DEMONSTRATIONS OF AN INTERDISCIPLINARY FARMING SYSTEMS APPROACH TO PLANNING ADAPTIVE AGRICULTURAL RESEARCH PROGRAMMES

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MIKE COLLINSON.

PART OF SIAYA DISTRICT,
NYANZA PROVINCE, KENYA.

Research Division, Ministry of Agriculture, Government of Kenya and
Department of Economics, Egerton College, Kenya in association with
International Maize and Wheat Improvement Centre.

Cimmyt Eastern African Economics Programme.
Cimmyt, P.O. Box 25171, Nairobi, Kenya, Telephone 48480

SUMMARY

The Research Division, Ministry of Agriculture, GOK and the Department of Economics, Egerton College cooperated with CIMMYT in the demonstration of an interdisciplinary farming system based approach to planning adaptive agricultural research in part of Siaya District, Nyanza Province, Kenya. Chapter 1 of the report describes the objectives of such demonstrations and the methods followed. Chapter 2 describes the circumstances of people farming in the part of Siaya District with less than 1500 mm rainfall per year.

SIAYA FARMING

Reliable family food supplies are a priority for Siaya farmers. Chapter 3 describes their management tactics to provide the family with a supply of food within the constraints of limited available land, labour scarcity, particularily for weeding, and the low levels of cash they have available to spend on hired resources and purchased inputs. A good farmer in Siaya, one respected by his fellow farmers, is a man who produces enough maize regularily every year to feed his family on their preferred food until the new harvest. He also produces enough sorghum to allow his wife to brew beer throughout the year, and a surplus of crops to raise enough cash to meet his family's household requirements and add to his herd of livestock from time to time. He will have his own oxteam and plough.

The farming system operated by Siaya farmers is under considerable pressure from increasing population. It is no longer possible to maintain soil fertility by shifting cultivation, land is too scarce. The arable area has grown at the expense of grazing and this increase in the arable area is jeopardising the livestock enterprise and breaking up the interdependence of arable and livestock husbandry in the system. A key decision (p.27) on the development of Siaya farming will be the future of the livestock enterprise. On the cropping side the relationship between sorghum, maize and cassava, all basic starch foods, will be critical. Both the sorghums and cassava play an insurance role in the farming system, underwriting the preferred starch staple maize. The sorghums have a dual role; as insurance and for brewing local beer. The real insurance sorghums are good storers, they are hard and bitter and less prone to storage pests. They are also long term and their establishment and maintenance require labour early in the season to give them time to mature within the Siaya rainfall regime. These long term insurance sorghums take priority over other crops at what is the optimal planting time in the season.

A high level of insurance cropping reflects the highly unreliable rainfall regime of this drier part of Siaya District. The start and finish of the main rains is very variable. Flexibility in management is an important asset in combating this type of uncertainty and the risks of food crop failures it creates. For Siaya farmers the availability of shorter term sorghum and maize varieties, particularlily varieties with good storage characteristics, would considerably enhance their flexibility of management in the face of uncertainities of rainfall. Chapter 4 of the report evaluates the implications for a maize research programme aimed at benefitting Siaya farmers.

A FRAMEWORK FOR A MAIZE RESEARCH PROGRAMME

Variety A shorter term maize variety (95 days in the drier parts of the District) will give management flexibility to farmers with the following advantages:

(1) The probability of being able to finish the crop in an increased number of years, even with a relatively late start to the rains or an early finish.

(2) Increased probability of a successful short rains crop.

(3) The increased possibility of taking the two crops, long and short rains, on the same land, important with increasing population density.

(4) Earlier food supplies in seasons following poor harvests when food stocks are low, avoiding the need to purchase on local markets when prices are very high.

(5) Farmers growing a surplus will be able to sell on the local market early in the new season when prices are high. Increased use of the short-term varieties will gradually remove the seasonality in food prices benefitting all in the area.

The use of purchased inputs. Forty six percent of the farmers sampled were spending cash on farm inputs, their estimated average outlay was Sh 260.00. Most money was spent on the hire of labour and oxen. Fifty four percent of farmers interviewed reported no cash spending on farm requisites. Nor does the Siaya farmers situation lend itself to a credit scheme for input purchase.

(1) Most crop sales are surplus to food requirements and are made in the local market. The cost of credit administration, particularily in controlling repayments in this type of marketing situation, is prohibitive for a programme aiming to reach the majority of Siaya farmers.

(2) The risk ceiling of the average Siaya farmer, with a low level of cash income, would discourage borrowings beyond an estimated two to three hundred shillings.

The major cash inputs in any package are for fertilisers. Research for Siaya should concentrate on efficient use of the animal manure available throughout the area and already being used by 62% of the farmers interviewed. Use of a shorter term variety is consistent with relatively low levels of manuring. In the longer term artificials will be needed, cattle numbers will not provide sufficient manure to maintain fertility. Recommendations should initially be at low levels, supplementary to the use of animal manure.

Constraints on changes in maize husbandry.

Time of planting and the frequency and timing of weeding are usual features of improved crop husbandry which present problems for Siaya farmers who operate under labour constraints during the period of crop establishment and weeding. These constraints are likely to become increasingly severe as the arable/livestock clash intensifies the need for hand cultivation. Operating under these constraints farmers spread the demand for labour by planting over a three month period. Most of the cash presently spent on farms in Siaya is on oxen or labour hire to alleviate these labour constraints. Asking farmers to plant

and weed at a particular time aggravates their situation. It increases the peaks of labour required and implies they must increase cash outlay on oxen or labour to boost family labour supply. Any such increase in cash outlay is directly competitive with increases also being urged for the purchase of intensifying inputs and aggravates further the farmers' already severe capital allocation problem. At the same time, under the rainfall regime in Siaya, single plantings at optimal times create increased risks of major losses, and a failure in family food supplies. These labour constraints on Siaya farmers' ability to plant and weed at a specific time suggest three guidelines for research effort on maize.

(1) Varieties should be screened for insensitivity to time of planting effect. Hand in hand with the shorter term variety such selections would further increase the farmers' flexibility of management under uncertain rainfall conditions.

(2) Varieties should be screened for rate of early growth and weed suppression.

(3) Experimenters should accept two weedings in the first two months after germination as the maximum feasible level and work within this level.

The final section of the report (p 37) details a five year maize research programme designed to give profitable recommendations which are acceptable to Siaya farmers because they are relevant to <u>their</u> priorities and can be implemented within their resource constraints.

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1. INTRODUCTORY

1.1. BACKGROUND

By a Memorandum of Agreement signed in November, 1975 Kenya Government (GOK) agreed that the International Maize and Wheat Improvement Centre (CIMMYT) should establish itself in Kenya as a base for a Regional Programme in Economics for Eastern Africa. The Ministry of Agriculture, GOK, expressed interest and it is fitting that the first project to have been completed under the programme is in association with the Research Division of the Ministry and the Department of Economics, Egerton College.

This report presents the results of this first project, undertaken in Siaya District, Nyanza Province, Western Kenya. Fieldwork was completed there between early August and mid September, 1976.

1.2. CIMMYT EASTERN AFRICAN ECONOMICS PROGRAMME - ORIGIN AND OBJECTIVES

A good deal has been heard of the need for improved technology which is 'appropriate' or 'relevant' to the situation of the farmer. This need is seen as particularly critical in the case of small farmers who have their improved technology selected for them, usually by Government. A huge edifice of training, extension effort, credit schemes, often including transport and processing as well as infrastructural investments, may be built around selected technology as the core of a development programme. If the technology does not fit farmers' priorities and circumstances it will be unacceptable to them and not only the research but also the development effort will have been wasted.

In 1972 CIMMYT began an economics programme to study whether eight sets of improved technologies, four each in maize and wheat, were being absorbed by farmers in eight different countries. Fieldwork on these studies was completed in mid-1975 and reports are now becoming available. These studies reaffirm the need for technology to fit the farmers circumstances. In the cases where adoption did not occur there is evidence that the technology did not fit farmers situations. CIMMYT perceived that criticism of the research programme orientation after the event was too late to be useful, research and development funds having already been expended. CIMMYT biologists and economists discussed the possibility of the interdisciplinary planning of research programmes. The procedures derived have been and are being tested in small studies in four countries. CIMMYT has felt sufficiently confident of the procedures and convinced of the importance of more relevant technological packages to focus the Eastern African Economics programme on this work.

CIMMYT is urging a cooperative effort between biologists, as experts in crop potential and crop production techniques and farm economists, as experts in farmers' priorities and circumstances, in the planning of adaptive research. Wherever research administrators manifest interest this programme demonstrates a set of procedures which allow such a cooperative research planning effort. The project in Siaya, in association with the Research Division, Ministry of Agriculture GOK and the Department of Economics, Egerton College, has been the programmes first such demonstration.

1.3. A SET OF PROCEDURES FOR INTERDISCIPLINARY RESEARCH PLANNING

The set of procedures used has been derived from experience in CIMMYT test projects and from consultation between biologists and economists at CIMMYT. It is anticipated that procedures will need modifying to the situation within the Kenya National Research Programmes. Such modification will be possible on the basis of experience gained in demonstration projects. It is emphasised that although CIMMYT's main interest is in helping research administrators improve the effectiveness of adaptive research in maize and wheat, the crops of CIMMYT's mandate, the procedures can be utilised to structure research work on all or any crops grown in the area studied. The approach embodied in the procedures is essentially system oriented. For example in the case of Siaya implications emerge for research efforts on sorghum, cassava, and cotton as well as for maize.

Comments on possible improvements in the sequence with reference to the organisation of agricultural research in Kenya are contained in the final section of the report.

1.4. THE SEQUENCE OF PROCEDURES FOLLOWED

1. Definition of a target population with maize as an important crop; the farmers of Siaya District.

2. A Pre-survey of the defined area by CIMMYT and Egerton economists occupied six days and had four objectives.

(a) Zoning the Siaya area on the basis of locally identified variation in rainfall quantity and reliability.

(b) Discussion with local biological scientists at Western Agricultural Research Station, Kakamega, on the problems of growing maize under the climate, soil and pest conditions of Siaya.

(c) Description of the local farming system in the identified zone in Siaya to evaluate farmers' objectives, priorities and resource constraints and the way their cropping pattern and management practices reflect these.

(d) Establishing a framework for a survey of farmers with the cooperation of Administration officials in five selected sub-locations of Siaya and the junior field staff of the Ministry of Agriculture.

3. Designing a farmer questionnaire on the basis of the description obtained of Siaya farming and of the problems of maize production highlighted by the staff at Kakamega.

4. A farmer survey, using eight Egerton students as enumerators covered 150 farmers, thirty in each of five selected sub-locations, in a fourteen day period.

5. Collection of general information including marketing, prices, input distribution and meteorology by an Egerton economist while supervising the farm survey work.

6. Tabulation by Egerton students, and analysis of data collected in the survey to verify pre-survey findings, taking some forty days.

7. Discussion of the findings of the pre-survey and survey with senior crop scientists in Kenya isolate the implications for:

(a) the orientation of adaptive research for the area.

(b) breeding work for maize.

(c) agronomy work for maize.

8. Compiling a draft report.

This full sequence has been followed through in a five month period, August to December 1976. It demonstrates the speed with which on farm information can be brought to bear in designing a research programme for a particular area, or in re-orienting the thrust of an existing programme. It can be a rapid and fairly cheap process. Should a decision be taken at an annual research meeting to re-organise particular programmes, an inter-disciplinary planning approach, following these procedures, would have detailed proposals ready for the following years meeting. Most importantly such proposals could be based on an organised study of the priorities and needs of the target farmer population.

It appears that the data from Karapul sub-location adjacent to the town of Siaya has been unduly influenced by its proximity to the town. It seems likely that the rapid growth of Siaya, as a District town, has distorted the local situation. Cultivated area per farm found in the survey was only .95 ha, less than half the area cultivated per farm in any of the other four sub-locations. The data presented on the farmers' situation in Siaya is from the 120 farms interviewed in the four sub-locations of Omia Malo and Nyawita in Bondo Division, Kambare sub-location in Yala Division and Simenya sub-location in Ukwala Division.

2. FARMERS CIRCUMSTANCES IN SIAYA DISTRICT

2.1. REASONS FOR SELECTING SIAYA

Siaya was selected as an area for the first demonstration of the approach for three main reasons:

1. A large, dense, farmer population with maize as their major and preferred starch staple food and as a locally important cash crop.

2. The ecological conditions of most of the District differ sufficiently from the high and medium potential areas to query the suitability of the 500 and 600 series of hybrids for Siaya farmers.

3. Studies of Gerhart (1975) and Hesselmark (1974, 1976) had shown low levels of adoption among the Siaya farmer population despite some 10 years exposure to a technological package based on available hybrid varieties.

The main aim, reflected in 2 and 3 above, was to select an area in which the approach would have an opportunity to prove itself. Clearly, a demonstration in a high potential area, with well adapted varieties and a high level of adoption among local farmers would give less scope for the approach to demonstrate its potential.

2.2. ZONING SIAYA DISTRICT

Zoning within Siaya District was not a complex procedure. The heterogeneous factor is rainfall which falls away from the North and North East towards the South of the District. The area around Kakamega in the highlands to the North East of the District receive up to 2000 mm

annually and has 11 humid months (Jaetzold 1974) in which crop growth could be started. Moving South and West the rainfall drops steeply and Yala in North East Siaya, is on the 1500 mm isohyet. At about the 1500 mm isohyet the number of humid months fall to 10. More importantly, of these 10, 4 months would be unable to reliable support crops at water demanding stages of growth so two clear seasons are distinguished. This bimodality continues to South and West to somewhere north of Bondo town itself. Here the August - November rainfall peak falls away and, on grounds of crop potential, the short season is lost. Nevertheless in the Bondo area, as the survey results show, most farmers attempt a short rains planting. The zone identified for study is bounded by the line where the rainfall pattern breaks into two clear seasons. It is assumed as the 1500 mm isohyet.

Although crop management problems intensify from North to South over the zone, essentially similar problems are involved. Within the area of the District receiving less than 1500 mm on average the potential moves from good long and short rains crops in most years in the North, to variable long rains crops and rarely successful short rains crops in the South. The economic and social circumstances are so similar through this zone that it was considered justifiable to examine it as an entity despite the very marked change in rainfall reliability. The zone covers South Gem location, Yala Division, the parts of Ukwala Division south of the Yala-Ukwala-Bunyala road, Boro Division and most of Bondo Division with the exception of the extreme southern and western areas bordering the lake.

2.3. NATURAL CIRCUMSTANCES OF CLIMATE AND SOIL IN THE SIAYA ZONE

1. Rainfall. There are no East African Meteorological Grade 2 stations in Siaya District. Use has been made of records held at Divisional level in the Ministry of Agriculture. Table 1 shows monthly averages of pooled data for sites and years for Bondo (939 mm annually), Boro(1225 mm annually) and Ukwala (1472 mm annually).

Table 1. Available observations on monthly average rainfall by Division. (mm)

Division	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bondo	42	59	89	175	139	44	55	75	68	69	88	36
Boro	47	61	156	180	147	102	89	81	100	122	100	30
Ukwala	53	80	111	262	202	113	80	80	139	132	179	33

The table demonstrates a marked similarity in the rainfall pattern of the three Divisions but a marked disparity in levels. Of particular interest are the differences in amount and distribution in the periods February - June and August - November, the long and short rain seasons. Rainfall levels fall moving South across the District, away from higher rainfall areas in the North West and North East. Reliability of rain during the cropping season, closely correlated with reliability of production levels, is of vital importance to small farmers dependent on the farm for staple food supplies. Table 2 presents very crude measures of the reliability of the rain, on a monthly basis over

the crop seasons, in the three Divisions studied in Siaya. The measures were derived by ranking pooled inter-year and inter-site data to give an indication of the frequency of various levels of monthly rain. The Table shows levels, in mm, below which rainfall can be expected to drop in the number of years indicated for critical months in the growing seasons.

Table 2. Crude measures of monthly rainfall reliability (mm)

DIVISION	Out of 5 years	Long rain season F	M	A	M	J	Short rain season A	S	O	N
BONDO	1	6	30	98	87	25	33	35	28	25
	2	30	83	135	119	40	48	44	50	53
	3	53	100	179	140	47	63	61	65	86
	4	110	135	233	176	56	101	102	119	155
BORO	1	15	60	130	83	38	40	55	80	46
	2	20	105	174	116	47	68	84	101	64
	3	43	140	205	145	100	73	140	135	138
	4	95	210	236	193	163	100	145	158	195
UKWALA AND SOUTH GEM	1	30	20	155	156	59	46	75	86	100
	2	48	76	230	186	96	68	120	109	112
	3	68	146	288	217	110	93	168	147	178
	4	120	214	374	254	145	135	213	202	264

Note: See Brown and Cocheme (1969) page 71.

2. Soils: There is little information available on the soils of Siaya District. Observation within the District suggests that soils are more generally fertile in the North and East of the District, becoming a more variable mixture of sands with blacker, heavier soils in the bottom lands in the South and West. There is more selective use of lands for cropping in the South and West, hardpan areas and the lower lying black soil areas are left uncultivated. It is unlikely that soils vary enough over the District to influence crop potential. Similarly the small differences in the present cropping pattern across the District are probably not attributable to soil variations.

2.4. OFF - FARM ECONOMIC CIRCUMSTANCES IN SIAYA

1. Communications. The District is bounded along the East and North side by the main, bitumenised road from Kisumu to Busia. There is a good network of all weather murram roads over the District joining the many minor settlements and markets. The network of roads is correlated with the density of the population and frequency of markets and is less developed south of Bondo in the less densely populated area of the Division.

2. Population. The District had a population of 383,188 at the 1969 census in an area of 2535 square kilometre. That is an average density of 151 persons per square kilometre. Extremes of density were from 27 persons per square kilometre in Kadenge sub location, Boro Division, to 498 persons per square kilometre in Mahera sub location, Yala Division. However 60% of the sub locations in the District had population densities between 130 and 260 persons per square kilometre. An estimated 90% of the resident population have farming as their major source of livelihood. Assuming population growth of the order of 2.5% per annum since 1969 and using the farmer survey data showing an average of 7.4 persons per household, gives an estimate of some 57,000 farm families in the District with an average land area of 4.2 to 4.6 ha each and supporting over 420,000 people. Average population density will be now be approaching 185 per square kilometre. The area is wholly populated by the Luo people, the few exceptions being employed persons in the towns and minor settlements of the District. Origins and social traditions are very homogenous through the District. The identified zone contains an estimated 70% of the District population; some 40,000 farm families.

3. Markets

(a) Structure. The District has a network of local markets which are very well patronised by farmers. The majority of transactions are of farmers selling produce and buying produce brought by other farmers. All dealing is done through cash. Each minor settlement has its market and market days, often two each week. Beyond these transactions the main marketing channel for crops surplus to local needs is the Siaya District Cooperative Union. Originally a cotton buying organisation it now buys a range of products acting as a purchasing agent for the Maize and Produce Board. The Cooperative currently has Produce Buying Stores at nineteen of the local markets throughout the District. With the exception of sugar, grown mainly in North and East Gem and sold mainly to local jaggery factories, and cotton, crops sold to the cooperative are surpluses of the dominant food crops in the area, maize and beans are particularly important. There are 22 producer dairy groups in the District, sales are made locally, none of the milk is sold to K.C.C. meat is marketed in the minor settlements and is slaughtered locally, animals sold by local farmers are supplemented by the import of animals from other Districts.

(b) Value of marketed products. No statistics exist to show the volume of trade in the local village markets. Most farmers surveyed reported this as their main produce outlet. Table 3 presents a summary of estimated sales values for produce moving through the organised marketing channels for 1975. The value of sales through channels which can be fairly reliably monitored amounts to Ks 200 per farm family. Commercial, sales of sugar are restricted to farmers in parts of Yala and Ukwala Divisions close to the centres of processing. Similarly although 67% of farmers were cattle owners, only 29% of owners, that is 19% of farmers reported selling cattle within 1976. At the same time only 17% of all farmers reported milk sales, necessarily these would also be stockowners. Taking out the value of sugar, meat and milk from the value of crops marketed through channels which can be observed it is clear that the majority of farmers only have contact with their village market. Omitting the value of these three products the average valued of cash sales through formal channels is only Ks 20 per farm family. 20% of surveyed farmers reported no crop sales; 53% of farmers reported maize and 43% sorghum sales, usually at the local village market.

Table 3. Estimates of the value of products marketed through assessable outlets in Siaya District in 1975

Product	Marketing channel	Sales value (Ks)
Cotton	Siaya Cooperative Union	840,708
Milk	Producer cooperative groups	330,670
Beef	Individual sales	7,307,400
Maize	(acting as agent	171,332
Beans	Siay C.U(for Maize & Produce	112,740
Other crops	(Board)	16,539
Sugar Cane	Individuals to jaggery factories	2,689,000
Sales value through assessable outlets		Ks 11,468,389

(c) Prices. Thus the main outlet for smallholders produce is the local village market. The District Agricultural Office, Siaya keeps price records for crops sold in local markets and these series, collected at Divisional level, give a measure of recent trends as well as comparison between areas and seasons. Seasonal variability is marked and closely related to long rains and short rains harvests in July/August and December respectively. Prices for selected crops and years are presented on a monthly basis in Table 4 for Ukwala and Bondo Divisions.

Table 4. Selected Market prices (Ks/bag) in Ukwala and Bondo Divisions

Products			Maize	Sorghum	Cassava	Beans
Ukwala		(1974	58	56	35	97
Average	Jan to July	(1975	82	58	52	125
		(1976	82	77	54	113
3 year averages	(Pre LR harvest		82(2)	83(2)	55	147
	(Post LR harvest		40(2)	35(2)	36	81
Bondo		(1974	68	64	35	125
Average	Jan to July	(1975	80	64	34	168
		(1976	102	97	58	341
3 year averages	(Pre LR harvest		91	91	52	253
	(Post LR harvest		49	41	33	132

The prices in the table have been selected to show; the trend over the last three years, the very large variation between seasons and any differences among prices in Bondo and Ukwala, only some 40 kilometres apart. In general it can be said; prices have risen dramatically in local markets over the last two years, most farmers need to buy as consumers before the new harvest is ready, the length of the period depending on the success of the previous years harvest, and finally that most farmers are probably restricted to selling in their own local market.

In Table 5 Maize and Produce Board 1976 prices are compared to local market prices; the January - July 1976 averages - a repeat from Table 4 - and the August - October post harvest, 1975 prices.

Table 5. Maize and Produce Board 1976 buying prices and local market prices (Sh/bag)

Products		Maize	Sorghum	Cassava	Beans
MPB buying price		59	39.80	11.25	97.65
Ukwala	Jan-Jul'76	82	77	54	113
	Aug-Oct'75	47	40	36	84
Bondo	Jan-Jul'76	102	97	58	341
	Aug-Oct'75	49	41	29	145

n.b. 1. For cassava MPB purchases specify 50Kg bag weights. The Ministry refers to 90 Kg bag weights in some of the reports used as sources.

2. Although the bean price for Mexican 142, the most marketed variety in Siaya, is shown in the table, the MPB 1976 purchase price is 201.30 per bag for other varieties.

It can be seen that the MPB prices are well pitched in relation to local market prices for maize and sorghum in the post harvest period. For the pre-harvest period it can be assumed that the market is demand led by farmers who have used their home produced supplies.

4. Input distribution. There is a network for the distribution of seeds and fertiliser throughout the District. Kenya Farmers Association (KFA) and Kenya Seed Company (KSC) cooperate in appointing agents. There were 56 such agents appointed in over 40 market centres across the District for 1975/76 season. It is difficult to assess the efficiency with which the network operates during August when few inputs are required. Agents claimed that they could not get stocks on credit and clearly the cash flow from the size of businesses they were operating would not give cash to hold significant quantities of inputs, particularly fertiliser. On the other side, farmers had no ready access to credit for the purchase of inputs at a time of the season when farm cash flow was very poor. It is probable that farmers

would seek inputs on credit from stockists. Given a two way squeeze on their own finances margins would have to be very high to attract dealers into holding significant stocks.

Although a distribution network exists on paper it is doubtful whether it operates effectively due to the limitations on cash flow of both stockists and farmers. No central records were available with KFA to show the history and present levels of input sales through agents in the three relevant Divisions of Siaya District.

2.5. LAND, LABOUR CAPITAL AND MANAGEMENT IN FARMING IN THE SIAYA ZONE

The resources Siaya farmers have at their disposal, both quantity and quality, may form constraints on the types of change in farming technique they will be able to absorb. The situation of land, labour and capital in farming in the zone and the way these resources are managed are described briefly.

1. Land

(a) Holding size was not measured in the course of the farmer survey. Allowing 20% waste and non-agricultural land on the 2535 square kilometres of area for the District gives 3.50 ha per farm family varying between 2.50 ha for the more densely populated parts and 4.50 ha for the less densely populated. Figures for the four sub-locations are given in Table 6 with average cultivated areas in the 1976 long rains season, based on farmers' and enumerators' estimates, included in the Table. Many data are rough estimates, adequate for purposes of the report.

Table 6. Population, land availability and use - survey areas

Sub location	Omia Malo	Nyawita	Simenya	Kambare
Population 1969 census	4387	3749	1474	2221
Population 1976 (at 2.5% per year)	5210	4460	1750	2630
Estimated farm population at 90%	4690	4010	1580	2370
Family size (1976)	7.8	8.3	7.1	6.6
Estimated at 80% usable land (Ha)	1480	3120	880	1520
Cultivated area per family (Ha)	2.11	3.08	2.08	2.17
Total to Arable (ratio)	1.53	2.10	1.90	1.95

The data in the table demonstrate varying degrees of land pressure. The most critical being in Omia Malo, Bondo Division (East), the least critical in Nyawita, Bondo Division (West). In none of the areas however is the traditional fertility maintenance practice of shifting cultivation any longer feasible, land cannot be rested more than one year in two and for Omia Malo resting is possible only in one year in three. Of the 122 farmers interviewed in the four sublocations 76 reported using manure on their fields. The great majority of these were from the 82 cattle owners, though 9 farmers, that is 23% of non-owners, reported manure use. Cattle owners averaged over 8 animals each, though with wide variations between individuals. Assuming production of one tone of manure per animal per year the animal population of 688 head, among the 122 farmers, would allow an application of 10 tons of manure per hectare every four years on the 281 hectares they cultivated, a modest, but useful level of manuring.

(b) Land Adjudication has been completed in four of the five sub-locations surveyed, Omia Malo being the exception. In adjudicated areas the number of plots per household averaged 1.7, with 83% of households having only one or two plots. By contrast, in Omia Malo 67% of farmers had three plots or more and stock owners had access to communal grazing. While adjudication often has serious repercussions on shifting cultivation as a fertility maintenance technique, in Siaya population densities have already made the technique obsolete. More immediately pressing is the need for farmers to manage their livestock within their own landholding. Farmers interviewed in the survey reported 24 cases of land renting to supplement their own holdings. In 17 cases (of which 12 were in Nyawita, the least densely populated sub location) land was given or received free of charge, 5 cases were for cash and two in kind. One farmers loaned land in return for the hire of oxen on his own fields.

(c) The cropping pattern in the District is fairly homogeneous, although there are localised specialities. Crops are grown on the long rains; March to May, and the short rains; August to November. There are major differences in the success rate of short rains cropping in the higher rainfall areas in the North, and the lower rainfall area of the South. Nevertheless attempts at short rains cropping are equally intensive in the drier sub locations surveyed. Table 7 sets out the cropping pattern on the surveyed farms in the 1976 long rains, and information on the proportions of farms which planted the main crops in the 1975 short rains and intended to plant in the 1976 short rains. Intercropped areas are counted twice and cannot be added across the table. There was extensive intercropping of maize and sorghum, but it is noteworthy that significant areas of these basic starch staples were planted as pure stands. The two staples were dominant throughout the survey area. There were some peculiarities among the surveyed sub-locations. Cassava was grown by 75% of farmers in three of the four sub-locations, Nyawita the least densely populated sub location was the exception. Beans were grown by 60% of farmers in three of the sub-locations, in Omia Malo groundnuts competed with beans in popularity, in Nyawita and Simenya cowpeas competed with beans.

Table .7. The Long Rains(LR) cropping pattern in the zone and supplementary information on Short Rains (SR) plantings.

Crop	Maize	Sorghum	Cassava*	Beans	Cowpea	Cotton	Sweet Potato
LR 1976;							
% farms planting	99	94	61	50	29	22	39
Average ha p. grower	1.28	1.03	.61	.87	.45	.54	.28
Average ha for sample	1.27	.97	.37	.44	.13	.12	.11
% area intercropped	71	60	62*	98	n.a.	53	45
% farms planting in SR 1975	73	3	24	12	2	13	3
% intending SR 1976	95	3	0	48	2	8	0

notes: * Cassava figures show the area in the ground and numbers growing at August 1976. Once mature cassava will stand pure until utilised.

n.a. Figures for area interplanted with cowpeas are not available 37% of cowpea growers intercropped.

Minor crops, recorded on a few farms were Green Gram and Sim Sim. A high proportion of farmers grow small areas of bananas, sukuma wiki and other vegetables.

Differences between the higher rainfall areas in Ukwala and Yala and the drier Bondo areas can be noted:

i. Intentions of (1976) short rains maize and bean plantings are equally high in each area, but actual (1975) plantings are lower in the drier areas.

ii. The area of sorghum grown per household is higher in the drier areas of Bondo.

iii. Cotton is grown more extensively in the drier areas of Bondo with a significant number of short rains plantings.

2. Labour

(a) Availability: In the Siaya zone farm labour is supplied mainly by the family supplemented by hired labour, usually casually employed at periods when the workload is heavy. Table 8 gives details of the labour force available for farm work in the areas surveyed. Permanent off farm workers refers to family members who have emigrated from Siaya.

Table 8. The labour force on farms in the Zone

Item	
Family normally resident	
Average number in family	7.4
Average number over 15 years	3.9
Percentage of households with family members as:	
- permanent off farm workers (%)	43
- temporary off farm workers (%)	39
From sampled farms, numbers of members:	
- in permanent jobs, non resident	81
- Away at boarding school	68
- taking some casual employment in 1976	14
Percentage of households:	
- employing permanent hired labour	1
- employing casual hired labour	40
Percentage of households receiving cash from non resident relatives	
- regularily	11
- occasionally	36

Several points are noteworthy. Adult members of 43% of families have emigrated from the zone. Numbers emigrating are much higher in the densely populated areas surveyed. As might be expected

Nyawita sub-location, with the lowest population density and largest cultivated area per family has the lowest number of emigrants and the lowest proportion of households with emigrants. Whereas in the three more densely populated sub-locations 55% of households receive some level of support from outside the area, in Nyawita only 25% of households receive support, none regularily. On the otherside of the coin Nyawita farmers send a larger proportion of their children to school and hire much more casual labour - suggesting a higher level of farm generated income.

(b) Use: Traditionally the Luo people had very marked specialisations in their use of family labour. Having been pastoralists the responsibilities of the men were towards the livestock. This had carried over into the responsibility for seedbed preparation done, whenever possible, by oxen. The women were responsible for the weeding and harvesting. This traditional specialisation has largely broken down, though vestiges were observed in recording crop management on over 200 individual maize and sorghum fields. Particular households stuck to traditional practice, women performed the work without the aid of men, particularly on the weeding operation. A further important aspect is the extent to which farmers are prepared to hire labour for the operations traditionally done by women as a substitute for employing male family labour on these operations. Clear evidence on this aspect is difficult to obtain, only 3 male heads of households interviewed hired labour to supplement their women and children in operations in which they, or other men in the family, did not participate. This is a low proportion of total hirings. It is impossible to rule out family contingencies as a reason for specialisation but, on balance, there is evidence of specialisation persisting in some 12 (11%) of male headed households, particularly in the weeding operation. It seems the tradition will disappear in the next decades.

Farmers were asked to name what they considered the busiest and the second busiest period of the year. As they were asked to answer for two periods the incidence of responses does not directly reflect the relative severity of the two work peaks. The incidence of responses is reported in Table 9. Most farmers mentioned two or even three month periods, particularly in the long rains season. Table 9 also shows how the incidence of reported labour hirings coincides with the busiest periods.

Farmers consistently named February to May as the major peak period with August to October as a secondary peak. The exception to this was Simenya where farmers distinguished between December to February and April to May with a small proportion of farmers putting emphasis on land preparation for the second rains crops in September and October. There are numerous hirings for weeding in Nyawita, the sub-location with low population density in which most farmers own and operate oxploughs and cultivate larger areas. This contrasts with the other three relatively densely populated sublocations, with less farmers owning oxploughs, where the hiring of ploughs, and in the case of Kambare labour for land preparation, predominates.

3. Capital

(a) Availability: Capital is defined as the surplus remaining for re-investment out of incomes after consumption requirements have been met. It is inevitably closely bound up with income levels. No attempt was made in the course of the survey to collect information on income

Table 9. Farmers opinions on the busiest season and the incidence of labour and ox plough hiring on farms

Sub location	J	F	M	A	M	J	J	A	S	O	N	D
Omia Malo Opinion on busy period	7	23	26	28	20	3	4	28	25	9	0	0
Ox hire-ploughing	4	4	2	-	-	-	-	1	-	-	-	4
Labour (land preparation	2	2	-	-	-	-	-	-	-	-	-	-
Labour (weeding	-	1	6	5	1	-	-	-	-	-	-	-
Nyawita Opinions on busy period	18	24	30	32	26	0	11	25	30	18	0	8
Ox hire-ploughing	2	-	-	-	-	--	--	-	-	-	-	-
Labour (land preparation	-	1	-	-	-	-	-	-	-	-	-	2
Labour (weeding	-	1	12	17	6	2	1	1	-	-	-	-
Simenya Opinions on busy period	16	14	9	24	21	9	1	4	4	6	3	7
Ox hire-ploughing	3	2	1	-	-	-	-	-	1	3	2	-
Labour (land preparation	-	-	-	-	-	-	-	-	-	-	-	-
Labour (weeding	-	-	-	1	1	-	-	-	-	-	-	-
Kambare Opinions on busy period	14	18	23	22	13	3	3	17	18	13	9	2
ox hire-ploughing	3	4	1	-	-	-	-	-	-	-	-	-
Labour (land preparation	3	4	4	1	-	-	-	-	-	-	-	1
Labour (weeding	-	-	2	3	1	-	-	1	-	-	-	-

n.b. Land preparation includes planting

levels. Some emphasis was placed on sources of income and information obtained is set out in Table 10.

Sources of cash income are very varied. Most farmers (80%) reported a dependence on crop sales, mainly of food crops in the local markets. Most farmers had two sources of cash income.

The productive investments into which surpluses are channelled in the Siaya zone are cattle and ox ploughs as assets, the hire of labour or machinery and the purchase of improved seeds and fertiliser. Evidence from the collected data strongly suggests a run down in assets is taking place, cattle numbers and the number of farmers owning ox-

Table 10. Numbers of farmers reporting various sources of family income in the Siaya Zone

Source	Omia Malo	Nyawita	Simenya	Kambare	Total
Crop sales	24	27	20	27	98
Livestock sales.	7	12	6	2	27
Milk sales	8	7	1	3	19
From relatives - regular	3	0	4	7	14
living away - occasional	12	8	15	10	45
Temporary off farm work	6	2	3	3	14
Hire out oxploughs	9	10	0	0	19

ploughs, are falling. This is most probably caused by pressures arising on grazing land from increasing arable requirements and the contingency demands for cash for major household expenditures met by the sale of animals. Cattle numbers on the surveyed farms have fallen from an estimated 862 five years ago to 688 head in August 1976 a 20% reduction. The number of owners has increased over the same period from 76 to 82 or 67 of the farmers surveyed. The average herd size has dropped from 11.3 to 8.4 head per owner. Some 98 farmers, 80% of the sample, reported owning cattle at one time. 27 farmers, a third of livestock owners, reported sales of livestock in the first nine months of 1976. 96% of these sales were to realise funds for consumption. Over the last three years 74% of owners reported sales of stock to meet cash needs for consumption and 76% of these sales were to make payments of school fees or to purchase food. 77% of farmers reported owning ox ploughs, 10% more reported having previously owned ploughs. Table 11 sets out the information collected on the use of cash as farm working capital. No information was collected on the costs of improved seed and fertiliser purchased by farmers. The main use for working capital was in the hire of labour and ox-ploughs. As has been detailed in Table 9 most of the hirings were for seedbed preparation and weeding.

Without information on the quantities of fertiliser and seed purchased it is not possible to assess exactly the average level of outlay of working capital of farmers in the Siaya zone. On rough assumptions that each purchasing farmer is spending Ks 25.00 on seed and Ks 100.00 on fertiliser gives an aggregate Ks 2225.00 for purchased inputs, and Ks 15,250 total outlay by surveyed farmers, that is an average Ks 125.00 per farm. Out of the full sample 67 farmers were using working capital with an estimated average outlay of Ks 228, of these 7 were buying only hybrid seed with an assumed outlay of Ks 25.00, and 4 were buying

Table 11. Use of working capital by surveyed farmers in 1976 long rains season

Item	Omia Malo	Nyawita	Simenya	Kambare	Total
Hire of labour and oxploughs					
Farmers hiring: no	14	19	9	14	56
% of survey farmers	47	59	30	47	46
Number of hirings	28	36	11	31	106
Total cost K.Ss.	3894	5430	1095	2604	13023
Average cost per hiring	139	151	100	84	123
Average outlay per hirer	278	286	122	186	232
Average outlay p. survey farmer	130	170	37	87	107
Purchase of seed and fertiliser					
Farmers buying seed: no.	5	13	12	7	37
%	17	37	40	23	30
Farmers buying fertiliser: no.	2	5	6	1	14
%	7	16	20	3	11

seed plus fertiliser; an assumed outlay of Ss 125.00. Of the residual 56 farmers (46% of those surveyed) using working capital, 26 were hiring labour or machinery and purchasing seed (16) or both seed and fertiliser (10). These 46% had an average outlay estimated at Ss 260.00 per farmer.

4. Management

Management is the coordinating resource, provided by the farmer himself. He works within the natural and economic circumstances of the area and within the constraints of the other resources to satisfy his family's needs and priorities. Evaluation of the management strategies of Siaya farmers depends on identification of their objectives and priorities. This leads into section 3, a key part of the report which analyses the present farming system as a manifestation of farmers strategies for achieving their production objectives.

2.6. A SUMMARY OF KEY CIRCUMSTANCES FOR FARM OPERATION IN THE SIAYA ZONE

The key circumstances which are likely to influence decision making by Siaya farmers on the development of their farms are:

(1) The high variability of rainfall and relatively short growing seasons.

(2) Population growth; breaking down the effectiveness of shifting cultivation and creating competition for land between use for arable and for grazing.

(3) Adjudication, reinforcing the effects of population growth but also creating individual responsibilities for grazing management.

(4) Wide seasonal fluctuations in selling and buying prices for foodstuffs, particularly starch staples, in the local markets.

(5) Falling soil fertility.

(6) Capital scarcity and a running down of numbers of oxen and ploughs as capital assets.

(7) Labour shortages in the February to May period of the long rains season and the possibility of these becoming more acute; a result of the apparent rundown in capital assets.

3. SIAYA FARMERS: THEIR OBJECTIVES AND PRIORITIES; THEIR FARMING SYSTEM AND ITS DEVELOPMENT

3.1. SIAYA FARMERS: OBJECTIVES AND PRIORITIES

Most people have the same objectives in production activities; family welfare comes first, then cash income; initially to meet 'necessary' purchases and subsequently to give command over an ever widening horizon of semi-luxury and luxury goods. These three 'objectives' are clearly graded. To the man earning Sh 50,000 a year basic family welfare is no problem. His priorities are increasing his command over wider range of luxury goods - can he afford that second car! The man producing to the value of Sh 2,000 a year has quite different priorities he operates close to subsistence level and the welfare of his family dominates his production objectives. Dominance in objectives depends where you are on the income scale. Attitude to risk also depends where you are on the income scale. A man earning Sh 50,000 a year may happily speculate with Sh 2,000 of his income, he may have to go for a smaller model of second car if his speculation fails but the consequences are not far reaching. Clearly a man earning Sh 2,000 a year can't speculate with it, the very survival of his family is at stake. Vis-a-vis the Sh 50,000 a year man's 4% speculative spending, this man's risk ceiling is only Sh 80.00. Farmers producing close to the substistence level will only move away from a tried and tested system, as long as it is meeting their priorities, in small steps.

Siaya farmers are low on the income scale, family welfare dominates their production objectives. Family welfare in the form of an assured, reliable, supply of food and enough cash to buy necessities. Within this dominant priority of a reliable food supply the family have preferences; these are now discussed.

Traditionally sorghum and finger millet were the starch staples for Siaya families, supported by supplementary cassava and sweet potatoes.

Finger millet and to a lesser extent sorghum have been replaced by maize as the preferred starch staple. Of 122 farmers interviewed in four sub locations 101 expressed a preference for eating maize ugali, 11 a preference for sorghum ugali and 10 reported no preference. Maize ugali is considered tasty by itself though some form of relish is usually eaten with it. Sorghum ugali is considered by most families to be heavy and tasteless, 91% of farmers reported mixing sorghum with cassava flour to lighten it. It also needs a strong relish to 'liven it up'. Sorghum ugali has a reputation for 'sitting on the stomache' and causing constipation if taken by itself. In the lakeshore areas, with ready access to low cost fish, it is considered as a good 'vegetable' to eat with sorghum. In addition to fish and meat, eaten when cash is available, a wide range of vegetables are used with ugali. Cowpea leaves and sukuma wiki are the most common cultivated vegetables and are widely sold in the local markets. Green grams and groundnut are also common. Beans are not used as a side dish but are mixed with maize as an ugali very acceptable by itself. A wide range of local plants are used as vegetables; some, including mito, sewewe, akao, ododo and onulo may be cultivated, others, including osuga, omboga, odielo and Apoth (ochre),are gathered. When making relish for use with ugali vegetables are often combined, popular combinations are cowpea leaves/mito/apoth/onulo, osuga/ododo and Akao/omboga, said to be particularly good with ghee. Mito is pepperminty in flavour and has a reputation in curing bad stomaches, with Akao and omboga added it is used to stimulate milk flow in nursing mothers. Sweet potatoes, relatively widely grown, is considered as a supplementary starch staple, not a meal in itself. Sorghum is of major importance as a base for local brewing. Home brewing is a mark of capable housewife.

In this context a good farm manager, a man respected by his fellow farmers in Siaya, is one who produces enough maize, every year, to feed his family on their preferred food through to the new harvest, who produces enough sorghum to allow his wife to brew regularily all through the year, and who produces a surplus to bring in enough cash to meet the families needs for household requirements, fish, meat,clothes and childrens school fees, and to add to his small livestock herd from time to time. Management strategies, in the face of the prevailing local natural and economic circumstances, are directed towards achieving a reliable food supply within the resource constraints operating on the farmer as manager.

3.2. THE RELIABILITY OF FAMILY FOOD SUPPLY IN FARMING IN THE SIAYA ZONE

This section details the evidence collected on the hazards that Siaya farmers feel they face, contingencies created by these hazards and the actions taken within the household to combat them. The food preferences described in Section 3.1 are often subordinated to the basic priority of food sufficiency due to hazards beyond the farmer's control. Farmers were asked to state their major problem in keeping their family's supplied with food in an effort to identify what they perceived as the most important hazards influencing the achievement of their primary production objective. Table 12 reports their answers.

The main hazard reported by farmers in three of the four sub-locations was unreliable rainfall. In Simenya it was shortage of land. An attempt was made to evaluate the effects of all such hazards on family

Table 12. Identification of the main production hazards recognised by Siaya farmers

Source	Omia Malo	Nyawita	Simenya	Kambare	Total No	Total %
No reply	2	1	3	1	7	6
No problem	13	1	2	2	18	15
Hailstorm	5	0	0	0	5	4
Drought, unreliable rains	15	19	5	16	55	45
Shortage of capital	1	12	6	2	21	17
Shortage of labour	0	3	1	6	10	8
Shortage of land	0	1	12	0	13	11
Poor soil, erosion	1	0	4	2	7	6
Pest attack	4	0	1	6	11	9

food supply and the type of action taken by the farm family to alleviate the contingency arising. Table 13 reports the incidence of some hazards and some resulting contingencies for the years 1974 - 76.

Table 13. The incidence of some hazards and some contingencies arising in Siaya farming 1974-76 (numbers of farms reporting)

Year	1974	1975	1976
Maize attacked by army worm	2	4	49
Maize damaged by hail	19	35	29
Replanted some maize fields	19	33	56
Replanted some sorghum fields	14	19	42
Ate maize throughout the year	26	30	17
Finished off all stored sorghum	77	73	56

A more detailed examination was made of the food supply situation arising from the 1975 long and short rain harvests. Table 14 gives the results.

Table 14. Farm families starch staple consumption for food and beer from homegrown and purchased sources August 1975 - July 1976

Period			By end Oct 1975	During Nov-Jan	During Feb-Apr	During May-Jul
Farm Grown	MAIZE	No. finishing	11	18	55	38
	SORGHUM	No. starting	103	6	5	2
		No. finishing	4	14	35	60
	CASSAVA	No. starting	49	8	16	5
		No. finishing	3	8	8	59
Bought	MAIZE	No. starting	5	14	39	29
		No. finishing	0	3	5	79
	SORGHUM	No. starting	4	6	10	11
		No. finishing	1	1	1	28
	CASSAVA	No. starting	10	4	5	3
		No. finishing	0	1	3	19

The table should be seen in the context of farmers reports on their own 1975 grain harvests. There was considerable variation between sub-locations; in Simenya and Nyawita the majority of farmers reported good 1975 harvests, in Omia Malo and Kambare the majority reported poor 1975 harvests. Overall the split was about fifty-fifty good and poor harvests. First maize pickings were reported in May, however 98% of reported maize harvests occurred after July 1st and 77% after the end of July, though 25% of farms reported eating green maize by the end of June. Only 31% of farm families had enough maize to last until the May/July period, 69% finished their home grown maize supplies by the end of April. Households purchasing maize increased significantly in the period February to July, but all reported finishing purchasing by the end of July. A higher proportion of households had home grown supplies of sorghum and cassava lasting through until July and purchases of these starch staples were not so widespread as of maize.

With maize as the most commonly purchased food farmers were asked where they obtained money from to buy maize during 1976. Their answers are set out in Table 15.

Table 15. Sources of money for farmers buying maize since the 1975 harvest

Sub location	Omia Malo	Nyawita	Simenya	Kambare	Total	
					No	%
Animal sales	5	9	5	4	23	19
Crop and vegetable sales	7	2	5	7	21	17
Relatives	2	2	9	7	20	16
Casual labouring	0	6	3	5	14	11
Poultry and milk sales	1	1	3	3	8	7

There are a wide range of tactics available within the household for spinning out food supplies. Maize may be mixed with sorghum or cassava flour. Maize may be purchased, sometimes from the sale of another stored crop. In extreme situations, when the cash cannot be raised or the maize price is considered too high, then sorghum and cassava flour will be mixed in making ugali. In emergencies sorghum is diverted from brewing and used for food, albeit the varieties are not preferred for ugali. Oloro and Ochuti, two red, bitter and hard varieties of sorghum with storing properties upto 2 years long under good management will be kept as a fall back food and brewing supply, often being sold from store or eaten once it can be seen that the new harvest will be adequate. Control of the foodstuffs is left with the senior woman of the household. She is responsible for the state of the food stores and for liaison with her husband, in times of shortage, as to how supplies will be spun out. She will for example initiate the plan for the opening of a new cassava field in anticipation of scarcities 6 months or a year ahead. Storage of foodstuffs is an important part of household management. Foods are stored inside the house, in the smoke of the fire and insect damage minimised by the use of ash scattered in the stored crop. Keeping qualities are enhanced if grain is removed from the store and re-dried from time to time and new ash mixed in. Some farmers now use purchased insecticides for storing grain. Out of the 122 sampled 65% still used ash, 8% used purchased insecticide alone, 7% used insecticide with ash and 20% reported not using either.

3.3. THE FARMING SYSTEM

Actions in the household reacting to food contingencies are 'curative' facets of the farm families strategies to ensure a reliable supply. Such actions are taken once contingencies show up. 'Preventive' facets are reflected in the farmers' decision making in managing his farm. Here the farming system is briefly analysed under categories of decision made by the farmer within local natural and economic circumstances, his resource constraints and his experience of the incidence of the various hazards facing him. A pre-occupation with reliability of food supply reflects its dominance in farmers objectives.

1. Cropping pattern

The cropping pattern is a straight reflection of the consumption pattern just described. Maize as the major crop among the survey farmers, 155.3 ha including intercropped areas in the 1975 long rains, closely followed by sorghum, 118.3 ha also including intercropped areas, with the two crops sometimes mixed on the same plot. Some 75% of farmers in three sub locations grew a much smaller area of cassava, Nyawita sub location, with a high average area cultivated per farm being an exception with only 25% of farmers interviewed growing cassava. Sweet potatoes grown by 39% of farmers on a very small average area, and Finger millet grown by 25% of farmers, were back up starch staples. Again Nyawita with a high proportion of ox owners and a large cultivated area per farm was exceptional with 56% of farmers interviewed still growing Finger millet. When farmers were asked which crops they had stopped growing or reduced the area of finger millet and the longer term red sorghums featured most prominently. Other crops featuring most prominently in the pattern were the legumes and pulses used as complements in the menu to the starches. These varied to some extent from area to area; Beans was grown by 60% of farmers in three sub-locations; Omia Malo was the exception with only 17%. Cowpea, green gram and groundnuts were others. Dominance of the basic starch staples in the economic activity of the Siaya zone is also demonstrated by the number of farmers selling these crops, mainly in the local markets. 21% of farmers interviewed (wholly in Omia Malo and Nyawita) reported selling cotton, and 16% reported selling beans often quoted as a cash crop. However figures for maize (53%) and sorghum (43%) were much higher, with 40% of maize sellers and 53% of sorghum sellers making some of their sales during the period of high local market prices in April - June.

A range of varieties of the main crops are grown by Siaya farmers. Notes follow on the main varieties identified in maize, sorghum and cassava.

(a) Maize Three varieties were noted:

i. Rachar: which means white, was the preferred variety for making ugali. It is a relatively good storer and takes about 5 months to mature. It is also called Ndere.

ii. Nyamula: Is a yellow maize, not considered as palatable as the alternatives. It is shorter term than Rachar and considered drought resistant. It is also called Kipindi.

iii. Hybrid: (Either H512, H511 or H632). Is considered very palatable even preferred to Rachar by those farmers using it. It is longer term than Nyamula and does not store well.

(a) Sorghum. There exists a profusion of sorghum varieties and there is some confusion in identification with the same variety having different names in different parts of the zone.

i. Ohunjo: A light brown variety favoured for both ugali and for brewing. It gives a lighter coloured appearance and less bitter taste than the red varieties when used in ugali. It is a short term variety taking about 3 months to mature but is vulnerable to birds when planted early and matures in advance of other varieties. It stores very poorly and will be the first sorghum used by the family. It is often sold for cash because of its value for brewing and poor storage quality.

ii. Oloro - similar to Ochuti though ochuti is goose-necked. Both are popular for their bird resistance and good storage qualities but are not preferred for either food or beer. They are mainly 'insurance' varieties. Both are long maturing, red varieties and have a hard seed with a bitter taste. Once the new harvest is ensured these varieties may be sold. They can be stored for over two years with good management.

iii. Kumba: A white (glumed) variety, favoured for both ugali and beer but very prone to bird damage as it is (relatively) sweet. It has a long maturity period and a relatively poor yield. It is a fading variety and little seed is available now.

iv. Serena: Short stalked, quick maturing in two and half months,, a red/brown variety. It is well liked for both ugali and beer but will store for less than six months. Because of its short maturity it can be grown on the short rains and sold on a high price market for brewing early in the new year. Seed is difficult to get.

Other varieties recorded were: Andiwo, Jagopari, Othuwa, Hongrangai, Nyakwadidi.

(c) Cassava. As with sorghum there is a problem with different names for the same variety on different farms. The three most common varieties were:

i. Duruma: Can be eaten fresh from the ground after boiling or made into chips. It can be consumed less than a year after planting and remains palatable for two years after planting.

ii. Khamisi: Is not eaten fresh from the ground, only used for chipping. In times of severe hardship the leaves will be used for a vegetable. Similar in growth pattern to Duruma.

iii. Rateng: Is reputed to be a high yielder and can remain palatable for well over two years after planting.

Other names noted were: Kiganda/Nyaganda, and Rabuor.

2. The Crop calendar and seasonal decisions

The range of crops and varieties discussed are management tools for the Siaya farmer and give him flexibility in deciding, within his resource constraints, which crops and varieties to grow, how much of each and which will take priority for establishment. The farmer has two major types of decision during the cropping year: what cropping pattern to adopt, and how to meet contingencies which arise as the season progresses.

The farmer will have a 'usual' cropping pattern as a basis for his planting decisions. This will depend on his families food preferences and his attitude to risk, particularily vis-a-vis the balance between maize and sorghum. At the beginning of the, season this 'usual' pattern will be modified by the current food stock situation from the last harvest and by knowledge of any special resource constraints (his wife may be pregnant) likely to operate in his forthcoming planting season. A wide range of scenarios can be exampled: with good stocks on hand of maize and storable sorghums the farmer may decide on initial priority to a large area of the preferred Rachar maize variety, then a small area of long term sorghums, Oloro or Ochuti, to supplement his store and finally, in the long rains planting, a large area of preferred short term sorghums, Ohunjo or Serena to give good brewing prospects and possibly as a source of cash income. With very low food stocks his priorities may be exactly the opposite; initially an area of Ohunjo or Serena giving the best chance of early new food supplies, then a large area of the storable long term sorghums trying to assure food grains through until the next season, finally an area of the short term, though less preferable, Nyamula maize. In such a case quantity takes clear priority over preferences. This sort of decision process faced again at the short rain plantings though, because of the short season, the alternatives are more limited, the long term varieties are excluded.

Within this framework of decisions on cropping pattern unforeseeable contingencies arise, two of the common ones for Siaya are described:
(a) Rains, having started enough to allow planting, stop and early planted maize is lost. The farmer may decide to replant the same variety, replant a shorter term though less preferable variety or replant with Ohunjo, a short term sorghum to give as much guarantee as possible of a grain crop. Similarily decision situations would arise with an attack of army worm.

(b) The grain crops are maturing badly, rain is scarce in May and June and grain filling is suffering. Depending on the urgency with which he sees a need for contingency food supplies the farmer may plant sweet potatoes, with prospects of food in four or five months, or cassava, with much greater flexibility as to when the production will be used. Farmers reported using cassava roots five months after planting, others reported expectations of using cassava roots three and a half years after planting. Adroit use of the crops and varieties with which he is familiar is an important tool for Siaya farmers. One of the most vital aspects of farming in the sub-optimal rainfall areas is to have enough flexibility with available management tools to react to hazards of weather, pests and disease beyond the farmers control. In Siaya flexibility is reduced towards the South and West of the District; the short rains is a less reliable standby and even in the long rains the longer term varieties must be planted early to give them the possibility of maturing within the available rainfall.

3. Crop Management practices

A description of the major crop management practices is given in the course of section 4 of the report. Not all management practices can be directly related to the farmers primary objective of an assured family food supply, however many can be indirectly related to it. Some of the intercropping practiced is directly related to assurance of food supply. In particular the mixing of maize and sorghum with the proportions of the two crops reflecting the farmers' own balance between a preference for maize, particularly perhaps the early green cobs, and a desire for certainty in grain production from the efforts expended in preparing the field. It is noticeable that sorghum is the more dominant in such mixtures in the drier areas of the South and West.

A major management practice indirectly related to the need for an assured food supply is time of planting. Farmers fully appreciate the yield benefits of early planting, particularly for the long maturing grain varieties. Constraints on land preparation prevent all crops from being early planted and the considerations of food stocks as well as the seasonal contingencies outlined in the last section order the priorities. It is quite clear that the very late planting of cotton is a direct consequence of the priority given to food grain establishment. The traditional method of planting by broadcasting, though now breaking down, at least in maize, lent itself more easily to the urgency of getting crops established as early as possible. Thus important management practices, which agricultural experimental programmes usually seek to influence, can be seen to be the indirect result of the priorities of the Siaya farmer and the constraints within which he has to meet these priorities.

3.4. PRESENT TRENDS IN THE EVOLUTION OF THE FARMING SYSTEM IN THE SIAYA ZONE

The farming system in the Siaya zone is in a rapid state of evolution, under very heavy pressure from increasing population density. Of the sampled areas Nyawita sub-location is probably the closest to 'the traditional' Siaya farming system. Simenya seems perhaps to have been pushed farthest away from it but is relatively fortunate in having far greater flexibility in management because of the better rainfall regime.

Increasing population has exerted pressure by raising the area required for growing crops with two major consequences:

1. There is no longer the possibility of maintaining soil fertility by shifting cultivation.

2. The arable area has grown at the expense of grazing, reducing the livestock carrying capacity of the remaining grazing land.

These two consequences have had inter-related effects on the evolution of the Siaya zone farming system, the effects have been intensified and, usefully, made clearer to farmers in those areas where adjudication has taken place. Falling fertility has brought falling yields and the increased use of cattle manure. 62% of farmers reported using manure, and 12% of those farmers using were not livestock owners. The inability to shift the cultivated area has brought on Striga as a major weed pest; 67% of farmers acknowledged it as a problem on sorghum and 52% felt it was also a problem on maize. It has intensified the labour needed for weeding; 55% of farmers felt that uprooting was the only way to get rid

of it. On the other side of the coin the reducing grazing area has begun to reduce the cattle numbers on Siaya farms. It is possible that the reported fall in numbers over the last five years in a cyclical phenominon. The fall off in numbers owning ox ploughs on the other hand indicates it is a general trend. Given the fact that farmers in the area aspire to own oxen and plough and the contrast between the two areas; the reporting of 17 farmers operating ploughs in Nyawita in 1976 and only 1 in Simenya supports it as a general trend. As cattle number fall, particularly if there are low calving percentages, long calving intervals and high calf mortality, as would be expected under overstocked conditions, it becomes more difficult to maintain a team of working oxen. Farm surveys in Ethiopia (Kelber and Mela 1970) suggest that 5 - 6 head of stock need to be kept to support one ox in working condition. Even using a figure of 4 head per ox implies a herd size of 8 animals to support a working pair and 16 to support two pairs.

Thirty one farmers, that is 30% of the sample reported working ox ploughs during the 1976 season, predominantly in the Southern sub locations were the shorter season would increase the urgency of timeliness in land preparation. Of those working ox ploughs 81% had a herd size greater than eight head of cattle, a further 13% of farmers currently working ox ploughs reported they owned more than eight head five years ago. Falling numbers of cattle in general and draught animals in particular has two disturbing effects on the future development of the farming system.

1. The use of manure as an alternative to shifting cultivation for maintaining soil fertility is jeopardised.

2. Increasing use of hand cultivation techniques implies even less timely planting due to labour constraints or a reduction in the area cultivated per family. It has particularily difficult implications for the use of longer term varieties in the South and West where the reliable rainfall season is much shorter, and timeliness in cultivation and planting more critical.

It is apparent from the extensive feeding of the leaves and stalks of maize and sorghum, reported by 93% of cattle owners, that the feeding situation is difficult. Leaves are stripped from maize still standing in the field once plant growth has stopped and while the cob is milky.

Extrapolations of these apparent trends in the Siaya farming system are inevitably gloomy. The combination of falling yields and increasing labour constraints will reduce the usefulness of the traditional management tools and the flexibility of action of the farmer. One must foresee an increased incidence of food scarcity in the area, lower cash surpluses as the farmers priority for an assured food supply further dominates his production decisions, a sacrifice of preferences for maize and a move into the lower risk starch staples; sorghum and cassava.

3.5. KEY DECISIONS IN THE DEVELOPMENT OF FARMING IN THE SIAYA ZONE

To allow the planning of adaptive agricultural research which effectively serves Siaya farmers, decisions are needed on the direction in which the farming system should be developed. In such decisions it must be borne in mind that if the direction chosen for development is to be acceptable to Siaya farmers it must be consistent with their priorities and the steps along the path must be within their resource capabilities to implement. We have seen which way the system is moving, the major question is whether to try to reverse this trend; preserve the livestock enterprise integrating it more closely with the cropping, or accept the trend and try to ensure an efficient use of arable land without a livestock component.

Elements of a true mixed farming system have emerged in Siaya. The long established tradition of draught animals and more recently the use of animal manure and the feeding of maize and sorghum leaves and stalks to the animals. In the adjudicated areas stockowners, grazing animals on their own land, have begun to be more aware of the pressures and more conscious of their own responsibilities for solving the problem. Given the very strong tradition and attraction to livestock among the people, they are likely to be receptive to developments in grazing management.

The potential benefits of keeping livestock are there; draught power with lower human energy requirements and better timeliness of operations, manure, milk, meat and potentially, grass as a valuable rotation crop. However, given the population density, large herds can not be supported. The evidence shows they are already fading out. With the relatively poor rainfall regime only modest stocking densities will be feasible. Traditional herd structures are too extensive to support enough milk cows and draught animals. It seems probable that a choice will be needed between draught and milk animals and that either draught or milk animals will have to be brought into the area from outside, or if the choice is for milk, artificial insemination introduced. The ultimate form of livestock enterprise in Siaya farming is well into the future. Information from this present study, concentrating on maize research, is inadequate to draw conclusions. The questions posed need answers if livestock and pasture research is to be oriented to the needs of Siaya farmers. The questions posed are:

1. Given the population density and the stocking densities feasible under the rainfall regime can the benefits from livestock; draught use, manure, milk, meat and grass as a rotation crop, justify the use of scarce land by a livestock enterprise in the Siaya farming system?

2. If so, given the limitations on grazing area and stocking density, is a choice between milk and draught necessary, with other benefits the same in both enterprises?

3. If so, which alternative; milk or draught, is of greater potential value to the Siaya farmer. A decision will require evaluation of the purchasing/breeding and feeding management possibilities for each alternative.

4. From the current existing situation what sequence of steps in the development of the chosen enterprise are compatible with Siaya livestock owners priorities and capacities?

On the crops side the position is less complex. Ultimately a decision on the desirability of developing the livestock enterprise will have important implications in the choice between organic and chemical fertilisers as a means of maintaining soil fertility. In the short term the direction of crop development can be determined independently without compromising a decision on the livestock side.

The strong farmer priority for a reliable food supply and the high proportion of available farm resources being used in food production pinpoints the foodcrops, particularly the starch staples, as the focus for development and thus for research work. Efforts directed towards satisfying the farmers' food priorities with less of his resources will allow reallocation of released resources to production for the market and increased cash incomes. A high level of risk aversion is embodied in the existing cropping pattern and decision strategies. Innovations which reduce the effects of rainfall variations, as the pre-dominant hazard, on crop production levels will allow a reduction in the extent of insurance cropping releasing farm resources to cash crop production. Reducing uncertainty in food supply is a development orientation in harmony with the farmers' own priorities. Maize is the preferred starch staple and, at the same time, the crop most vulnerable to rainfall variations. Research to improve the productivity and reliability of the maize crop has a key role in implementing a development policy designed to reduce uncertainty in food supply and encourage a shift of resources into cash crop production. Section 4 details present maize management and sets out a research programme designed to give technology for improving maize productivity which is appropriate to the circumstances of Siaya farmers.

3.6. ANALYSIS OF THE FARMING SYSTEM: IMPLICATIONS FOR CROP RESEARCH

The analysis of the farming system allows some comment on criteria to aid the orientation of research efforts in sorghum, cassava and cotton. The limitations imposed by present resource constraints will be similar to those to be discussed in some detail for maize; largely problems of capital and labour scarcity. Comments are restricted to an outline of the crop characteristics which would be particularly acceptable to Siaya farmers.

1. Sorghum. As we have seen sorghum is a multi-purpose crop in Siaya farming, it is used for brewing, as a supplementary starch staple and as an insurance crop being less susceptible to rainfall failure than maize, and finally as a cash crop. Serena is well favoured for both brewing and food, its short maturity period gives the added flexibility in management which is of such value to Siaya farmers. It shortcoming, like that of Chunjo, the local short term variety, is poor storing quality. If short maturity and good storing characteristics are genetically compatible, breeding work to incorporate storing quality into a serena type variety would allow a single variety to cover the needs of Siaya farmers. It would reduce the need for the longer term sorghum presently grown for their storing qualities and which, because they are long term, necessarily take priority for farmers' resources at the critical period early in the long rains planting time; February to April. Resources released from these purely insurance crops would be re-allocated into cash earning opportunities.

2. Cassava. Cassava remains a valuable crop in the farming system as a complement in ugali making to both maize and sorghum and as a rotation crop. In addition to improved yields valuable characteristics to Siaya farmer are:

(a) The ability to form tubers very rapidly
(b) The ability to remain in the ground in a palatable state for a three period or better.
(c) Leaves which are acceptable as vegetables to Siaya families.

Here the emphasis in the supplementary characteristics is to give the farmer a management tool which increases his ability to react to food supply contingencies arising as a result of poor growing conditions for the preferred grain staples.

3. Cotton. Given the pre-dominance of reliable food supply as a production objective among Siaya farmers cotton planting will always be subordinated to the establishment of food grains. Improved productivity of the food grains will allow an increase in the area devoted to cotton, and a degree of earlier planting as the area of food crops grown to meet fixed family needs is reduced in response to lowered risks of failure. Cultivation and planting the smaller area absorbs fewer resources. However cotton would still have to compete for the released resources and earlier planting time with other cash crops, including food crops produced in surplus for sale on the local markets. In the Northern and Eastern areas of the zone where relatively sure short rains crops can be grown, in addition to the long rains ones, cotton is unlikely to become a viable cash crop. Picking the crop is labour intensive and it must compete for labour with the establishment and care of the short rains crops. A further disadvantage is that boll opening in the rains downgrades a high proportion of the lint. In the South and West on the otherhand, if food crop production from long rains crops can be made more reliable, removing the need for highly speculative short rain plantings of food crops, cotton might spread further as a cash crop - subject always to its competitiveness with other possible cash crops. Because food supply is a priority cotton is always likely to be planted in May or later. Screening varieties for tolerance to late planting would fit selections more closely to the priorities and resource capacities of Siaya farmers. Although the UK varieties were bred to carry over a short (3 week) drought period it is unlikely that this principle could be extended to justify short rain plantings in Siaya, the dry period from December to February is too long.

4. IMPLICATIONS FOR THE DESIGN OF A MAIZE RESEARCH PROGRAMME TO IMPROVE THE PRODUCTIVITY OF SIAYA FARMING.

4.1. INTRODUCTION

This section of the report examines the implications of the Siaya farmers situation for each of the components which usually features in a research programme designed to improve maize management, and in the extension recommendations which emanate from such a programme. Components covered are; variety, the use of purchased inputs, method of planting, time of planting, thinning and weeding. Each component will be examined on the basis of present practice in the Siaya system, determinants of present practice, the implications for the system of changes in practice and the conclusions on the part the relevance of each component to a research programme oriented to the needs and circumstances of Siaya farmers. The final part of this section outlines a maize research programme for the Siaya zone based on the conclusions drawn for each component.

4.2. VARIETY

1. Present Varieties

The present maize varieties grown have been described in section 3; Rachar a 130 - 150 day white variety is preferred for ugali making. The longer maturing hybrids (not specifically named by any surveyed farmers) and the rather shorter maturing H 511 and H 512 were also preferred by farmers for ugali. The shorter term Nyamula, a yellow variety, was used frequently by farmers due to its ability to produce grain earlier, or to give a crop despite relatively late planting, though it is not preferred for ugali due to the yellow appearance of the food. These are the varieties being used and the ones for which seed is readily available.

The survey showed 29% of farmers using purchased hybrid seed. This figure is rather higher than data produced by Gerhart (1975) for his Zone 3. Covering an area including Siaya (except the North of the District) and South Nyanza, he found 15.8% of farmers using hybrid in 1973. Hesselmark (1975) found 13% in 1974 in the same zone as Gerhart. Repeating this work in the 1975 season Hesselmark (1976) found 35% of farmers using hybrid seed. The increase is usage in 1975 and 1976 is possibly the result of a major sales campaign, supported by demonstration plots mounted by Kenya Seed Company partly as a result of the 1973 and 1974 findings. The impetus of this campaign is confirmed by farmers responses concerning year of first use in the survey done for this study. Although 29% of farmers interviewed used some hybrid seed in 1976, 39% reported having used hybrid at some time, of which half (24 farmers out of 48) tried it for the first time in either 1975 or 1976. 10 farmers, 42% of farmers who used hybrid before 1975 had stopped using it. This is not so dramatic as Gerhart's (1975) findings for his Zone 3. He reports 15.8% using hybrid in 1973 yet he also reports a total of 32.9% having tried hybrid in the zone, including 1.1% trying it for the first time in 1973. The implication here is that a massive 56% of farmers who had tried hybrid in Zone 3. before 1973 had reverted to local varieties. Gerhart (1975) asked the question 'why do you not plant hybrid maize'. A similar question was asked in the current survey and the sets of answers are compared in Table 17. As Gerhart notes total responses exceed the number of non-adopters since some farmers gave more than one answer. Of responses in the 1976 survey

Table 17. Responses to the question why farmers do not use hybrid seed

Response	Gerhart 1973 season	1976 season
Cost too high	52	77
Availability difficult	6	1
Never heard of it	14	7
Performance	20	24
Doesnt fit in with local practice	7	8

criticising performance, 10 specifically mentioned too long to maturity or susceptibility to rainfall shortages. In both surveys costs of seed and complementary inputs required were the major reason advanced for non-adoption.

2. Characteristics of maize varieties suited to farmers in the Siaya zone.

Diagrams 1, 2 and 3 are for Ukwala Division, South Gem location, Boro Division and Bondo Division respectively. The solid histogram shows average monthly rainfall, the broken lines show probability levels for 1, 2, 3 and 4 years out of five. The shaded areas show the water requirements for 150 day, 120 day and 95 day maizes. It must be emphasised that the rainfall averages and probabilities and the water requirements are very crude estimates. Rainfall data for each Division was obtained from local records maintained by the Ministry of Agriculture All available site and year records were pooled to estimate averages and probabilities. Water requirements estimates were based on work done by crop scientists in Kenya. Brown and Cocheme (1969) P.288 maize water requirements, Cooper (1975) P.8 H613c water requirements at Kitale, Law (1974). Growth patterns for major Kenya maize varieties, Darrah (1973) Effects of altitude changes on variety maturity. There are clear differences in the 'goodness of fit' of varieties with varying lengths of maturity in the three areas. Common features of the three areas are: highly unreliable rainfall in February which effectively limits earliest plantings to the end of the month or early March, and a shut off in rainfall in December. Beyond this each area is examined briefly.

(a) Ukwala Division and South Gem

This is the part of the zone closest to the higher rainfall areas in the north. Only one site with limited rainfall data (Akala) was available in South Gem. Much of this large sub-location may be more appropriately linked with Boro Division. On average the rainfall distribution can carry a long term (150 day) variety in the long rain season and a medium term variety (120 days) in the short rain season. On average residual moisture from relatively reliable May rainfall, helped by the contribution in June, will allow a 150 day maize to finish in the long rains. However in two years out of five June rainfall is relatively low. Accepting that residual moisture can help the crop for a month, long term varieties still grain filling into July will be prejudiced in a relatively high proportion of years. Given:

i. Siaya farmers priority for reliability in food supply and flexibility in management tools.

ii. The predominance of hand cultivation techniques in this area implying inability to plant much land on the beginning of the rains. (81% of all maize plantings in Simenya and Kambare, the two sub-locations in this area, were made after March 1st, and 35% were made after April 1st. Long term varieties would finish poorly in a high proportion of years if planted after the middle of March).

There is a strong case for a 120 day variety for the long rains capable of finishing off residual May rainfall even when planted in mid-March. There may be a case even here for a shorter term variety in the long rains to give more flexibility in planting time. Similarily, because of the relatively poor October and November rainfall in two years out of five, there is a case for a shorter 95 day term variety for planting in the short rains.

(b) Boro and Bondo Divisions

Based on the same grounds of farmer priorities and resource constraints the case for a short term variety (95 days) in these areas is very strong. A 120 day variety is too long in the drier areas of Bondo Division, even when early planted. In Boro grain filling of such a variety would be jeopardised in a high proportion of years due to relatively unreliable rain in May and June. Planting after the first of March would increase the failure rate. Similarly a short term variety gives a better chance of success in the short rain period, though, even in Boro Division, as indicated by the September and October probabilities in particular, the failure rate will be relatively high. Chances of a short rains crop in Bondo Division are very low. As we have seen, a high proportion of farmers have expectations of planting maize even in the Southern and Western parts of the zone. (94% for Omia Malo and Nyawita, sub locations in this area). This can be done within the traditional system at very low cost but it is clear that the yield possibilities from the short rains levels for this area could never support a high cost system of maize production. Importantly, given the population pressure, a short term maize will allow two crops from the same land. A shorter term variety will improve flexibility in management in ways which are of great importance to farmers in the Siaya zone.

(i) A shorter term variety will allow earlier food supplies in seasons following a poor harvest when household stocks are low.

(ii) Early harvests from a short-term variety will save farmers from having to purchase maize on the local markets at a time when prices are very high.

(iii) At the same time good managers will be able to sell maize on local markets at a time of high prices. It will be a profitable crop for them and it will help to reduce seasonal food prices by bringing supply closer to seasonal demand at this time.

(iv) In years when rains begin late, or start and stop again, a short term variety will more often be able to finish properly before the rainfall trough in June and July.

Overall a shorter term maize variety will improve the reliability of supply of farmers preferred starch staple and reduce the need to use resources on the long term 'insurance' sorghums which, because of their long maturity period, compete for cultivation resources in the early long rains and push back the timing of many of the maize plantings. There is insufficient information on the interseasonal yield distributions of various varieties to permit a probability analysis on yield variability among existing varieties.

3. Other desirable varietal characteristics

Yield remains the key criterion for variety selection, the selection should out yield the local Rachar under management conditions achievable by the local farmers. Yield is qualified, on the grounds set out above, by reliability in season to season yield levels, and the increased flexibility in management given by a short term variety, of particular value under farmers' circumstances in the Siaya zone. Further characteristics require consideration in selection work. Any selection should be white giving a preferred appearance to the ugali. Selections should

Diagram .1.

UKWALA DIVISION AND SOUTH GEM LOCATION, SIAYA DISTRICT, WESTERN KENYA.

1. Monthly average rainfall (mm) pooled for available years and sites - solid line
2. Probabilities for critical months showing number of years in five rainfall will be lower than levels indicated by the broken lines.
3. Approx. water requirements for 3 varieties of maize.

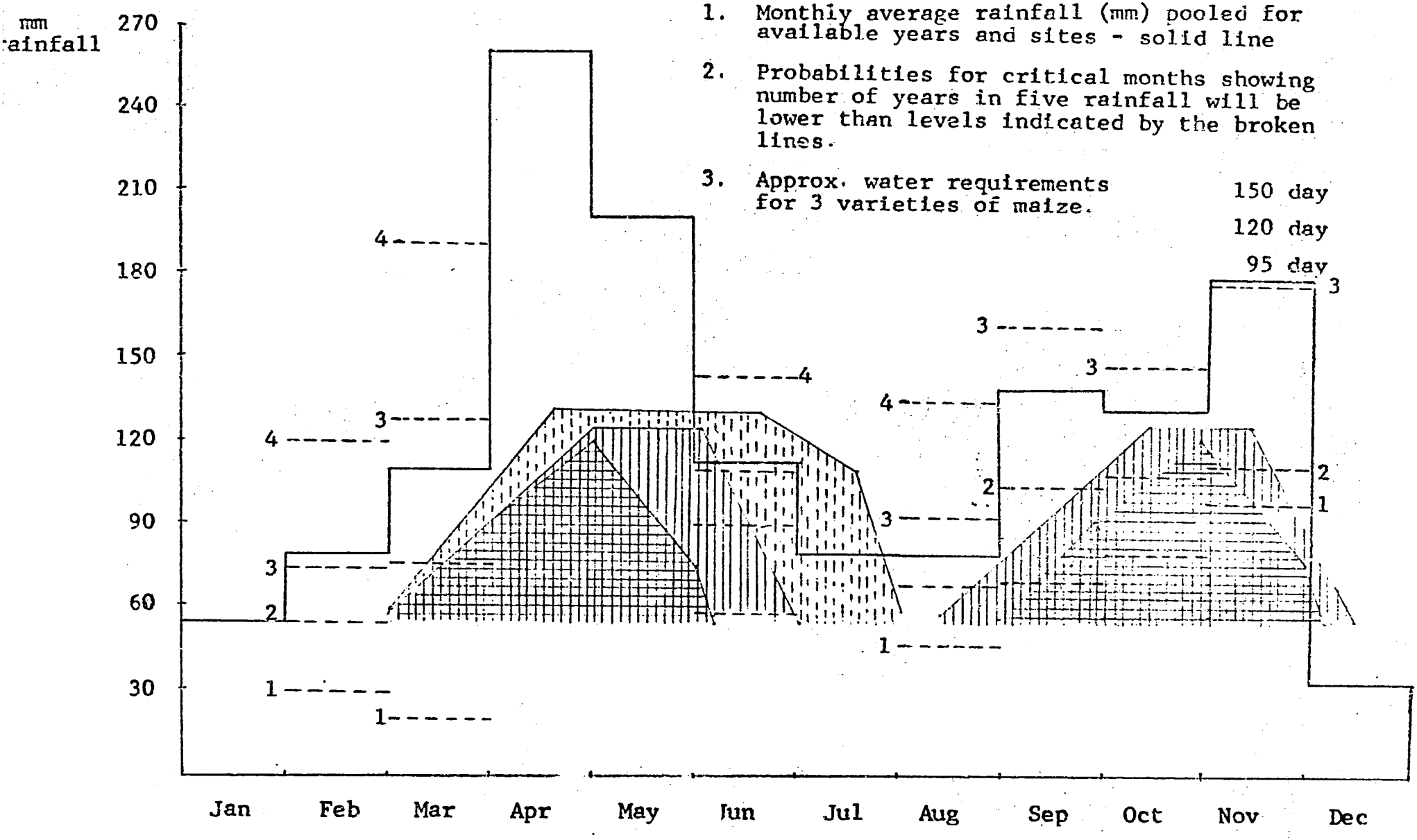


Diagram .2.

BORO DIVISION, SIAYA DISTRICT, WESTERN KENYA

1. Monthly average rainfall (mm) pooled for available years and sites; solid line.

2. Probabilities for critical months showing the number of years in five rainfall will be 'less than' the levels indicated by the broken lines.

3. Approx. water requirements for 3 varieties of maize.

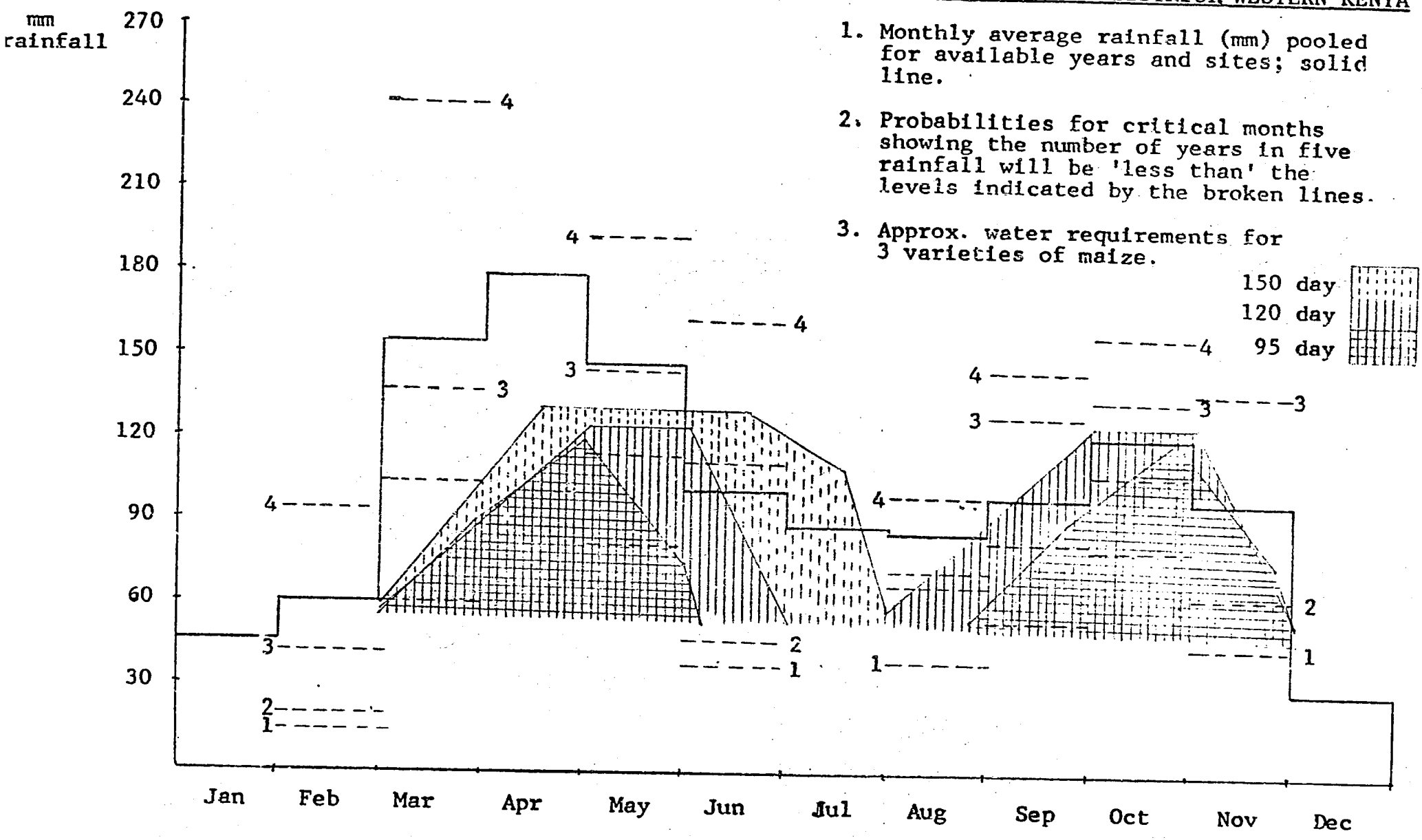
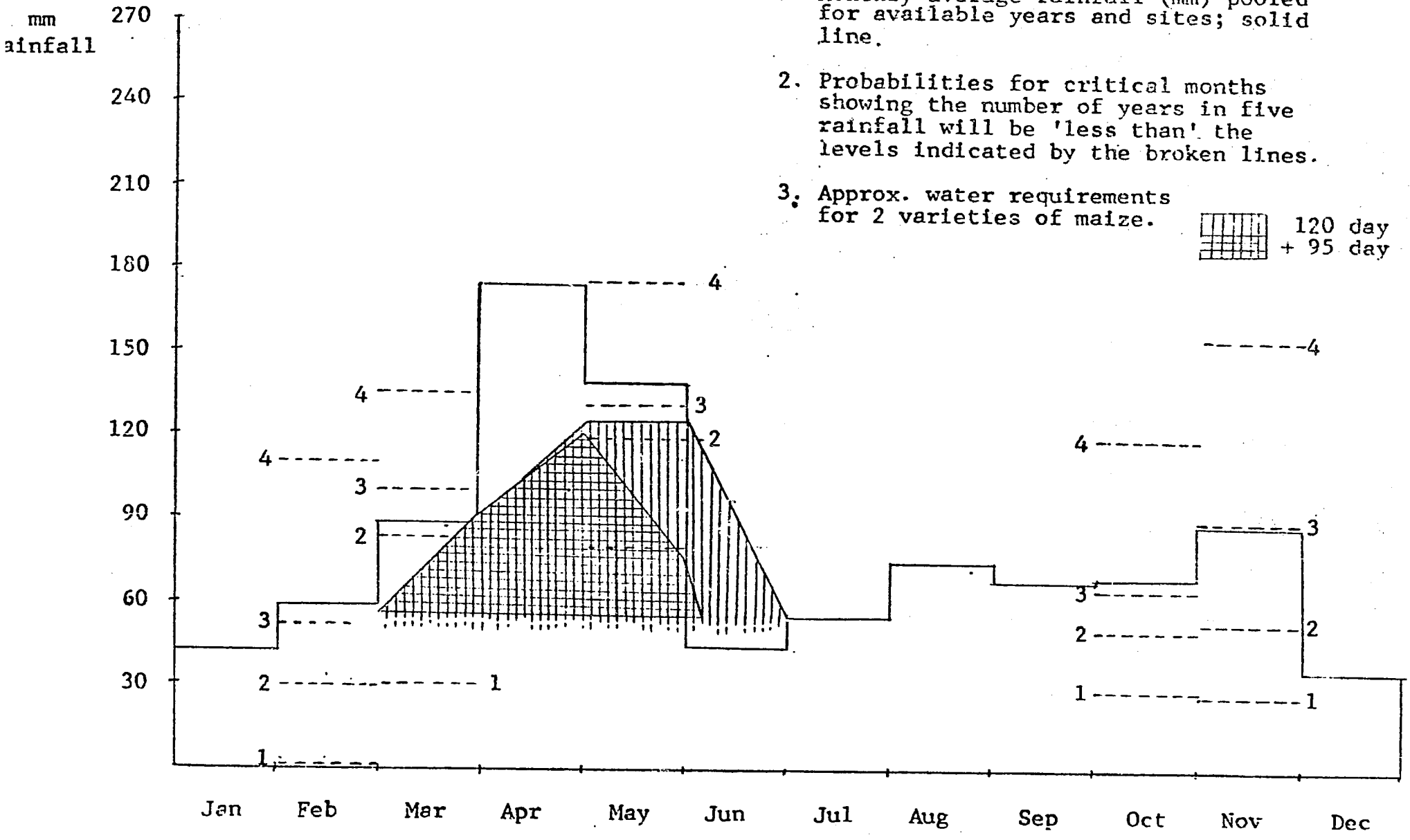


Diagram .3. BONDO DIVISION, SIAYA DISTRICT, WESTERN KENYA

1. Monthly average rainfall (mm) pooled for available years and sites; solid line.

2. Probabilities for critical months showing the number of years in five rainfall will be 'less than' the levels indicated by the broken lines.

3. Approx. water requirements for 2 varieties of maize.



store well; the seeds should stay on the cob and be at least as resistant to storage insects as the local variety but should also be easy to shell and hand pound into flour. Costs of the seed will be an important element in the farmers' evaluation of the change. A majority of non adopters gave cost as their reason for not using hybrid seed, however, it is unlikely that the cost of seed alone will deter farmers from using a hybrid, but as will be argued later it is the cost of fertiliser as a complementary input which is a major deterrent to adoption. A choice between hybrid and composite will depend mainly on the efficiency of the seed distribution in the zone, this, from available information, will require improving by helping stockists to finance the holding of seed stocks. If performance on other criteria is not significantly different a composite variety would be preferable.

4.3. THE USE OF PURCHASED INPUTS

The purchased inputs, in addition to seed, relevant to improved maize growing in Siaya are fertiliser and insecticide against stalk borer and storage pests. Of major concern, because of the high and the urgent need for an alternative means of fertility maintenance, is fertiliser. 11% of the interviewed farmers used purchased fertiliser in 1976, all these were using hybrid seed. 62% of farmers were using animal manure. The 46% of Siaya farmers buying purchased inputs had an estimated average outlay of Ks 260.00 per farmer. Using it as an example, the level of fertiliser application on the majority of the Kenya Seed Company 1976 demonstrations in Siaya was 500 kg/ha single superphosphate and 250Kg/ha ASN. At current prices the cash outlay for these applications is KSs 1,100.00 per hectare. This is something over 4x the average total working capital outlay of the 46% of farmers current purchasing inputs in Siaya and is probably close to the Gross Cash income of a significant proportion of Siaya farms. This level of outlay is covered by an increment of 18 bags of maize per hectare as a response to the fertiliser applied at current fertiliser/maize price relationships. Some authorities would not expect much demand for fertilisers from small holders, particularily in areas of high yield variability, unless they could earn a 50% return on their outlay. (CIMMYT 1976) This implies a yield increment of 27 bags per hectare in our example. A ratio of 2:1 for the minimum acceptable return is also quoted, implying, for our example a response of 36 bags of maize per hectare.

It is not so much the profitability levels which concern us here, although these require careful evaluation over a number of seasons, it is the high capital outlay. By far the majority of Siaya farmers do not have anything like these cash sums available. The little working capital they do layout is mainly on machinery and labour hire for long rains planting and weeding. Nor does the Siaya farmers' situation lend itself to a credit scheme for fertiliser purchase.

1. Most crops sales are surplus to food requirements and sold onto the local market. The cost of credit administration in terms of manpower and funds, particularily in controlling repayments in this type of marketing situation, is prohibitive when aiming to reach the majority of Siaya farmers.

2. The risk preferences of even the minority of Siaya farmers currently using working capital are unlikely to encourage them to double their present cash outlays. Even this would only provide fertiliser and seed for a half acre of improved maize at the rates of application exampled.

These circumstances have important implications for an adaptive maize research programme for the zone. Fortunately short-term varieties are usually more efficient in converting plant foods absorbed to grain and should respond better than longer term varieties to low manuring levels. The selection of shorter term varieties for the zone should be done under a low level manuring regime which a majority of Siaya farmers can be expected to achieve in the near future. Animals in Siaya are estimated to produce about 2.5 tons of farmyard manure per year per hectare. In all farmer populations there are a significant proportion of late adopters, perhaps a level equivalent to 4 tons of farmyard manure per hectare per year could be considered as a guide to the availability of manure with say 5 tons per hectare per year a constraint on the levels examined in experimentation.

4.4. METHODS OF PLANTING.

Due to the timing of the farmer survey, after farmers had harvested their maize, observations on plant populations and spacings are limited. No data was obtained on the spacing of intercrops. The limited data collected during the survey refers to 119 fields which had carried maize in the 1976 long rains this is compared to data from Gerhart (1975) and from Hesselmark (1976).

1. Present practice

71% of the maize grown was intercropped (110.7 ha out of 155.3 ha). 29% was grown in pure stands. This is exactly the same proportion recorded by Gerhart in 1973. 52% of farmers (62) made some pure stand plantings and a further 21% (26) made plantings of maize mixed with sorghum and no other intercrop. Of the 119 maize fields examined (after harvest) 48% were row planted, 29% were hill planted - that is the seed was placed but not in rows - and 23% were broadcast. Gerhart recorded 47% of farmers row planting in his study.

Table 18 sets out the data obtained on the spacing being used and the resulting plant populations for row planted and broadcast maize. Weighted

Table 18. Data obtained on plant populations in maize

Sub:location	Omia Malo	Nyawita	Kambare	Simenya	Total
Row planting					
no. of observations	16	24	17	13	70
Average interrow(cms)	85.0	80.0	80.0	87.5	82.5
Average interplant(cms)	40.0	35.0	55.0	29.5	40.0
Plant population (ha)	29,400	35,700	22,700	38,750	30,300
Broadcast					
no. of observations4	11	4	9	3	27
Plant population (ha)	29,400	10,000	18,550	23,300	22,200

by the number of observations (assuming these reflect the proportions planted in rows and broadcast) the average number of plants per hectare

recorded was 28,045. This is close to Hesselmarks (1976) figure of 28,200 for the whole of his Zone 3, and is equivalent to 11,200 plants per acre. Usually 2-3 seeds were planted per hole, 47% of these fields were thinned and an average of 1.6 plants found per surviving stand.

2. Implications for a maize research programme

Intercropping still predominates in the management of the maize crop. It is known to produce a higher value of crops than pure stands in many traditional farming systems. It is recognised as having value in insuring a return to resources employed in cultivating planting and weeding by mixing in crops less susceptible to hazards, in the case of Siaya, poor rainfall conditions. Despite the predominance of intercropping a significant proportion of Siaya farmers, 73% if those mixing only maize and sorghum are included, plant in pure stands. Research on intercropping is highly complex, the extra variables greatly increase the factorial permutations and thus the experimental work and the time required. The methodology associated with intercropping experimentation needs further development, and, unless monocropping is clearly unacceptable to farmers, short term adaptive research can more easily be undertaken on this basis. In the Siaya zone, despite the high level of intercropping, a high proportion of farmers are already planting maize in pure stands and the payoffs to research on a pure stand basis will be more readily achievable.

Despite a continuing prevalence of intercropping maize populations in the area are quite high, averaging over 28,000 plants per hectare. There is no reason why the close spacing usually associated with recommended practices should be difficult to accept for Siaya farmers. However, given only a low level of manuring is feasible, the interactions between the level of fertility and plant population will be an important aspect of the agronomy work.

It was reported from discussions from farmers that there is an increasing adoption of row planting. Under increasing pressure from a labour bottleneck during the weeding period farmers have begun to appreciate that row planting facilitates rapid weeding. Although presently only 48% of fields are row planted with a further 29% hill planted, only 23% of fields are now broadcast. Present practice does not place any obvious limitations on the planting techniques which it may be desirable to incorporate in experimental work.

4.5. TIME OF PLANTING

1. Present time of planting of maize

Two sets of observations were obtained for the time of planting of maize. Each maize planting was recorded for each farm and also planting time on the 119 selected fields were recorded. Table 19 sets out the incidence of all maize plantings and the proportion of area planted in each month. Out of the 119 fields examined in more detail 33 or 28% had to be replanted, these were all completed before the end of April. As has already been intimated farmers appreciate the value of early planting. It is beneficial to all the crops they grow. 28% of farmers had started cultivation in December and 47% by the end of January in order to be ready for the rains. However it is not feasible for them to plant all their crops at the onset of the rains, nor, given frequent false starts to the rains is it desirable. Priorities competing for the limited labour and draught resources ensure that planting will be stretched over a two month period on most farms. This staggering of planting helps to stagger

Table 19. The incidence of maize plantings on sampled farms

MONTH	Feb	Mar	Apr.	May
Number of plantings	52	66	35	16
% of area planted	33	40	21	6

demands for labour for other operations, in particular weeding, and allow the farmer to manage a larger area of cultivated land. Given the likely trend towards more hand cultivation the spread of planting is likely to be wider as more labour is required for the hand operation. Further, as hand cultivation on the heavier soils is very difficult to do before the ground is thoroughly wet, the trend may be towards later planting in general.

2. Implications for the maize research programme

It is because this resource constraint in seed bed preparation and weeding is very widespread in small family farming that time of planting components have been a great stumbling block in extension recommendation. Analysis of the farming system has suggested that risk of crop failure in maize, and therefore the use of resources to insure against such failure can be reduced by the use of a shorter term maize. Given local rainfall conditions a 95 day variety will increase reliability in yield levels and improve the flexibility of action available to managers. Both these desirable features would be further enhanced if the chosen variety was insensitive to the time of planting effect. It is recommended that tolerance of late planting is a further, supplementary selection criterion.

4.6. WEEDING

1. Present practice

As has been discussed in section 2.5 the evidence, both the subjective responses of farmers and their actions in supplementing family labour by hired resources, indicates a labour peak at a time when the weeding of early crop plantings and the establishment of later plantings overlap. March and April were indicated as the busiest period of the year for farmers in the Siaya zone. In this context all farmers weeded their maize once and 61% of farmers weeded it a second time. Distributions show the timings of first and second weedings on 119 fields of maize in Table 20. (Some farmers mentioned two months in responding) A short, 2 ft long hoe, weighing some 1½ kg is used for weeding.

2. Implications for a maize research programme

The fact that labour for weeding, and capital for hiring supplementary labour for weeding are in short supply in the system has important implications for a maize research programme. It is true that higher yields will allow food maize requirements to be met off a small area planted. However, because the farmer is averse to risk he is unlikely to reduce his planted area in anticipation of higher yields. He will

Table 20. Distribution of first and second weedings on 119 fields of maize

MONTH	Feb	Mar	Apr	May	Jun
Incidence of 1st weeding	2	32	60	23	8
Incidence of 2nd weeding	-	1	15	44	18

continue to cultivate the same area at least until he has been assured, by experience, that his yields are higher and/or more reliable. Further, in the case of the Siaya farmers; surplus food crops being their major source of cash income, they are likely to maintain their planted area regardless of yield levels, to realise larger cash surpluses.

The effects of asking Siaya farmers to increase their weeding intensity as part of recommendations for improved maize management are likely to be counter productive; either they will be pressured into cultivating reduced areas or into using scarce capital funds to hire extra labour for weeding. Any maize improvement programme would hope to see those scarce funds moving into the purchase of manure or fertiliser. In the medium term the enhanced flexibility in management provided by the short term varieties will allow a further spreading of the demand for labour resources, at this stage increased intensity of weeding may be feasible. In the shorter term it is recommended that weeding levels in the experimental programme are held to those now being achieved on Siaya farms; a maximum of two weedings in the two month period after planting. At the same time varieties should be screened for weed suppression from rapid early growth and large leaf areas.

4.7. A MAIZE RESEARCH PROGRAMME FOR FARMERS IN PARTS OF SIAYA DISTRICT RECEIVING LESS THAN 1500 mm ANNUAL RAINFAL

A five year programme with the probability of initial recommendations emerging after three years work might have three overlapping phases.

- Variety selection over years 1, 2, 3
- Agronomy work on the three best adapted varieties over years 2, 3, 4
- Management refinement over years 3, 4, 5.

The programme assumes effective adminstration and supervision and would be multi-locational within the zone on soils typically used by farmers for growing maize. The first phase of variety selection, would be wide based in Year.1. with perhaps 10 sites across the range of rainfall found in the zone; 800 - 1500 mm, treating sites as replicates. It would be repeated in the long and short rain seasons. In the second year repetition of the variety selection trials would be limited to perhaps five sites and factorials would take place at the same sites with perhaps two replicates at each. Refinements, beginning in year 3, would be done at a single site which is relatively easily administered.

1. Variety selection

Readily available white composite and hybrid varieties with maturity periods of between 90 and 120 days in the Siaya area would be compared with the local variety in a three year programme covering both long and short rain plantings. This programme would be implemented at a management level as close as possible to that now being achieved by farmers; time of planting in mid March, 2.5 tons of FYM per hectare per year, a population of 28,000 plants per hectare and a maximum of two weedings in the two months following planting. Recording should cover rainfall data at each site, physiological features including speed of growth/ degree of ground cover, time of tasselling, time of grain setting and time of grain harvest, also the incidence of pest and disease attack in the field. Major selection criteria will be yield of course, and reliability of yield using inter site data, comparisons between long and short rains and inter year data for assessment, 20 observations on each selection would be available at the end of the first year from long and short rains plantings at 10 sites. Parallel with the first years field work checks should be run among the farm population on palatability and ease of processing. Checks should also be run on the resistance to storage pests of the entries in the variety trials. These checks, together with records on in field pest and disease attacks would serve as supplementary selection criteria.

2. Agronomy work; varieties and management

The best three varieties should be selected and used as one factor in two sets of factorials, each set examining two management factors in relation to the varieties. If the local variety is only marginally inferior to the third best selection it should be included as a variety in the factorials rather than this selection. Entries may differ at higher and lower rainfall sites. The varieties entered may change in years 3 and 4 as a result of the additional experience with varieties in the selection trials. If entries are changed in year 4 it will be desirable to continue the agronomy work into the 5th year.

(a) The first set of factorials should examine the interactions between FYM use at three levels; perhaps 0, 2.5 tons/ha and 5.0 tons/ha, plant population at three levels; perhaps 25,000, 35,000 and 45,000 per hectare and the three variety selections. In this set time of planting should be held at the median time at which farmers are now planting; say mid March. Similarily weeding should be limited to twice at intervals of 3 - 4 weeks.

(b) A second set of factorials should test the three selections for time of planting effect with three treatment levels of say 1st and 20th of March and 5th April. Also for weed tolerance with perhaps 1, 2 and 3 weedings within the first six weeks of growth. In this set plant population and manuring should be held at farmers levels; say 28,000 plants per hectare, and 2.5 tons/ha FYM.

There should be no non-experimental treatments which are not consistent with present farmer practice in any of the selection or agronomy work.

3. Management refinements

As a result of the farming system analysis more detailed work is justified on three aspects of management. Clues on the orientation of this work should emerge from the initial agronomy work in year 2.

(a) Examination of the optimal timing of the limited weeding input the farmer can manage.

(b) Examination of the rates/frequency/placement alternatives in the use of FYM within the bounds of the 4 tons/ha/year judged to be available to farmers.

(c) Examination of the response to artificials with a budget constraint of about Sh 400.00 per hectare. Lower levels of inorganics will probably be found to be consistent with the shorter term varieties being advocated and the later planting dates.

From the results of three years work; given positive results emerge, it should be opportune to mount a set of demonstrations in farmers fields comparing the local and selected varieties with and without manure. In the demonstrations the selected varieties should have the benefit of findings on plant population and the timing of the weedings. Local varieties should be demonstrated under farmers' management levels.

5. SOME COMMENTS ON PROCEDURES

5.1. INTRODUCTORY

The report documents the findings from a demonstration of a set of procedures designed to allow an interdisciplinary approach, marrying the skills of crop scientists and economists, to adaptive research planting. The philosophy behind the approach is that adaptive research efforts should be based on an evaluation of the priorities of local farmers and of the constraints within which they are obliged to operate. Only such a basis can produce recommendations which will be acceptable to and absorbed by farmers in the area the research is serving. In these concluding paragraphs of the report we look at some of the problems which arose in implementing the demonstration and some possible modifications in the methodology to suit Kenyan circumstances.

5.2. PROBLEMS IN IMPLEMENTING THE DEMONSTRATION

The essence of the methodology is a team approach to the identification of farmer problems and of possible solutions to the problems. For the demonstration we liaised closely with the Research Division, the Ministry of Agriculture, we received considerable help, in the field, from the extension staff of the Ministry of Agriculture following support of the project by the Director of Agriculture, and we had first class support in everyway from our associates in the project; The Department of Economics and Farm Management, Egerton College. Yet, due to the geographical and administrative isolation of these various units, it would be difficult to consider them as a team in the sense of the word envisaged by the approach. It is considered that much greater insights into farmers needs and problems would be possible with a team of scientists operating at the level of the local research centre, with a day today interest in a coordinated effort to solve local problems. This being the first demonstration a closer coordinated team effort was difficult. Two changes would considerably enhance further use of the approach in Kenya.

1. The establishment of a post for an economist within the Research Division of the Ministry of Agriculture.

2. An appointment of a team, including a breeder, agronomist, a plant protection worker an extension worker and an economist, as far as possible with existing, local responsibilities, by the Director of Research to implement the approach in areas selected for further

demonstrations.

The major component of the approach is the farmer survey. Its implementation is the responsibility of the economist and takes about 4 man months of his time. Other professionals are involved in orienting the survey work and interpreting the results, their commitment involves only 10 - 15 days over a six month period. Such a limited commitment is unlikely to interfere with their existing programmes and could reasonably be undertaken by existing personnel.

5.3. MODIFICATIONS OF METHODOLOGY

A great deal has been learned in the course of implementing this, the first, demonstration of this approach to adaptive research planning in Eastern Africa. Three major points have already aided the orientation of other demonstrations currently underway in Tanzania and Ethiopia.

1. The balance of effort between pre-survey and farm survey can usefully be modified. A longer pre-survey period using a more carefully designed approach to farmers, allows a much closer focussing of the survey questionnaire, a shorter formalised interview during the survey, a faster rate of work and a cheaper operation.

2. The documentation of factors in the environment seen as hazards by farmers, and the documentation of their management alternatives in the face of such hazards, gives very useful indications of the criteria likely to be important in designing an adaptive research for the area. These areas of investigation deserve more emphasis in future work.

3. A post survey visit may be just as valuable as a pre-survey visit in verifying conclusions reached from analysis of the collected data.

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