:</u> grass is		<u>North West Province:</u> grass is	
	burnt %	used for manure%	burnt%	used for manure%
isolated	88.9	11.1	100.0	-
remote	70.0	30.0	66.7	33.3
marginal	75.0	25.0	37.5	62.5
poorly served	28.6	71.4	69.2	30.8
well served	30.0	70.0	52.4	47.6
urban/semi-	27.3	72.7	53.3	46.7
Total	52.7	47.3	58.9	41.1

Farmers know that burning was strongly discouraged by the Department of Agriculture. They gave specific reasons why they continued it, or under what conditions they used fire for clearing:

- to kill off roots and stumps of trees and shrubs
- to grow groundnuts - they do very well immediately after burning (Nhiangse/Bakossi)
- to grow egusi (Shiy/Bui; Awing near Santa)
- to grow cocoyams (Baligham)

In most areas it will be necessary to work towards the elimination of burning as a means of farm clearance. But the situation is different in the two provinces. Whereas in the North-West Province, especially in the grassland savannah, nearly every community already has progressive farming women whom the teacher could cite and show as an example, he would face great difficulties in the isolated, remote, and marginal areas because the use of fire is universal there. On the other hand, in the easily accessible areas, in the South-West Province, his task would be easier and he could concentrate on explaining the reasons for the already established modern practices of bush clearing and farm preparation.

2.2.2. Tilling

In the overwhelming majority of cases tilling is done by hand. A short-handled hoe with a large blade is the universal tool for tilling. So far, only in the Wum area and in parts of the Ndop plain are ox-drawn ploughs used. But there are plans to extend this method of tilling to other parts of the North West Province where the slopes are gentle. Deep ploughing as done in Europe would be disastrous in tropical conditions since it would aggravate soil erosion. There are several traditional methods of tilling. The simplest one, practiced on fertile, well drained soil, is the simple scratching



of the surface with a cutlass, planting maize seeds and covering them at once with soil. Tilling and planting are done at the same time. According to the slope of the land, the farmers often make mounds or ridges when tilling. These ridges, mounds or beds often contain grass and the remains of the previous crops as manure. Initially, ridges were made down the slope of a hill. In this way, work was easier for the women who worked moving uphill. Contour ridging means a much more uncomfortable working position, the more so the steeper the slope. Yet, due to administrative pressure it has been adopted in most areas. The downward sloping ridges made erosion worse.

2.2.3. Timing - the Crop Calendar

The correct timing of farm operations is part of good farm management. Timing is particularly important with respect to planting, weeding, and, for some crops, harvesting.

The right planting time is a matter of great concern in traditional agriculture. It is so important that many ethnic communities in Cameroon follow a religious ritual in determining the right time for planting. After consulting an oracle, a dignitary, often a woman, sometimes the chief of the area, will announce the start of the planting season. In fact, since germination and healthy plant growth very much depend on the availability and distribution of rainfall, a good deal of familiarity with the local climate is needed in order to be able to choose the best time for planting.

Research findings on planting times can again be drawn from the study "Traditional African Farming Systems in Eastern Nigeria":

Time of planting is significantly related to the output on compounds as well as on outer fields in all three villages. (There is statistical evidence that)

supports farmers' experience that late planting reduces the yield of their crops. The data suggest that farmers who planted their crops later than others suffered a worse labour bottleneck during planting time ..."
(Lagemann, 1977, p. 70)

"... other things being equal - later planting reduces the aggregate production of arable crops".
(Lagemann, 1977, p. 73)

The effect of weeding on plant development also depends on good timing. In traditional agriculture, weeding may be done later than in modern agriculture, due to the effect of fire on weeds:

"... early weed growth after the burn was minimal, and as most farmers only weeded once, the one weeding gave superior results if performed later than very close to planting, when weed competition was minimal."
(Lagemann, 1977, p. 74)

Although this result was obtained from a study on maize farming, similar results have been obtained for arable crops in general. If weeding is carried out more than two months after planting, yields decrease in proportion to the length of the delay in weeding.

The importance of good timing in traditional agriculture can be seen in the fact that mutual help is most prominent when the time factor is important. The institutions of mutual help, e.g. the work groups of men and women, are organized for farm clearing and tilling - in order to get the farm ready in time - but also for planting and sometimes weeding.

Information about timing in Cameroonian traditional agriculture is summarized in the crop calendar. A crop calendar shows how farm work spreads throughout the year for each crop that is included. The crop calendar proposed here shows the major annual and perennial crops grown in the anglophone provinces of Cameroon. It is

subdivided into two calendars, one for the rain forest zone, and one for the savannah zone. For maize, a further subdivision has been made in the calendar for the grassland savannah. There is one calendar for areas with two yearly crops of maize - mostly in the transitional zones of Momo and Mezam Division -, and another calendar for areas with one maize crop per year. These are the highlands of Bui and Donga-Mantung Division.

The crop calendar does not show the "best" times for each activity, not even the best starting or finishing times. It shows the times as indicated by local farmers in their various communities. Therefore, there is quite a long time-span shown even for activities like planting that are done in rather a hurry. The two calendars represent the average for a zone. This average can conceal important local differences.

- reading the crop calendar

- For easy comparison, all farm work has been grouped into four main operations: soil preparation, planting, farm maintenance, and harvesting. Any teacher is free to break these operations down into their component parts. For example, soil preparation in maize farming may consist of cutting down grass, burning, tilling, and ridging.
- Taking the example of maize, this is the information contained in the crop calendar of the rain forest zone:
 - Farm preparation (clearing, tilling) starts in January and will be finished by the end of February.
 - Depending on the first rains, planting may be done between late February and early April, mostly around mid-March.
 - Farm care (weeding and thinning) starts in mid-April and may go on until the middle of June.
 - Harvesting depends on planting time and the length of

the life cycle of the varieties used. It starts as early as the beginning of June and may end only by the end of July.

- In areas with very early planting, tilling for a second maize crop has already started the beginning of July.
- Planting starts in August and ends by the end of September.
- Since the second crop is planted during rainy season, weed growth starts earlier. Therefore, weeding is done earlier after planting than is the case with dry season maize crop.
- Harvesting spreads over November and December, again due to differences in planting time.
- The crop calendars do not show a time for farm preparation for crops like beans, groundnuts, egusi and Irish potatoes. This is because most of the time they are inter-cropped with major staple food crops such as maize and yams. Therefore their time of farm preparation is the same as for the main staple food crop are combined with.
- For the annual crops, all the farming operations occur in a yearly cycle. For some staple foods - cassava, some varieties of yams, cocoyams and colocasia - this cycle is longer than one year but once it is finished, the whole sequence with all the operations will have to start afresh.
- The cycle is different with tree crops. Farm preparation is done only once during the lifetime of a coffee, cocoa, or oil-palm tree. The plot will have to be prepared for transplanting the seedlings. Once the tree farm is established, the annual activities are farm care - weeding, pruning, mulching, application of fertilizer -, and harvesting. Processing of the harvest - drying, fermentation, de-pulping, oil making, safe storage, transportation and marketing - are much more important than for the annual crops but are not shown on the calendar.

- using the crop calendar

a) selecting crops for school farm work

The crop calendar can be useful in selecting crops for the school farm. When checking the crop calendar against term time and holiday periods, four questions must be answered:

- Is there enough time for harvesting, drying, and storage - if not, what can be done to ensure that these operations are done in time, especially during the summer holidays?
- What important farm work tasks fall in holiday periods?
- Is the vegetative cycle of a given crop longer than 9 months (one academic year) or even longer than 12 months (this is the case when harvesting is shown in the same month or a few months later - mostly in the case of root and tuber crops) ?

If any such crops are grown, or if perennial food crops like pineapples are farmed, they should be farmed early enough for the class which planted them to harvest the whole crop. Thus, pineapples should be farmed as soon as a class starts farming, cassava, cocoyams and cococasia should be farmed in class 5, so that at least by the end of class 6 the crop can be harvested.

Annual food crops must be preferred since they limit farm planning to periods of one year. In the highlands of the North-West Province (Bui and Donga-Mantung Division), the maize harvest is so late that even maize might have to be left out. But this would be inconvenient because maize is the staple food in the area. Therefore, it is important that holiday arrangements be made and enforced. On the other hand, Irish potatoes can conveniently be grown as an early crop.

All the late crops with planting times from August

to October are ruled out because of the holidays. The only possible late crop is beans which could be planted in October, if the work involved in clearing the plot is not too great.

As the main planting season for plantains and bananas is the rainy season, schools have little interest in farming these crops. They could very well, however, establish coffee, cocoa, and oil palm nurseries which could be prepared in February and started in March. The seedlings could be sold at transplanting time, i.e. at the end of the third term.

b) lesson topics

- Finding out the crop calendar of the school community

Taking the appropriate crop calendar as a reference, the class can be asked to work out the calendar of farm operations for the crops to be farmed on the school farm. Groups of children can be asked to find out from their mothers the locally agreed timing for the various farm operations. This can then be checked against the information provided by the general crop calendar. As the year goes by, observations made on the school farm and on local farms will add precision to the first draft based on questions asked.

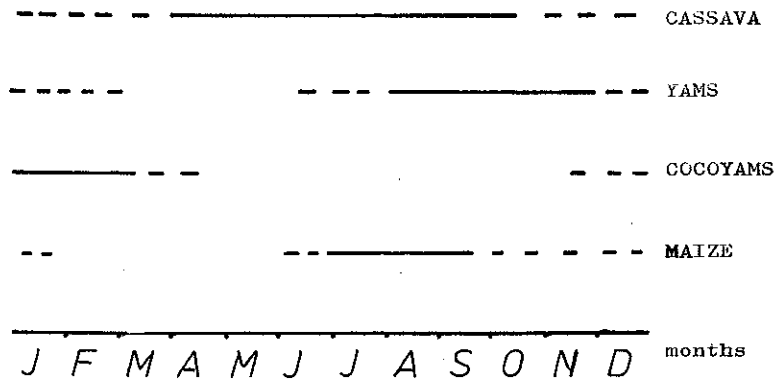
- Breaking the main farm operations down into their component parts

This is an exercise in further precision and might be useful in final year language teaching as well as in teaching on agriculture. In defining the different activities that make up farm preparation or farm care, one might refine the calendar for the crops selected.

- The crop calendar with its many crops and four activi-

ties shown at the same time will be too complicated for immediate use in classes four to six. A simplified version should therefore be prepared. This may be done by concentrating on one crop only or on the two or three crops being grown on the same plot, e.g. maize, beans, and okro. Simplification could also be achieved by concentrating on one activity, e.g. harvesting, for a number of important crops. This would show the availability of various crops throughout the year. An example from Nigeria is provided in the following figure.

Time Sequence of Harvest and Availability of
Major Annual Staples in Eastern Nigeria



--- minor harvest period or consumed from storage
 _____ major harvest period

Source: adapted from Lagemann, J., 1977, figure 6, p. 41

- Concentrating on harvesting periods would give an approach to market studies. Price fluctuation for different foodstuffs could be studied in terms of harvesting periods.
- Harvesting periods can equally well be used to discuss the changing composition of meals throughout the year in different regions. This can be done particularly well if from the crop calendar a calendar is derived which shows the availability of the main food crops throughout the year, and which adds the harvest times for the various fruits, and the main fishing and hunting seasons. This leads to a complete picture of the nutritional situation.
- In a social studies teaching unit on work organisation, the distribution of work loads for men and women in a typical forest area or grassland area farm household can be analysed.
- Similarly, one can also speculate about food requirements, taking into account how heavy the work load is at different times of the year.

These are only a few suggestions. We shall depend on the creativity and resilience of the teachers to make full use of the possibilities which the crop calendar offers.

2.2.4. Planting and Sowing

Work connected with planting and sowing differs very much according to the crops grown. We shall therefore make a few general observations about planting in traditional farming. Much of the detail will be left to the sections on particular crops.

- Selection and preparation of seed material

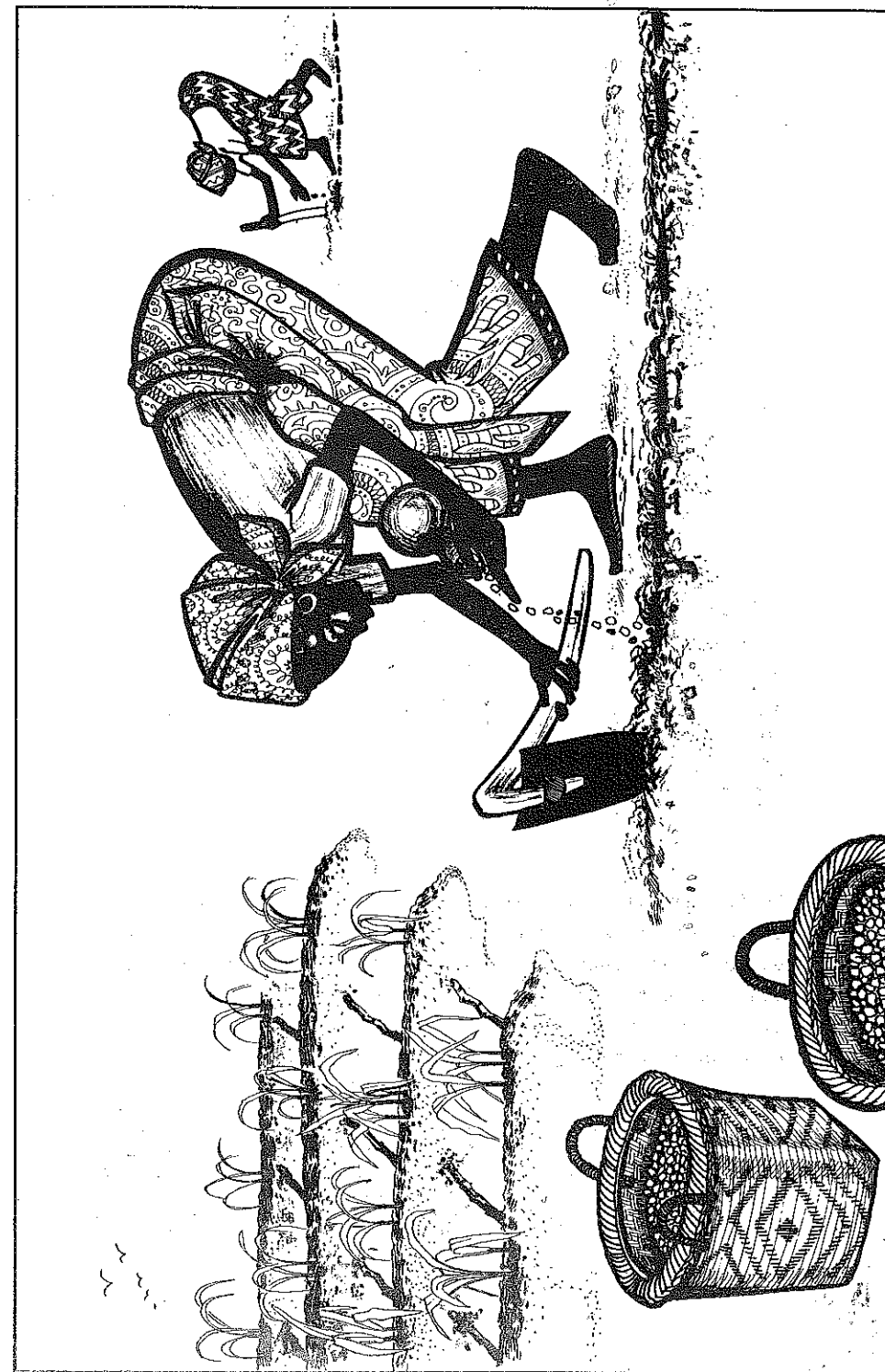
Selection of seeds, tubers, corms, suckers or cuttings as planting material always involves a lot of skill and careful observation. Each farming community has its set of rules in order to find out what will make the best planting material. Pupils could be asked to find out from their mothers and fathers how they organize suitable planting material and what signs they look for when they reject a plantain sucker or a groundnut seed for planting. There are also a number of techniques of safe storage and of preparation of seed material for planting. One such technique is pre-germination (maize and bean seeds, seed yams) which advances plant growth after planting. These techniques should be described and discussed in school.

- Actual planting

Crops are always planted by digging a hole and burying the seed material in the soil. Unlike in earlier European farming, cereals are not broadcast but the individual seed grains are planted one by one.

Some crops are planted together at the same time under the method of mixed cropping. Thus, maize and bean seeds or groundnut seeds may even be mixed in the same calabash used for planting. There are never less than three maize seeds, put in a stand often more, and the same number of bean or groundnut seeds. If cocoyam or colocasia are interplanted with maize, this is done when the maize has already germinated and the plants are well established. This has the advantage, among other things, that patches of ground can be used where the maize seeds failed to germinate.

Planting is not done in straight lines, nor according to precisely measured distances. Since neither animal drawn implements nor engine-powered machines are used



at any stage during farming, there is not really a need for straight lines. All that is required is that enough space is left for people to pass when they weed or harvest without damaging the crop,

On a mound farmed with maize, beans, and leaf vegetables according to traditional methods, the average distance between stands was roughly 40 cm, with a standard deviation⁺ of 15.7 cm. This certainly does not represent a strict standard of planting distances. But as can be seen from the table below, most stands are between 25 cm and 55 cm apart from each other:

Distance between stands (in cm)	frequency	
	absolute	in per cent
9 - 15	5	17.9
24 - 35	3	10.7
40 - 49	11	39.3
50 - 55	6	21.4
56 and above	3	10.7
	28	100.0

On the mounds, crop density is high and amounts to 6 - 7 stands per square meter. Making allowance for the paths between the mounds that use up quite a lot of land, this would amount to about 45,000 stands with at least two plants each per hectare. The study from Eastern Nigeria reports crop densities of 22,000 to 31,800 stands per

⁺The standard deviation is a statistic showing how individual observations differ or "deviate" from the average. Thus, if all the distances between stands fall in the range from 35 cm to 45 cm, standard deviation will be much smaller than if the distances range between 20 cm and 60cm

hectare on compound farms immediately surrounding the house, and between 12,000 and 40,000 stands on farms away from the compound (Lagemann, J., 1977, pp 36 and 45). Near Buea, on very fertile soil, the following densities were recorded, using the density square:

- 14,400 stands of maize per hectare in mixed cropping on the flat,
- 39,000 stands of maize and beans in mixed cropping on mounds,
- 12,000 stands of maize per hectare in mixed cropping on mounds.

Crop density varies a lot according to soil fertility, the crops grown, and the amount of preparatory work a farmer is willing to do. Well prepared soil will support a higher crop density than poorly tilled soil.

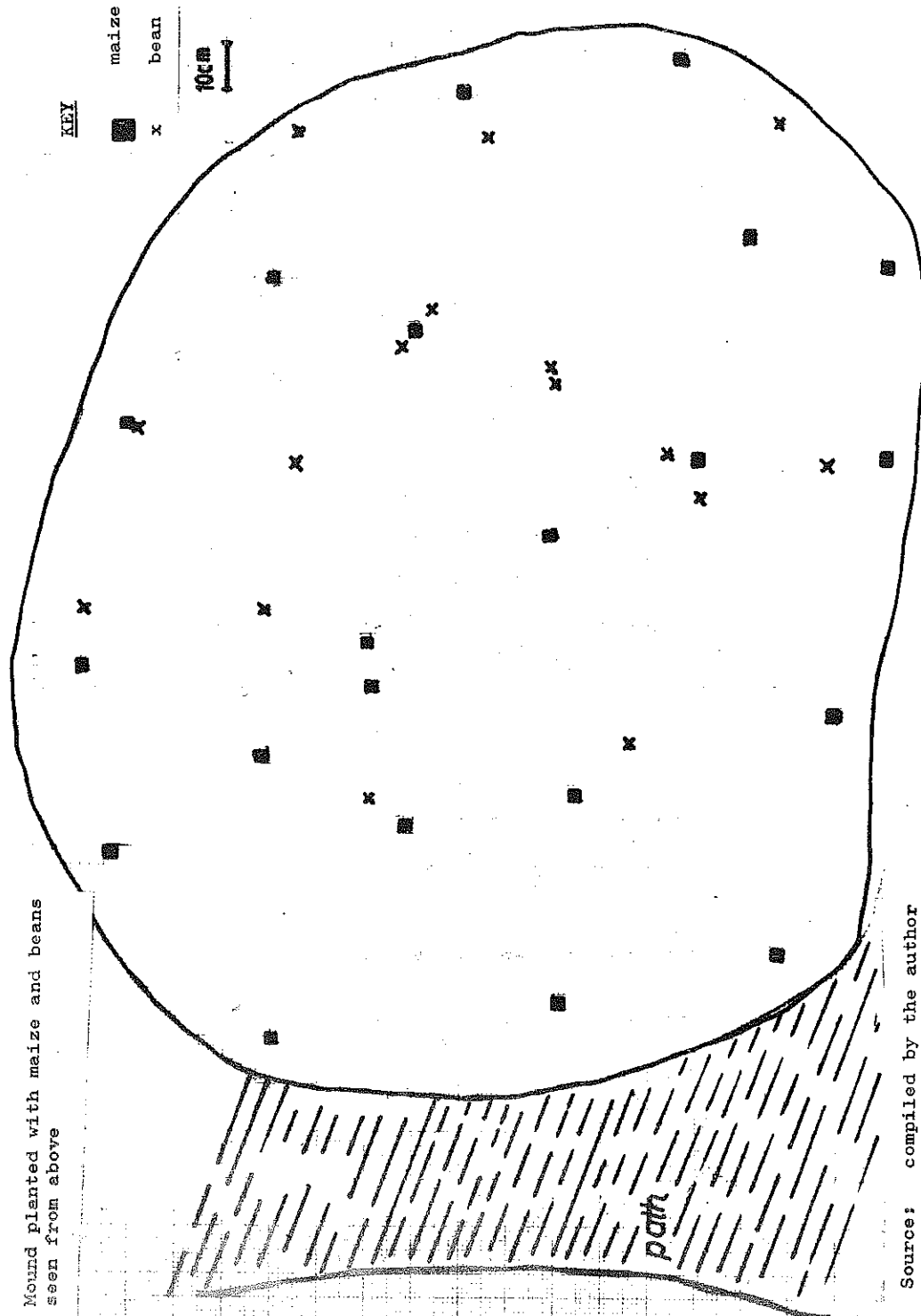
When ridges are formed, as is normally the case across the slopes of hills, more or less continuous contour lines are formed. Ridges are of rather uniform width, depending on the work habits of the woman building them. Near Buea, a traditional farm with eleven ridges was measured. These are the measurements:

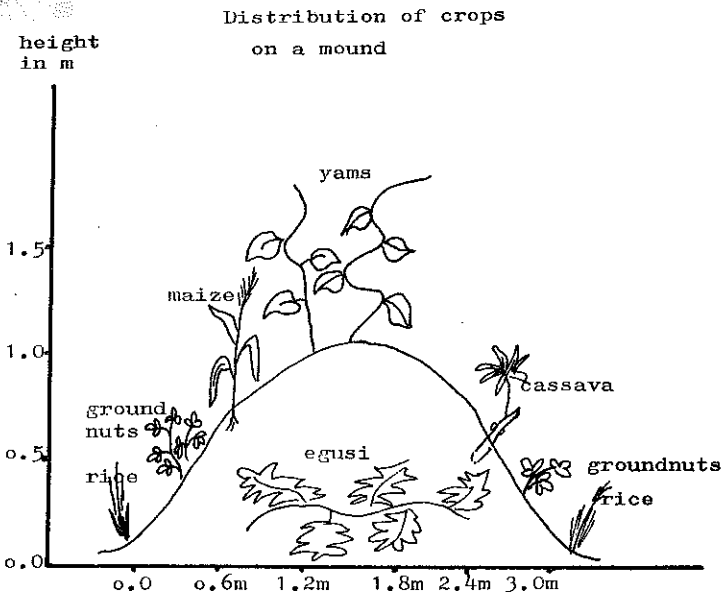
- length of ridges: uniformly 14.60 m due to pre-established straight boundaries
- widest ridge: 2.66 m
- narrowest ridge: 1.14 m
- average width of ridges: 1.66 m including all ridges
1.56 m excluding the widest ridge
- standard deviation of ridges: 0.38 m including all ridges
0.20 m excluding the widest ridge
- average width of furrows: 0.80 m
- standard deviation of furrows: 0.14 m
- highest ridge: 0.57 m (this is also the widest ridge)
- average height of ridges: 0.32 m all ridges included
0.29 m excluding the highest ridge
- standard deviation of height: 0.09 m all ridges included
0.05 m excluding the highest ridge

The widest and highest ridge was prepared for particular crops since grass was burnt in it using the nkara technique.

Planting on ridges is often done in staggered rows. For example, up to three rows of maize and beans or groundnuts or cowpeas may be planted on a ridge. Again, planting distances are not measured out by a yardstick, but they are not haphazard either. They follow rule-of-thumb knowledge about the best density on a given soil. If a school class went to measure the distances between stands of maize or cocoyams along one or two ridges planted according to traditional methods the children might be surprised by the degree of regularity they found.

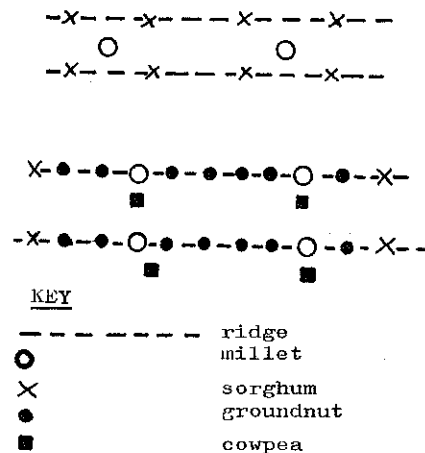
The illustrations in this section show how one might represent graphically the planting patterns used on mounds in traditional farming. Similar patterns may be used for ridges.





Source: adapted from Okigbo and Greenland, *Intercropping Systems in Tropical Africa*, in *Multiple Cropping*, p.74

Planting pattern in a Sahel region



Source: adapted from Okigbo and Greenland, *Intercropping Systems in Tropical Africa*, in: *Multiple Cropping*, p.84

2.2.5. Weeding

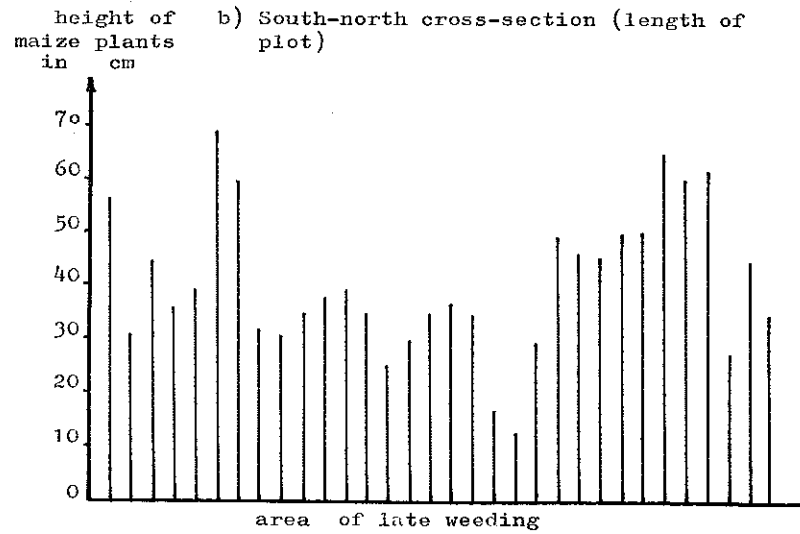
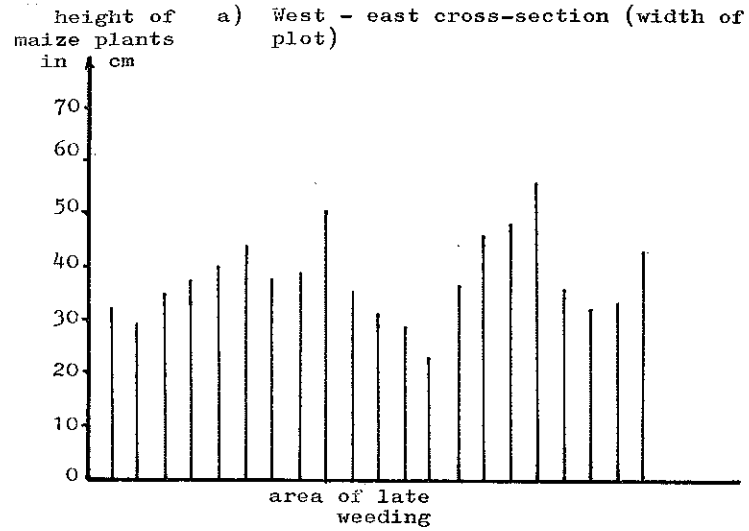
Weeding is a feature of nearly all farming. Exceptions are farms where crop associations are found which keep down most or all the weeds so that weeding becomes unnecessary. This is the case where pumpkins or various species of melons are grown as a secondary crop.

Weeding is usually done with a short-handled hoe. Weeds are left on the farm to wither - except those that would immediately start to grow again. As they decompose, they add nutrients to the top soil. If they are available in sufficient quantities they act as mulch, protecting the top soil against erosion and loss of water. Weeding is very demanding in terms of labour. If it is done too late it will cause serious damage to crop yields (see the section on timing of farm operations above).

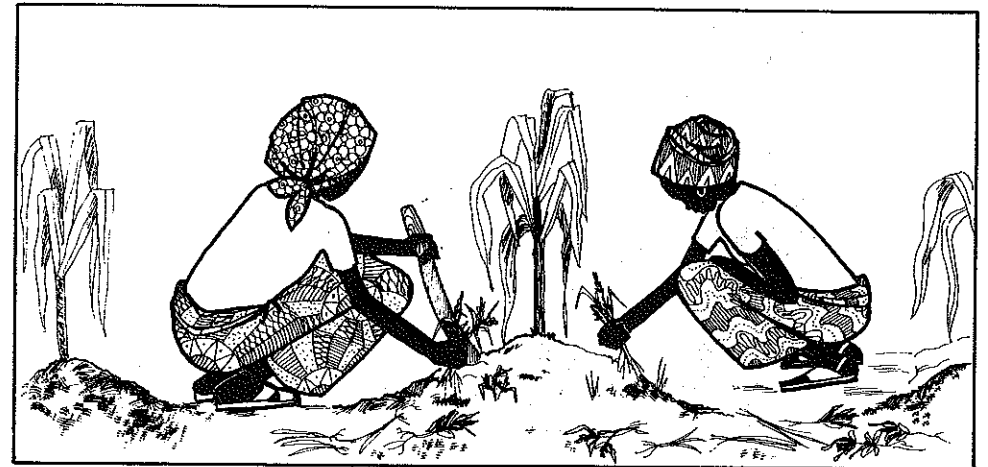
The following is an example of the effect of late weeding on maize growth:

On a local farm with maize and cocoyams the farming woman and her helpers had started weeding from the boundaries of her farm towards the centre. They had given up, however, before finishing the job, probably because they lacked sufficient cocoyam cormels which they were planting as they went along. Therefore, in the centre of the farm, weeds continued to grow for another two weeks. Subsequently, most of the maize plants in the central part of the farm were significantly shorter than the ones in the parts that had been weeded earlier. The measurements presented in the charts below were taken by doing two cross-sections through the centre of the farm at right angles, and measuring all the maize plants along these lines.

The effect of weeding on plant growth
(maize farm near Buea)



Source: compiled by the author



2.2.6. Manuring

Farms are usually not manured. As was mentioned above, soil fertility is restored by

- the fallow period,
- burning at the beginning of a new farming period.

The cultivated areas directly surrounding the houses are manured with all sorts of suitable materials, e.g.

- kitchen and household refuse,
- ashes,
- animal dung,
- waste from the processing of crops, e.g. coffee berry pulp.

Compost is hardly ever prepared. The often-quoted study on traditional African farming systems reports the following methods of manuring the compound farm:

- mulching: all kinds of smaller branches, twigs and leaves from trees and shrubs are used for mulching the compound. The yam mounds especially are covered with a thick layer of these materials;
- animal waste: dung, mainly from goats, is applied throughout the year to the crops. It is usually applied to individual plants;
- ashes: as with animal waste, ashes are distributed directly around the individual plants;
- composting: this practice is common in Owerre-Ebeiri (a village with a high population density, H.B.) where grasses from the fallow areas are collected and thrown together with household remains, into pits where the materials decay. The resulting rich soil is then applied to the crops;
- shifting of latrines: every year the latrines are shifted to another site within the compound. After a period of one cropping season the latrines are filled in, and bananas or plantains are planted, and so receive ample nutrients for many years. These manuring habits have not been developed to such a degree in the lower populated areas, ... the labour-intensive way of building up soil fertility is a result of the people's efforts to overcome the increasing food shortage which results from the high population density."

(Lagemann, J., 1977, p. 39)

Where ridges are built, a certain form of green manuring is sometimes used: At the beginning of a new planting

season weeds, grasses and crop residues such as maize stalks are cut and gathered in the furrows. After this, neighbouring ridges are divided up and new ridges are built in the former furrows. Crops growing on the new ridges not only profit from the decaying plant material buried in the soil but also from nutrients that rain may have washed down from the former ridges.

2.2.7. Crops

A large number of crops are grown in traditional agriculture in Cameroon. We shall first provide some information about the frequency of the different crops in the two provinces, as shown in the IPAR-Buea survey. We shall then discuss mixed cropping as practised in Cameroon, crop sequences and rotations, and finally, cropping patterns according to various land-up zones.

This table shows the frequency of growing various crops in the two provinces. The main crops are emphasized.

Percentage of Communities Growing
the Respective Crops

C R O P	P R O V I N C E		T O T A L
	SOUTH WEST	NORTH WEST	
COFFEE	88.8	88.1	88.5
COCOA	69.4	11.9	38.4
OIL PALM	91.7	50.0	69.2
RAFFIA	38.9	78.6	60.3
YAMS	83.3	76.2	79.5
CASSAVA	91.7	90.5	91.1
COCOYAMS	94.4	95.2	94.8
COLOCASIA	47.2	30.9	38.4
MAIZE	86.1	100.0	93.6
BEANS	66.7	88.1	78.2
SWEET POTATOES	35.1	71.4	54.6
IRISH POTATOES	0.0	54.8	29.5
PLANTAINS	94.4	95.2	94.8
BANANAS	66.7	83.3	75.6
EGUSI	21.6	30.9	26.9
GROUNDNUTS	44.4	54.8	50.0
GUINEACORN	0.0	16.7	8.9
RICE	11.1	19.0	15.4
VEGETABLE	69.4	83.3	76.8
SUGAR CANE	8.3	26.2	17.9
FRUITS	50.0	54.8	52.6
KOLA	52.8	73.8	64.1
TOBACCO	0.0	2.4	1.3
N	36	42 ⁺	78

⁺ Because of geographic similarities, two communities in Fontem subdivision were counted as N.W.P. communities

- crop husbandry

Nearly all farming done by smallholders uses the system of mixed cropping. Various crops are grown together on the same farm. Single cropping is only practised in the case of tree crops, most frequently with oil palms. There are good reasons for mixed cropping:

- The risk of crop failure is spread over various crops. If one fails, the other may still yield a harvest.
- Heavy infestation with a pest attacking a particular crop is less likely, as the distance between plants of the same kind is larger than with single cropping.
- Work on one and the same piece of land is spread out over time. Harvesting and early crop can be an extra weeding operation for the later crops.
- Intercropping tree farms with food crops is an inducement for women to help weeding the coffee or cocoa farm or even do it all alone. As they weed the food crops under and between the trees they mulch the trees at the same time.
- In some areas, land is so scarce that heavy food farming becomes a necessity on coffee farms.

As one author on tropical agriculture puts it:

"By planting a succession of crops with varying planting times, rooting habits and maturities, the cultivator may make better use of his or her time, permit plants to tap the nutrients in various soil layers more effectively, distribute the risks due to vagaries of climate or incidence of pests and diseases, assure a more regular food supply and gradually, as the season progresses, cover the soil so well with vegetation that there is more effective protection against the effect of sun and rain and comparatively little need for the time-consuming job of weeding. Moreover, as long as only 'unimproved' varieties of crops are available or are used, the total yield from a given area may well be higher than when a single crop is planted in pure stand."
(de Wilde, J.C., et al., 1967, p. 20)

The study from Eastern Nigeria quoted several times already provides further insights into the effects of mixed



cropping. On compound plots, more than 40 species of useful plants were counted. These crops were planted very densely, coming close to bush or forest conditions which represent a stable system where soil fertility is continuously kept high. (Lagemann, J., 1977, p. 35) In the forest zones, trees and shrubs remain on the farms. "Most fields carry more trees and shrubs than commercial tree crop plantations." (Lagemann, J., 1977, p. 43) The reason suggested by the author for such a high plant density is that most of the plants are not vigorous because of the poor soil fertility. This seems to indicate that up to a certain extent the weakness of individual plants can be offset by an increasing number of plants. More important, he sees "... a deliberate effort by the farmers to maintain a dense vegetation in order to reduce leaching and erosion." (Lagemann, J., 1977, p. 43, emphasis mine). Continuous dense vegetation is also maintained by phased planting, i.e. planting at different times. A final conclusion is offered:

"The lower the fertility status, the greater the number of stands and species grown on a given piece of land. Phased planting and mixed cropping are apparently tools to counteract the yield-depressing effect of a decline in soil fertility."

(Lagemann, J., 1977, p. 46)

The following crop associations under the system of mixed cropping have been found to be typical in the anglophone provinces of Cameroon:

Crop Associations in tree crop farms

Most newly established tree crop farms are used for annual crops as long as the trees are small, have not yet formed a canopy, and do not yet yield. As the tree plantations mature and shade most of the farm, all food crops except plantains and bananas tend to disappear. But even in old established tree farms cases of inter-

cropping with annual food crops can still be found.

Coffee

Out of 207 farm plots growing coffee, 63.7% are pure coffee farms, with plantains and bananas as food crops in most cases. 6.3% combine another tree crop with coffee, mostly cocoa and occasionally oil palms. All these farms have plantains/bananas and cocoyams. The annual foodcrop most commonly found in coffee farms is cocoyams/colocasia (on 23.7% of all coffee farms), maize is much less common.

Cocoa

Of the surveyed cocoa farms, 42% are pure cocoa farms combining only bananas or plantains with the tree crop. The other farms all combine another tree crop with cocoa, most of the time oil palms which are dotted here and there on the farm plot and were probably left over when the farm was cleared. One third of the cocoa farms mix cocoa and coffee. Apart from plantains, food crops are rarely grown on cocoa farms, probably because the canopy, once formed, gives a heavier shade than on coffee farms. Intercropping with annual food crops is restricted to cocoyams/colocasia (25% of cocoa farms).

Oil palm

38.5% of the oil palm plots seen were pure palm farms. This low percentage is due to the fact that most of the time, oil palms are not planted but are exploited as they grow wild. People arrive at relatively pure oil palm plots by allowing wild palm seedlings to grow while cutting down other shoots. They may even transplant wild seedlings found elsewhere to their plot. These plots then contain trees of different ages; no attention has been paid to spacing, and usually, as the trees grow

very high, there is enough light to allow the farming of food crops. Oil palm growing as practised by the plantations (CDC, PAMOL) is spreading slowly among smallholders. Palms are often dotted about on coffee farms (another 38.5% of the plots with oil palms). Food crops grown with oil palms are plantains/banana, cocoyams/colocasia, and cassava.

Crop associations on food crop farms

Food crops are rarely farmed as single crops, the only notable exception being cassava with its heavy demand on soil nutrients.

Cassava

Apart from being planted as a single crop, cassava is farmed together with cocoyams, and sometimes with cocoyams and maize. Only very rarely is cassava combined with yams (on 17% of all cassava farms). Equally rare are plantains/bananas found on cassava farms.

Yams

Yams are equally often combined with maize and with cocoyams, but the joint farming of all three crops is very rare.

Colocasia

The association of colocasia with plantains/bananas which is common on coffee and oil palm farms is also found on pure foodcrop farms. This association may be extended by yams, or maize and/or groundnuts. Occasionally, colocasia go together with other tuber or root crops, but they are intercropped with yams rather than with cassava.

Maize

Maize is never grown as a single crop. The association of maize with cocoyams or with plantains/bananas is very common, but all three crops rarely occur

together. In the areas suitable for the growing of Irish potatoes, these are most of the time intercropped on maize farms. Leguminous crops like beans and groundnuts are much more common on maize farms than on farms without maize. Especially when cocoyams/colocasia and plantains/bananas are missing on a maize farm, the incidence of beans or groundnuts is very high. Egusi also are more commonly combined with maize than with cocoyam farming.

Irish potatoes

Irish potatoes are practically always mixed with another crop, mostly with maize and groundnuts/beans or with maize alone, and less often with cocoyams, yams, or cassava.

Other crops

African vegetables (huckleberries, "native carrots" etc.) are grown occasionally with other crops. They are slightly more often combined with maize than with colocasia but nearly never with cassava. Sweet potatoes do not seem to follow a regular pattern of mixed cropping.

Main Crop Associations

COFFEE	COCOA	OIL PALMS	YAM	CASSAVA	COLOCASIA	PLANTAINS/BANANAS	MAIZE	GROUNDNUTS/BEANS	IRISH POTATOES	REMARKS
X										single cropping
X					X					
X					X					
X					X					
X	X				X					single cropping
	X	X			X					single cropping
		X	X		X					
		X	X	X	X					single cropping
		X	X	X	X					
		X	X	X	X		X			
		X	X	X	X		X	X		
		X	X	X	X		X	X	X	
		X	X	X	X		X	X	X	
		X	X	X	X		X	X	X	
		X	X	X	X		X	X	X	

Note: Various other crops are usually grown on the plots where the above crop associations have been found. Here we show associations of major crops which, as associations, cover the whole area of a given plot, omitting the occasional plant of hot pepper or okro dotted here and there. These associations are the most frequent ones, therefore, they seem to be those that are the most viable.

Crop Sequence and Crop Rotations

The crop rotations taught on the school farms are copied neither by the school leavers nor by the adult population nor even by the teachers on their private farms. Does this mean that one should abandon the teaching of crop rotation in school farm work as being ineffective? The findings presented below show that the local farmers, at least in some areas, practise definite crop sequences in a system of mixed cropping. In some cases, these sequences come close to real rotations because of the short periods of fallowing (one to two years) between the period of farming. It would seem as if the school farm rotations have been rejected because they insist on single cropping. We describe below the different crop sequences encountered during our survey, and indicate where they have been found. It will have to be established through experimentation by the agricultural research stations and by the teachers in charge of school farms which of these are viable or can be made viable, and which ones will have to be discouraged.

Crop Sequences on Tree Crop Farms

As already mentioned, it is common practice to grow food crops on newly established coffee or cocoa farms. On coffee farms, mostly colocasia are farmed during the first three to four years until the coffee starts bearing. Occasionally, maize is added.

Observed: On the slopes of Mt. Cameroon (Biyuku/Buea, Ekona, Munyenge)
 in the Rumpi hills (Lokando)
 in the Ndian-Mundenba area (Beoko, Esoki, Bima)

Similar patterns can be observed in the North-West

Province. More elaborate sequences of food crops with young coffee are:

year	crops		Inokum, Manyu Division		
1	coffee,	colocasia, maize, beans, groundnuts, vegetables			
2	coffee,	colocasia, - - - -			
3	coffee,	- - - -			

year	crops		Mbepji, Donga Mantung D.	
1	coffee	groundnuts		
2	coffee	-	maize	
3-5	coffee	-	maize	
6	coffee	-	-	

Newly established cocoa farms may be left for one or two years without food crops before cocoyams and/or maize are grown between the young trees. From the fourth or fifth year onwards, food crops are no longer grown systematically on cocoa farms.

(Munyenge, Bombanda near Kumba, Ekenge on the Kumba-Mamfe road)

A more complicated sequence has been observed in Ekenge:

year	crops					
1	cocoa	plantains	colocasia	cassava	maize	beans
2	cocoa	-	-	cassava	maize	beans
3-5	cocoa	-	-	cassava	maize	beans
6	cocoa	-	-	-	-	-

Intercropping on oil palm farms depends on the height of the palms and the shade they give. As a farmer in Anyake, Momo Division observed, bush clearing under oil

palms ensures big bunches. But in order to benefit fully from the work of clearing, maize is grown under high palms.

In other regions, palm seedlings, which grow naturally on food crop farms, would be allowed to continue growing until they make food crop farming unprofitable. (Kunku, Akwaya Subdivision)

The following food crop sequences have been observed:

1) year	crops						Kajifu, Manyu Division
1	oil palm	cocoyams	plantains	water yams	yams		
2	oil palm	-	-	-	-	-	cassava
3	oil palm	-	-	-	-	-	cassava
4	oil palm	-	-	-	-	-	-

2) year	crops					Widihum, Momo Division
1	oil palm	plantains	cocoyams	colocasia	pepper	vegetables

Crop Sequences in Food Crop Farming

Sequences starting with yams

There are short sequences covering two years of farming and one or two years of fallowing, in which yams are grown only during the first year. A very simple one was found near Ndian, in Ikassa. It is a sequence of monocropping:

1) year	crops		Ikassa, Ndian Division
1	yams		
2	-	cassava	
3	f a l l o w		

Sequences with the usual mixed cropping are:

2) year	crops			Sabes Agong/Manyu Division
1	yams	plantains	colocasia	
2	-	-	colocasia	maize groundnut
3-4	f a l l o w			

3) year	crops			Njunye/Bangem Subdivision
1	yams	plantains	maize	colocasia
2	-	plantains	maize	- cassava
3	-	plantains	-	-

4) year	crops			Tugi/Momo Division
1	yams	maize	beans	groundnuts
2	-	maize	beans	-
3-5	f a l l o w			

Then there are the sequences in which yams are grown throughout, again mostly for only two years.

5) year	crops					Njunye and Kombone/Meme D.
1	yams	plantains	maize	colocasia	beans	groundnuts sw.yams
2	yams	plantains	maize	colocasia	beans	groundnuts sw.yams
3	cassava	sweet	potatoes			
	f a l l o w					

6) year	crops			Bambalang, Mezam Division
1	yams	calabash	egusi	
2	yams	calabash	egusi	maize groundnuts
3	yams	calabash	-	maize groundnuts
4-10	yams	-	-	maize groundnuts
11-12	f a l l o w			

Similar sequences can be observed with sweet yams.

7) year	crops		Bamali/Ndop Mezam Division	
1	sweet yams	maize	groundnuts	
2-5	-	maize	groundnuts	
6-7	f a l l o w			

8) pattern 3 has been observed with sweet yams instead of yams in Great Soppo (Buea), but sweet yams cultivation went on for two years, and after that, cassava was farmed for four more years before a long fallow of about 6 to 10 years.

9) year	crops		Kombone, Meme Division		
1	sweet yams	colocasia	plantains	vegetable	
2	sweet yams	colocasia	plantains	vegetable	cassava
3	sweet yams	colocasia	plantains	vegetable	cassava
			beans	groundnuts	

Sequences starting with cocoyams but without maize

1) year	crops		Nhiangse/Tombel, Meme Division	
1-2	cocoyams			
3	-	maize	groundnuts	
4-10	f a l l o w			

2) year	crops		Baligham, Mezam Division	
1	cocoyams			
2	-	maize	beans	
3-4	f a l l o w			

3) year	crops		Foreke Bellua/Fontem Manyu D.		
1	cocoyams	plantains			
2	-	plantains	maize	beans	groundnuts
3-5	f a l l o w				

4) year	crops		Sabes Agong/Manyu Division		
1	cocoyams	plantains	colocasia		
2	-	plantains	-	maize	groundnuts yams
3-5	f a l l o w				

5) year	crops		Awing Bambuluwe/Mezam		
1	colocasia	egusi	vegetables		
2-5	-	-	-	maize	beans
6-8	f a l l o w				

6) year	crops		Bamali/Ndop, Mezam Division		
1	cocoyams	sweet potatoes			
2-3	cocoyams		-		
4-5	f a l l o w				

When the farming of a plot starts off with colocasia, most of the time this crop is only grown for one year and is replaced or interplanted by a cereal and one or several leguminous plants in the next year.

Sequences starting with colocasia and with maize

1) year	crops		Ande/Nkambe, Donga Mantung D.		
1	colocasia	maize	beans	egusi	
2-3	colocasia	maize	-	-	
4-20	f a l l o w				

2) year	crops		Nhiangse/Tombel, Meme Division		
1	colocasia	cassava	maize		
2-3	colocasia	cassava	-		
4-6	f a l l o w				

3) year	crops		Mbebele/Bafut, Mezam Division	
1	colocasia	maize		
2	colocasia	-		
3-4	f a l l o w			
5	-	-	yams	beans
6-7	f a l l o w			

4) year	crops		Baligham, Mezam Division	
1	cocoyams	maize	groundnuts	
2	cocoyams	maize	groundnuts	beans
3	-	maize	groundnuts	beans
4-6	f a l l o w			

5) year	crops		Njunye/Bangem S.D. Meme Division			
1	colocasia	maize	groundnuts	beans	vegetables	egusi
2-5	-	maize	groundnuts	beans	vegetables	egusi
		cassava				
6-14	f a l l o w					

As can be seen above, when farming starts with colocasia and maize, most of the time colocasia are farmed throughout or at least through the major part of the farming period.

Sequences starting with maize but without tuber or root crops

1) year	crops		Tugi/Momo Division	
1	maize	beans		
2	-	-	yams	
3	-	beans	-	
4	-	-	-	cassava cocoyams
5-7	f a l l o w			

2) year	crops		Baligham, Mezam Division	
1	maize	groundnuts		
2-3	-	-	cassava	
4	f a l l o w			

3) year	crops		Kajifu/Manyu Division	
1	maize	plantains		
2	-	plantains	cassava	
3-9	f a l l o w			

Whereas these sequences incorporate a tuber or root crop later, mostly cassava, there are others with equally short farming periods which leave out such crops altogether:

4) year	crops		Mumfung/Menchum Division	
1	maize			
2	-	okro	guineacorn	
3-16	f a l l o w			

5) year	crops		Mmen and Kom area, Menchum D.	
1	maize			
2	beans			
3	tephrosia	as fallow crop		

There are, finally, instances where maize is grown all through the farming period of the sequence:

6) year	crops		Soppo/Buea, Fako Division	
1	maize	plantains		
2	maize	plantains	cocoyams	
3-5	f a l l o w			

7) year	crops		Chup/Nkambe, Menchum Division	
1	maize	groundnuts	vegetable	
2	maize	-	-	beans
3	maize	-	-	cocoyams

8) year	crops		Kitongwang/Oku, Bui Division	
1	maize	groundnuts		
2	maize	-	sweet yams	
3-4	maize	groundnuts	sweet yams	beans
5-7	f a l l o w			

9) year	crops	Shiy/Jakiri, Bui Division
1	maize	- egusi
2-10	maize	beans -
11-16	f a l l o w	

Sequences starting with cassava

1) year	crops
1-2	cassava
3	- beans
4	- maize cocoyams
5-6	f a l l o w
7	cassava
8	- yams

2) year	crops	Okoromanjang/Menchum Division
1-2	cassava	
3-4	-	cocoyams
5		maize
6-7	f a l l o w	
8		maize groundnuts

3) year	crops	Mbamsong, Bui Division
1	cassava	maize
2-7	cassava	-
8-9	f a l l o w	

4) year	crops	Shiy, Bui Division
1-2	cassava	maize
3-5	cassava	-
6-10	f a l l o w	

Sequences starting with Irish potatoes

Irish potatoes are one of the few food crops introduced by the colonial powers. Being a tuber crop, it has been

completely incorporated into traditional farming. Irish potatoes are grown in a variety of crop sequences. In one type of sequence, they are grown in the first year of a sequence of variable length.

1) year	crops	Baligham
1	Irish potatoes	
2	-	maize beans
3-4	f a l l o w	

2) year	crops	Awing
1	Irish potatoes	maize cocoyams pumpkins
2	-	maize cocoyams - beans
3	-	maize - - beans
4-5	f a l l o w	

3) year	crops	Shiy, Bui Division
1	Irish potatoes	maize beans egusi
2	-	maize - - cassava
3-5	-	maize beans - cassava
6-7	f a l l o w	

In another type of sequence, Irish potatoes are grown through half or more of the sequence.

4) year	crops	Potang, Manyu Division
1	Irish potatoes	cabbage
2	Irish potatoes	cabbage
3	-	- beans maize
4	-	- beans maize
5-6	f a l l o w	

5) year	crops	Meluf, Bui Division
1-3	Irish potatoes	maize cabbage carrots
4-5	-	maize cabbage carrots
6-8	f a l l o w	

6) year	crops				Mbamsong, Bui Division
1	Irish potatoes	maize	cocoyams	beans	
2	-	maize	cocoyams	beans	
3	Irish potatoes	maize	cocoyams	beans	
4	-	maize	cocoyams	beans	
5-6	f a l l o w				

There are sequences in which Irish potatoes are grown throughout, whereas other crops are added or dropped from the cropping pattern. The sequences covering more than four years of continuous farming always have maize associated throughout, and most of the time beans. The short sequence in Banjong brings in maize and beans only in the second year of the rotation:

7) year	crops				Banjong, Bui Division
1	Irish potatoes	colocasia	vegetables		
2	Irish potatoes	colocasia	vegetables	maize beans	cabbage
3-4	f a l l o w				

8) year	crops				Vekovi, Bui Division
1	Irish potatoes	maize	beans		
2	Irish potatoes	maize	-	cassava	
3	Irish potatoes	maize	beans	-	
4-5	Irish potatoes	maize	-	cassava	
6-8	f a l l o w				

9) year	crops						Vekovi, Bui Division
1	Irish potatoes	maize	beans				
2	Irish potatoes	maize	beans	cassava	egusi		
3	Irish potatoes	maize	beans	cassava	-		
4-10	Irish potatoes	maize	beans	-	-		
11-20	f a l l o w						

10) year	crops					Mbamsong, Bui Division
1	Irish potatoes	maize	-	colocasia	huckleberry	
2-10	Irish potatoes	maize	beans	-	-	
11-12	f a l l o w					

11) year	crops				Dzeng, Bui Division
1	Irish potatoes	maize	beans		
2-5	Irish potatoes	maize	beans	cocoyams	
6-10	f a l l o w				

Sequences starting with upland rice

1) year	crops		Ngale/Akwaya, Manyu Division
1	rice	cassava	
2	-	cassava	
3	-	cassava	
4-16	f a l l o w		

2) year	crops		Ngale/Akwaya, Manyu Division
1	yams		
2	rice		
3-12	f a l l o w		

3) year	crops			Banade/Esimbi, Menchum Division
1	rice			
2	-	maize	groundnuts	
3-4	f a l l o w			
5	-	-	groundnuts	
6	f a l l o w			

Other sequences

1) year	crops				Okoromanjang/Menchum Division
1	sweet potatoes				
2	-	groundnuts			
3-9	-	-	sw.yams, water yams,	colocasia	plantains
10-20	f a l l o w				

2) year	crops	Ngusi/Tombel S.D., Meme D.
1	beans	groundnuts
2	-	groundnuts
3-10	-	cocoyams
11-13	f a l l o w	

3) year	crops	Mbepji/Donga Mantung Division
1	groundnuts	
2-3	-	colocasia
4-5	f a l l o w	

The cropping sequences and rotations shown above have been restricted to the main crops. Vegetables and minor crops have been left out. Here is a crop sequence from Wum and Weh, Menchum Division, which shows all the crops grown on the farm plots:

year	crops
1	maize, colocasia, cassava, spotted beans, sweet potatoes, calabash egusi, pumpkin, melons, okro, garden eggs, huckleberry,
2	maize, colocasia, cassava, cowpeas, yams (very rare)
3	maize - - - groundnuts
4	cowpeas

Source: H. Simon, W.A.D.A. Survey 1975, unpublished

Notes: Information on crop association and sequences obtained as an average from 5 women. Only three out of the five women had farms in the 3rd and 4th year.

In the fourth year, groundnuts may be grown instead of cowpeas. If the land is infertile, fallowing starts already in the 4th year.

(adapted from WADA, a Programme of establishing a training centre for draught cattle, Wum 1975, p. 9a)

General remarks on crop sequences

The information presented above is based on interviews with men on their farms. Since, most of the time, they do little of the work on food crop farms, their information may not have been very reliable. Teachers are invited to examine critically the crop associations and sequences for mistakes. They will find it fairly easy to work out these associations and sequences in their own area. Pupils and their mothers will be very helpful in this respect. With these reservations in mind, what conclusions can be drawn from our observations?

- 1) Some crops are definitely more likely to start a crop sequence and be left out later - usually after one or two years - than to be introduced into a farm plot which has already been used for some years. These crops are:

- yams
- egusi
- Irish potatoes
- cocoyams
- colocasia
- rice.

- 2) Some crops clearly are more likely to be introduced later to a farm plot. These are

- cassava
- beans
- guineacorn

Cassava especially is usually introduced towards the end of a sequence when the soil has already been exhausted by the previous crops.

- 3) Maize and beans may start a crop sequence or may

just as well be introduced later. In fact there are many cases where they are farmed throughout the time of farming one and the same piece of land.

- 4) Changes in the cropping pattern of a particular plot, i.e. dropping one crop and/or growing another crop, are most likely to occur in the second year of cultivation (dropping occurs in the second year in 70% of all cases, adding a new crop in the second year in 85% of all cases).

Usually, no additional crops are introduced after the third year of continuous farming. On the other hand crops may be left out, and thus the range of crops grown on a plot is reduced till the end of the sequence is reached and the farm plot is fallowed.

- Cropping Patterns

By cropping patterns we mean typical combinations of crops in particular areas. Cropping patterns are not the same as crop associations. Crop associations are crops grown together at the same time on one and the same piece of land. Cropping patterns represent the typical set of crops in a given area, whether grown in crop associations or not. The following examples will make this clear:

- 1) Suppose that in a given area in Europe wheat, potatoes, and sugar beet are grown as single crops. There are no crop associations, but the cropping pattern will be "wheat - potatoes - sugar beet".
- 2) Suppose that in a rain forest area in tropical Africa, all women grow maize and beans as one crop association, and yams and egusi melon as another one. Here are two typical crop associations with two crops each, but the cropping pattern will be "maize - beans - yams - egusi".
- 3) In another area, all farming women mix four crops on all of their farms: cassava, groundnuts, okro, and maize. Only in this case will crop associations and cropping patterns be the same.

The range of crops grown in an area, i.e. that area's cropping pattern, is certainly determined by ecological factors like climate and soil fertility. But the cultural habits of the people living there also matter, as well as the availability of new crops. The cropping patterns described below have emerged from the research carried out by IPAR-Buea. They are the result of a deliberate effort to group data which show an overwhelming variety. Others might have arrived

at different patterns. All the ten cropping patterns are presented here for the benefit of the teacher. But he would be ill advised to try to teach all of them to his pupils, and the same is true for the crop associations. The idea is to get away from cramming huge amounts of facts into pupil's heads. Documenting all the cropping patterns (and crop associations and crop sequences/rotations) serves the following purposes:

- 1) They make the teacher aware of the enormous variety of agricultural practices and traditions in Cameroon.
- 2) They make teachers curious to see which pattern best suits the place where he is teaching, and in what respect local cropping patterns differ from the ones described for his area.
- 3) In their teaching, teachers might usefully start with the local cropping pattern, deal with its component crops, establish reasons why they are grown in the area, and contrast it with one or two very different cropping patterns found elsewhere. The observed differences will help to stimulate the pupils' curiosity and motivation for learning.

There are a limited number of cropping patterns in the anglophone provinces. They are defined by a group of food crops which can be found virtually everywhere: - cassava, cocoyams, maize, and plantains/bananas -, and a number of further crops, tree crops as well as annual or biennial food crops. Within each cropping pattern, people regard a limited number of crops as their main food and cash crops. The patterns are labelled according to the geographical areas where they occur. We make a rough distinction between the rain forest zone of low altitude, the coast line area, the transition zone, the zones of high altitude (e.g. Bui Highlands

and the area around Santa), the isolated lowlands north of Nkambe, and the Esimbi-Akwaya region, finally the swamp areas (the Ndop plain, the Mbo-Nso plain etc.) The term "transition zone" is borrowed from F.E. Ngende, Geography of West Cameroon, Victoria, 1966, and J.A. Ngwa, An Outline Geography of the Federal Republic of Cameroon, London 1967, p. 95. Ngwa equates it with the Guinea Savannah vegetationtype and refers to the regions which are intermediate between the equatorial rain forest and the savannah, and which lie between 600 and 900 m altitude.

The cropping patterns of the low altitude rain forest zone

a) Forest zone pattern I

Crops	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts
	M																			

M

(M = Main Crop)

The tree crops are cocoa, robusta coffee, and oil palms. The most important tree crop is cocoa. Oil palms are mostly those which grow wild, although smallholder plantations are springing up around Mbonge, Mamfe, and along the Kumba-Mamfe road. In addition to the common food crops, yams and green vegetables are grown nearly everywhere. Beans are less common. The staple foods are plantains and cocoyams.

This pattern is much in evidence around Kumba, in the Rumpi Hills, in the Bakossi trough, along the Kumba-Mamfe road, and in the Cross river basin west of Mamfe.

b) Forest zone pattern II

Crops																					
	M M			M																	
	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts	

(M = Main Crop)

The tree crops are as in the preceding pattern, but the emphasis shifts markedly from cocoa to coffee. Raffia palms are exploited for palm wine. Yams are grown as additional food crops with plantains and cocoyam/colocasia still being the main food crops. This pattern is found in areas bordering on raffia palm growing zones (Akwa in "Mamfe Overside", Anyake) or in places with a heavy concentration of immigrants from the grassland who are used to raffia wine rather than to palm wine (Ekona, Muyuka, Bekora, Ikassa), and finally in the Ejagham area.

c) cropping pattern along the coast

Crops																						
	M			M																		
	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts		

(M = Main Crop)

Most of the land along the coast from the Mungo river westwards to Idenau belongs to the Cameroon Development Corporation (C.D.C.) and is covered by large plantations of oil palms and rubber. The plantations are interspersed, however, with villages inhabited by fishermen. Farming is essentially food crop farming. Cassava is grown for garri-making. Garri is sold to the fishermen. Raffia palms are tapped for wine. Some Bakweri villages on the slope of Mount Cameroon also follow this pattern although they are gradually taking to coffee farming.

The cropping patterns of the transition zone

d) Transition zone pattern I

Crops																						
	M M																					
	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts		

(M = Main Crops)

The tree crops here are coffee and oil palms. The raffia palm is used for wine tapping. The main cash earner is coffee. Kola trees are also common. Food crops include yams, beans, green vegetables and sweet potatoes. Groundnuts are often grown in addition. While the main staple food is still the plantain, maize is gaining in importance and is mentioned as the main food crop as often as cocoyams.

This pattern is common around Mount Cameroon, the Western border of the South West Province - the slopes of Mount Kupe and the Manenguba heights, and in the mountains and valleys west of the line from Bangem to Melong. It is found in the transition zone between forest and savannah, e.g. in Kunku and Bantakpa (Mamfe Overside), and Widikum. In these areas, robusta coffee is grown. In places like Bali-Nyonga, Mankin, Bafut, in the areas north of Oshie, and from Beba Befang to Weh, the same pattern with arabica coffee is found. Further to the east, it reappears in transition zones like Mayo Binka (Donga Mantung), and Bamali near Ndop.

e) Transition zone pattern II

Crops	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts
					M	M				M										

(M = Main Crop)

The tree crops are oil palms and arabica coffee, but coffee is much more important than oil palms. Kola trees are very common. The raffia palm is grown everywhere. Food crop farming here includes yams, beans, sweet potatoes, Irish potatoes, and green vegetables. Plantains and maize are equally important as the main staple foods. This highlights the transition from the forest zone to the savannah even more than the preceding pattern.

Irish potatoes do not as well as in the higher areas since the average temperature is too high. They are therefore less important.

This pattern can be found from Batibö towards Mbengwi, around Baligham and Bambalang, and from Belo/Njinikom through Bambui and Mankon to Bamenda.

The cropping patterns of the high altitude areas

f) high altitude pattern I

Crops	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Egusi	Guineacorn	Kolanuts

(M = Main Crop)

The tree crops are arabica coffee, and kola nuts. Irish potatoes are grown as a cash crop, but most money is earned from coffee. Yet, in roughly one quarter of all communities following this pattern, Irish potatoes provide more income than coffee. Food crop farming here includes beans and green vegetables. A local variety of yams is found in many places but not everywhere. The staple food is clearly maize, followed by cocoyams and beans. But whereas maize dominates in Bui where it has replaced guineacorn during the last forty years, cocoyams take on much more importance in the Ngemba area as the daily staple food. Raffia palms are grown every-

where for wine. Yams are part of the cropping pattern except in the very high areas like Potang/Mundani, Dzeng, Vekovi (Bui Highlands) and Sabgah (Mezam).

The pattern is common throughout the Bui Highlands on both sides of the Ring Road, in the very high areas in Donga Mantung, from Bamenda to Santa, in the highlands north of Mbengwi, in Mundani and high up on the Manenguba heights.

g) High altitude pattern II

This is a variant of the previous pattern which substitutes sweet potatoes, groundnuts, and sugar cane as cash earners for Irish potatoes. The main staple food crops are plantains, maize, and cocoyams. This pattern has been observed around Fontem and in the Nkor-Lassin basin (Bui Division).

h) The cropping pattern of the isolated lowlands

crops	Cocoa	
	Raffia Palm	
	Oil Palm	
	Coffee	
	Plantains	M
	Bananas	M
	Cassava	
	Cocoyams	M
	Colocasia	M
	Maize	
	Beans	
	Yams	
	Sweet Potatoes	
	Irish Potatoes	
	Green Vegetables	
	Rice	
	Groundnuts	
	Egusi	
	Guineacorn	
	Kolanuts	

(M = Main Crop)

The tree crops are oil and raffia palms. Oil palms provide most of the cash income. Food crop farming includes maize and groundnuts in addition to the common

group of food crops. The staple foods are faize, cocoyams, plantains, and guineacorn. This is the only cropping pattern where guineacorn is mentioned as a main foodcrop. In earlier times it used to be much more common throughout the North West Province. It is still relatively frequent in the Kom and Wimbum area. The frequency of indigenous dryland rice farming as well as the attempt at cocoa and coffee farming points to the potential of the lowland area.

This pattern is common in the lowlands north and north-east of the Ring Road (Mbembe and Mfunte areas), but also in isolated areas like the one north of Oshie (Batomo, Okoromanjang), the one between Oku and the Kom Highlands. It is to be expected also in the isolated areas between Esoki Bima (Ndian Division) and the Ejagham Forest Reserve.

i) The cropping pattern of the Esimbi/Akwaya Plateau

Crops	Cocoa	
	Raffia Palm	
	Oil Palm	
	Coffee	
	Plantains	
	Bananas	
	Cassava	
	Cocoyams	
	Colocasia	
	Maize	
	Beans	
	Yams	
	Sweet Potatoes	
	Irish Potatoes	
	Green Vegetables	
	Rice	M
	Groundnuts	
	Egusi	
	Guineacorn	
Kolanuts		

Only palms growing wild are exploited as tree crops. The common set of food crops is supplemented by rice. Rice supplies most of the cash income in areas close enough (less than a day's walk) to the nearest market. This is Benakuma for the Esimbi area and Nigerian markets for most of Akwaya subdivision. It replaces maize as the

staple food. Only the remoter communities stick to maize. This pattern is close to the preceding one and may be considered its poorer variant.

k) The cropping pattern of swamp rice cultivation

The cultivation of swamp rice is relatively recent and is done extensively only in suitable areas in the North West Province: in the Ndop plain, the Obang-Tingo area, and the Mbo-Nso plain. Whether in the South-West Province it will be extended beyond the experimental plots near Kumba remains open to doubt. Rice is grown as a single crop, but traditional food cropping continues on the slopes of the surrounding hills and is done by the women.

Summary table of cropping patterns

Crops	Cocoa	Raffia Palm	Oil Palm	Coffee	Plantains	Bananas	Cassava	Cocoyams	Colocasia	Maize	Beans	Yams	Sweet Potatoes	Irish Potatoes	Green Vegetables	Rice	Groundnuts	Erusi	Guineacorn	Kolanuts
forest zone pattern I																				
forest zone pattern II																				
coast line pattern																				
transition zone pattern I																				
transition zone pattern II																				
high altitude pattern I																				
isolated lowland pattern																				
Esimbi/Akwaya pattern																				
swamp rice pattern																				

2.3. Instruments for school surveys of traditional agriculture

- 2.3.1. Calendar of Farm Work (one crop only)
- 2.3.2. Crop Calendar Schedule (several crops)
- 2.3.3. Survey Schedule on Farming in the Community
- 2.3.4. Interview Guide for a survey on traditional farming

Note:

Enter the various farm work activities for the crop indicated in the heading in the order in which they occur. Indicate the time it takes to complete each task from beginning to end by blocking in the respective rectangles in the body of the table. Thus if clearing for your crop starts at the beginning of February and ends in mid-March, you would block in the three corresponding rectangles. This form gives a more detailed picture for one crop whereas the other form makes possible a less detailed analysis of several crops at a time.

CALENDAR OF FARM WORK

(FOR ONE CROP ONLY)

CROP UNDER OBSERVATION:.....

Month

farm work activity	Month													

MONTH	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	CROP

2.3.3. SURVEY SCHEDULE ON FARMING IN THE COMMUNITY

What crops are grown on the farms of the community?

crop	for con- sumption	for home consump- tion & for sale	for sale only
(1) CROPS CONTAINING MOSTLY STARCH AND SUGAR			
a) <u>cereals:</u> maize guinea corn rice	{ } { } { }	{ } { } { }	{ } { } { }
b) <u>root & tuber crops:</u> yam cassava cocoyam colocasia sweet potatoes Irish potatoes	{ } { } { } { } { }	{ } { } { } { } { }	{ } { } { } { } { }
c) <u>other crops:</u> plantains bananas sugar cane fruit	{ } { } { } { }	{ } { } { } { }	{ } { } { } { }
(2) CROPS CONTAINING MAINLY PROTEIN			
beans cow peas	{ } { }	{ } { }	{ } { }
(3) CROPS CONTAINING FAT AND PROTEIN			
groundnuts egusi melon	{ } { }	{ } { }	{ } { }
(4) CROPS CONTAINING MOSTLY FAT			
oil palm	{ }	{ }	{ }
(5) OTHER CROPS			
vegetables spices kola trees coffee trees cocoa trees rubber trees tobacco	{ } { } { } { } { } { } { }	{ } { } { } { } { } { } { }	{ } { } { } { } { } { } { }

Please tick where appropriate!

2.3.4.

INTERVIEW GUIDE
FOR A
SURVEY ON TRADITIONAL FARMING

In order to acquire a good understanding of traditional agriculture in your community, we would suggest that you collect information from individual farmers, both women and men. The best way to do this would be to discuss with them their various plots one by one. Such an investigation could be done with small groups of pupils. In that case, however, only a few of the topics treated in this guide should be taken up at one time.

1. Size of the Farm

See together with the woman or man in question as many of her/his plots as possible

1.1. number of plots farmed. by men in the household ...
 by women in the household ...

1.2. size of plots

It is difficult to know the approximate size of traditional farm plots since size in itself does not usually matter to the farmer. Plots rarely have straight boundaries, which makes exact measurement very time-consuming and difficult. We shall therefore propose methods of estimating the size of the plots approximately.

- If the farmer knows the size of his farm plots, enter this information in the table below and specify the unit of measurement (hectare, acres,...)
- If the farmer does not know the area of his farm plots, proceed as follows:

(1) in the case of tree crop farms (coffee, cocoa oil palms, raffia, etc.)

- if the farmer knows the number of trees, find out the average planting distance between the trees (by pacing the distance between a number of trees). Once you know the average distance you can estimate the total area of the plot using the formula:

$$\text{area} = \text{number of trees} \times \text{planting distance}^2$$

- if the farmer does not know the number of trees, walk around the farm boundary, pace it out and draw a sketch on a piece of paper. Where the boundary is curved, draw it in your sketch as a series of short straight lines joining up the main points. Find out the average planting distance between trees. Estimate the area of the plot from your sketch (for details see instructions at the end of this section). To get the number of trees, use the formula:

$$\text{Number of trees} = \frac{\text{Total area of plot}}{\text{planting distance}^2}$$

(2) in the case of food crop farms

Proceed as with tree crop farms where the number of trees is unknown and estimate the size of the farm plot from your sketch.

Plots with tree crops:

Plot No	Kind of trees	average planting distance	number of trees	area of trees	other crops grown between the trees

Plots with food crops (annual and biennial):

Plot No	area of plot	Crops grown				

Many farmers have a large number of small plots scattered over a wide area. If this is so, you may not have the time to inspect all of them, although it would be desirable. Try to get an estimate of their size by asking the farmer and his wife/wives to compare them with the plots you have seen.

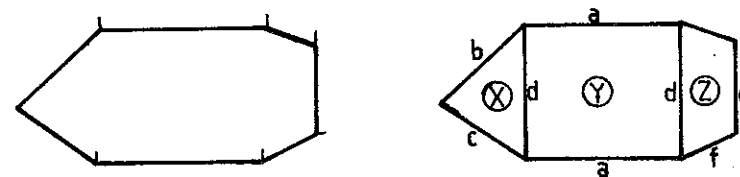
As far as farm size is concerned, you should now be able to find out

- the total area of the farm plots (by adding all the estimates of size)
- the largest and the smallest plot,
- the average size of the plots (dividing the total area by the number of plots)

How to calculate the area of a farm plot

Walk around the plot to get an idea of its shape. You may stake out each main angle. Measure the distance between each angle (if you have not staked them out and if you are with someone, ask him to go to the next angle and walk up to him counting your steps).

On a piece of paper, draw the shape of the field, after selecting a scale (e.g. 1 square on the paper = 1 meter)



Divide your drawing into common geometrical shapes (squares, rectangles, triangles, trapezoids).

Calculate the area for each of the shapes. Here is the example of the above Figure:

$$\text{the area of triangle} \quad X = \frac{C \times H}{2}$$

$$\text{the area of rectangle} \quad Y = A \times D$$

$$\text{the area of trapezoid} \quad Z = \frac{E + D}{2} \times F$$

Total area = Area X + Area Y + Area Z

Convert the total area into ares

$$100 \text{ M}^2 = 1 \text{ are}$$

$$1 \text{ hectare} = 100 \text{ ares} = 10,000 \text{ M}^2$$

GEOMETRY REMINDERS

The area of a rectangle is the product of two adjacent sides (length multiplied by width)

The area of a triangle is one-half the product of the base and the corresponding altitude.

The area of a trapezoid is the product of its altitude and one-half the sum of the length of its bases

The slope of a farm plot is important because it has a major influence on erosion. Especially in hilly areas it would be a good exercise to find out the slope, and also whether farmers control erosion, and if so, how. The following is a very simple method of finding out the gradient, which is a recognized measure of the slope.

How to measure the slope of a farm plot

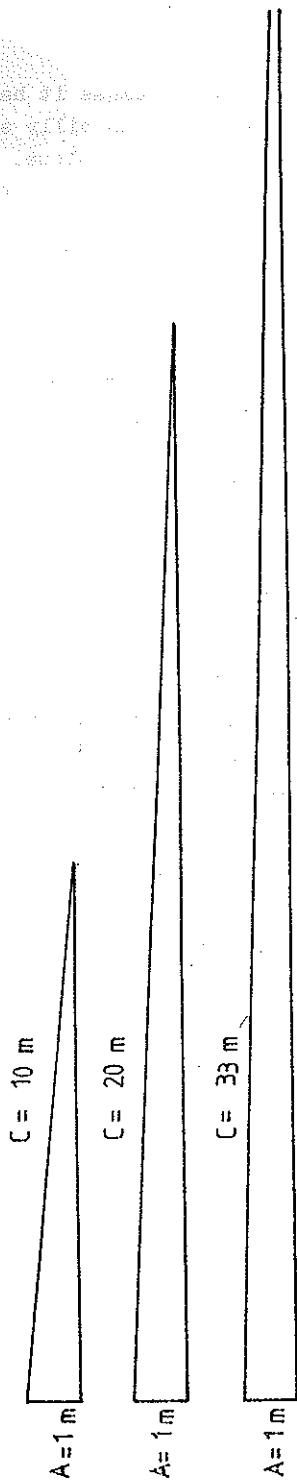
- Cut a one-meter long pole and vertically place it in the ground at the bottom of the slope. (A)
- Ask someone to climb the slope until you see his feet on a level with the top of the pole (B) (Your own eye must also be on a level with the top of the pole).
- Measure the distance between the base of the pole and your friend's feet (C)

The gradient will be equal to $\frac{A}{C}$

Example: if $C = 10 \text{ m.}$, the gradient = $1/10 = 10\%$
 if $C = 20 \text{ m.}$, the gradient = $1/20 = 5\%$
 if $C = 33 \text{ m.}$, the gradient = $1/33 = 3\%$

With a little practice you will soon be able to estimate the slope of a farm plot simply by looking at it.

The figure below shows the 3 gradients.



2. Crops Grown

As you find out the size of each plot, make a note of the crops grown and enter them with the plot number and its area in the tables on the preceding page. Complete for each plot by checking with the farmer, and ask him for information about the plots not inspected.

The tables now show for each plot the crop associations in multiple cropping for the current year. How far do these crop associations agree with the ones shown in our documentation?

Indicate which crop will be harvested first and which ones later. Which crops are planted systematically all over the plot and which ones are dotted here and there? Use your own symbols to show this information in the tables above.

3. Farming Methods

3.1. When you prepare an unused plot for farming, how do you usually clear it?

	forest	grassland
cutting down grass	()	()
cutting of shrubs and bushes	()	()
felling trees	()	()
ringbarking trees	()	()
burning trees on the farm	()	()
leaving some trees for shade	()	()
covering grass with soil	()	()
leaving grass on the surface without burning it	()	()
burning grass	()	()
using machinery	()	()
uprooting trees	()	()
other work involved in clearing		

.....

3.2. Prepare several tables of the type shown below and fill in one for a plot with food crops that has been burned, one for a food crop plot that has not been burned, and at least one for a newly established tree crop farm. (If there are not any, ask what was planted when the present tree crop farms were originally established.).

Type of plot: tree crops () food crops only ()
 first clearing with burning () without burning ()

year of farming	crops grown			
1				
2				
3				
4				
5				
6				
7				

These tables will repeat at least some of the crop associations which have occurred in previous tables. But they do more than that. They also show typical crop sequences according to the type of clearing used and the main crops grown (tree or food crops). The questions to ask are:

- What do you plant in the first year after clearing?
- What do you plant in the year after that? And what in the next year?

Continue the questions until the informant says that the soil would by then be exhausted, and the plot must be allowed to lie fallow.

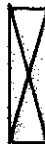
Do the sequences and rotations match with any of those shown in the documentation? Which one is it? Do people in the community agree on the crop sequences or does every farmer have his own sequences?

You can now also see how long food crops are grown in tree crop farms. How do people justify what they are doing in this respect?

3.3. For how many seasons can the farmer continue to

C R O P S

Method	Coffee	Cocoa	Oil Palm	Yams	Maize	Cassava	Rice	Ground nut	Irish Potato	Pineapple	Banana Plantain
Staking											
Planting with cuttings, sets, suckers											
Standard planting distances											
Digging holes for planting											
Shading/capping											
Pruning											
Chemical fertilizer											
Manuring											
Mulching											
Insecticides											
Irrigation											
Transplanting											
Grafting											
Thinning											
Hoeling											
Propping											
Earthing up											
Tapping											

Key:  Method not used with this particular crop

farm a newly cleared piece of land until the soil is so exhausted that it must be allowed to lie fallow.

Number of years of continuous farming: years

3.4. Some crops exhaust the soil faster than others. Can you tell, for the main crops in the respondent's farm, how long they can be grown continuously?

crop	Number of seasons of continuous farming

3.5. Once a plot is exhausted, how many years or seasons is it left fallow before it can be used again?
 Number of years left fallow:

3.6. The table shows for each crop which methods could and should be used. Check for each of the crops farmed by the respondent which methods she/he uses and which ones she/he leaves out.

3.7. In order to compare results (e.g. total yield per hectare or yield per crop per hectare) in multiple cropping with yields from single cropping in "scientific agriculture", you need to know how many plants there are per hectare. The number of plants per hectare is the plant density. It is not possible to count all the plants, on a given plot, and standard planting distances will not have been used from which the density could be easily calculated. Therefore, you can proceed by sampling. Your sample is a small area in which you count all the plants growing in it. From there you generalise to one hectare. The easiest way of taking a sample of this sort is to use a density square.

HOW TO BUILD A DENSITY SQUARE

- Take a 20-meter long rope and 4 stakes. "Country-rope" will do.
- To find out where to make your survey, stand in the field and throw a stick behind you at random (your density square should be a random sample).
- Around the spot where the stick has fallen, draw a square of 5 x 5 meters (on a ground-nut field, 3 - 5 squares of 2x2 meters) by planting your sticks at the 4 corners and stretching the string around them.
- Count the number of stands or single plants of each variety within the square.
- Enter the figures in the table below and calculate the density per hectare using the formula:

$$\text{density per hectare} = \text{density per 25 square meters} \times 400$$

NOTE: You may add to your list rare species present on

the field but not found within the square.

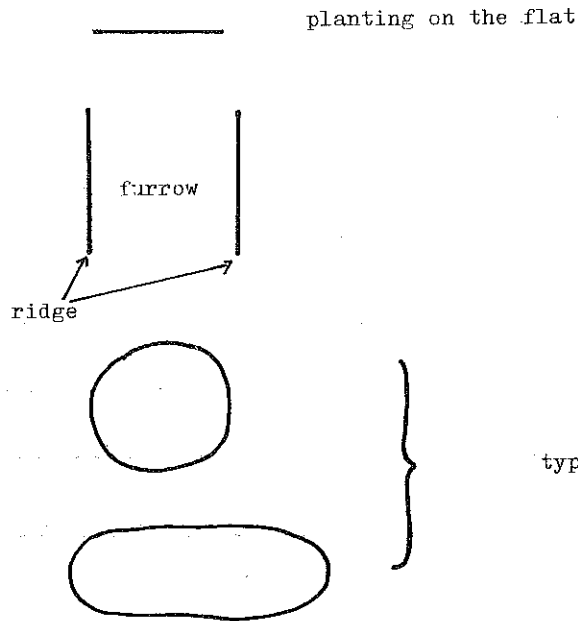
- For a large (e.g. 1 hectare) farm, you will have to make several density squares.

Density table

Crop	N ^o of plants in density square	estimate for one hectare
Total plot		

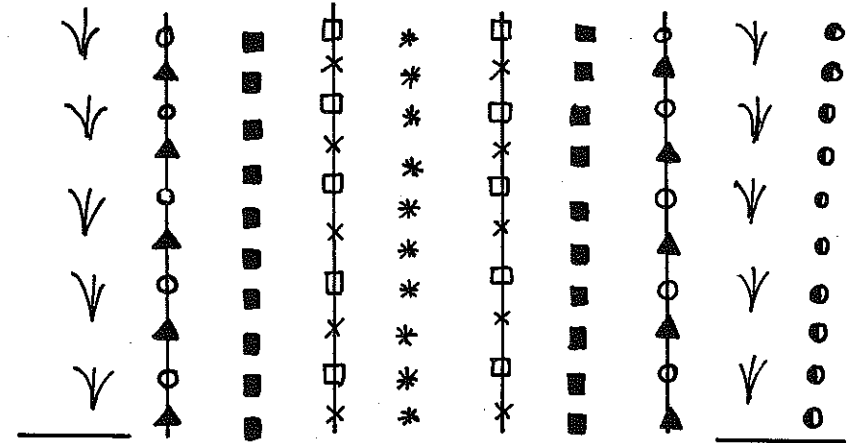
You will need one such table for each of the plots on which you use a density square.

3.8. In order to see more clearly how multiple cropping is being done make a simplified graphical representation of the way crops are arranged on the farm. This means you will have to use two sets of symbols. First you will need one set of symbols to indicate the tillage.



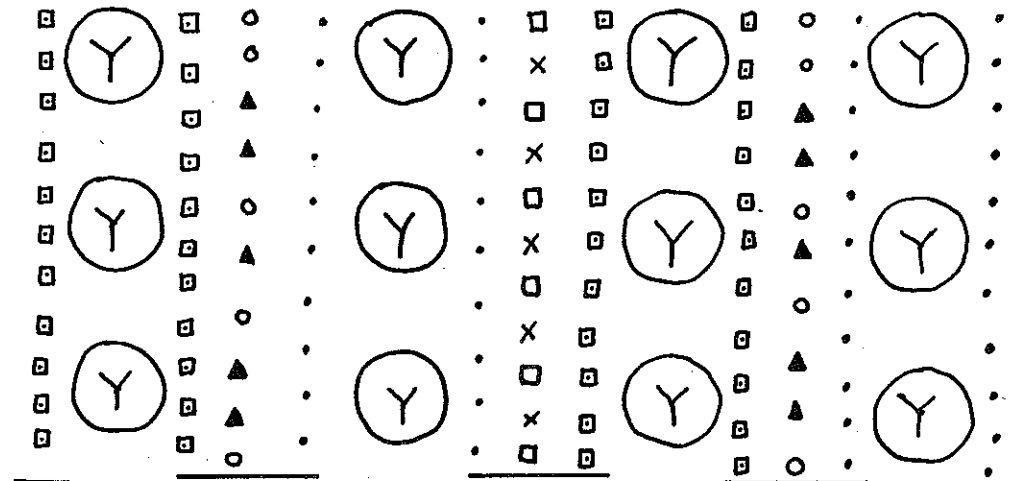
You will need to invent another set of symbols to represent the crops. Examples are given in the documentation in the section on planting and sowing. The following figure gives two more examples:

Graphical representation of multiple cropping systems in Northern Ghana



KEY

- | | | | | | |
|---|-----------------------|---|--------------------|---|------|
| ○ | Early Millet | * | Rice | | |
| ▲ | Late Millet | ∇ | Pigeon Peas | | |
| ■ | Cowpeas | ● | Pepper | ⊙ | Yams |
| ◻ | Maize | • | Groundnuts | | |
| X | Guinea Corn (Sorghum) | ◻ | Bambara Groundnuts | | |



In example (a), starting from the left pigeon peas are planted on the flat, then there is a ridge where early and late millet are planted. Next, there is a furrow planted with cowpeas, and on the next ridge, guinea corn and maize alternate. The following furrow has upland rice in it. The next ridge again has guinea corn and maize, followed by a cowpea furrow and another ridge of early and late millet. After that, two rows are planted on the flat, one row of pigeon peas and one row of pepper.

In example (b), again starting from the left yams are grown on mounds, and they form rows. The rows of yam mounds have on each side of them rows of either groundnuts or bambara groundnuts planted on the flat. Between two rows of leguminous crops, there is one row of cereals, either late millet interplanted with early millet or maize alternating with guinea corn.

(Graphic representation adapted from Bennet and Schork, 1978, p 112)

4. Yields

Crop	Amount harvested	unit of measurement	market price per unit

In order to get information on this touchy question, ask the following:

For cash crops: How many bagscan you harvest in a good year, and how many bags in a bad year? Write down the range thus obtained.

For food crops: How many baskets or bagsdid you (your wife/wives) harvest last year, both for sale and for consumption? If you had to buy a basket/bag on the local market, how much would you pay? Enter the price per unit in the last column.

For plantains/bananas: How many bunches per week do you usually harvest? How many bunches do you eat in a week which come from your farm?

Of course it is difficult to get reliable information by asking questions. Except for cash crops, farmers simply may not be able to remember things in terms of numbers. Since you live in your school community, a more direct approach is possible. You can measure yields directly. Here are some guidelines on how it could be done for one crop at a time:

- If the farm plot has been completely harvested:
 - count the number of baskets, bags or sheaves.
 - weigh one basket or bag or sheaf.

By multiplying the number of baskets by the unit weight (remembering to deduct the weight of the bags, baskets, buckets, basins etc. used as containers) you can calculate the yield of the field. By dividing the yield by the area of the field (which has already been calculated) you will also obtain the yield per hectare for each variety.

- If the plot is not fully harvested:
 - You can estimate the average production of one plant (tuber, ground-nut) by weighing the tubers or the products of some twenty plants and dividing this weight by the number of plants whose production you have measured.
 - Subsequently you can use the sample established in your density square to calculate the average production of one are (knowing that the $5 \times 5 \text{ m}^2$ density square = 0.25 are)

Example:

average production of one yam plant = 2 kg.
 density noted = 9 plants/0,25 ares
 density per are = $9 \times 4 = 36$ plants/are
 production per are = $36 \times 2 = 72$ kg/are.

- You can then estimate the yields per hectare (in the above example: 7,2 T/Ha)

- Since you have already measured the area of the field, you will have no difficulty measuring the total production of the field (if the field is 20 ares, yam production may be calculated:
 $72 \text{ kg} \times 20 \text{ ares} = 1,440 \text{ metric ton.}$

3. Scientific Agriculture

3.1. The Meaning of Scientific Agriculture

School farm work so far has been guided by principles of scientific agriculture. Scientific agriculture in this context may best be described as the traditional European land-use system systematically changed and improved by applied science.

Any traditional land use system in the world tends to be well adapted to the conditions under which it works - the climate, the soil, the existing technology, the population density and social conditions. If changes in these factors occur slowly, the land-use system will be able to adapt to them, but adjustments are not usually fast enough to cope with rapid change. The slow pace of natural change in farming systems is due to the fact that a change of habit derives exclusively from everyday experience. Experience comes in the form of shortcomings and disasters on the one hand, and successful innovations on the other. Such innovations are often due to good luck and chance as much as to conscious efforts to remedy a deteriorating situation. Since these innovations, these new and better ways of farming, are always introduced by individual farmers, they will spread only very slowly, depending on how widely the farmers travel.

Scientific agriculture in Europe was the result of an approach that put the findings of scientific disciplines such as biology, chemistry, geology, and physics to the task of solving agricultural problems which European farming traditions alone, faced with an increasing population and urbanization, could not solve. This has resulted in a variety of land-use systems all permitting permanent cultivation. These

systems all did away with the fallow year in the traditional three years' rotation. The major breakthrough in this respect was the application of chemistry to the problem of soil fertility. The exact properties of the plant nutrients were identified. Chemistry found ways and means of producing these nutrients so that the farmer did not have to rely exclusively on the slow natural processes by which they were made available in the soil. The resulting development of chemical fertilizers (also called inorganic fertilizers) has been very successful, and did more than anything else to establish the firm belief in the omnipotence of science in agriculture. Pesticides and insecticides, the systematic breeding of high-yielding varieties of all sorts of crops, farm machinery, sophisticated techniques of soil improvement and systems of crop rotation are all instances of the application of science to agriculture.

The following table contrasts scientific agriculture with both the approach followed in Rural Science as taught and practised in Cameroonian primary schools, and traditional Cameroonian agriculture. The table warrants careful reading since we shall comment only on some of its elements.

Factor	Scientific Agriculture	Rural Science Teaching	Traditional Agriculture
SOIL			
- pre-para- tion	- deep tillage - removal of all shrubs and trees - levelling - boundaries with straight lines and right angles	- shallow tillage - removal of all shrubs and trees - boundaries with straight lines and right angles	- shallow tillage - tolerance of selected shrubs and trees - shape of plots not important

Factor	Scientific Agriculture	Rural Science Teaching	Traditional Agriculture
- improvement of soil quality	- drainage - anti-erosion measures - addition of limestone etc.		- terracing in some areas (e.g. North Cameroon)
Crops	improving the quality of plant material through breeding for - high yields - adjustment to climatic and soil conditions - nutritive value - resistance to diseases and pests - taste, etc. introduction of new crops	careful selection of planting material introduction of new crops	careful selection of planting material introduction of new crops
CROP HUSBANDRY	- single cropping - planting/sowing along straight lines - exact planting distances - clean weeding (use of chemicals) - chemical plant protection (pesticides, insecticides)	- single cropping - planting/sowing along straight lines - exact planting distances - clean weeding - no plant protection	- mixed cropping - phased planting - planting at random on a given area - no exact planting distances - some weed tolerance, weeds used as mulch - plant protection assured by mixed cropping
SOURCE OF POWER	traditional: man, draught animals modern: fuel-powered motors, electricity	man	man
TOOLS AND IMPLEMENTS	traditional: specialized hand tools, animal-drawn implements modern: sophisticated engine-powered machinery	- African all-purpose hand tools - specialized European tools for gardening	- African all-purpose hand tools - a few European-type hand tools

Because of the great successes achieved through science in European agriculture, methods developed for agriculture in temperate zones were transferred to tropics with only minor adjustments. It took people some time to realize that scientific farming in the tropics meant more than identifying and breeding high-yielding varieties of crops. It meant that science would have to take an altogether new look at principles of soil preparation and crop husbandry, and that basic procedures and methods would also have to vary according to climatic and soil factors.

We shall comment briefly on the above table:
Deep tillage using the plough needs farms without trees and shrubs as these would disturb ploughing. Advanced farming machinery such as the various sowing machines and harvesters need levelled land, i.e. farm areas where small depressions and holes are filled in and small elevations are levelled down so as to make a smooth surface. Farming along straight lines is also a requirement of cultivation techniques (weeding, application of fertilizer) that use animal-drawn or engine-powered equipment. This has so much shaped the appearance of the European and American countryside that the newcomer to Africa has difficulty in distinguishing a food-crop farm from the bush, especially in the forest and tree savannah zones.

Manuring differs for gardens and farms. Traditionally, farms were fertilized with farmyard manure. But farmyard manure is available only where animals are kept in stables so that their dung, mixed with the straw used for bedding, decomposes to form a very rich mixture that is ploughed into the soil. In Africa, where farming and livestock rearing are usually done by quite different groups of people, farms do not produce any farmyard

manure. Compost is prepared and used in vegetable gardens that are much smaller in size than fields. Preparing good compost is so much work that it cannot possibly be applied to farms far away from the compound, although it might prove feasible for the compound farm. As mentioned above, compound farms are manured by all sorts of household refuse and animal droppings thrown on top of the soil as a kind of mulch. Composting all these items and hoeing them into the soil at the time of farm preparation and/or planting would provide more soil nutrients.

The science-based methods of improving soil quality have permitted the cultivation of land formerly thought unsuitable for farming. By careful drainage, water-logged areas have been put to use. By adding limestone and other substances, the structure of the soil has been changed to suit various crops.

"The Green Revolution", (in use long before such a movement was launched in the United Republic of Cameroon), is a slogan denoting spectacular developments in agriculture due to the breeding of high-yielding varieties of rice, maize, and wheat. With cereals such as these, the most surprising yields were achieved by careful crossbreeding of a large number of varieties of the same cereal. Similar attempts have now been made in the case of root and tuber crops, and specialists assert with confidence that they can breed almost any desirable quality into a given plant. However, as far as high-yielding varieties are concerned, there is a drawback: they thrive only under optimal conditions and thus are very demanding on the farmer. The right planting time, correct spacing, the right amount of water, no competition from weeds, chemical fertilizer and chemical control of pest - all are required in order to assure the heavy harvest these varieties are able to yield.

Some of these requirements involve a lot of work, some mean heavy financial expenditure. It is not surprising, therefore, that the result of this kind of Green Revolution has been that the rich landowners have profited most while smallholders have not been able to buy the necessary artificial fertilizers and pesticides even when seed material was distributed free.

Exact planting distances are justified by considerations about the growth of roots and competition between plants. The best planting distance obviously is such that the root systems of neighbouring plants just touch each other when fully grown. If they are further apart, parts of the soil are not used. If they are closer together, they compete for soil nutrients and will not grow to be healthy plants. This is certainly true for single cropping where all the plants on a plot - apart from the weeds - need the same kind of soil nutrients. One would have to reason differently when it came to mixed cropping.

In case of single crops, pests and diseases particular to the crop being farmed find ideal conditions. Many high-yielding varieties are more vulnerable to pests and diseases than varieties with lower yields. Plant protection by means of chemicals therefore becomes important. Since in mixed cropping plants of the same species are further apart than in single cropping, pests and diseases do not spread as fast as in single cropping, and, some plants, even some weeds, seem to keep away pests from other species. The best known example is the pyrethrum flower which East African farmers grow as a cash crop, and which forms the basic ingredient of most insecticides. Vegetable gardeners in Europe know, for instance, that it is advantageous to plant carrots and onions in alternate rows. The onions drive away certain insect pests which attack carrots, and the carrots keep out a pest which feeds on

onions.

Finally it must be pointed out that today's modern scientific farming is highly mechanized and labour saving. It would not be possible, otherwise, for five per cent of the population of the industrialized countries to feed the rest and produce surpluses for export. But this type of agriculture is certainly not suitable for areas where unemployment is a big problem and where all the farm machinery would have to be imported from abroad, using up scarce foreign exchange.

3.2. Scientific Agriculture in Cameroon

3.2.1. The Plantations

Scientific agriculture is most evident in the large tree crop plantations in the South-West and Littoral Provinces, in the tea plantation of Ndu, North-West Province, and, on a more limited scale, at the former Santa Coffee Estate. The plantation crops are grown strictly as single crops, soil preparation is done with huge, powerful machines, and planting distances are carefully measured out. Weeds along the edges of the rubber plantations are killed by chemicals. At certain times of the year an aeroplane sprays pesticides over the banana plantations between Muea and Ekona, and, under the trees, a leguminous cover crop prevents any weed growth. But the care of the trees and the harvest cannot be mechanized, and therefore the plantations employ a large number of labourers.

3.2.2. Research Stations

Research into improved farming methods is carried out at a number of research stations spread over Cameroon. Selected seeds and planting material are adapted to

local conditions and multiplied, promising species from abroad are adapted to conditions in Cameroon, etc. These research stations are administered by ONAREST (Office National de Recherche Scientifique et Technique - National Office for Scientific and Technical Research). Those located in the two anglo-phone provinces are

- Barombi Kang station near Kumba,
- Ekona CDC station on the Buea-Kumba road,
- Bambui research station near Bamenda,
- Santa research station and smaller stations at Mankon and Bali.

It is suggested that teachers in the neighbourhood of these centres should establish contact with them with a view to obtaining suggestions, advice, and planting materials. The Teacher Training Colleges could also profit from some kind of cooperation with these research stations.

3.2.3. Higher education

Scientific agriculture at the post-secondary level is taught at the Ecole Nationale Supérieure Agronomique (ENSA) at Dschang, Province de l'Ouest. ENSA is part of the University of Cameroon in Yaoundé and trains agronomists. Members of its staff have published highly technical books on a number of tropical crops. Some of the books are available in English. (see list of references).

3.2.4. INADES

In Douala there is an institution called INADES which offers correspondence courses to groups of farmers with at least one literate farmer among them. These courses teach the basic elements of modern agriculture in the tropics. Like Rural Science in primary

schools, they tend to ignore traditional African farming methods. The course covers a period of three years and is very well adapted to the language level of the small farmer. Booklets are available in French and English. Schools with some funds from school farm work might do well to enrol in this course.

3.2.5. Rural Development Projects

There are a number of large and small rural development projects where modern scientific agriculture methods are put into practice and taught to the local population. In the North West Province there is W.A.D.A. (Wum Area Development Authority) with extension activities geared to food crops and coffee and, as a very special feature, the introduction of oxen as draught animals. In 1978 the project, now almost entirely run by Cameroonian management and staff, had three programmes. The programmes all aim at improving the living conditions of the rural population through better farming methods. They are

- a so-called 'Block Extension Programme' in the area immediately surrounding Wum, where farmers are settled on a 2.5 hectare farm and benefit from intensive advice on farming methods and planting programmes,
- a Group Farming Programme in areas further away, mostly dealing with upland and swamp rice,
- an Animal Draught Programme training oxen as work animals, teaching farmers how to use them, and selling them to farmers on credit (see our text: Farming Becomes Easier).

In the Ndop plain, the U.N.V.D.A. (Upper Nun Valley Development Authority) fosters rice farming in the plain which is flooded every year. It is therefore

ideally suited for irrigated or swamp rice (see text on Rice), and as a consequence, rice production has increased at a fast rate. People in the area are rushing to buy land suitable for rice farming.

Other development schemes are run by the churches. The Presbyterian Church runs two Rural Training Centres (R.T.C.s), one at Kumba and one at Mfonta. Here, young farmers receive a one-year training course in modern methods of farming adapted to Cameroon. The Catholic Church initiated a resettlement scheme for young farmers involving rice cultivation in the Mbo-Nso plain, and also several cooperative oil palm schemes (Mbonge, Mamfe, Widikum). Nearly all of these development projects produce annual reports and teaching materials such as brochures and extension leaflets. Schools could very well benefit from this experience and knowledge by writing to ask for copies of these documents.

3.2.6. Commercial Farming and Production under Supervision

In areas immediately bordering the North-West Province and between Bafoussam and Fouban there are a few large commercial farms growing vegetables for sale in the urban centres of Cameroon and abroad. In order to increase production, they pass contracts on to local farmers whom they then instruct in the appropriate methods. The farm management also organizes the supply of necessary materials such as seeds, fertilizer, and insecticides.

3.2.7. Peasant Farmers

In general the average farmer in Cameroon - man or woman - continues to use traditional farming methods, especially for food crops. The cultivation of coffee

and cocoa has been a major concern of the extension service. Since the crops were formerly unknown in Cameroon, farmers were willing to take advice. The following list shows how many farmers of a sample surveyed by IPAR-Buea use methods advocated by scientific agriculture:

Method	per cent of sample farmers	remarks
Single cropping in food crop farms	4.2	
preparation and use of compost manure	4.7	very demanding in terms of labour
crop rotation or sequence	9.8	
use of selected planting material for coffee, cocoa or oil palms	15.9	most farmers raise seedlings themselves from coffee berries or cocoa beans. Some farmers establish nurseries and sell seedlings. The department of agriculture is setting up nurseries for the distribution of selected plants.
fencing the farm	16.4	farms not fenced suffer damage from animals - mainly goats in the forest zones and goats and cattle in the grassland savannah.
use of chemical fertilizer	20.6	Fertilizer is only applied to tree crops. Farmers lack confidence in the beneficial effects of fertilizers and are poorly informed about the way it acts. Also, there are frequent shortages of supply.
shade trees in young coffee and cocoa farms	28.5	
single cropping in tree crop farms	32.2	Even if allowance is made for the growing of food crops in young tree farms, intercropping is done to a large extent on mature tree farms.

Method	per cent of sample farmers	remarks
insecticides and pesticides	32.7	spraying against pests and diseases on coffee or cocoa farms is recognized as important, but the necessary chemicals were in short supply at the time of the research.
correct spacing of trees (planting distances)	44.9	for details see table on planting distances
mulching	46.3	mulching is mostly done in young tree crop farms and in yam farms.
pruning	75.7	

The table below shows what planting distances have been recorded on coca and coffee farms.



= acceptable planting distances

Planting distance in m	Coffee farms forest	Coffee farms savannah	Planting distance	Cocoa farms
below 1.5	5.7	5.5	1.0 - 1.5	5.9
1.5 - 1.99	20.8	13.7	1.51 - 2.0	2.9
2.0 - 2.29	17.0	30.1	2.01 - 2.5	11.8
2.3 - 2.49	3.8	6.8	2.51 - 3.0	17.6
2.5 - 2.89	9.4	15.1	3.01 - 3.5	17.6
2.9 - 3.49	15.1	13.7	3.51 - 4.0	8.8
3.5 - 4.49	15.1	8.2	4.01 - 4.5	8.8
4.5 and above	13.2	6.8	4.51 - 5.0	8.8
			5.0 and above	17.6
Total	100.0%	100.0%		100.0%
number of farmers	53	73		34
percentage of farmers with acceptable planting distances	41.5	50.7		44.1

Planting distances depend among other things on the fertility of the soil. Therefore, we have defined a range of planting distances as being correct rather than just one. For coffee, this range lies between 1.5 m and 2.5 m. For cocoa it is higher and lies between 2.5 m and 4.0 m. A relatively high proportion of coffee and cocoa farms in the forest zones show very high planting distances, sometimes double the required distance. This is due to the fact that on some farms cocoa and coffee trees are mixed which requires larger distances between the trees of one species. From advanced statistical analysis one can conclude that modern methods of tree crop cultivation have a comparatively small effect on the income derived from the tree crops. Taking the example of coffee, the most important factors accounting for high income are

- 1) the total number of trees owned,
- 2) the employment of skilled labour (e.g. for pruning and spraying)
- 3) the use of modern methods like skilled pruning, weeding, and mulching, the use of fertilizer and chemicals for spraying,
- 4) the use of selected planting materials, especially important in the South-West Province.

Thus, for the average farmer with his limited resources and financial possibilities it was, at the time of the research, more profitable to extend his coffee or cocoa farms in size than to increase his own efforts or to employ hired labour in order to apply the recommended farming methods, or to buy costly materials like fertilizer and insecticides or pesticides.

We have already seen the large differences in the use of modern, scientific farming methods, even in tree crop cultivation where these methods are better adapted to tropical conditions than in food crop farming. What

could be the reasons for these pronounced differences? One important factor is certainly the availability of training and good examples. Thus, coffee farming in the communities around the Santa Coffee estate was much better than, for example, in Bui Division. Surprisingly well kept farms were also found in Nwa subdivision, from where people migrate to the coffee estates between Foumban and Bafoussam, and in the northern Bakossi area where people migrate to the coffee farms around Nkong-samba for seasonal work.

In many cases, plantation workers came back to their place of origin, took over the farms of their parents, and tried to apply what they had learnt during plantation work. This was evident in Ngolo-Batanga area (zone of influence of PAMOL-plantations) and even in an isolated community like Akwa in Mamfe-Overside, to cite only remote areas. It is common in the better accessible areas like Widikum, Ekenge, Kombone. But even in a newly opened area like Okoromanjang/Momo Division, an ex-CDC worker was starting a modern type oil palm plantation and a cocoa farm.

3.2.8. Teachers, Schools, and School Leavers

The methods advocated by Rural Science as taught in Cameroon, are a blend of African and European farming methods, applied largely to African crops but also to vegetables and other garden crops brought in from Europe. All the expensive methods of scientific agriculture have been left out as schools would not be able to pay for them. "Rural Science" emphasizes crop husbandry where much more effort is required than by traditional crop husbandry procedures. The contrast between Rural Science and traditional farming is striking although many of the new methods of scientific agriculture, like soil improvement, plant breeding, and equipment in the form

of sophisticated tools and machinery have been left out. A detailed account of present school farm work is to be found in the IPAR-Buea report on the reform of Primary Education. Summarizing the findings one might say:

"The results are not very encouraging. Many parents are not convinced that the agricultural techniques of the school are superior to their own. Student graduates (i.e. school leavers, H.B.) seldom apply their acquired knowledge."
(Bergmann, H., 1978, p. 9)

"How alien the content of the instruction has remained is evident in the fact that many teachers themselves do not even see to it that their own fields are tended in accordance with the methods prescribed by the curriculum."
(Bergmann, H., 1978, p. 10)

A hand-out distributed by IPAR-Buea states this as follows:

"Most teachers are not convinced as to the usefulness of 'scientific agriculture'. They therefore either apply local farming methods wholesale or practise a mixture of the two sets of methods. Educationally, this is disastrous, because children know what is happening very well (often, some of them are sent to work on teachers' farms during periods of manual labour). Teachers should therefore feel free to seriously reconsider local ways of farming and should have the courage to apply what seems useful to them on the school farm."
(Bergmann, H., 1977, p. 3)

The conclusion therefore is:

"The basic mistake of existing curricula is that they apply European principles to the agricultural field. This makes translation of the subject matter into practical application for daily living difficult, and this applies to teachers as well as to parents and students."
(Bergmann, H., 1978, p. 10)

If what is taught in school is not applied in practice, this means that the teaching has failed. If, despite such failures, teaching is not changed to incorporate

methods that can be used, this shows a frightening lack of realism.

3.3. Conclusion

It is not only the school which experiences this failure. In a study on farming in Northern Ghana, Bennet and Schork state:

"The question should be posed, however, why then, after so many years of discouragement by extension agents and technical advisors, do so many farmers in Northern Ghana, as well as other parts of West Africa, continue to practice these methods (the traditional ones, H.B.). A critical examination may yet prove these techniques to be of the highest value as a basis for the upgrading of the indigenous farming predicament."
(Bennet and Schork, 1979, p. 103/104)

The Rural Education Centre at Umuahia, well known to many of the older teachers in the anglophone provinces of Cameroon, has attempted continuous cultivation based on a heavy dressing of compost manure. As the figures on crop yields over a period of 20 years show, yields seem to be stable at or even above the initial level. Maize yields rose from one ton per hectare to roughly 2.4 tons per hectare, yam yields fell from eight to below seven tons per hectare but rose afterwards to nearly nine tons per hectare. Cassava yields did fluctuate strongly but seem to be generally on the rise. Yet this experience seems unique, and is limited to areas small enough to be manured by compost.

Another experiment conducted at the Agricultural Research Station at Umudike leads to rather pessimistic conclusions. Here are the main facts:

"The problem of declining soil fertility resulting from washing and leaching of the principal soil nutrients led to the question of whether continuous

cultivation could be introduced. Researchers conducted experiments with green manuring in order to replace fallowing. For this reason a six-year trial rotation incorporating different cover crops was set up in 1924 at the Agricultural Research Station at Umudike ... During the first years the reports were optimistic ... After ... completion of the experiment a total failure had to be reported: "As a result of seven years experimental work with continuous cultivation, incorporating green manure, it has now been established that the system as practised at Umuahia is not compatible with the maintenance of soil fertility ... whereas the fertility of the 'native' plots was just as high as it had been in 1925, that of the continuously farmed plots had fallen practically to nil'."

(Lagemann, J., 1977. p. 14/15)

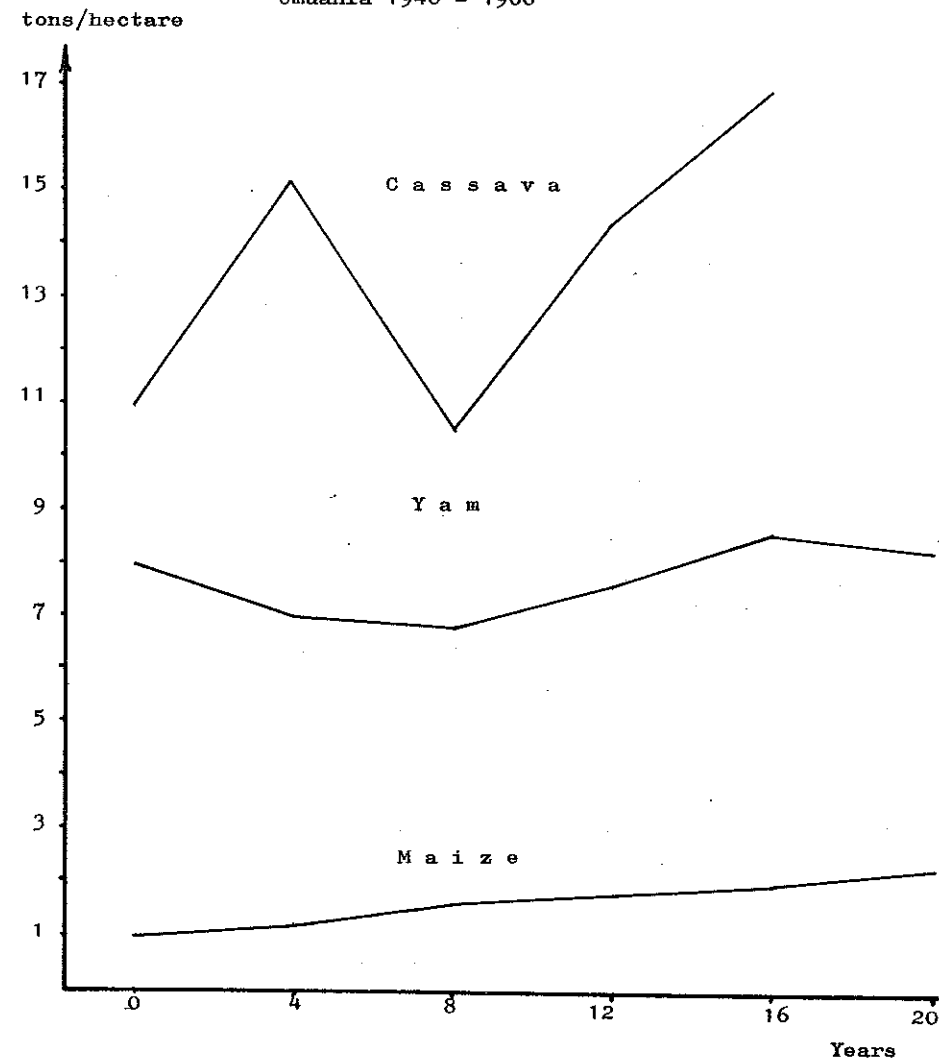
14 native plots were checked for comparison. They yielded an average of 12.2 tons of yams per hectare. The plots under continuous cultivation yielded, after seven years of farming, 4.7 tons per hectare. Lagemann concludes:

"The search for a feasible technology which is able to hold or even improve soil fertility under continuous cultivation has not found an adequate answer and this is still one of the main problems for research in the humid tropics."

(Lagemann, J., 1977, p. 17)

But scientific agriculture as conceived by those who drew up the syllabuses for Rural Science has not only disappointed its supporters in the tropics. Fertilizer and chemicals against pests and diseases are used in such large quantities and often so carelessly that health hazards and widespread pollution of the environment have become a real danger. Alternative farming methods are being tried out by a number of people. A fresh look at traditional African agriculture would therefore be in keeping with this world-wide movement.

Average Yields of Three Crops - Rural Education Centre
Umuahia 1940 - 1960



Source: Obi, J.A., and Tuley, P., as reproduced in Lagemann, J., 1977, p.17, Fig.1

4. New Approaches to Farming in the Tropics

4.1. The Need for a New Approach

The approach to the development of agriculture favoured by the colonial powers in Africa must be considered a failure. The following statement bears out the concluding remarks of the previous section.

"In spite of extension efforts, mixed cropping has given way to pure cultures⁺ in only a few regions in Africa, and it is relevant to consider whether technological progress could be achieved more widely through the improvement of mixed cropping than by persisting in attempts to replace this practice by pure cultures."
(Tourte, R., and Moomaw, J.C., 1977, p. 304)

Accepting the old approach to agricultural development as wrong is one thing, recognizing the traditional farming systems as reasonable and well-founded is something different:

"We consider it wrong to characterize the farmer as dumb and backward and to consider his working methods as something which must be completely replaced by modern methods"
(Egger, K., and Mayer, B.J., 1979, p. 8)

The two statements do not mean, however, that one can safely sit back and rely on individual farmers making the adjustments necessary to cope with changing conditions. There is widespread agreement that the old, stable system of shifting cultivation has given way to a system of bush fallowing with ever shorter fallow periods. This is due mainly to population pressure and it cannot restore the fertility of the soil. The old system with very long fallow periods has been replaced by

"mining" systems of farming which generate a more or less rapid decline of the soil fertility ...

⁺) pure cultures = single cropping, monoculture

land becomes a limiting factor ... while natural fertility diminishes ... the capital resource of the land is likely to be degraded by extensive cultivation."

(Tourte, R., and Moomaw, J.C., 1977, p. 298)

The International Institute of Tropical Agriculture (IITA) at Ibadan plainly states:

"The fact is that the countries in the humid tropics are finding it harder and harder to grow enough food for their people."
(International Research in Agriculture, 1974, p. 34)

At the same time, with really suitable farming methods, food shortages need not become a problem for a long time to come.

"The food-producing potential of these lands is unknown - some estimate it to be very great."
(International Research in Agriculture, 1974, p. 34)

"... the abundance of rain in conjunction with high temperatures endows this zone ... with high production potential: nearly 4 times that of the temperate zones."
(Tourte, R., and Moomaw, J.C., 1977, p. 296)

This means that one hectare of land in the humid tropics could produce four times as much as one hectare of land in a temperate climate. If this is true, then most African countries could feed, from their own resources, a vastly higher population than the one they have at present. Yet, an equatorial country like Rwanda is likely to face problems of acute food shortage, of famine, in the immediate future. One of the main reasons is that tropical soils are very vulnerable. The same factors that sustain dense vegetation can constitute a major danger:

"Under continuous cropping, the abundant sunshine

and rainfall soon become a liability, tending to aggravate soil erosion, leaching, and nutrient depletion."

(International Research in Agriculture, 1974, p. 35)

But erosion and leaching are already a danger now that the fallow periods are being shortened. The conclusion from all the arguments presented above is simple:

"If the practice of shifting cultivation is to be superseded⁺ - and pressures on land and food supply rule that it must be - new means have to be found to conserve moisture, restore organic matter and preserve soil fertility, prevent erosion and leaching, control weeds, keep down insect and nematode populations (all of which the bush fallow achieves), and in addition support continuous cropping and produce higher per-unit yields."

(International Research in Agriculture, 1974, p. 35)

This situation holds both great dangers and high hopes. The old approach to agricultural development could be seen as one attempt at realizing the hopes, but in fact it has not brought the solution. The more clearly this is seen, the more important it becomes to look for better solutions, new approaches. We shall discuss a limited range of such approaches because

- they justify a departure from the view of farming embodied in the old Rural Science,
- they offer new lines of teaching and learning,
- they contain suggestions that could be tried out in school farm work and in observational activities,
- they link up with traditional farming techniques, encouraging teachers to do away with the break

+) supersede = to replace by something else

between what is taught in school and what is put into practice by parents, pupils, and teachers out of school,

- they indicate areas of fruitful cooperation between school and research geared to national development.

These approaches are

- 1) the zero tillage or minimum tillage approach,
- 2) "biological" farming,
- 3) the development of farming systems for the low-land tropics (IITA),
- 4) eco-farming.

All these approaches are very similar to each other. They all agree that modern agriculture as practised in the industrialized countries should be rejected. They differ with regard to the emphasis placed on various cultivation methods.

4.2. The Main Approaches

4.2.1. The Zero Tillage Approach

Zero tillage is an attempt to cope with soil erosion. Where it can be applied, it also reduces the amount of labour needed. For a description of the approach and the reasoning behind it we shall turn to an article by an American, John Holway:

"For centuries American farmers have been turning the earth every spring or fall and laboriously cultivating weeds all summer. Now they're discovering that, without their plows, they can grow as much - and sometimes more - while also saving money, time, labor, energy, water, and - perhaps most important of all - saving soil.

. . .

No-tillage - it's also called "zero tillage", "minimum tillage", "conservation tillage", etc. - rests on two revolutionary principles:

- One, the plow may be the soil's worst enemy, breaking it up and leaving it at the mercy of wind and water erosion.
- Two, mulch from last year's crop may be a valuable tonic for both soil and seedling. It holds moisture around the plant and helps choke off weeds.

. . .

The plow was good for Europeans with their soft rains. It increased their food supply so they could colonize the rest of the world. But they also carried the plow with them, and now the whole world is battered by this European system which isn't suited to any area of the world except Europe.

. . .

William S. Greiner, Iowa's director of soil conservation, estimates that the state loses an average of 10 tons of soil per acre (25 tons per hectare) every year. On sloping land that could reach 25 tons per acre (62 tons per hectare). "We are losing about an inch of topsoil every 12 years", Greiner says. A century ago Iowa had an estimated 14 inches of topsoil over most of the state. Today half of it is gone. If no conservation is practiced, the rest will be lost in another 36 years, he predicts."

(Holway, J., 1978, p. 16)

. . .

"Nearly 25 percent of our cropland is being damaged at a rapid rate of erosion. This is an area of something over 100 million acres of cropland. The productive capacity of much of this highly vulnerable

land will be permanently damaged and around 500.00 acres a year ruined for further cultivation unless and until it has the benefit of sound conservation farming within the next 10 to 15 years. On another large area (around 115 to 120 million acres) of cropland, erosion is taking place somewhat less rapidly but still at a serious rate."

(Smith, R., 1977, p. 7)

Soil erosion can be checked, however "The way to do it is to plant on terraces following the contour of the land, without plowing, and leaving last year's stalks and other residue on the ground as mulch.

About 40 years ago some U.S. farmers began leaving a stubble mulch on their fields after harvest. It was the first step toward a minimum-till system. It was not until the 1950s that farmers discovered that they could prepare their seedbeds and plant all in one operation, eliminating at least one trip over the field. But without plowing, weeds multiplied and yields went down. Then, with the introduction of the new herbicides such as 2-4-D, farmers could give up plowing too, letting the chemicals do the work that plows had formerly done.

Ingenious new machines were developed to open a narrow slot in the soil, deposit the seed, cover it lightly, fertilize it, and deposit herbicides and pesticides, all in one operation. The biggest machines could do up to 16 rows at one time. The mulch left between the rows catches and holds the rain water, while helping to suppress weeds. The need for additional trips over the field is reduced. The fewer trips over the soil, the less it is compacted.

. . .

No-till has also extended croplands into thousands of acres of hillsides too steep to plow, into other soil impossible to plant, and even into sandy soil formerly fit only for pasture. In fact, no-till works best on hills - it needs plenty of drainage. It's not so good on poorly drained land or on clay soils - the mulch holds too much water there.

... about one-third of the energy consumed on U.S. farms is in tractor fuel. By eliminating unnecessary trips over the field, this bill can be cut in half. Average savings nation-wide: an estimated 850 million gallons a year.

One-fourth of a farm's energy expenditure is in the manufacture of nitrogen fertilizer. Because no-till cuts down on water run-off, less of this expensive fertilizer is washed into the rivers as pollution. Insects and plant diseases are a problem - but no more so than in conventional tillage. In fact, the mulch cover in no-till fields protects the earth worms that keep the soil aerated. And no-till farmers report yields at least as high as under conventional tillage. Often they are higher: The U.S. 1975 record crop yield was set on an Illinois farm that hadn't been plowed in six years. When double-cropping is added, the yield per acre is even higher.

No-till saves the soil

Erosion protection is even more dramatic. In one Ohio test plot, a single five-inch rainfall washed 20 tons of soil off a conventionally plowed field with a seven percent slope. A neighboring no-till field with a 20 percent slope lost only 100 pounds.

Wind erosion can be even more damaging than rain.

In the 1930s in the U.S. Southwest, clouds of dust obscured the sun and drifts of earth covered the highways. In a recent test in Ohio, in a severe windstorm a plowed field lost 130 tons of soil. The loss on a no-till farm in the same storm: two tons.

Yet only one out of seven erodible acres in the United States is planted in minimum-till. Only one in 40 is planted in no-till. Why? For generations farmers have been taught to be proud of their "clean" fields of black, weed-free soil between the rows. Stubble or mulch on the field looks like "trash" in some farmer's eyes. But as they see their neighbor's no-till fields producing as much or more with less work and money, they make the change themselves.

Solution for the Third World?

Can no-till succeed overseas? Even Europe, which invented the plow in the first place, is beginning to use it. Many authorities warn that it cannot be used successfully in the developing countries. Herbicides are essential to the system, they say, and their cost is prohibitive. The no-till planting machines are another prohibitive capital cost. And a very sophisticated level of management is required, these experts say. Nonsense, say others. The system is working now in Brazil, Argentina, Colombia, Uruguay and Rhodesia, Professor Young of Kentucky maintains. The high temperatures of tropical soils can damage seedlings. A mulch helps keep the temperatures down. For farmers who can afford to, small two-row planting machines are available for under \$ 1,000. They can even be drawn by an ox. For others, a hoe can do the same job. Much subtropical agriculture is now very near no-till farming. A farmer can easily substitute

labor for herbicides, hoeing weeds by hand as farmers have for centuries.

. . .

Buchele worked with farmers in Ghana in 1969. They harvested grass for the extra mulch they needed, raked the straw off the seedbed by hand, planted, and raked the straw back over. They planted on ridges eight inches (20 centimeters) high. "Our tests show" he says, "that you should leave one ton of crop residue per acre."

Kimberlin has had similar experiences working with farmers in Paraguay. They set up new colonies using very simple tools, no chemicals and an ample supply of family labour. They chopped off the weeds to form a mulch, planted their crops in rows of 90 degrees to the slope, and let the mulch catch the rains. A man just about has to use no-till where only the simplest tools are available. In some climates, for instance in parts of Europe, and in some soils the plow is still needed. But around the world more and more farmers are learning how to turn a profit without turning the soil".

(Holway, J., 1978, p. 17)

The IITA at Ibadan is experimenting with this approach, and the institute's appraisal of the method is encouraging:

"Mulching and minimum tillage, in combination with weed control research, have been found to have several advantages, including keeping top soil in place, holding moisture reserves in the upper layer of cropped soils, and lowering soil temperature. Marked benefits were recorded in both yam and maize crops.

Leaving crop residues on the ground after harvest ... and sowing the new crop through the layer of felled

weeds, are variations of the same approach. Like mulching and zero tillage, they mimic the bush fallow system, and are ... a good deal handier. This tactic has given good results with maize ..."

(International Research in Agriculture, 1974, p.37)

4.2.2. Biological Farming

"Biological" Farming is a farming system which tries to do without inorganic inputs as much as possible. The soil is fertilized with farmyard manure and compost instead of chemical fertilizer. Weeding replaces the use of herbicides that are highly poisonous. The crops are protected against insect pests and diseases by careful crop rotation, by a certain amount of mixed cropping, and by interplanting certain plants that are known to keep insects away. Biological farming in this sense must be seen, in the industrialized countries, as a conscious rejection of certain forms of industrial and scientific progress. It is a reaction against environmental pollution: some of the chemicals in common use do not decompose fast enough and start poisoning people and animals. Insecticides do not only kill insect pests but also a large number of harmless or even useful insects like bees. At the same time, they favour the development of pests that are immune to insecticides so that higher and higher quantities of insecticide and more and more poisonous substances have to be applied. Often, too great a quantity of chemicals is used. Some of them get washed into the soil, disturbing soil life. A lot of the fertilizer applied to the land is not used up by the crops. It leaches away into the underground water and seriously affects life in rivers and lakes. As

people became aware of these large-scale harmful effects of agricultural "progress", the idea of "biological" farming was evolved in order to counteract them. What it does do in the African context is to serve as a warning against uncritical acceptance of just any kind of "progress" and "modern methods".

4.2.3. Farming Systems for the Lowland Tropics

Let us take the case of the I.I.T.A. at Ibadan to illustrate various attempts to arrive at viable farming systems. We have seen above how pessimistically the institute views the future of agriculture if things remain the way they are. One major task of the institute is to develop farming systems which are stable, i.e. which maintain soil fertility. At the same time, they have to rely on existing technology - the mechanization available in the industrialized countries is no solution for a variety of reasons. Also, the farming systems must be adapted to the farmers' present level of knowledge and skills. Farmers will not agree to change their work habits thoroughly unless the benefits from such change are substantial. The new farming systems furthermore must not require too many farm inputs like fertilizer and pesticides since a steady supply of them cannot always be guaranteed and their cost keeps rising. Therefore the proposals for new farming systems include such features as

- minimum tillage: apart from its beneficial effect on sloping land it reduces the amount of labour required, compared with traditional methods;
- multiple cropping: crop combinations are recommended that cover the soil throughout the rainy season, thus

reducing erosion; they ought to incorporate crops that fix nitrogen, and crops producing a large amount of residue. Residues like stalks and leaves are needed for mulching;

- mulching: this has the advantage of further reducing erosion and leaching. At the same time, the mulch provides soil nutrients as it decomposes;
- tree crops: they are to be included for their climatic effects - they provide shade and humidity - their usefulness in checking erosion, but also for their function as "nutrient pumps" (see below for further explanation)
- chemical fertilizer and insecticides: "High rates of fertilizer are needed to produce the required mulching material. Insecticides are needed to decrease the risk due to insects, and are usually required to maintain luxurious growth of crops. Chemical inputs can therefore be a substitute for the use of expensive machinery. The application of inputs is possible even on very small fields ..."
(Lagemann, J., 1977, p. 133)

One such proposal for a complete farming system for the lowland tropics is presented in the study of traditional farming systems in Eastern Nigeria. Taking account of differences in soil characteristics, it contains the following elements:

- valley bottom development,
- modern tree crop plantations,
- improvement of farming methods for annual and biennial foodcrops in farms at a distance from the compound;
- multi-storey cropping on compound farms.

The study maintains that in Eastern Nigeria, valley bottoms with their fertile, humid, but often poorly drained soils, are hardly used. A similar situation certainly exists in Cameroon in the regions bordering

Nigeria. Swamp rice is suggested as a rainy season crop, locally consumed vegetables as dry season crops. Swamp rice means learning to farm a new crop altogether (see section on rice) but it fetches a high price, and since rice is in high demand in Cameroon, growers are assured of a large domestic market independent from changes to prices on the world market. Where valley bottoms are already used for the cultivation of raffia palms, this proposal might have limited application.

Vegetable growing is highly profitable when urban markets (Douala, Kumba, Mamfe, Bamenda, Bansa) can be supplied. Since the land need not lie fallow in swamp rice cultivation, two crops per year could be harvested from the same area on a continuous basis. As tree crops, the study suggests high-yielding oil palms. Tree crop plantations should be established especially on land threatened by erosion "...because erosion and leaching are much more easily reduced by tree crops than by annual or biannual crops." (Lagemann, J., 1977, p. 121)

High yields are possible only if palms are not intercropped with food crops, but on the area between the palms a cover crop could grow producing mulching material for the food crop farms. Improved oil palm varieties should replace the local ones, the study suggests. Yields per hectare could thus increase five to seven times, compared with yields from wild palms, and the fat content of the improved varieties is higher. Introducing hand-operated oil presses to replace the traditional method of oil extraction would further increase oil production and income.

The improvement of food crop farming would have to

happen within the traditional farming system instead of replacing it by something entirely different. Multiple cropping, minimum tillage and mulching are regular features here. Research at IITA has shown that multiple cropping produces higher yields per hectare than single cropping; this is shown in the following table:

Trial N ^o	Crops			Month of planting cassava	Total yield (tons/hectare) (dry matter)
	Maize	Melon	Cassava		
1	x				4.49
2		x			1.02
3			x	April	14.95
4	x	x			4.66
5	x		x	April	15.17
6	x	x	x	April	16.15
7			x	May	15.79
8	x		x	May	15.63
9	x	x	x	May	15.96
10			x	June	11.84
11	x		x	June	16.59
12	x	x	x	June	23.73
13			x	July	10.47
14	x		x	July	14.15
15	x	x	x	July	12.99
16			x	August	7.46
17	x		x	August	11.73
18	x	x	x	August	10.30

Note: Maize and melons are planted in April. Cassava was relay intercropped (i.e. planted later than maize and melons) in most of the trials. Yield refers to dry matter. This means that after harvest the whole crop including leaves and stalks were dried and weighed.

adapted from Lagemann, J., 1977, p. 129, table 47

For I.I.T.A. it is obvious that mixed cropping needs a certain minimum of chemical fertilizer if soil fertility is to be maintained under conditions of continuous cultivation. But it is known from scientific research that certain types of chemical fertilizers are much more effectively used in conjunction with mixed cropping with its high plant density than they are with single cropping. It follows, therefore, that yields from mixed cropping would rise faster than the amounts of fertilizer needed.

Since mulching is a necessity in the improved farming system, farmers must make sure that enough mulching material is available. Two alternatives are proposed:

"-arable crop and mulch production on separate plots but close to each other. Mulch production has to be very high on a relatively small plot ... A production of 30 t mulch/ha requires 25% of the total land available for arable crops for mulch production if 10 t mulch/ha are to be reapplied to the crops,

- trees with a cover crop alternated with narrow but long strips of arable crops, e.g. improved oil palm grown in monoculture with a mulch cover, which serves two purposes: firstly high outputs from oil palms can be expected, and secondly large quantities of mulch will be produced which is applied to nearby fields ..."

(Lagemann, J., 1977, p. 134)

Finally, the multi-storey cropping system has emerged from careful analysis of the farm compound. The name is due to the fact that on a well-cultivated compound - much like in the forest - there are several layers

or canopies of leaves at different heights. These layers are then likened to the various ceilings in a house with several storeys, hence the term "multi-storey cropping".

"The crops (in a multi-storey compound farm, H.B.) can be divided on a height basis into 10 different groups:

Tree crops

- oil palms, coconuts; (20 - 25 m high)
- breadfruit, raffia palms, oil beans, avocado pears; (12 - 20 m high)
- cola-nuts, mangoes (8 - 15 m high)
- oranges, grapefruit, limes
- paw-paws (5 - 10 m high)
- bananas, plantains (3 - 8 m high)

arable crops

- yams (3 - 6 m high)
- maize (1.5-2.5m high)
- cassava, cocoyams, pepper etc. (1 - 2 m high)
- groundnuts, melons, vegetables (0.1-0.3m high)

Various trees form the upper part of the storey whereas arable crops (food crops, H.B.) grow under the shade of the trees. The leaf canopy becomes denser the closer it is to the ground, and hence it

- reduces erosion by absorbing rainfall,
- shades the land and so reduces soil temperature,
- provides a leaf litter for nutrient recycling,
- maintains reasonable levels of organic matter and
- conserves soil moisture during dry periods."

(Lagemann, J., 1977, p. 32)

The land-use system of multi-storey cropping closely resembles the natural vegetation of the forests and tree savannahs. Apart from the advantages mentioned above it has the following:

- There are always leaves to convert the energy of the sunlight into plant food. Light is used by leaves at various levels of the multiple storey system.
- "Growth of weeds is suppressed by the close cover

of the leaf canopy." (Lagemann, J., 19777 p. 135)
 - The roots of the various plants making up the multi-storey system reach different depths. A root system like this can absorb moisture and nutrients effectively. Also, nutrients supplied by chemical or other fertilizers are used efficiently due to the dense root system.

Because of their deep roots, trees have been termed "nutrient pumps" in this and related systems of farming. In fact their roots reach down much deeper than those of the food crops. They tap water and nutrients inaccessible to the annual plants. They use these nutrients to grow leaves and fruits. A large proportion of the water they use evaporates into the surrounding air, thus creating an environment favourable to the growth of other plants. Finally, leaves and fruits decompose on the soil and release nutrients to the top soil which would not have become available without the trees. Since they take nutrients from deep down and add it to the top soil, in the form of fallen leaves, twigs and fruits they have been called "nutrient pumps".

A word of caution is in order, however. Neither the system described here nor any other new farming systems of the lowland tropics have yet been extensively tested. In particular, the economics of the various systems have not been worked out. "Nothing is as yet known about costs and returns under the conditions of practical farming." (Lagemann, J., 1977, p. 134)

4.2.4. Eco-farming

Eco-farming is a shorthand expression for ecological farming. Here the term to be explained is "ecological".

It comes from "ecology". Ecology is the science of the way plants and combinations of plants adjust to their environment and finally form a stable system if they are left undisturbed. It is a special branch of biology. Ecological farming starts from the idea that most geographical zones with their climatic and soil characteristics sustain a natural vegetation producing a relatively large amount of plant materials, and that this natural vegetation continues to thrive indefinitely, without any such inputs as chemical fertilizers and insecticides. Is it possible to farm in such a way that the natural conditions, i.e. conditions undisturbed by human activities, are preserved as much as possible? The proponents of eco-farming are positive about this. Their main concern is to maintain the productivity of the farmland. They reject farming systems which, with the help of current, advanced farming methods, produce high output but at the same time tend to destroy the productivity of the "natural" setting. Destroying the natural fertility means that

- unless large quantities of inputs are supplied, production will drop drastically. High-yielding varieties depend on fertilizer, insecticides, mechanical or chemical weeding, and the right amount of water at the right time in order to realize their potential fully.
- the desired level of production can only be reached if increasingly large amounts of such inputs are used. As insect pests, bacteria, and viruses become gradually resistant to farm chemicals, more powerful chemicals have to be used in order to keep them in check.

Keeping up the productivity of an environment means, among other things:

- maintaining and/ or building up soil fertility;
- controlling erosion;
- breeding and/or selecting varieties resistant to climatical hazards, pests, and diseases;
- maintaining a good water-level.

A stable ecological system where the natural vegetation of an area remains unchanged for very long periods of time is governed by a set of natural laws involving biology, chemistry, and physics. Maintaining and improving the productivity of a system is only possible if those laws are known and applied.

Eco-farming incorporates the principles of minimum tillage with its emphasis on erosion control, for reasons both of soil conservation and saving labour, since mechanization is not envisaged. It also includes the principles of biological farming, rejecting the unconditional use of farm chemicals. It advances recommendations quite close to the ones presented above under the heading of "farming systems of the lowland tropics", but it has a deeper insight into the biological laws and mechanisms that keep a stable natural environment going. But while the search for viable "farming systems of the lowland tropics" seems to accept traditional farming largely because the farming population cannot change their behaviour fast enough or are not willing to do so, eco-farming has a much more positive approach to traditional farming. Traditional farming is farming without machines and chemicals. The fact that it has been stable under conditions of low and medium population density shows that it respects and uses biological laws to a large extent. Therefore, traditional farming is not seen as a hindrance to progress but as a source for learning.

Learning from traditional farming from the point of view of eco-farming would mean, first of all, finding out and documenting the many successful methods used in various places. Since traditional farming has evolved slowly and without any conscious attempt at coordination, some methods are in use in one area but not in others. One such example in Cameroon is the use of tephrosia as an intercrop and a fallow crop with maize in Kom area, North-West Province. The usefulness of tephrosia for the maintenance of soil fertility and the provision of firewood is known in an area of 3.000 to 4.000 square km. Documenting the more successful traditional farming methods would make them available to other farmers in distant areas, and this might lead to major progress in increasing crop yields.

It must be recognized, however, that there is a limit to the usefulness of knowledge about traditional farming. People hardly ever know the exact reasons why traditional methods work. This is all right as long as all other factors remain as they are. It is then, and only then that a farming system developed by trial and error and adjusted to the environment will continue to function without people knowing why it works.

Building on the knowledge of general laws of nature and making use of well-tested experience from similar climatic and geographical zones all over the world - in other words eco-farming - involves at present the following practices:

- The integration of trees in agriculture for the reasons outlined in the section on farming systems for the lowland tropics;
- The integration of animal husbandry not only for

the production of foodstuffs like meat, milk, eggs, but also for the production of farmyard manure.

- Fodder production for the animals. Traditional grazing soon leads to erosion and uses large areas compared with growing fodder crops.
- Erosion control by living contours. On slopes, lines of trees, shrubs and tall grass are planted across the slopes. This means very little work compared with terracing, but it has the added advantage of checking soil run-off during rains and of finally building up terraces as soil is caught in the anti-erosion lines.
- Contour planting also acts as a form of erosion control, but especially on steep slopes it is not sufficient in itself and needs to be supplemented by the erosion control measures described above.
- Intercropping or multiple cropping is retained because of its many advantages (for details see below).
- Rotation in a system of multiple cropping is a way of making multiple cropping more rational and of ensuring some control of soil pests like nematodes. Well-chosen crop rotations are a standard feature of permanent cultivation.
- Seasonal Fallow as opposed to the fallow periods of the traditional farming systems does not just mean leaving a plot without crops and allowing any spontaneous vegetation to grow. It means planting selected fallow crops particularly suited to help in rebuilding soil fertility. Often these are non-edible leguminous plants. A careful mixture of plants sown as a fallow crop would not only enrich the soil but would also kill nematodes and harmful soil bacteria.
- Weed tolerance essentially means an end to clean

weeding but not to all weeding. One instance has been found in the Usambara Mountains of Tanzania, East Africa, and is described as follows:

"In young cultures weeds are allowed to grow in a considerable amount together with the crop. After some time, weed 'control' takes place when it is thought to be necessary. The weeds are germinating, but now the crops are strong enough to support themselves. The competition between these and the growing weeds ... is balanced by the decomposition of the mulching layer.

(Egger and Mayer, 1979, p. 21)

According to the authors the soil bacteria make available the nitrogen which is contained in the mulching material, provided there is enough phosphate. If the soil is not too dry, weeds continue to grow and produce green manure. They must not be cut before they produce seeds. When they are dry they are left as mulch on the soil.

"Both the growing weeds and the layers of mulch result in effective erosion control ... As a result, more water is available for the crops. Both weeds and mulches lower the daily changes in temperature in the soils, thus reducing the evaporation in a considerable measure. This system retains more water - and the water remains longer in the soil. Humus formation, nitrogen assimilation, improvement of water balance - the secret of the tremendous success of the system of weed tolerance!"

(Egger, K., and Mayer, B.J., 1979, p. 21)

- Mulching,
- Composting is regarded as necessary since well-prepared compost is a better fertilizer than mulch left on the surface of the soil.
- Resistant varieties rather than high yielding varieties are what is required. High yielding varieties, up to now, have proved very sensitive to poor growing conditions.

- Limited use of fertilizer and pesticides - if all the other methods which together make up eco-farming are applied properly, there should not be much need for farm chemicals.

Egger and Mayer, whose concept of eco-farming we have presented, point out that the limited use of farm chemicals (and machinery) not only happens to suit the habits and attitudes of the farming population (who simply are not used to spending much money on farming, and who would need a lot of guidance in order to apply these innovations correctly), it also takes into account the economic interest of countries that want to save foreign exchange and maintain as much independence as possible from foreign aid and foreign suppliers.

Concluding remarks: How much is known about the new approaches?

The new approaches discussed above all result from the application of modern science to agricultural problems in the tropics. It is a recent field of investigation, and none of the approaches have been really field-tested in the tropics. Zero tillage is practised in the United States of America as one variant of a highly mechanized system of farming which uses farm chemicals freely. Eco-farming has so far been tried on an experimental scale in an agricultural development project in Rwanda. Below there is an extract from a report on the project. As with the "farming systems for the lowland tropics", the economic viability of eco-farming has not yet been investigated. But even in the field of natural

sciences such as biology, soil science etc., much remains to be discovered. Nevertheless, quite a number of interesting findings are available, and we shall list certain of them in order to show some of the more promising lines of thinking and to stimulate teachers' curiosity.

4.3. Backing for the New Approaches

4.3.1. A Project on Eco-Farming

The initial aim of the project in Rwanda was to start up a dairy and the attendant veterinary service. Another dimension was soon added, the development of peasant agriculture in a country where land was becoming increasingly scarce and where erosion is a major problem.

"One of the aspects of the project ... and which is of the greatest importance in the 'poor man's energy crisis' is the planting of various kinds of trees. Tree nurseries have been established in a distance of some kilometers from each other, so that they can easily be reached on foot by the local farmers, who traditionally live in individual family holdings "dans les collines", Rwanda's ten thousand hills and not in villages or towns. Each nursery produces seedlings twice a year, and 95 percent of them produce after having been replanted in the specific areas, i.e. both forest and fruit trees such as grevillia, eucalyptus, jacaranda, and papaya, coeur de boeuf, and avocados. The latter are of particular interest since they make an improvement of the farmers' everyday diet.

Trees are mainly grown on the family holdings of individual farmers. We learnt that a farmer, who

plants 150 trees, can not only expect to supplement his diet, but after 15 years, also cut down one tree every two months without endangering the ecology, and thus solve his own energy crisis.

. . .

Soil quality can improve only if the right kind of mixed plant system is introduced.

This is where the so-called "planned disorder", the planting together of useful plants and weeds comes in. For the aim is to create a new balance of plants, whereby, for example, weeds are planted and left to grow profusely. They are plants that give a mass of foliage twice as great as that of "good" plants. When cut and left to rot on the ground they can produce up to 20 centimeters of humus. In encouraging mixed cultivation the Nyabisindu experts go against commonly accepted European prejudices against planting in close neighbourhood cocoyams, cassava, soybeans, sweet potatoes etc. Whereas traditionally coffee was grown in isolation, with the soil under the trees being kept clear, in Nyabisindu an attempt is being made to grow coffee and pine-apples together, using the open space between the coffee trees. The main aim is to keep the soil constantly covered, thereby preventing the loss of humidity and stopping erosion when the next rains come. And although at the time, when we visited the project, it was already well into the dry season we could see that the underlying soil was still fairly humid.

The experts prefer the growth of leguminous plants which produce a lot of foliage and up to 200 kilograms of nitrogen per ha. Fodder plants, which have a life of six years, are especially welcome during

the dry season or hibernage, when fodder is scarce. And in general these plants provide much better and richer food than the poor pastures in the valley.

To a layman then, who in so many years has seen so many "white elephants"[†] the Nyabisindu project looks like the start of something revolutionary new. The success so far seems to be mainly due to the confidence created among the local population by the efficient and remunerative collection of milk and the veterinary service, upon which all the other activities could be built.

It also seems to reside, however, to a very large extent in the willingness of the foreign experts to learn from the local farmer. Once the innate intelligence of that farmer had been recognized it was fairly easy to "bundle together" various findings and "to enrich them with modern ecological findings" and "offer them back to the farmer." Acceptance seems to have been all the more willing since those new methods were "directly comprehensible and accessible."

The total and continuing success, however, will only be assured, if the experts in cooperation with the farmers "constantly integrate new findings", keep the system open.

(Meuer, G., 1977)

[†] a 'white elephant' is something which costs a lot but is of no practical use to the purchaser.

4.3.2. Evidence from Research

The following findings all refer to multiple cropping. Since multiple cropping figures in all the approaches presented above, research results in this area are of considerable importance. They have been taken from a number of sources and are meant to stimulate the reader's interest.

Firstly, they show that even after only a few years of systematic research valuable knowledge is becoming available. Secondly, simple experiments on the school farm and careful observation of local farms might reveal similar things. Once one knows what to look for one stands a good chance of finding something of interest.

Yields

There is evidence that multiple cropping produces yields per hectare and per working hour that substantially exceed yields from single cropping under comparable conditions:

- In a study of three villages in Northern Nigeria the gross return from mixed cropping was 60 per cent higher than if the same crops were grown alone.
- "Tardieu and others in the wet highlands of western Cameroon demonstrated that intercropping maize, taro (*Colocasia*) and macabo (*Xanthosoma*) under both traditional and improved methods of culture resulted in improvements over single-crop cultures ..."

(Tourte and Moomaw, 1977, p. 303)

- A combination of three crops, millet, maize, and sorghum "produced not only higher yields but nearly doubled the gross return." (Tourte and Moomaw, 1977, p. 303)

- When a certain species of beans was grown together with maize, in an experiment in the Philippines, the maize yield was greater than when maize was grown alone, and the weight of weeds decreased. (cf. Litsinger, J.A., 1979, p. 302)
- "The combination of minimum tillage and intercropping seems to prevent erosion and to produce yields which are higher than from sole (single, H.B.) crops"

(Lagemann, J., 1977, p. 133)

Here are a few possible reasons for the higher yields obtained from multiple cropping:

- Often, the different species in a combination of plants use the growth factors of a given plot - soil nutrients, water, light - in different ways. Instead of competing with each other, one plant uses what the other crop does not need. It is quite easy to turn this into a rule for finding productive crop combinations.
- Different crops use growth factors at different times. Once this is known for the plants of a particular crop combination it can be used to advantage: "Relative planting dates of the two crops (maize and beans, H.B.) influence yields of the bush beans. Bean yields were reduced from 939 kg/ha in monocrop (single crop, H.B.) to less than 400 kg/ha when maize was planted before the beans. A 15-day advantage for the beans gave the highest yields, a result confirmed by small farmers."

(Francis, Flor, and Temple, 1979, p.241)

When pigeon peas were grown with maize they grew less well in the first four months of growth than when grown as a single crop. When the maize was ripe, however, it no longer competed for growth factors. The pigeon peas caught up and produced yields comparable to those achieved under single cropping. The

plot in question thus produced a full crop of pigeon peas and a full crop of maize.

Observations at the IPAR-Buea demonstration plot showed a similar pattern: two plots were planted with cocoyams. On one plot, cocoyams were planted between maize. On the other plot, cocoyams were planted as a single crop. When the maize was ripe, it was quite clear that the cocoyams in the maize plot were much smaller than the ones in single cropping. But since they had another twelve months of growth before they were ready for harvesting, one could be quite sure that the smaller ones would catch up in size with the single crop. Summing up these findings one could say:

"When the earlier component has matured, conditions become especially favourable for the other component."
(Trenbath, B.R., 1979, p. 155)

- If leguminous plants are grown together with other crops, the legume gets much of its nitrogen from the nitrogen-fixing bacteria living in its root nodules. It competes hardly at all for nitrogen with the other crops. Therefore, adding a crop like beans, cowpeas, pigeon peas, groundnuts or soya beans to a crop of cereals or tubers will increase the total yield.

"Intercropping leguminous green manure crops with cereals is another possible way to supply nitrogen. Agboola and Fayemi reported that yields of four successive corn crops, each of which was fertilized with nitrogen, were comparable with corn yields from a corn-legume intercrop without nitrogen fertilizer. When the corn was neither fertilized nor grown with a legume, grain yields from the fourth crop of corn were reduced to one half that of the first."

(Oelsligle, D.D. 1979, p. 287)

- Some plant species seem to be able to cure nutrient

deficiencies in neighbouring plants of other species, but just how this works is not completely known.

- Pests usually do not attack all the crops of a plot with multiple cropping but only one or two. The plants which are attacked are weakened and thus compete less effectively for growth factors (light, soil, nutrients, water) than before. The plants not under attack now stand a better chance of growing. They may produce enhanced yields compensating for the poor yields from the attacked plants.

Soil Fertility

Soil fertility is less threatened by multiple cropping than the proponents of single cropping usually fear. Reasons for this are:

- Plants in viable crop combinations have root systems of various depths and get their nutrients from different layers of the soil.
- The root system of the plot is denser than that of a plot under single cropping. It therefore uses available nutrients more effectively. (This is due to the fact that some soil nutrients are not available in liquid form and are therefore highly localised. Unless a root happens to come across them, they cannot be used by plants).
- When fertilizer is applied to a plot under multiple cropping, it is used more efficiently than under single cropping. Less fertilizer is lost by leaching since the total root system goes down deeper into the soil.
- Fertilizer in multiple cropping does not necessarily lead to higher yields from all the crops:

"Increasing fertility levels in two multiple cropping patterns in Costa Rica (Latin America, H.B.) caused an increase in yields of beans and corn, a moderate increase in yields of cassava, no change in soybean yields, and a decrease in sweet potatoes." (Oelsligle, D.D., 1979, p. 278)

- Soil fertility cannot be properly guaranteed by the use of chemical fertilizers alone. Organic matter in the form of mulch and compost is of great importance. Good-quality humus which results from mulch and compost has the following properties:
 - "1. it breaks down readily to yield the available forms of mineral nitrogen, sulphur, and phosphorus, but does not decompose so rapidly that excessive losses of nutrients occur ...
 2. it improves the constitution of the soil, thereby improving its water retention and diffusibility of carbon dioxide and oxygen through the soil.
 3. it provides food for soil micro-organisms, especially the nitrogen fixers.
 4. it provides sandy soils with an improved water holding capacity thus reducing the incidence of soil erosion."

(Bennet and Schork, 1979, p. 116)

Weed Control

In multiple cropping, weeds are often kept down by the dense leaf cover close to the ground of one of the crops. Egusi and other melons, cucumber, and pumpkin grown between maize or yams cover the ground so completely that weeds have not much chance. Some species of melons and related plants also release a poison through their roots which prevents other plants from germinating.

Insect Pests

- Intercropping of maize and groundnuts reduced the damage caused by the stem borer to maize. The

- distance between plants attacked by an insect is an important factor. In a plot under multiple cropping, the proportion of maize plants attacked by the stem borer was smaller when the plants were further apart.
- "Because of severe insect damage, cowpeas are seldom planted as a sole crop in Northern Nigeria." (Litsinger, J., 1979, p. 302)
 - Where there is a mixture of crops, the tall plants tend to obscure the short ones and make them invisible to insect pests.
 - Plants other than the ones attacked by a given insect pest may either attract the pest and thus protect the other plants, or may actively repel them. Thus, some plants drive insect pests away by releasing some kind of poison into the air.
 - Plant combinations provide more cover for predatory insects that feed on insect pests (spiders etc.)

Soil Pests

- Certain plants - crops or weeds - release chemicals from their roots that repel or kill nematodes. One of them is marigold (tagetes), another one is croton. In the Usambara Mountains, there is a common weed that also seems to kill nematodes.
- In many areas farmers know of plants that "clean the farm". Schools should document these plants and try to find out what effect they really have.

The effect of plant-produced chemicals

As mentioned above, some plants release chemicals through their roots into the soil. These chemicals not only influence soil pests, they may also affect other plants: In some cases they prevent other plants from growing, in other cases they stimulate growth. Little systematic knowledge

is available to date. Some species of eucalyptus and of the cucumber family (to which melons etc. belong) are known for effects of this kind. It would seem that there is a lot of opportunity here for plant breeders. Once such characteristics are known they can be reinforced by selective breeding.

4.4. Suggestions for School Activities

Since new approaches to farming have not yet become an established practice, teachers can not rely on mere classroom teaching to transmit them to their pupils. On the other hand, there are no model farms for teachers to turn to for observation. The best method of teaching therefore seems to be the experiment. Experiments can be done on comparatively small plots on the school farm. (For details on the experimental method see the section on experiments). Here are a few suggestions for experimentation:

- experimentation with various patterns of mixed cropping:

Select two crops (e.g. maize and beans) to be grown on the same plot. Grow 5 rows of maize in single cropping. Then grow 10 rows, one row of maize alternating with one row of beans. Finally, grow maize and beans in the same row, one row using the standard planting distance for maize but replacing every other maize stand by beans, and one row following the traditional method of planting.

- experimentation with planting times in intercrops:

Select two crops to be grown on the same plot, e.g. crop A and crop B.

- a) Plant crop A 2 weeks earlier than crop B.
- b) Plant crop A 1 week earlier than crop B.
- c) Plant crop A and B at the same time.
- d) Plant crop A 1 week later than crop B.
- e) Plant crop A 2 weeks later than crop B.

Observe the development of the two different plant species under the five different conditions and record yields for each plot and crop separately.

- experiment on the fertilizing effect of a leguminous crop in mixed cropping:

Plant one plot with maize as a single crop and a second plot with maize and beans as mixed crops. Repeat this on the same plots for at least three farming seasons and record total yields for each of the plots separately. At the end of the last season, you should be able to see whether yields have declined on the two plots in the same way. If yields on the plot under mixed cropping have gone down less than on the plot under single cropping, this indicates that the leguminous crop has a beneficial effect on soil fertility.

- experiment on the effect of egusi melons or pumpkins on germination and growth of other plants:

Select a crop usually grown together with melon or pumpkin (maize or yams). Plant three small plots in the following way:

- a) Plant maize or yams first. When this crop is well established, plant egusi or pumpkin.
- b) Plant maize or yams and egusi or pumpkin at the same time.
- c) Plant egusi or pumpkin first. When the seeds have germinated and are well developed, interplant maize or yams. Water the crops planted later if necessary.

Observe:

- germination of the two crops grown together
- growth of the two crops
- weed development

for each of the plots a, b, and c.

- experimentation with zero tillage:

This experiment should be done on sloping plots or well drained flat plots only.

- a) Till one plot according to the methods normally used on the school farm.
- b) Mulch one plot but do not till, and plant into

the mulch using a digging stick or a cutlass.
Compare yields for the two plots.

- experiment on erosion control:

experimentation with mulch and live terracing on slopes:

design: 4 small plots of equal size on a slope

- a) no erosion control measures, the crop or its residues (stalks, leaves) are left on the farm,
- b) heavy mulching with grass and crop residues as an erosion control measure,
- c) anti-erosion rows at a distance of 7 - 10 m. Along these rows bananas, plantains, and/or strong, tall grass are planted,
- d) heavy mulching and anti-erosion rows as described in (c) are used as erosion control measures.

This is an experiment for the rainy season. It could be set just before the beginning of the long holidays. It can be evaluated when school reopens. On each of the four plots, look carefully for signs of erosion. Estimate the amount of soil caught in the anti-erosion rows of plots (c) and (d).

- experiment on the effect of shading on various crops:

design: Two plots farmed with maize and cocoyams mixed:

- a) The plot is fully exposed to the sun
- b) The plot is shaded by a light roof made from palm fronds

Observe:

- the growth of the two crops under conditions (a) and (b),
- the maize yield under conditions (a) and (b),
- weed growth under conditions (a) and (b),
- the cocoyam yield under conditions (a) and (b).

- experiment on the effect of thinning:

design: two plots of equal size farmed with maize

- a) maize is planted in rows, three to four seeds per planting hole. All the plants which come up are allowed to grow.

- b) maize is planted in rows. Three to four weeks after germination, each stand is thinned down to one plant only.

Observe:

- the growth of ten to twenty stands on plots (a) and (b),
- the yield per plant (number and size of maize cobs) for the ten to twenty stands selected,
- the total yield of plot (a) as compared to plot (b),
- the average weight of a cob on plots (a) and (b)

- experiments with weed control:

Maize is particularly sensitive to competition from weeds. The effect of weed control is therefore easy to see.

design: four plots and two methods of dealing with weeds: heavy mulching and weeding.

- a) after germination, maize is left without weeding or mulching,
- b) maize is carefully weeded with all weeds removed from the plot,
- c) after germination, the plot is heavily mulched. No weeding is done,
- d) the plot is weeded at the appropriate time, weeds are left as mulch and more mulch is added

Observe:

- plant growth on the four plots. When do differences in height and colour become marked?
- growth of weeds on plots (b), (c), and (d)
- yields from the four plots.

- experiments with burning when a plot is cleared:

The effect of burning is controversial. Crops grown on the plots of this experiment should include crops that do particularly well after burning.

design: three plots all planted with a crop combination that includes a crop responding favourably to burning

- a) The plot is cleared and the grass and crop residue are burned on the soil.
- b) The plot is not burned. Tilling is done as usual.

- c) The plot is not burned. There is no tilling (zero tillage).

Observe:

- growth of the two or three crops,
- growth of weeds,
- damage done by insects and other pests,
- yields from the three plots.

- experiment on insect control by certain plants:

Some plants and flowers are known to drive away insects. If there are some in your area, do the following experiment:

design: two class plots farmed with a crop usually attacked by insects (borers, weevils),

- a) The crop is farmed as usual
- b) plants known to drive away insects are interplanted with the crop

Observe:

- growth of crops
- signs of insect attack during growth
- yield of the two plots.

Collect information, together with the pupils on plants known locally to "clean the soil" and to indicate a return of good soil fertility. Write up the findings. Collect the seeds of these plants and try them out as fallow crops.

Take a crop under single cropping and the same crop under multiple cropping, and look for insects that feed on other insects (e.g. spiders, praying mantis etc.). Also, look for insects harmful to the crops (e.g. borers, weevils, grasshoppers, locusts, etc.). Is there any difference in the number of the various insects you find on the two plots?

4.5. Some Terms used in connection with farming methods

single cropping, sole cropping, farming in pure stand, monocropping, monoculture are all synonymus. They all mean that only one crop is grown on a given plot.

Multiple cropping

Multiple cropping means growing several crops on one and the same piece of land in one year.

We distinguish between two cases:

- 1) Farming several crops during one year. The emphasis here is on a succession of crops:
 - 1.1.) successive cropping: as one crop is harvested, the plot is prepared for a new crop which is planted after harvesting the first one. This is sequential cropping involving monocultures;
 - 1.2.) relay intercropping, on the other hand, means that a second crop is planted on the plot while the first one is still growing. This is also known as phased planting.
- 2) Growing several crops on the same plot at the same time. The set of crops grown is called a crop mixture or a crop combination. Synonyms for this meaning of multiple cropping are mixed cropping, polyculture, and intercropping. There are several ways of arranging different crops in a polyculture or system of mixed cropping. The one most common in traditional agriculture is

mixed intercropping, i.e. planting the various crops without any strict order. Beans growing from the same planting hole as maize would be an example. One method is alternate strip intercropping where rows or strips of one crop alternate with rows or strips of another crop, e.g. one row of maize with one row of beans.

Multi-storey systems

The idea of multi-storey systems is linked with the concept of multiple cropping. Storey in this context refers to the leaf canopy. If plants of the same species are planted roughly at the same time, their leaves will all spread out at roughly the same height, forming a canopy. If different species grow on one plot, they will form canopies at different heights. Single cropping always leads to one storey. Multiple cropping with crop combinations containing plants that reach different heights leads to multi-storey systems. This is particularly pronounced when trees are part of the crop combination.

Classification of farming systems based on the duration of farming and fallowing

- shifting cultivation (see text)
- bush fallowing
- degraded bush fallowing
- permanent cultivation; synonyms are:
 - continuous cultivation,
 - permanent cropping systems

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