FOOD RESEARCH INSTITUTE

(C.S.I.R.)

THE RELATIVE ECONOMIC POSITION OF COWPEA

IN THE PROGRAMMES OF FARMERS IN THE

NAVRONGO-BAWKU & DENU-ABOR

AREAS OF GHANA

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S U M M A R Y

The relative position of cowpea in farmers' programmes in the Navrongo-Bawku and Denu-Abor areas in the Upper Region and Volta Region of Ghana respectively has been investigated.

Most farmers in the Navrongo-Bawku area engage in arable as well as livestock production in a complimentary relationship while in the Denu-Abor area livestock production is relatively unimportant. Several crops are produced in both areas and the system of intercropping which prevails has made it possible for several enterprises to occur. The following enterprises however stand out as the most common or popular in the two areas:- Navrongo-Bawku area - millet; rice; groundnut (as pure crops); millet/cowpea; Cowpea/groundnut; millet/sorghum/cowpea and millet/groundnut/cowpea (as mixed enterprises). In the Denu-Abor area, cassava; maize; cowpea; groundnut, tobacco (as pure crops) cassava/maize; cassava/cowpea; cassava/maize/cowpea and cassava/maize/groundnut are the most common enterprises.

According to the farmers' own ratings, cowpea is their 4th and 3rd most important crops in the Navrongo-Bawku and Denu-Abor area respectively. However, in terms of its contribution to farmers total annual output from crop production cowpea was found to rank 5th in the Navrongo-Bawku and 3rd in the Denu-Abor area while in terms of cash receipts or farmers' cash incomes from crop production, cowpea's contribution was found to be the 3rd largest in both survey areas.

Food for the household and cash motivate farmers in both areas to cultivate cowpea and they would produce more cowpea if there were assurances for good yields. In the present circumstances of the farmers, cowpea as a

pure crop is not a profitable enterprise in the Navrongo-Bawku area although when produced as an intercrop with millet and sorghum, the three ~~afford~~ *Constitute* the optimum enterprise (among the popular ones) for investment.

In the Denu-Abor area cowpea (pure crop) is the ~~most~~ optimum enterprise for investment by the farmers however where August labour is seriously limited, cassava (pure crop) should take precedence. over cowpea.

CHAPTER I

INTRODUCTION

1. Problem;

Ghana produces about 30,500 metric tonnes of cowpea annually (10). However as a result principally of insect damage, 20-30 percent of this becomes unavailable for human consumption. In addition to total domestic production an estimated 1000 metric tonnes of the produce enter the country every year from the neighbouring countries especially Togo and Upper Volta. It is therefore estimated that about 6.0 - 6.8 lbs. or 13-15kg of cowpea is potentially available for consumption per capita per annum in Ghana for those aged one year and above. This compares with the FAO estimated consumption rate of 40gm per day per person for Africa South of Sahara (5).

It is the opinion of many people that cowpea should assume more importance in the diets of large sections of the population in many low income countries. This opinion is based largely upon the fact of low or inadequate protein intake by the majority of the peoples in these countries and the existence in these countries of the potentials for increased production of the crop. In the case of Ghana the very frequent pressures on the supplies of the preferred protein-sources meat and fish - emphasise the need to exploit other sources. Cowpea is high in digestible protein (4) and is one protein source which is already well known to a large section of the population and which can be produced locally, cheaply and at very short intervals. However any campaign to promote increased consumption of cowpea would most certainly raise the economic status of the crop vis-a-vis the others. Such a campaign should be based on a sound knowledge of the present production and consumption trends; the potentials for, and the bottleneck of increased output. In addition

farmers' attitudes towards the crop should also be well known.

2. Objectives:

It has been observed in a reconnaissance study of cowpea production and marketing in Ghana that although the crop is cultivated throughout the country it is cultivated almost entirely as a subsidiary crop (10). This however, does not give a precise definition of its relationship with other crops. The present study is therefore aimed at finding the relative importance of cowpea in the programme of farmers. More specifically the study would assess the competitive position of cowpea in farmers' overall crop production programmes. Other objectives of the study are:-

    i. To identify the bottlenecks in cowpea production;

    ii. To assess farmers' motivation (if any) for increased production of the crop and

    iii. To evolve an optimum enterprise mix including cowpea

                  (if possible) which would enable

farmers to maximise their returns.

3. Methodology:

Since it was decided to carry out an in-depth study of the subject only two areas in Ghana were selected for the study. The selection of these areas was based on total annual output of the crop, for example the Navrongo-Bawku areas was chosen for the study because it is the most noted area for cowpea production in the Upper Region which produces the largest tonnage of cowpea in Ghana (see Appendix Table I). Volta Region is the third largest producer of cowpea after Upper and Northern Regions besides it is believed that the largest number of cowpea varieties is grown in this

Region[1]   . Volta Region was therefore chosen as the second

Region with the survey being conducted in Denu-Abour area because it is

the foremost area in the Region for cowpeas (Appendix Table 1). The

Navrongo-Bawku and the Denu-Abor survey areas together cover 488 square

miles or 801 Sq. Km. and they are shown by Maps 2A and 2B while Map 1

indicates their position in Ghana.

4. Details of the Survey:

Field surveys in the Upper Region were carried out from August to

November 1974 while those in the Volta Region were started in late

September and ended in late November. In the Navrongo-Bawku area (Map A)

a total of 18 villages were randomly selected over the whole area while

every village in the Denu-Abour area (Map B) was visited. To obtain a

sample of farmers, every village divided into blocks of houses with every

third house within a block being selected for a visit. One farmer,

owner-operator of a holding within the house was then chosen for an

interview using a set of questionaire. In addition to the questionnaire

the farms of ten per cent of the farmers thus selected were visited to

assess crop acreages and plant population and to observe the execution of

some of the farming operations. On the whole 253 and 50 farmers were studied in

the Denu-Abor and Navrongo-Bawku areas respectively. However this report

is based on the analysis of the responses given by 190 and 47 farmers

from the Denu-Abor and Navrongo-Bawku areas respectively.

5. Definitions:

Farmers in Navrongo-Bawku area had very good idea about the extent

of an acre of land. Perhaps this was due to very frequent contact with

extension workers. This was however not the general situation with

farmers in the Denu-Abor area. Farmers in the latter area measured the

land with ropes

[1] Personal Communication with the Assistant Director
of Agriculture Volta Region.

MAP 1
GHANA

—4—
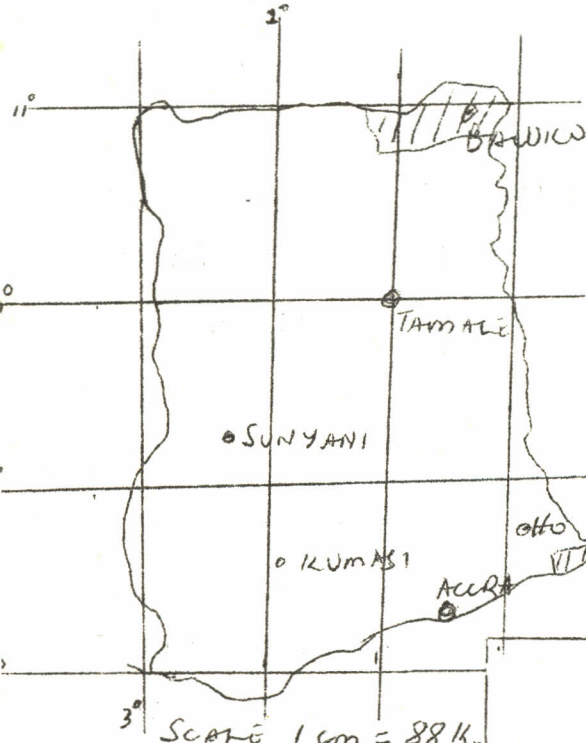
2°

1°
11°

0°

BAWKU

TAMALE

2A NAVRONGO-
BAWKU SURVEY
AREA ↓

SUNYANI

KUMASI

Otto
Denu

AFLAO

ACCRA

3°
SCALE 1 cm = 88 Km

Scale: 1 cm = 16.1 km

magan ori
Bawku

Paga
Navrongo
Chuchai ga
Bolga
Kologo

Bongo

Zebilla

Binduri

Pusiga

Zuarungu
Tongo

Garu

Kologu
Pwalugu
Karamenga

Nakpanduri

Walewale

2B
DENU-ABOR
SURVEY
AREA ↓

To Ho
←

Hevi

Dzodze

Ayitikope
Gefia

Kuli

Penyin

Tadzevu

Tadzi
Afoeta
Horme

Weta

Ehi

Kutsum

Amedzikope Denu
Waive

Wuti
Ohawu

Glitana

Dueyakope

Abor

Afife

Agbozuma

Sasieme

Atsiane

Anyako
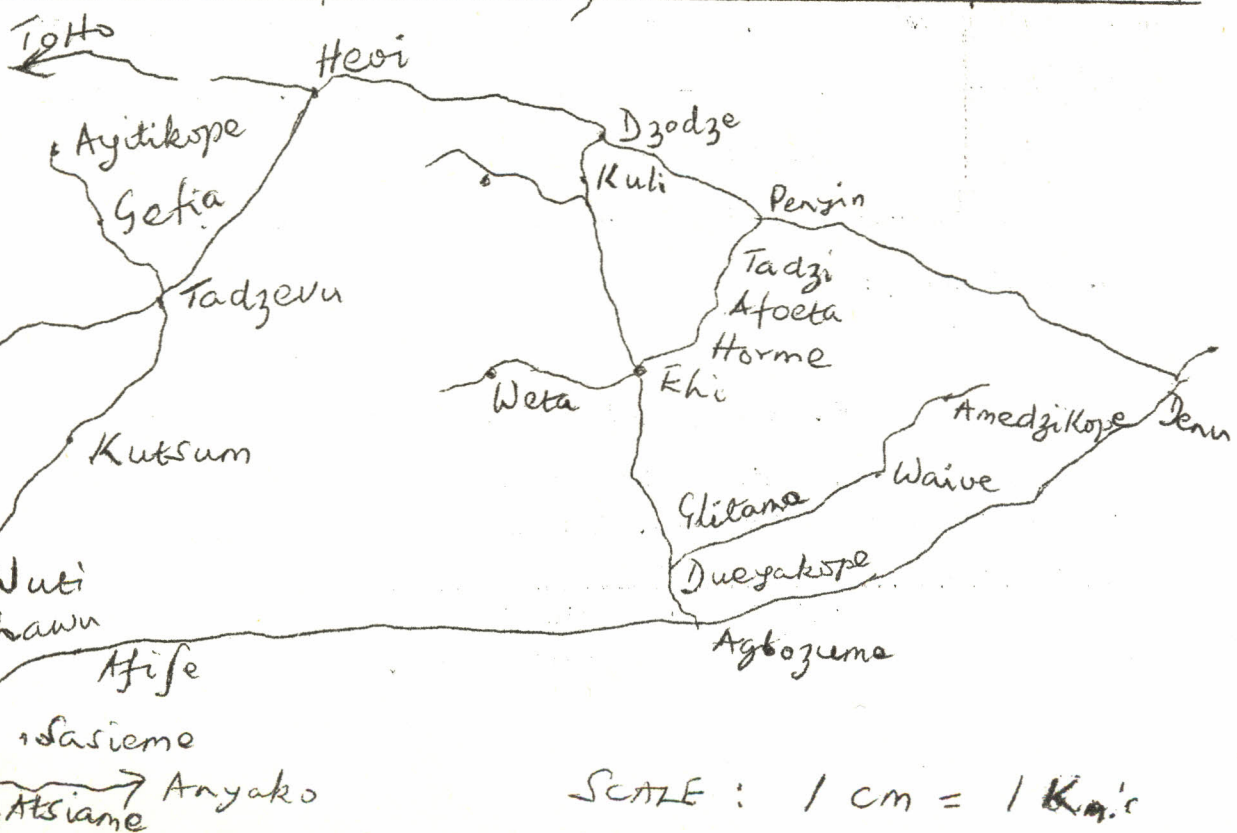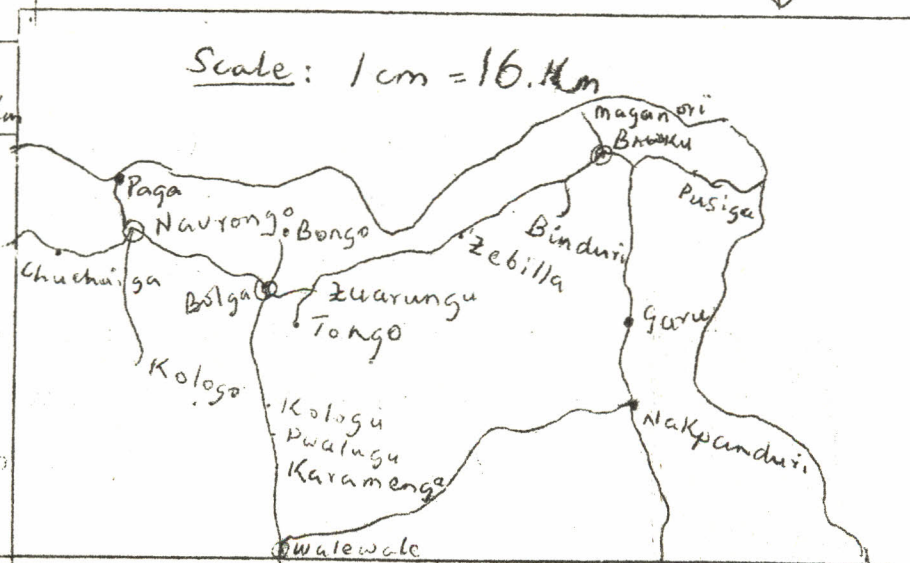
SCALE: 1 cm = 1 Km's

The same observation was made by Steckle (_18_) in the
Avatime area. Each household possessed its own rope. These
ropes were measured by the arm's length and therefore varied
slightly from household to household. The ropes encountered
varied from 5 to 8 yards (4.6 - 7.3 metres) and averaged 6
yards (5.4 metres). The square of 5 - 8 of these/normally 6
(lengths square) were taken as one acre by the farmers - although
that in actual fact worked out to be 0.7 acre. This has been
taken into account throughout the report and conversion
made where necessary.

CHAPTER II
FACTOR RESOURCES FOR FARMING

1. Available Land Resources

Land as a factor of production has often been blamed for being a large contributor to the low total output of farmers in many parts of this country. The fertility of the soil is said to be very poor in many parts while the difficulty of tenure systems is often mentioned as militating against expanded crop production. Attempts were therefore made in the study to find the extent of land available to the farmers studied and to investigate the nature of the constraints, if any, imposed by land on their farming operations. Table 1 gives the data on the land possessed by the farmers.

TABLE 1   LAND AVAILABILITY TO & UTILIZATION BY FARMERS - 1974

	Navrongo-Bawku Area Acres (Hectares)	Denu-Abor Area Acres (Hectares)
Range of land available to the farmers	3-60 (1.2-4.3)	1-100 (0.4-40.5)
Average available Land/ Farmer	16.7 (6.8)	11.6 (4.7)
Land Utilised per farmer	12.2 (4.9)	5.6 (2.3
% of total available land/farmer	73%	48%
Average Annual Rent/Acre/ Hectare of land	-	₡10.32 (₡25.50)

The size of farming land immediately available[1] to the farmers varied quite considerably with the variation being greater among the farmers in the Navrongo-Bawku area than those in the Denu-Abor area. The total size of land immediately available for use by a farmer was estimated to average 16.7 acres (6.8 hectares)   in the Navrongo-Bawku area and 11.6 acres (4.7 hectares) in the Denu-Abor area (see Table 1). The percentage variation was calculated to be 34 and 7 among farmers in the Navrongo-Bawku and Denu-Abor area respectively. In terms of land use, it was found that besides having larger tracts of lands for farming, farmers in the Navrongo-Bawku area generally had larger farms and used much more of the land available to them per farmer than their counterparts in the Denu-Abor area. For example farmers in the Navrongo-Bawku area were estimated to have used 73 percent of the land imme- diately available to them in the 1974 farming season while those in the Denu-Abor area utilized only 48 percent of what they had (see Table 1). Total land area put under crops in the 1974 season was estimated at 12.2 and 5.6 acres (4.9 and 2.3 hectares) per farmer in the Navrongo-Bawku and Denu-Abor areas respec- tively[2]. The rest of the available land in both areas was under fallow.

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[1] Land which the farmers had the right to use at the time.

[2] The differences in the extent of land utilization by farmers in the two areas may be explained in terms of the differences in vegetation, technology used in farming and the crops cultivated in both areas. The vegetation in the Upper Region

The data in Table 1 suggest that subject to some other factors than land, farmers in the Navrongo-Bawku and Denu-Abor areas could have expended their crop holdings by a total of 27 and 52 percent respectively if they adopted settled farming and its concomitant practices. However in the present circumstances where the farmers in the two areas, especially those in the Denu-Abor area, operate the land rotation system, it can not be said that the farmers have adequate land because they utilized only 48 percent of what is available to them. This is because assuming the same scale of operation every year, the un-utilized land in 1974 would be cultivated in 1975 and again in 1977 allowing only one year fallow period. Without the application of fertilizer or manure this land would certainly not have regained its fertility and since short fallow periods are known to be responsible for very low yields of crops under land rotation systems (17), it can be said that there is some amount of land shortage at least in the Denu-Abor area and that this is a contributory factor to the low yields of crops in the area.

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is savanna grass which is easily cleared even by burning; bullock ploughing is common while the popular crops of millet and sorghum usually encourage the cultivation of large acreages of land. The situation in the Denu-Abor area is very different. The vegetation is savanna woodland: farmers clear the land with the hoe and cutlass while cassava, the most predominant crop in the area is relatively more difficult to handle hence farmers' inability to cultivate larger acreages.

Land Tenure

Regarding land tenure, all the farmers studied in the Navrongo-Bawku area operated freehold family lands. However two farmers operated rented land in addition to the family lands. In one of the two cases the rent was settled my means of kind-payment of one bag of paddy rice, 180 lbs. (82 kg) per annum for all the 14 acres (5.7 hectares) acquired. In the other case there was a cash payment of ₡20.00 per annum for 11 acres (4.5 hectares). Acquisition of land for farming by the farmers appeared fairly easy as most of them indicated that they could obtain additional land when necessary although they did not consider the issue a pressing one at the time of the survey. In the Denu-Abor area the story was slightly different. Out of the 190 farmers in the sample, 161 or 85 percent operated on freehold while the remaining 29 farmers rented land. The tenancy for 10 of these was the share cropping of the Abusa type - the land owner taking a third of the output from the land. The remaining 19 farmers paid annual cash rents ranging from ₡5.00 to ₡17.00 per acre and averaging ₡10.32 per acre or ₡25.50 per hectare. The impression obtained was that land acquisition in the Denu-Abor area was more difficult than it was in the Navrongo-Bawku area.

2. Labour

Apart from land, labour can also impose a serious constraint on production expansion in traditional agriculture. It is often

argued that in traditional (rural) economics disguised un-
employment exists and that labour is often available provided
there is the purchasing power to pay for the services. The
fact is however that within the context of a village where every
individual is potentially not landless and where agricultural
activities tend to exhibit great periodicity, labour could be a
used both family and hired labour although the incidence of farmers
serious constraint. In the two survey areas, most farmers $\angle$
relying solely on family labour was lesser in the Denu-Abor area
than in the Navrongo-Bawku area. The absolute amounts of labour
requirement by the various crop enterprises are discussed later
in chapter VI of this paper.

3. Capital

In a strict sense, capital resources used in agricultural
production include farm implements/equipment:- hoes, cutlasses,
baskets, farm machinery (like tractors etc.) and the stock of
seeds and animals (especially those kept as breeding stock).
Table 2 gives the items of capital equipment possessed by the
farmers studied in the Navrongo-Bawku area. Corresponding data
were not obtained from farmers in the Denu-Abor to enable any
comparisons. However the hoes, cutlasses and baskets are widely
used in both areas. The most interesting thing however is the
use of bullocks for land preparation by many of the farmers in
the Navrongo-Bawku area. It was estimated that every farm
family possessed an average of two bullocks the range being from
0 to 10 bullocks per farm family (see Table 2).

The size of working capital available to the farmers for their
farming operations could not be assessed. However it must be
mentioned that none of the farmers studied in both areas had
an access to a source of institutional credit /although it was common
for then   to use the proceeds from other enterprises (e.g.
poultry & livestock) to finance their cropping activities and
vice versa.

TABLE 2   CAPITAL EQUIPMENT POSSESSED BY FARMERS - NAVRONGO-
BAWKU AREA

Name	Av. No. Per Farmer	Average Age	Total Original Value ₵	Current Value ₵
Hoe	9	11 months	9.00	3.00
Cutlass	4	13 "	4.00	2.00
Axes	0	-	-	-
Baskets	12	12 "	19.00	0.00
Bullocks	2	12 "	400.00	400.00
Tractors	-	-	-	-
Knives	10	-	4.00	4.00
Total	-	-	436	418.00

CHAPTER III

FARMING ENTERPRISES

1. Animal Production

The Upper Region of Ghana especially the Bawku-Navrongo (the area of the survey) is noted for livestock production. Data obtained from the 1970 Agricultural Census of Ghana indicated that about 54 percent of the total cattle population of Ghana occurred in the Upper Region with the Navrongo-Bawku area alone producing a good 21% of this (54%) ((12)) (see Appendix Table 2) /Results of the same census also showed that 69 percent of farm holders in the Navrongo-Bawku area were owners of cattle and that the average size of a herd in the Bawku sub-district was about 7 animals p56). Sheep, goats and poultry were also revealed to be important in the area (12). This shows that animal, especially livestock production, is an important enterprise of the people. Most farmers in the Navrongo-Bawku survey area were found to combine arable farming with livestock production for the mutual benefit of both enterprises. The system of livestock production was the extensive one with boys between the ages of 10-13 years being left to attend to the herds while the adults concentrated on crop production. The livestock was usually kraaled amd their droppings used as manure for the farm lands (particularly the compound farms). The animals in turn fed on the crop residues - the stalks of the sorghum and millet, and the vines of the groundnuts and cowpeas after harvesting.

Table 3 gives the stock position of the farmers studied in the sample - in the Navrongo/Bawku area at the time of the survey.

TABLE 3   STOCK OF ANIMALS AND SALES PER FARMER
           IN THE NAVRONGO/BAWKU AREA

Name	No. of Farmers	% of the sample	Av. No. Possessed by Farmer	Av. No. of Animals Sold/Year	Gross Income derived from Animals/year
Cattle	21	70	7	0.76	₵106.00
Sheep	14	46	6	0.57	9.00
Goats	14	46	8	2.00	14.00
Poultry	18	60	30	6.00	5.40

In all 21 or 70 percent of the farmers in the sample possessed herds of cattle. The average size of herd was 7 animals (see Table 3). This means that herd sizes had not undergone any detectable change since 1970 (12). It was estimated from the survey that farmers sold an average of 4 cattle in five years (Table 3) deriving about ₵106.00 in gross revenue per annum from the sales. It was not possible to place a value on the herds of animals possessed by the farmers, because of the difficulty in obtaining the age structure within the individual herds. Data were therefore not obtained to support nor dispute the frequent allegation that most livestock owners in northern Ghana like to keep their animals as status symbols (15). Table 3 also shows that cattle rearing is more important in the Navrongo-Bawku area in terms of the cash returns derived than the rearing of sheep and goats although the latter is also a fairly popular enterprise.

In the Denu/Abor area however, it was found that cattle rearing is not as popular as the keeping of poultry and goats. About 32% and 23% of the farmers studied kept poultry and goats respectively with each farmer possessing an average of 22 birds and 8 goats respectively (see Table 4). Only 2 or 1% of the farmers reared cattle while sheep was kept by only 16% of them. All the animals were kept under the extensive system and it was estimated that a farmer sold 4 chickens and 2 goats a year and derived ¢14.30 and ¢32.22 respectively from the sales. (see Table 4).

TABLE 4   STOCK OF ANIMALS & SALES PER FARMER IN THE DENU-ABOR AREA

Animals	No. of Farmers	(% of Sample)	Average No. Possessed per Farmer	Average No. Animal sold/year	Gross Income derived from Animal/year
Cattle	2	(1)	22	2.5	¢250.00
Sheep	31	(16)	8	2.3	53.96
Goats	44	(23)	8	2.2	32.27
Poultry	60	(32)	23	4.6	14.31

2. Crop Production

Crops Cultivated

Several factors determine the crops produced in a given area. These factors include physical conditions such as the soil and the climate; social factors like the eating habits of the people; economic factors such as the level of demand for the various crops and therefore the market expectations or relative economic gains from the production of existing crops. Sometimes too

political factors such as the direction of government policy on certain crops or the provision by government of auxilliary or facilitating services also influence the choice of crops by farmers. A total of 9 crops were produced by the farmers studied in the Navrongo-Bawku area. These crops were millet (late and early varieties), sorghum, cowpeas, groundnuts, rice, maize, kenaf, cotton and bambara beans (see Table 5A). In the Denu-Abor area of the Volta Region, the 11 crops encountered included maize, cassava, cowpeas, groundnuts, tobacco, sugarcane, tomatoes, okro, pepper and oil palm. (See table 5B)

3. Farmers' Ratings of Crops by Their Relative Importance

Within the dictates of the factors mentioned above, the final choice of crop or crop combinations by the farmer largely depends upon his objective function which may or may not conform to economic realism. To obtain the relative importance the farmers placed on each of the crops they produced, the farmers were asked to rank these crops. The crops were then scored according to the order in which they appeared. Points ranging from 5 to 1 were awarded to the crops which occurred from the first to fifth positions respectively in the farmers ranking. Tables 5A and 5B give the results for the Navrongo-Bawku and Denu-Abor areas respectively. The inclusion of livestock and poultry in the tables enables a comparison to be made between them and the crops in terms of their importance to the farmers. Millet and sorghum (in that order) were considered by the farmers in the Navrongo-Bawku area to be their two most important crops. They obtained the highest scores of 168, and 115 respectively (Table 5A).

TABLE 5A THE RELATIVE IMPORTANCE OF CROPS, LIVESTOCK AND POULTRY TO FARMERS IN THE NAVRONGO-BAWKU AREA OF THE UPPER REGION

Crop/Livestock Poultry	NO. OF FARMERS					Total Scores
	1st	2nd	3rd	4th	5th	
Millet	30	4	0	1	0	168
Sorghum	1	21	5	5	5	115
Groundnuts	0	5	13	6	2	73
Cowpeas	0	1	11	11	6	65
Rice	3	2	3	3	5	43
Livestock	3	2	1	2	2	32
Poultry	0	0	3	1	0	11
Maize	0	10	1	0	0	7
Cotton	0	1	0	0	1	5
Bambara Beans	0	0	0	0	2	2
Kenaf	0	0	0	0	0	0

TABLE 5B THE RELATIVE IMPORTANCE OF CROPS, LIVESTOCK & POULTRY TO FARMERS IN THE DENU-ABOR AREA - VOLTA REGION

Crop/Livestock Poultry	1st	2nd	3rd	4th	5th	Total Scores
Cassava	94	83	3	1	1	814
Maize	90	70	4	0	0	742
Poultry	1	1	21	10	6	98
Cowpeas	1	7	18	8	1	88
Livestock	3	1	10	12	6	79
Groundnuts	2	0	18	5	2	46
Tobacco	0	2	9	0	1	37
Sweet Potatoes	0	1	1	1	0	9
Sugar Cane	0	1	1	0	0	7
Oil Palm	0	1	0	1	0	6
Okro	0	0	1	1	1	6
Pepper	0	1	0	0	1	5
Shallot	0	0	0	2	2	4

The popularity of millet and sorghum stems from the fact that they are the people's most favoured staples which also find uses in the brewing of pito, a household beverage. Groundnut was the farmers' third most important crop while cowpea occupied the fourth position followed by rice, livestock and poultry. Bambara beans, Cotton and Kenaf were relatively less important to the farmers (see Table 5A).

In the Denu-Abor area, however, the farmers considered cassava to be by far their most important crop followed closely by maize (see Table 5B). The two constitute the maim staple of the people(18 p73-4). It is interesting to note that poultry (chicken) appeared as the third most favoured enterprise to the farmers. Cowpea was the farmers' fourth most important enterprise[1] and their third priority crop (Table 5B). It was followed in the rank by livestock (principally goats and sheep) and tobacco. Vegetables - shallot, pepper and okro were of lesser importance to the farmers.

4. Farm Holdings

The 47 farmers studied in the Navrongo-Bawku area operated a total of 141 farms or an average of about 3 farms per farmer. In the Denu-Abor area of the Volta Region the 190 respondents had an average of 1.6 farms each and a total of 307 farm (see Table 6). Those figures exclude holdings of livestock and poultry. Table 6 also shows that the average size of farm in the Navrongo-Bawku area was more than twice as large as the one in the Denu-Abor area.

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[1] poultry being the 3rd.

TABLE 6   DISTRIBUTION OF FARMERS BY NO. & SIZE OF FARMS

	Navrongo-Bawku Area	Denu-Abor Area
No. of farmers in sample	47	190
Total No. of Farms	141	307
Average No. of Farms/ Farmer	3.0	1.6
Average size of farm /Farmer	4.5 (1.8 hectares)	2.7 (1.1 hectares)

5. Occurrence of Crops on Farms

Inter-cropping is widely practised by farmers in both survey areas. In fact it is the system of cropping which dominates traditional agriculture in Ghana and other West African countries and which is likely to persist for a very long time to come. In addition to this pure cropping is also very common. Norman (16) points out several merits and demerits of inter-cropping and concludes that it has a slight advantage over pure cropping. Inter-cropping enables one particular crop to occur several times in the farmers' programmes. This is illustrated in Table 7 which gives the number of farmers in the samples producing the various crops and the frequency with which these crops occur on their farms.

TABLE 7   DISTRIBUTION OF CROPS BY FARMERS & NO. OF FARMS

	NAVRONGO-BAWKU AREA				DENU-ABOR AREA			
Crops	No. of Farmers	(% of Sample)	No. of farms	(% of Total No. of farms)	Crops	No. of Far-mers	(% of sam-ple)	No. of farms	(% of total No. of farms)
Millet	47	(100)	78	(55)	Cassava	180	(95)	222	(72)
Sorghum	42	(89)	43	(30)	Maize	167	(88)	191	(62)
Groundnuts	37	(79)	39	(28)	G'nuts	18	(10)	20	(6.5)
Cowpeas	46	(99)	68	(48)	Cowpeas	37	(20)	51	(16.6)
Rice	22	(47)	25	(18)	Tobacco	15	(8)	13	(4.2)
Others	9	(19)	15	(9)	Others	33	(17)	-	

Table 7 also shows cassava, maize cowpeas and groundnuts (in that order) as the most popular crops to the farmers in the Denu-Abor area. The relative frequency of occurrence of the crops on farmers' farms as indicated in the table also supports the order of priority presented in Table 5B. The same could be said about millet, sorghum, cowpeas and groundnuts from Tables 7 and 5A

6. Existing Enterprises

Denu - Abor Area

The essence of inter-cropping is to enable a farmer to reap more than one crop on a given farms. The system therefore gives rise to several crop combinations or farm enterprises[1] in any particular farming area. Table 8 provides data on the types and number of farm enterprises (pure as well as mixed) with acreages operated by the farmers in the Denu-Abor area.

[1] a farm of crop/s is here referred to as a farm enterprise

TABLE 8   CROP COMBINATION BY FARMERS IN THE DENU-ABOR AREA

Crop Enterprise	No. of Farms	(% of Total Farms	Total Acreage	(Hectares)	% of Total Acreage
Pure-Crop	117	(38.1)	402	(163)	33.4
Two-crop	160	(52.1)	630	(255)	52.2)
Three-Crop	25	(8.2)	68	(60)	12.3
Four or More Crop	5	(1.6)	26	(10)	2.1
Total	307	(100.0)	1206	(488)	100.0

The table shows that two-crop enterprises were by far the most popular in the Denu-Abor area. They accounted for 52 percent of the total number of farms and about the same percentage of the total land area cropped by the farmers studied. Pure-crop enterprises were the second most important. They comprised 38 percent of the farms and occupied 33 percent of the total acreage cropped by the farmers. It is important to note from the table however, that inter-cropping with more than two crops was relatively uncommon in the Denu-Abor area. This contrasts with the situation in the Navrongo-Bawku area where three or more crop mixtures were very common (see Table 10). Noted among the pure crops in the Denu-Abor area were cassava, maize, cowpeas and tobacco which occupied 42.3, 26.0, 6.0 and 2.7 percent respectively of total area covered by pure crops. It is also noteworthy that the extent of land devoted to the first three of these crops in pure-culture corresponds to the relative importance the farmers attached to these crops (see table 5B).

Other crops produced as pure crops were sugarcane, oil palm, yams and vegetables like groundnuts, shallots, pepper and okro but all these were relatively less significant in terms of frequency of occurrence and total acreage occupied - (see Appendix Table 3).

The combination of cassava and maize was the most common single enterprise in the Denu-Abor area. It occurred on 125 or 40% of The farms operated by the farmers. and occupied 35.6% of the total cropped land. Table 9 gives other two-crop enterprises operated by the farmers in the sample.

TABLE 9   COMPOSITION OF TWO-CROP ENTERPRISES - DENU-ABOR AREA

Crop - Components	No. of Farms	(%)	Acreage	(Hectare)	(% of Total Acreage)
Cassava/Maize	125	(78.2)	429	(194)	(68.1)
Cassava/Cowpea	21	(13.1)	83	(34)	(13.2)
Cassava/Groundnuts	4	(2.5)	18	(7)	(2.9)
Maize Cowpea	3	(1.8)	71	(29)	(11.2)
Others	7	(4.4)	30	(12)	(4.6)
Total	160	(100.0)	630	(255)	(100.0)

The table shows cassava/cowpea to be the second most popular enterprise appearing on 13 percent of the farms   and occupying 13 percent of the land devoted to two-crop enterprises. Other two-crop enterprises encountered were cassava/groundnuts and maize/cowpea. With regard to three-crop enterprises, which together formed only 12.2% of the cultivated land, cassava/maize/cowpea and cassava/maize/groundnuts were predominant. Together, the two

combinations covered 90 acres. Appendix Table 3 provides a list
of all the various crop enterprises or combinations found in the
Denu-Abor area. The table also provides information on the
frequency of their occurence as well as their acreages.

Navrongo - Bawku Area

Crop combinations in the Navrongo-Bawku area differed slightly
from those in the Denu-Abor area. Pure cropping appeared to be as
popular as intercropping in the Navrongo-Bawku area. Thirty-four
percent of the farms were pure-cropped while the same percen-
tage was occupied by three-crop enterprises. In terms of crop
acreages, however, pure crops occupied the largest percentage
(33%) of the total land area cropped in the season followed by
three-crop enterprises which covered 20.3% of the land (see Table 10).

TABLE 10   CROP ENTERPRISES (COMBINATION) IN THE NAVRONGO-
                              BAWKU AREA

Type of Crop Enterprise/ Combinations	No. of Farms	(% of Total No. of Farms	Total Acreage	(Hectare)	(% of Total Acreage
Pure-crop	48	(43.1)	252.0	(157)	(38.1)
Two-crop	39	(27.7)	211.5	(134)	(32.6)
Three-crop	49	(34.7)	130.5	(83)	(20.3)
Four or more Crop	5	(3.5)	58.0	(37)	(9.0
Total	141	(100.00)	652.5	(411)	(100.0

Rice was by far most important of the pure crop enterprises. It
accounted for 24% of the pure crop farms and occupied 198 acres

(80 hectares) or 79% of the land devoted to pure crops. It was

followed by groundnut which was produced on 12 pure crop farms

covering 27 acres (16 hectares) (see Appendix Table 4). The

importance of rice, and groundnut in this area can be explained

in terms of farmers' positive response to the Government's

Operation Feed Yourself Programme (OFY)[1]. It should be noted

that only one pure-crop cowpea farm as was encountered in the Navrongo-Bawku

(see Appendex Table 4) area as opposed to eleven farms in the

Denu-Abor area.   As a percentage of the total number of farms these were

equivalent to 0.7 and 3.5 in Navrongo - Bawku and

Denu-Abor area respectively. This indicates that even in the two

areas, cowpea is produced largely as a subsidiary crop or in con-

junction with other crops on the same farn and   as

a pure crop.

Regarding three-crop enterprises, the combinations of millet/

sorghum/cowpeas and millet/groundnut/cowpeas were the most popular.

They occurred 38 and 7 times and occupied 108 (68 hectares) and

14 acres (8 hectares) respectively. Of the thirty-nine two-crop

enterprises encountered millet/cowpeas was the most popular while

groundnut/cowpeas; millet/sorghum; Sorghum/cowpea and groundnut/

bambara were also fairly common. All the other crop combinations

produced by the farmers in the Navrongo-Bawku area are shown in

Appendix Table 4. In conclusion Table 11 gives the crop enterprises

or farms
in the two survey areas which selected for detailed study.

The enterprises have been selected because they were

the most common or popular to the farmers in the two areas.

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[1] Under this programme farmers are encouraged to increase the pro-
duction of these crops especially rice, through the provision of
extention services, credit and marketing facilities including
guaranteed prices.

TABLE 11   MOST POPULAR CROP ENTERPRISES IN THE TWO SURVEY AREAS

Denu-Abor Area	Navrongo-Bawku Area
Pure Crop Enterprises	
Cassava	Millet
Maize	
Cowpea	Cowpea [1]
Groundnut	Rice
Tobacco	Groundnut
Two-Crop Enterprises	
Cassava/Maize	Cowpea/Millet
Cassava/Cowpea	Cowpea/Groundnut
Three-Crop Enterprises	
Cassava/Maize/Cowpea	Millet/Sorghum/Cowpea
Cassava/Maize/Groundnut	Millet/Groundnut/Cowpea

1. Pure Crop Cowpea was not a common enterprise in the area but
   it is studied in subsequent chapters to provide a comparison with
   the other enterprises.

CHAPTER IV

THE ECONOMICS OF OPERATING THE VARIOUS ENTERPRISES

This chapter discusses briefly the technology employed in farming
and outlines the operation costs and returns derived from the most common
farm enterprises of the farmers studied in the two survey areas. The
enterprises discussed under the Navrongo-Bawku area are: rice, millet and
groundnut (as pure crops) and the following as mixed or composite
enterprises: millet/cowpea; cowpea/groundnut; millet/sorghum/cowpea; and
millet/groundnut/cowpea. Under the Denu-Abor area, cassava, maize,
cowpea and groundnut are discussed as pure crop enterprises while cassava/
maize; cassava/cowpea; cassava/maize/cowpea and cassava/maize/groundnut
are treated as mixed enterprises.

A. NAVRONGO-BAWKU AREA

Farming Technology

1. The technology of farming employed by many of the farmers in the
area is fairly advanced. The use of tractor services and bullock ploughs
for land preparation and the application of fertilizer were very common
among the farmers. Perhaps the nature of the land-topography, the
vegetation and soil type has made the situation possible and even impera-
tive. For example the relatively flat savanna land is very amenable to
mechanized land clearing. In addition the grass vegetation is easily
cleared even by burning and what is left "ploughed-under" the soil by
means of tractor or bullock ploughs, while the relatively poor soil makes
fertilizer use imperative in most parts of the survey area. It must also
be noted that apart from applying inorganic fertilizers, it is a common

practice by most farmers in the area to apply animal dung especially cow dung on their farms before planting.

Table 12 gives the percentage of farmers operating the various enterprises who applied fertilizers and those who used tractor or animal power for land preparation. The average dose of fertilizer used in the enterprises is also given in the Table. The Table indicates that inspite of the above the use of the hoe (or muscle power) for land preparation is still very important while inorganic fertilizers are still not used by the majority of the farmers. It can be seen from the Table however that fertilizer application and the use of tractor or bullock ploughs are closely identifiable with rice and groundnut cultivation. Mention must also be made of the fact that the extent of land preparation by the farmers generally depended upon the crop to be planted and also upon the availability of mechanized services or animal power. For example ridging or the making of mounds was found to be more commonly associated with groundnut than any other crop while rice, sorghum and millet were normally planted on the flat land although soil was gathered around the base during under-cultivation. None of the farmers applied fertilizer in pure crop cowpea and pure crop millet farms (see Table 12).

2. Operation of Rice Enterprise

Labour Inputs

The most common variety in the area was C4-63. It was usually cultivated as a pure crop and acreage varied from 0.5 to 120 with mode clustering around 13 acres or 4.6 hectares.

Table 12

FERTILIZER AND TRACTOR/ANIMAL POWER USE BY % OF FARMERS OPERATING VARIOUS ENTERPRISES (NAVRONGO-BAWKU AREA)

Enterprise	% of Farmers using Fertilizer	Av. Dose (lb) of Fertilizer per Acre	(Av. Dose of Fertilizer Kg/Hectare)	Farmers Using Tractor/ Bullock
Millet	0	-	-	33
Cowpea	0	-	-	30
Rice	47	158	177	71
Cowpea/Millet	20	112	126	20
Groundnut	40	158	177	53
Cowpea/Groundnut	50	-	-	75
Millet/Sorghum/Cowpea	33	336	377	30
Millet/Groundnut/Cowpea	38	228	256	38

Planting was usually by hand with 3 or 5 seeds being placed per hole at very close spacing or by broadcasting. It was estimated that an average total of 34 mandays of labour working between 6 and 9 hours a day were used to operate one acre of rice farm applying 158lbs (72kg of fertilizer). This was equivalent to 84 mandays per hectare and included 10 mandays per acre (about 25 mandays per hectare) for harvesting (cutting and threshing the grain) and 16 mandays per acre (40 mandays per hectare) for two times of weeding (under-cultivation) before harvesting. It must be mentioned that mechanical harvesting with combine harvestors cost ₵1.50 per bag of 180lbs (82kg) of paddy.[1]

Production Cost:

The cost of operating one acre of pure crop rice was estimated at ₵69.00 or ₵170.50 per hectare using 158lbs (72kg) of fertilizer (see Appendix Table 5). This comprised 41% of non-labour cost and was equivalent to producing a bag (180lbs or 82kg) of paddy at ₵9.00. Farmers who did not use any fertilizers incurred ₵57.60 per acre (₵142.33 per hectare) production cost, equivalent to producing 180lbs (82kg) of paddy at the cost of ₵14.40.

Yields & Returns

Yields of paddy varied from two bags to 11.5 bags and averaged seven bags (1260lbs) per acre or 1.4 metric tons per hectare for those using fertilizers.

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[1] This was cheaper than harvesting by hand but the risk of fire and the difficulty of getting the combines at the right times forced most farmers especially the small scale ones to use manpower.

The farmers who did not use any fertilizers obtained yields ranging from 1.5 to 8 bags averaging 4 bags (720 lbs) per acre or about 808kg per hectare (see Appendix Table 7).

Users of fertilizers obtained an average gross margin of ₵57.00 per acre (₵140.85 per hectare) while those who did not use the input obtained only ₵9.60 per acre (₵26.72 per hectare) (see Appendix Table 8).

3. Operation of Groundnut, Millet and Cowpea Enterprises

Labour Inputs and Production Costs:

Appendix Table 5 gives the labour inputs and the production costs of these enterprises. Groundnut with fertilizers (158 lbs/acre) required an estimated 33 mandays of labour per acre or 82 mandays per hectare and cost ₵67.80 per acre or ₵167.53 per hectare to operate. Without fertilizer, the enterprise required an average of 30 mandays of labour and cost ₵60.00 per acre to operate. These are equivalent to 74 mandays and ₵148.26 per hectare respectively. In terms of production cost per unit of output, it was estimated that it costs farmers who did not use any fertilizers ₵20.00 to produce one bag (180lb or 82kg) of dried unshelled nuts while their counterparts using 158lbs of fertilizers per acre (177 kg/hectare) incurred only ₵13.56 on the same quantity of groundnut.

The average total labour inputs for millet and cowpea farms (both without fertilizer) were estimated at 24 and 26 mandays per acre or 59 and 64 mandays per hectare respectively, while their production costs were ₵41.30 and ₵53.20 per acre or ₵102.05 and ₵131.45 per hectare respectively (see Appendix Table 5).

Yields and Returns

Farmers obtained yields of about 950lbs per acre (1 metric tonne per hectare) for millet while cowpea yielded only 310lbs per acre (348kg per hectare).[1] Users of fertilizer for groundnut obtained an average yield of 1 metric tonne per hectare (900lbs per acre) of dried unshelled nuts while non-users of fertilizer obtained lower average yield of 580ks per hectare (520lbs per acre).

Millet gave a relatively high gross margin of ¢66.70 per acre (¢164.82 per hectare) while cowpea gave a meagre ¢3.05 per acre (¢7.54 per hectare). Both groundnut with fertilizer and without fertilizer gave net losses[2] of ¢7.80 and ¢30.00 per acre or ¢19.27 and ¢74.13 per hectare respectively (see Appendix Table 8).

4. Operation of the Mixed (Composite) Enterprises

Labout Input and Operation Costs:

The operation costs and labour inputs for the mixed enterprises are presented in Appendix Table 6. Total labour inputs for these enterprises varied from 28 mandays per acre (69 mandays per hectare) for cowpea/groundnut and millet/groundnut/cowpea (both without fertilizer) to 37 mandays per acre (91 mandays per hectare) for cowpea/millet but operation cost varied from ¢45.80 per acre (¢113.17 per hectare) for cowpea/millet to millet/groundnut/cowpea (with fertilizer) whose operation cost was estimated at ¢65.00 per acre or ¢160.62 per hectare.

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[1] This yield of cowpea can be considered very low. It was about half the average yields obtained by farmers in the Denu-Abor area (see Appendix Table 11). It must also be mentioned that yields of 1000lbs and 2000lbs per acre (or 112 & 225ks per hectare) have been obtained under controlled conditions at Kpong.(1)

[2] The enterprises would give net gains if family labour and other inputs supplied freely by the household were awarded zero opportunity cost.

Yields and Returns

The yields of the various crops within the mixed enterprises seemed rather interesting (see Appendix Table 7). Some crops within the mixtures appeared to be more responsive to fertilizer application than others. For example, in the millet/sorghum/cowpea enterprises, only millet appeared to respond positively to fertilizer application; cowpea did not. On the other hand evidence of cowpea's positive response to fertilizer application is shown in the yield figures obtained for cowpea/groundnut enterprises. The two results seem inconsistent. In the millet/groundnut /cowpea enterprise, all the component crops seemed to respond well to fertilizer treatment although the response by groundnut was relatively less pronounced.

Millet/sorghum/cowpea with fertilizer and without fertilizer were the two most profitable mixed enterprises. They gave average gross margins of ₵73.20 and ₵66.60 per acre (₵180.88 and ₵164.57 per hectare) respectively (see Appendix Table 8). It can be concluded from Appendix Table 8 that crop mixtures or the mixed enterprises in the Navrongo-Bawku area do generally give higher gross margins than the pure crop enterprises. This finding validates one made by Norman (1971) in Zaria, Northern Nigeria, although it is inconsistent with the findings in the Denu-Abor area of the of the Volta Region of Ghana as reported later in the chapter.

B. DENU-ABOR AREA

1. The Type of Labour and Technology Used

Type of Labour:

Farmers used both family and hired labour for their farming
operations although their reliance on hired labour was more pronounsed.
Only three farmers in the sample of 190 relied on family labour only.
Three types of hired labour could be distinguished in the area. The first
type is the daily-rated labour and the most commonly used. In this case,
the labourer usually works between 6 and 9 hours a day and is paid a daily
wage of ¢1.00 excluding two meals provided by the farmers. The second
type of labour is engaged on piece-rate basis-where the farmer and the
labourer bargain over the charge for a specified job to be done. The
final type of labour is employed for harvesting. This type usually
involve women who offer their services for kind payment of one-third of
the total harvest.

For the purposes of this study all labour inputs estimated are based
on the daily rated with the prevailing wate rate of ¢1.30, the 30 pesewas
being the estimated cost of the two meals provided for the labourer.
Family labour has also been charged ¢1.30 per manday against the farmer
while the values of other inputs supplied freely by the household have
similarly been assessed according to their market value at the time of
use.

Technology Used:

The farm implements used by all the farmers in the sample were cutlasses and hoes. Fertilizer application and tractor services for land preparation were employed only in tobacco production. No farmer using insecticide before harvesting was encountered while the local varieties of maize, cassava and cowpea were planted by all farmers.

Appendix Table 9 gives the labour inputs and the per acre operation costs of pure crop enterprises operated by the farmers while Appendix Table 10 gives the same data for the mixed crop enterprises. The yields from the various farms (enterprises) are given in Appendix Table 11 while Appendix Table 12 presents a summary of per acre operation costs and returns from all the various enterprises.

2. Operation of Maize (Zea Mays) Enterprise

Labour:

Maize produced as a pure crop was found to use the least labour among all the farm enterprises dealt with (see Appendix Table 9). The range of labour used was 20 to 40 mandays per acre or 49 to 99 mandays per hectare. The average was 27 mandays per acre or 67 mandays per hectare with a percentage variation of 9. The relatively low total labour input for maize (pure crop) can be explained by fact that under-cultivation (weeding) of the farms was done only once before harvesting whereas this operation was usually repeated in the case of the other enterprises.

Production Cost:

Total production cost of pure crop maize averaged ₵37.80 per acre or ₵93.40 per hectare.

The range was ₵28.00 to ₵50.90 per acre or ₵69.20 to ₵125.77 per hectare.
Compared to the other enterprises one acre of maize cost the least to
produce with labour cost accounting for 93 percent of the total production
cost, (see Appendix Table 11). The production cost of ₵37.80 per acre compares
fairly well with the average of ₵41.00 incured by farmers in the Gomoa area
in the Central Region of Ghana (11 ₧7).

Yields:

Maize yields obtained by the farmers in the area can be considered
low although they are not significantly different from yields obtained
without fertilizer and improved seeds in many parts of the country. Farmers
studied in the sample obtained yields ranging from 560 to 1200 lbs. per
acre averaging 720lbs per acre or 808kg per hectare of the shelled dried
grains (see Appendix Table 11). These yields are very close to the yields
of 880 and 660 lbs per acre obtained by farmers in the Ejura and Wenchi area
in Ashanti and Brong-Ahafo respectively (2 5) and slightly lower than the
average yields of 1035 lbs per acre of 1.2 metric tons per hectare obtained
by farmers in the Gomoa area of the Central Region (11). All these yields
can however be said to be very low considering that a yield of 2540 lbs
per acre or 2.8 metric tons per hectare has been obtained with improved
seeds and fertilizers near Ho a distance of only about 60 miles or 156 Km.
from the survey area (2).

Returns:

Using the mode of prevailing farm gate prices at harvesting time it
was estimated that a farmer obtained ₵54.00 per acre or ₵133.43 per hectare
gross revenue from pure crop maize.

His gross margin was similarly estimated to be only ₵16.20 per acre or ₵40.03 per hectare while the return to one manday of labour expended in the enterprise was calculated to be ₵1.30 (see Appendix Table 12). Comparing these two with the returns from other enterprises it can be seen that maize (pure crop) was the least profitable enterprise undertaken by the farmers. Kuranchie (1971) made similar findings about maize in the Ejura and Wenchi areas of Ghana. (2) He found maize production under traditional conditions (the use of local seed stock without fertilizers) to be the least profitable of the existing arable farming enterprises in the two areas

3. Operation of Tobacco (Nicotina) Enterprise

Tobacco is the most popular industrial crop in the survey area. The production and marketing of this crop is administered by a central body - The Ghana Tobacco Company with its district headquarters at Akatsi (see Map 2B). The company insists on the use of tractor services for land preparation and on fertilizer application. The two inputs are therefore supplied at subsidised pricesand on credit to the farmers by the company. It must be mentioned that the farmers who used fertilizers and tractor services in the Denu-Abor Sample were all tobacco farmers and they did not apply the fertilizers on other crops than tobacco.

Labour Input and Production Cost:

Total labour inputs for tobacco production averaged 55 mandays per acre or 136 mandays per hectare with the most labour being employed in harvesting.

Harvesting alone required about 27 mandays per acre or 67 mandays per hectare. Post-harvesting treatment of the tobacco required very little labour and consisted of hanging the leaves in the open space for the air to cure them. In terms of cost, tobacco was by far the most costly enterprise to operate. Total production cost was estimated at ¢114.90 per acre or ¢283.92 per hectare with the total non-labour costs (cost of tractor services, fertilizer and seedlings) accounting for 40 percent (see Appendix Table 12).

Returns:

Tobacco gave an estimated ¢202.00 per acre or ¢499.14 per hectare gross revenue, ¢88.00 per acre or ¢217.45 per hectare gross margin while the return to one manday of labour from this enterprise was calculated to be ¢2.84 (see Appendix Table 12). It can be seen from the Table that as an enterprise tobacco ranked third after cassava (pure crop) and cowpea (pure crop) in terms of high profitability per acre/hectare.

4. Cowpea (Vigna Ungiculata); Groundnut (Arachis Hypogea) and Cassava (Manni hot Utilissima) (Pure Crops)

Labour Input and Production Cost:

It must be mentioned that crop enterprises with cassava either as a pure crop or in mixed crop generally required more labour per acre/hectare than the non-cassava enterprises. This is because cassava farms were normally weeded three times before harvesting while the other farms were usually weeded once or twice only. Consequently the non-cassava farms enterprises (except tobacco) tended to be more expensive to operate.

Labour input per acre of pure crop cassava farm was estimated at 53 mandays per acre or 131 mandays per hectare while total production cost was ¢72.40 per acre or ¢178.90 per hectare (see Appendix Table 9).

Cowpea utilized an average of only 42 mandays of labour per acre or 104 mandays per hectare. The range was 34 to 58 mandays per acre. Weeding (under-cultivation) was done only once before harvesting while harvesting which required the most labour took an average of 15 mandays per acre or 37 mandays per hectare. It cost the farmers ¢58.35 to operate one acre of cowpea (pure crop) or ¢144.18 per hectare (see Appendix Table 9). This was equivalent to producing 1kg of the dried shelled beans at 5.5 pesewas (see Appendix Table 11).

Groundnut cost ¢71.00 per acre or ¢175.44 per hectare to operate and required 50 mandays of labour per acre or 124 mandays per hectare.

Returns:

Cassava (pure crop) gave the highest gross margin of ¢97.60 per acre or ¢241.17 per hectare while cowpea appeared as the second most profitable enterprise giving gross margin of ¢88.05 per acre or ¢217.57 per hectare (see Appendix Table 12). In terms of rewards to labour however cowpea was found to give the highest returns among all the enterprises (both pure or composite). It gave a reward of ¢3.40 per manday while cassava gave ¢3.10 with maize (pure crop) giving the least rewards of ¢1.30 per manday (see Appendix Table 12). The implication of this is that when labour is the most constraining factor of production it is more rational to invest scarce labour resource in the production of cowpea than any of the other crops.

5. Operation of Mixed Enterprises

Labour Inputs and Operation Costs:

Appendix Table 10 gives the labour inputs and the production costs of the mixed enterprises in the Demu-Abor area. In the main the labour requirements of these enterprises did not differ significantly because they all had cassava as a constituent crop. Cassava/cowpea used 57 mandays per acre (141 mandays per hectare) while cassava/maize/cowpea utilised 55 mandays per acre (136 mandays per hectare).

Average total operation cost per acre ranged from ₵70.30 per acre (₵173.71 per hectare) for cassava/maize/groundnut to ₵81.50 per acre ₵201.40 per hectare) for cassava/maize. Cassava/cowpea was estimated to cost ₵77.18 per acre (₵190.71 per hectare) to operate while the production cost for cassava/maize/cowpea was estimated to average ₵75.00 per acre or ₵185.00 per hectare (see Appendix Table 10).

Yields:

Some interesting observations may be made about the yields of the various crops in the mixed enterprises (see Appendix Table 11). Firstly none of the crops understandably yielded as much as it did when produced as a pure crop. This may be explained by the lower plant population of the individual crops in the crop mixtures as well as by the effect of competition between the crops within the mixtures for nutrients and sun-light. For example the dwarfing of groundnut and cowpea plants by cassava and maize could adversely affect the yields of the two crops.

Perhaps the differences between the yields of cassava and maize within the cassava/maize/cowpea and cassava/maize/groundnut enterprises deserve special comment.

The average yield of cassava in the cassava/maize/cowpea enterprises was more than twice as high as it was in the cassava/maize/groundnut enterprises. In the latter enterprise however, maize yields were about three times higher than in cassava/maize/groundnut. Since cowpea and groundnut are harvested about the same time as maize, cassava is the crop most likely to benefit from any nitrogen fixed by cowpea and groundnut in the mixtures. Assuming the same plant population for cassava in the two mixed enterprises (cassava/maize/cowpea and cassava/maize/groundnut as indicated by Appendix Table 10), it may be conjuntured that the very high yields of cassava in the cassava/maize/cowpea enterprises are the responsibility of the nitrogen fixed by cowpea.[1] If this were true, the implication would be that cowpea fixes more nitrogen than groundnut and therefore it is more rewarding to intercrop cassava and maize with cowpea than with groundnut.

Returns:

Cassava/maize/cowpea was found to be the most profitable of the mixed enterprises. It gave a gross margin of ₵62.90 per acre (₵155.43 per hectare) and a return of ₵2.44 per manday of labour used (see Appendic Table 12). The least rewarding of the mixed enterprises was cassava/cowpea which gave an average of ₵39.84 per acre (₵98.44 per hectare) gross margin and a reward of only ₵2 per manday of labour expended. It may be seen from Appendix Table 12 that in general the pure crop enterprises in the area gave higher returns than the mixed enterprises - quite unlike the situation in the Navrongo-Bawku area. Perhaps whether a pure crop gives higher returns than a mixed crop or not depends upon the individual crops - their relative market value and their effects on each other when they are intercropped - the latter influences the yields.

[1] This needs examination by agronomists.

CHAPTER V

THE RELATIVE CONTRIBUTION OF VARIOUS CROPS
TO FARMERS' TOTAL OUTPUT

This chapter discusses very briefly the individual crops in terms of their relative contribution to the farmers' gross annual output and incomes. The figures discussed are based on 1973 crop yields and sales. It must be mentioned however that gross proceeds are dealt with since estimates of production costs for 1973 were not obtained. In spite of this difficiency it is deemed that the relative contribution of the individual crops to the gross family output or incomes would give an idea about the importance of each crop to the farmer.

A. NAVRONGO-BAWKU AREA

Table 13 gives the distribution of the gross potential returns (output)[1] and the gross returns from the marketed surplus by crop per farmer in the sample. The Table indicates that if all the produce harvested had been sold, a farmer would have realised an average of ¢780.00 gross revenue per year from crop production. Out of this, millet would have made the highest contribution of ¢300.00 or 39%. Cowpea would have pulled at the rear with gross revenue of ¢80.00 (10%) after rice, groundnut and sorghum (see Table 13). This means that in terms of its contribution to the gross output of the farmer, cowpea is of lesser importance than millet, sorghum, rice and groundnut.

The balance between the gross potential output and the gross returns from marketed surplus is made up of the value of output consumed by the household and the crop wastes incurred or more precisely the value of that

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[1] This refers to the gross proceeds that would have accrued to the farmer if he had sold all his harvest.

portion of the total harvest which did not enter the marketing stream.
Table 13 shows that although a lot of millet and sorghum was produced/very
little of it, 3% and 10% respectively, was marketed indicating that the
major part of it went into household consumption. It must be mentioned here
that millet and sorghum are the two main staples of the people . This
explains why only a small proportion of the output entered the market. A
fairly similar story could be told about cowpea. The table shows that only
16% of the gross output of cowpea passed as the marketed surplus. The rest
went into household consumption and probably waste.

In terms of cash receipts, Table 13 indicates that farmers realised
the greatest proportion of their cash incomes from groundnuts and rice.
Groundnut and rice contributed about 36% and 30% respectively to the farmers
gross cash receipts from crop production. Cowpea was the third highest
contributor to the farmers' gross receipts while millet and sorghum
contributed the least. Comparing Table 13 with Table 5A, it would appear
that farmers consider millet and sorghum as their most important crops
because they are their staple food. On the other hand groundnuts and rice
are important principally because they constitute the cash crops for the
people while cowpea is important both as a source of food for the farm
family and a source of cash income.

TABLE 13   THE CONTRIBUTION OF THE VARIOUS CROPS TO FARMERS' TOTAL OUTPUT - NAVRONGO-BAWKU AREA

	Total	(%)	Millet	(%)	Rice	(%)	Ground-nuts	(%)	Sorghum	(%)	Cowpea	(%)	Others	%
Gross[1] Potential Output (A)	¢780	(100)	¢300	(39)	¢140	(18)	¢130	(17%)	¢120	(15)	¢80	(10)	¢80	(1)
Gross Returns from Marketed Surplus (B)	¢180	(100)	¢8	(4)	¢ 54	(30)	¢ 63	35%)	¢ 12	(7)	¢13	(7)	¢30	(17)
(B) as % of (A)	23		3			39	48		10		16		-	

[1] This refers to the gross proceeds that would have accrued to the farmer if he had sold all his harvest.

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B.   DENU-ABOR AREA

Table 14 gives the relative contribution of various crops to
the farmers gross output as well as their contribution to farmer's
gross marketed surplus. The table shows that cassava is the highest
contributor to the farmers' gross output accounting for 62% of the
total output for the 1973 season. Maize contributes the second largest
amount and accounts for 28% of the total gross output. Cowpea comes
third with a meagre contribution of only 4 percent.

In terms of cash receipts - or the value of marketed surplus
cassava is still the most important crop accounting for as high 66
percent of the total of farmers' receipts from crop sales while maize
and cowpea take the second and third places respectively.

Comparing Tables 13 and 5B it would appear that farmers in the
Denu-Abor area consider cassava and maize as their two most important
crops not only because the two crops constitute their chief staples
but also because they are their largest source of cash incomes.
Cowpea is also important to farmers in the area for similar reasons
although its relative contribution to farmers' gross output and/or
cash incomes is insignificant.

TABLE 14   THE CONTRIBUTION OF THE VARIOUS CROPS TO FARMERS' TOTAL OUTPUT
DENU-ABOR AREA

	Total	(%)	Maize	(%)	Cassava	(%)	Cowpea	(%)	Groundnut	(%)	Others	(%)*
Gross Potential Output (A)	₵470	(100)	₵130	(28)	₵290	(62)	₵20	(4)	₵5.00	(1)	₵25	(5)
Gross Returns from Marketed Surplus (B)	₵350	(100)	₵90	(26)	₵230	(66)	₵15	(4)	₵4.00	(1)	₵11	(3)
(B) As % of (A)	74		96		79		75		80		44	

* Tobacco, pepper, sugarcane, shallot, tomatoes, etc.

CHAPTER VI

FARMERS' IMPRESSIONS ABOUT COWPEA AS A CROP

As a crop, cowpea is well-known to all the farmers studied in both survey areas. All the farmers had produced the crop before although not all of then cultivated it in the 1974 season. For exanple while nearly 99% of the farmers studied in the Navrongo-Bawku area cultivated the crop in the 1974 season only 20% of those studied in the Denu-Abor area cultivated it in the sane year (see Table 7). It can be seen from Tables 13 and 14 that cowpea features proninently as a source of food and incone for farmers in both survey areas especially those in the Navrongo-Bawku area. In terns of profitability, Appendix Table 12 indicates that cowpea is second only to cassava in the Denu-Abor area while in the Navrongo-Bawku area cowpea (without fertilizers) ranks eighth anong 13 enterprises in terns of profitability (see Appendix Table 8). The pertinent questions to ask are (i) why cowpea is very inportant in the Navrongo-Bawku area inspite of its relatively low profitability; (ii) why farmers in the Denu-Abor area do not produce nore cowpea.

A. DENU-ABOR

1. Conplaints by Farmers

One hundred and two (70%) of the farmers studied in the area considered cowpea a highly risky crop. These farmers believe that to produce cowpea successfully, planting needs accurate tining. Failure to do this nay lead to a total loss of the crop (the fruits may not set at all or the pods nay be enpty). However the farmers do not seen to be sure about the correct tine for planting.

The few farmers who try to brave the situation are usually afraid to invest heavily in the crop. They prefer to hedge in other crops. Many farmers also complained of low yields which they attributed to poor weather and poor soil. Fifteen farmers in the area complained that their soil was not good for cowpea. As such they would rather cultivate cassava for use as food for the household than to grow cowpea which would not yield enough to sustain them for the year. Five farmers spoke about the difficulty of harvesting cowpea (including the shelling of the beans). They claimed these activities were tedious and required too much labour while only two farmers in the sample talked about storage problems of the crop.

2. Motivation of Farmers

Thirty-seven farmers in the sample produced cowpea every year because they considered the crop both profitable and highly nutritious. However these farmers also held the view that cowpea is a tricky crop.

It may be concluded that almost all the farmers studied in the sample would want to produce cowpea or increase their production of the crop if they would be told each year the right time to plant it. A higher yielding variety would also immensely help the situation while any integrated plan for increased cowpea production in the area should also consider the type and dosage of fertilizer necessary. Such a plan should also anticipate the difficulty of shelling the beans from the pod.

B. NAVRONGO-BAWKU AREA

Cowpea can be considered a household crop in the area although as a crop it is usually intercropped-chiefly with millet and sorghum.

In fact it is the common practise of the farmers to mix the seeds of cowpea, millet and sorghum together during planting. The crop is therefore popular as an intercrop but not as a pure crop.

1. Complaints & Motivation of Farmers

Forty-one (85%) of the farmers in the sample would not operate pure crop cowpea farms because they considered the returns very low and unremunerative. This complain is justified by the size of gross margin derived from this enterprise vis-a-vis the others (see Appendix Table 8). The low returns from one acre of pure crop cowpea is mainly a function of low yields. Farmers obtained an average yield of 380 lbs of the shelled beans per acre or 348 kgm per hectare (see Appendix Table 7). The low yields stems apparently from low genetic quality of seeds used as well as from high rate of insect damage in the field. It has been estimated by Kuranchie (1974) that cowpea farmers in northern Ghana lose between 20 and 30 percent of their crop through insect damage both in the field and during storage (10).

Farmers in the Navrongo-Bawku area produce cowpea both for household consumption and for cash and they would produce more for the same reasons if they obtained higher yielding varieties and were introduced to simple and economic methods of preservation against insect infestation both in the field and during storage.

CHAPTER VII

OPTIMUM FARM PLANS OR ENTERPRISE MIX FOR FARMERS
IN NAVRONGO-BAWKU AND DENU-ABOR AREAS

Having outlined the cropping patterns in the two survey areas, the existing arable enterprises with their resource requirements as well as their returns, it is intended to use the data to evolve the appropriate enterprise mix which would enable farmers to maximize their net returns subject to the labour, capital and land constraints facing them.

1. The Technique Used-Linear Programming

The technique employed to evolve the optimum enterprise mix is Linear Programming which analyses problems in which the linear function of a number of variables is to be maximised (minimised) when those variables are subject to a number of restraints in the form of linear inequalities. The problem can be stated generally in the following mathematical form assuming 'n' number of variables in the function and that the objective is to maximise the preference function:

$$^*U = a_i x_i + a_2 x_2 + \ldots\ldots a_n x_n = \sum_{j=1}^{n} a_i x_i$$

where the variables are subject to the

following 'n' constraints:

$$P_{11}X_1 + P_{12}X_2 + \ldots\ldots P_{1n}X_n \leq b_1$$

$$P_{21}X_1 + P_{22}X_2 + \ldots\ldots P_{2n}X_n \leq b_2$$

$$\vdots$$

$$P_{m1}X_1 \quad X \quad P_{m2}X_2 + \ldots\ldots P_{mn}X_n \leq bn$$

or more briefly

$$\sum_{j}^{n} P_{ij}X_j \leq bi, \quad i = 1, 2, \ldots\ldots n$$

with X_i

$$
\begin{cases}
X_1 > 0 \\
X_2 > 0 \\
\vdots \\
X_n > 0
\end{cases}
$$

---

2. Competition among Enterprises

Seasonality of rainfall in both survey areas perforces strong competition among existing crop enterprises for farmers' resources particularly labour and capital. For example although the land within the areas may be suitable for the production of many crops, land preparation and the/planting of the crops must necessarily be carried out within a particular period for the crops to take advantage of early rains. Similarly the harvesting of groundnut, tobacco and cowpea in the Denu-Abor area and the harvesting of millet, sorghum, cowpea and rice in the Navrongo-Bawku area should be carried out within a/certain period to forestall crop losses. This brings about demand peaks for labour and capital along the course of the crop season (see Figures 1 and 3). In such times the farmer needs guidance as to which enterprises he must invest his scarce resources for maximum returns, hence the need to evolve the optimum enterprise mix.

A. NAVRONGO-BAWKU AREA

1. Technical Co-efficients

Available Working Capital:

Given an adequate stock of farming implements - hoes, cutlasses etc., working capital can still constrain the level of farming activities because of the need probably to pay for hired labour and tractor services as well as other purchased inputs like seeds and fertilizers. In the design of the optimum enterprise mix (plans) a working capital base of ₵100.00 is used.

This is then varied up to ¢1000.00 to determine its effect on the original plan. The choice of ¢100.00 is arbitarily when it is considered that an estimated average of ¢180.00 cash revenue was received per farmer during the 1973 season from his arable farming (see Table 13). It must be mentioned however that most farmers in the sample relied more on family labour and other inputs supplied freely by the household then on purchased or hired inputs (including labour). This enables farmers to carry out their farming operations with relatively small working capital. Revenue from animal production may also be used to support crop production.

Available Land Resource:

It has been estimated in Table I that farmers in the sample possessed an average of 16.7 acres of land of which they utilised 73 percent in the 1974 farming season. This 16.7 acres (6.8 hectares) is used in designing the strategies.

Available Labour Resources:

Table 15 gives the estimated monthly labour resource available to the farmer in the sample. It was estimated that a farmer had about 3^1 male and 4^1 female adults within his family who provided their services to him free of charge. However unlike in the forest areas of Ghana where female labour features more frequently in almost all the farm operations, female labour is more commonly employed in harvesting and to a minor extent in planting in the Navrongo-Bawku area. Most farmers in the sample worked 5 days in a

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[1] These are the modes of figures quoted by respondents.

week while the maximum number of casual labourers engaged by a farmer in

an operation was 6^2. On the basis of these facts it has been estimated

that a farmer in the sample has available to him an average of 207 mandays

of labour in May, July and October. This comprises 69 mandays of family

labour and 138 of hired labour (see Table 15). Similarly he is estimated

to have 198 mandays of labour (66 mandays of family labour and 132 hired

labour) in June. Appendix Table 13 and Figure 1 show the monthly

distribution of per acre labour requirements of the enterprise in which the farmer

invests his resources. The figure indicates that competition among

enterprises for labour is most intense in May–June and in October–November.

This is because sowing, first under-cultivation and fertilizer application

are carried out in May–June while the second under-cultivation and

harvesting are also carried out in October–November. Thus as shown by the

figure these are the months in which the most labour is needed for the

operation of enterprises.

The labour resources available to the farmer in these months is therefore

used as a technical constraint in designing the optimum plans.

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[2] This is taken as the number of labourers a farmer can conveniently
supervise in a day in addition to the three adult males and 4 adult
females from his household.

FIGURE I: Per Acre Monthly Labour Requirement of Enterprises-
Navrongo-Bawku Area
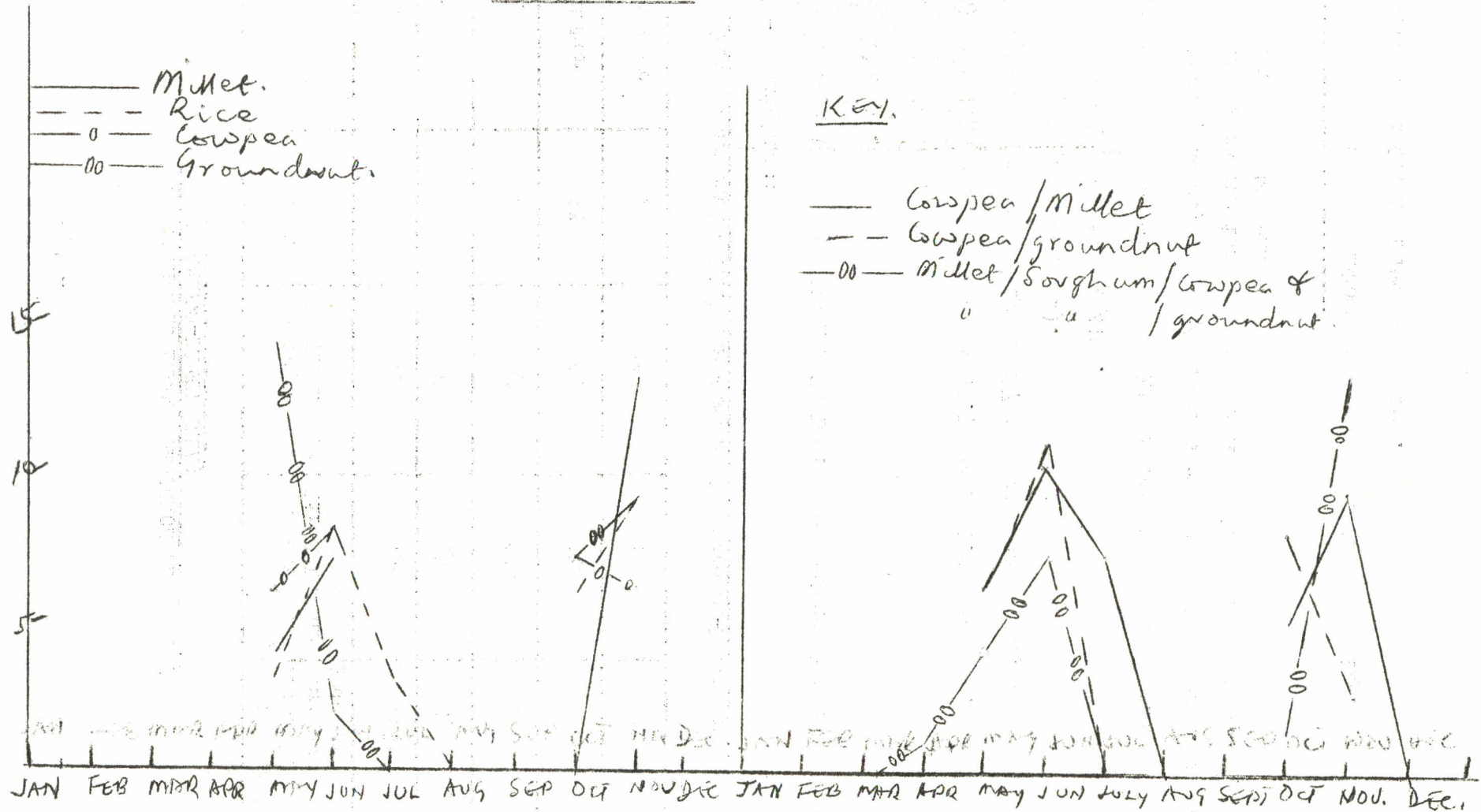
TABLE 15   AVERAGE MONTHLY AVAILABLE LABOUR RESOURCE PER FARMER
(NAVRONGO-BAWKU AREA)

Month	No. of Days	Mandays of Family Labour	Mandays of Hired Labour	Average Total Available Mandays of Labour
May	23	69	138	207
June	22	66	132	198
July	23	69	138	207
October	23	69	138	207
November	22	110[1]	132	242

2. **Optimum Plans (Enterprise Mix) for Farmers in Navrongo-Bawku area**

   Plan 1 - Assumptions:

   The programming or the Simplex Tableau[2] for optimum Plan 1 is shown in Appendix Table 14.

   The plan assumes the following:

   (i)   a total available land of 16.7 acres (6.8 hectares).

   (ii) farmers labour supply of 207 mandays each of May, July, and October (see Table 15).

   (iii) a working capital of ₡100.00

   (iv) that the farmer pays for all the variable inputs - all labour, seeds, tractor/bullock services and therefore obtains the gross margins presented in Appendix Table 8 for the various enterprises.

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[1]This includes 22 mandays of labour from 4 females in the family.

[2]Also referred to as Original Problem Matrix.

Results:

     The optumum plan or enterprise from the above assumptions is given in Table 16. It consists of the operation of 2.1 acre (0.9 hectare) of the mixed enterprise millet/sorghum/cowpea without fertilizer. The plan yields a net revenue of ₵142.00.

TABLE 16   OPTIMUM PLAN ONE - NAVRONGO-BAWKU AREA

Real Activities	Acreage	Z-C ₵	Disposal Activities	Level of Unused Resources	Z-C ₵
P_8 M^1	0.0	54.66			
P_9 C^2	0.0	72.49			
P_{10} $R^{(F)3}$	0.0	40.98	P_1 May L	198.4	0.00
P_{11} $R^{(NF)4}$	0.0	79.01	P_2 June L	183.0	0.00
P_{12} $G^{5(F)}$	0.0	104.07	P_3 July L	207.0	0.00
P_{13} $G^{(NF)}$	0.0	117.41			
P_{14} C/M	0.0	78.83	P_4 October L	202.7	0.00
P_{15} C/G $^{(F)}$	0.0	84.59	P_5 November L	214.2	0.00
P_{16} C/G $^{(NF)}$	0.0	104.59	P_6 Working Capital	0.0	1.42
P_{17} M/G/C$^{(F)}$	0.0	12.4			
P_{18} M/S/C$^{(NF)}$	2.1	0.00	P_7 Land	14.56	0.00
P_{19} M/G/C$^{(F)}$	0.0	57.40			
P_{20} M/G/C$^{(NF)}$	0.0	71.04	Total Net Revenue	₵142.00	

1. M = Millet   2. C = Cowpea   3. $R^{(F)}$ = Rice (with fertilizer)
4. $R^{(NF)}$ = Rice (without fertilizer)   5. G = Groundnut

Implications of Optimum Plan 1:

Table 16 gives a detailed implication of operating Plan I. None of the monthly supplies of labour is depleted from operating the plan. In the Real Activities row, the Z-C column, which shows the marginal cost of each enterprise in the optimum plan, indicates that groundnut without fertilizer (P_{13}) and cowpea/groundnut without fertilizer (P_{16}) are the least profitable enterprises and therefore the least favoured to enter the optimum plan. The Z-C column in the Disposal activities row gives the marginal value product per unit of the various resources used. All the ¢100.00 working capital is exhausted in the plan. The Z-C value for this resource indicates that an additional ¢1.00 would yield ¢1.42 additional net revenue in the plan. Working Capital therefore comes out as the most constraining resource in the plan.

3. Effects of Raising the Level of Working Capital in Plan I

Net Returns:

The effects of raising the level of working capital without changing the original problem matrix are summarised in Table 17 and by Figure 2. The figure shows that the total net returns accruing from the optimum strategy increases from ¢142.00 to ¢1,220.00 as the size of working capital increases from ¢100.00 to ¢1,000.00 while other resource levels are held constant.

Figure 2: Effect of Working Capital Size on Net Revenue from Optimum Plan 1 (Nautongo-Bawku Area)

Net Returns

Level of Working Capital

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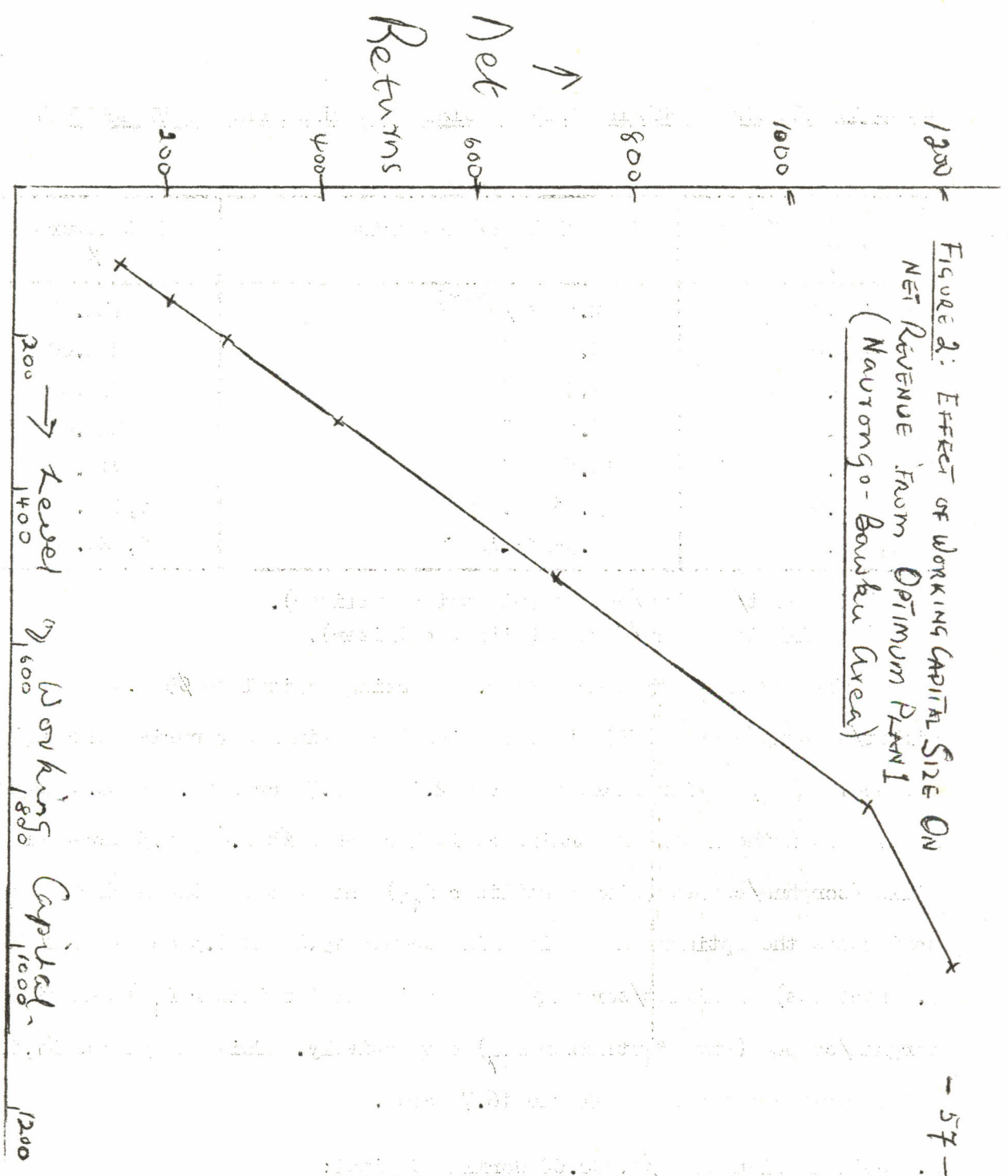
TABLE 17   EFFECT OF WORKING CAPITAL SIZE ON OPTIMAL PLAN & NET RETURNS

Level of Working Capital ¢	Optimal Plan/Enterprise Mix	Net Returns ¢
100.00	2.1 m/s/c^{NF*1}	142.00
150.00	3.2 "	213.00
200.00	4.3 "	284.00
300.00	6.4 "	426.01
500.00	10.6 "	710.02
800.00	15.4 + 1.3 m/s/c^{F*2}	1,120.60
1,000.00	0.3 + 16.4 "	1,220.00

* 1 millet/sorghum/cowpea (without fertilizer).

* 2 millet/sorghum/cowpea (with fertilizer).

Table 17 shows that from ¢100.00 working capital to ¢500.00 millet/sorghum/cowpea (NF) still remains the optimum enterprise although the scale of operation increases from 2.1 to 10.7 acres (0.9 to 4.3 hectares). However when the level of working capital reaches ¢800.00, 1.3 acres of millet/sorghum/cowpea (with fertilizer P_{17}) enters the optimum plan. At that stage the optimum enterprise mix becomes 15.4 and 1.3 acres (6.2 and 0.5 hectares) of millet/sorghum/cowpea (without fertilizer P_{18}) and millet/ sorghum/cowpea (with fertilizer P_{17}) respectively. This mix yields ¢1,120.00 net revenue and takes up all the 16.7 acres.

4.   Optimum Plan with ¢1,000.00 Working Capital:

The levels of P_{17} and P_{18} in the optimum mix changes considerably when working capital rises to ¢1,000 without any change in the problem matrix.

The level of millet/sorghum/cowpea with fertilizer (P_{17}) increases to 16.4 acres (6.6 hectares) while the level of millet/sorghum/cowpea without fertilizer (P_{18}) diminishes to 0.3 acre. The total net returns from this mix is ¢1,220.00. At this stage the size of available land becomes the most crucial constraint. The marginal value product of one acre of land at this stage is ¢43.14 while an additional ¢1.00 to the working capital would increase the total net revenue by only 50 pesewas. The full results of the problem matrix with ¢1,000 working capital are presented in Table 18. One point worthy of notice is the diminution of the Z-C value of Rice (P_{10}) from ¢40.98 to ¢20.65 from ¢100.00 working capital to ¢1,000.00 (see also Table 15). This supposes that Rice will be a feasible crop to enter the optimum plan when working capital is raised somewhere above ¢1,000.00 and more land becomes available. This suggests that rice production for profit in the Navrongo-Bawku area is a rich man's venture.

TABLE 18   OPTIMAL PLAN WITH ₵1,000.00 WORKING CAPITAL

Real Activities	Acreage	Z-C	Disposal Activities	Level of Unused Resources	Z-C ₵
P_8 M	0.0	59.81	P_1 May L	74.5	0.00
P_9 C	0.0	66.69	P_2 June L	81.1	0.00
P_{10} $R^{(F)}$	0.0	20.65			
P_{11} $R^{(NF)}$	0.0	64.75	P_3 July L	207.0	0.00
P_{12} $G^{(F)}$	0.0	84.84	P_4 October L	173.6	0.00
P_{13} $G^{(NF)}$	0.0	103.14	P_5 November L	24.9	0.00
P_{14} C/M	0.0	79.84	P_6 Working Capital	0.0	0.50
P_{15} $C/G^{(F)}$	0.0	70.14			
P_{16} $C/G^{(NF)}$	0.0	99.34	P_7 Land	0.0	43.14
P_{17} $M/S/C^F$	16.4	0.00			
P_{18} $M/S/C^{NF}$	0.3	0.00			
P_{19} $M/S/G^F$	0.0	40.75			
P_{20} $M/S/G^{NF}$	0.0	61.75	Total Net Revenue = ₵1,220.00		

5. The Conclusions from Analysis:

The following conclusions may be drawn from a comparison of the outcome of the optimum plans and the existing situation in the area:-

Most farmers in the Navrongo-Bawku area are not getting the maximum possible returns their resources endowment can give them. This is because of over-diversification of crops or crop enterprises leading to mis-application of resources through (a) under-investment in the appropriate enterprises and (b) investment in enterprises which are relatively unremunerative.

The choice of millet/sorghum/cowpea (mixed) enterprise by most of the farmers in the area is rational in economic sense but many farmers have to increase their investments in this enterprise to achieve the optimum level of resource utilization.

Groundnut production is relatively an unprofitable enterprise. But the existence of the oil mills at Bawku makes it imperative to make the enterprise more rewarding through yield increases.

Rice appears to be a 'rich man's crop' in the area. Its cultivation becomes profitable only when working capital investment exceeds ₡1,000.00. To make the enterprise rewarding to small-scale farmers efforts need to be made to decrease the operation cost per unit of the physical output of the crop.

B. DENU-ABOR AREA

1. Technical Coefficients

Available Working Capital

As in the Navrongo-Bawku area no meaningful estimates could be obtained of the size of farmers' working capital at the beginning of the farming season. Thus ₵100.00 is used as the base in the model. Later the amount is raised up to ₵1000.00 to investigate what optimal plans would have to be adopted with changes in the size working capital.

Available Labour Resource

Labour was found to be relatively a scarce resource in the Denu-Abor area compared to the situation in the Navrongo-Bawku area. Farmers' family labour resource in the former area was much more meagre while the supplies on the local labour market were much lower. A farmer's family labour resource was estimated to consist of only himself and 2 adult females[1]. From the labour market a farmer in the area hired a maximum of 4 labourers per day. Farmers in the area usually worked 5 days in a week resting on Fridays or market days and on Sundays. Based on these facts the farmers' monthly labour supply levels have been calculated and presented in Table 19. The table indicates that the average farmer would have available to him a total of 120, 132, 132 and 126 mandays of labour for the months of February, March, April and May respectively. Similarly he would have 126 mandays of labour for August.

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[1] These are the modes of the Figures quoted by farmers.

TABLE 19   MONTHLY LABOUR RESOURCE AVAILABLE PER FARMER
(DENU-ABOR AREA)

Month	No. of Working days	Total Family Labour [2]	Hired Labour	Total
February	20	40	80	120
March	22	44	88	132
April	22	44	88	132
May	22	44	88	132
August	21	42	84	126
September	22	44	88	132

Figure 3 and Appendix Table 15 give the monthly labour requirement of one acre of the various enterprises. It can be seen from the Figure that labour requirement for the enterprises is highest in August when harvesting of most of the crops takes place and in April and May when planting (sowing) and the first weeding (under cultivation) are carried out. The demand for labour is also fairly high in February and March when the farmers prepare the land. February, March, April, May and August are therefore used in the model as the months in which labour may be most constraining.

Available Land

It has been estimated in Table 1 that a farmer in the Denu-Abor area had at his disposal an average of 11.6 acres (4.7 hectares) of land of which he utilized about 5.6 acres or 2.3

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[2] Two mandays of female labour is taken to be equivalent to 1 manday of male labour.

FIGURE 3.

Per Acre Monthly Labour Requirement of Crop Enterprises
(Demu — Abau Area)

Legend (upper figure):

.... Cowpea
– – – Groundnut
–––– Cassava
–o–o– Maize
–oo–oo– Tobacco
———— Av All Enterprises

Legend (lower figure):

———— Cassava/maize
–o–o– Cassava/maize/cowpea
– – – Cassava/maize/cowpea
Av for All Mixed Enterprises

Graph labels: Maize, Groundnut, Cowpea, Tobacco

Months (x-axis): JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
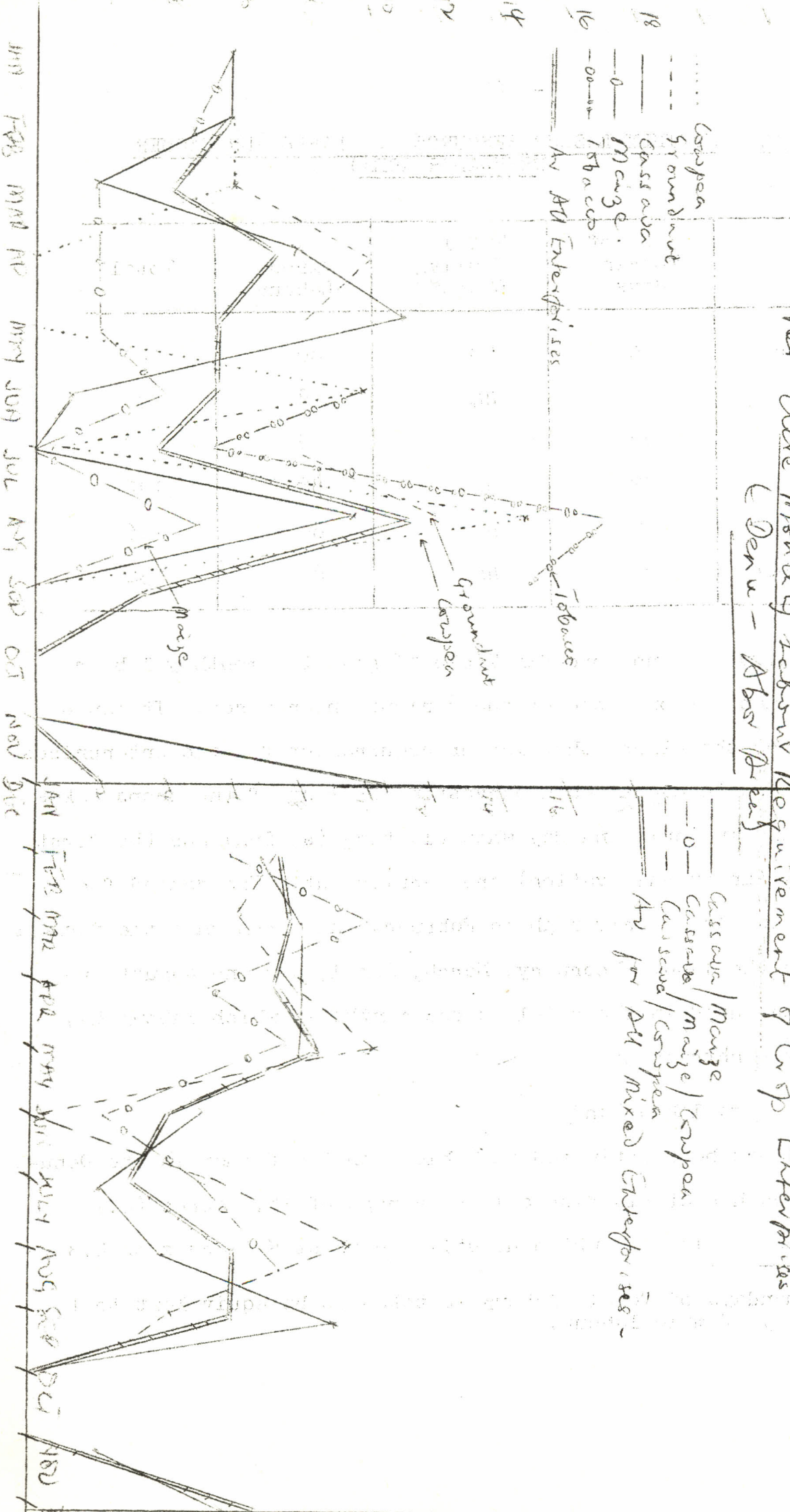
hectares in the 1974 farming season. These 11.6 acres are considered in the plan.

2. Optimal Plans (Enterprise Mix) for Farmers in Denu-Abor Area

Optimal Plan 1. Assumptions:

Appendix Table 16 gives the Simplex Tableau or Problem Matrix for optimal plan 1. The plan assumes the following:

(i) a total available land of 11.6 acres (4.7 hectares) for the farmer;

(ii) available labour supply of 120, 132, 132, 132 and 126 mandays for February, March, April, May and August respectively;

(iii) a working capital of ₡100.00.

(iv) that the farmer pays for all the variable costs of production and obtains the average gross margins presented in Appendix Table 12.

Results:

Table 20 gives the details of optimal Plan 1. The plan is made up of only 1.8 acres (0.7 hectare) of cowpea (pure crop) and yields ₡157.05 net revenue.

TABLE 20   OPTIMAL PLAN 1.   DENU-ABOR AREA

Real Activities	Level	Z-C ¢	Disposal Activities	Level of Unused Resource	Z-C ¢
P_9 Ca[1]	0.0	16.10	P_1 (Feb L)	109	0.00
P_{10} M[2]	0.0	43.16	P_2 (March L)	121	0.00
P_{11} Co[3]	1.8	0.00	P_3 (April L)	132	0.00
P_{12} Gr[4]	0.0	44.50	P_4 (May L)	126	0.00
P_{13} Tob	0.0	93.35	P_5 Aug	99	0.00
P_{14} Ca/M	0.0	82.69	P_6 Sept	132	0.00
P_{15} Ca/Co	0.0	81.34	P_7 WK[5]	0.0	1.57
P_{16} Ca/M/Co	0.0	54.89	P_8 LN[6]	9.8	0.00
P_{17} Ca/M/Gr	0.0	60.70	Net Revenue - ¢157.05		

[1] Cassava [2] Maize [3] Cowpea [4] Groundnut [5] Working Capital [6] Land.

Implications of Optimal Plan 1.

Plan 1 leaves 9.8 acres (3.9 hectares) of available land un-utilized and a lot of labour resources also un-used. However all the working capital is exhausted (see Table 20). The results indicate that an additional ¢1.00 working capital would enable production expansion and bring about additional net revenue of ¢1.57. It can also be seen from Table 20 that Tobacco should be the last enterprise to be considered for investment by the farmers. Its marginal cost (   ) per acre of ¢93.35 (¢230.66 per hectare) is the highest among the excluded enterprises.

3. Effects of Raising The Level of Working Capital In Plan 1

Figure 4 and Table 21 show that the net revenue derived from the optimal plan increases rapidly as the amount of working capital increases from ₵100 to ₵500. The gradient of the curve however decreases slightly from ₵500 to ₵800 of working capital while the curve almost flattens off from ₵800 to ₵1000.00. When the level of working capital reaches ₵500.00, August labour in the plan (labour for harvesting) becomes depleted and constraining. The Marginal Value product of one manday of August labour at this stage is ₵1.57.

Optimal Plan-Enterprise Mix

Table 21 depicts the changes which take place within the optimal plan or enterprise mix as the size of working capital increases progressively to ₵1000.00 without any changes in the original problem matrix. Cowpea (Pure crop) remains the optimum enterprise for investment and the acreage (scale of operation) increases as the size of working capital increases to ₵500.00. When working capital is ₵500.00 the optimal plan involves 8 acres (3.2 hectares) of cowpea and 0.7 acre of cassava and gives a net revenue of ₵774.14 (See Table 21). From a working capital of ₵500.00 the prominence of cowpea as an optimum enterprise diminishes from 8 acres to only 0.1 acre at ₵1000.00 working capital. This happens because August labout gets depleted at ₵500 working capital. From that stage and with more money for investment farmers have to select enterprises which utilize little or no August labour. This explains the importance of

cassava (pure crop) in the optimal plans when working capital
rises above ₵500.00. (See Table 21)

TABLE 21   EFFECTS OF WORKING CAPITAL SIZE ON OPTIMAL
            PLAN AND NET RETURNS

Size of Working Capital ₵	Optimal Plan/ Enterprise Mix Acres	Net Returns ₵
100.00	1.8 Co[1]	157.05
150.00	2.7 "	235.58
200.00	3.5 "	314.10
300.00	5.3 " +	471.10
500.00	8.0 " + 0.7 Ca[2]	774.14
600.00	6.4 " + 3.3 "	889.45
800.00	2.5 " + 9.1 "	1109.57
1000.00[3]	0.1 " +11.4 "	1130.83

[1] Cowpea   [2] Cassava

[3] ₵162.49 of this is left unused while May labour
   becomes constraining with ₵0.82 marginal value product.

The conclusion to draw from the above analysis is that cowpea is the
optimal enterprise for investment when working capital is up to ₵500 and
labour resource level is as estimated above. With more August labour
cowpea is still the optimal enterprise when working is above ₵500.00.
Cassava becomes more important where the supply of labour in August is
small. This situation raises a lot of issues of agronomic, economic as
well as political nature.

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FIGURE 4. Effect of Working Capital Size On Net Revenue
From Optimum Plan 1
(Demu Flow Area)

Net Revenue →

Size of Working Capital →
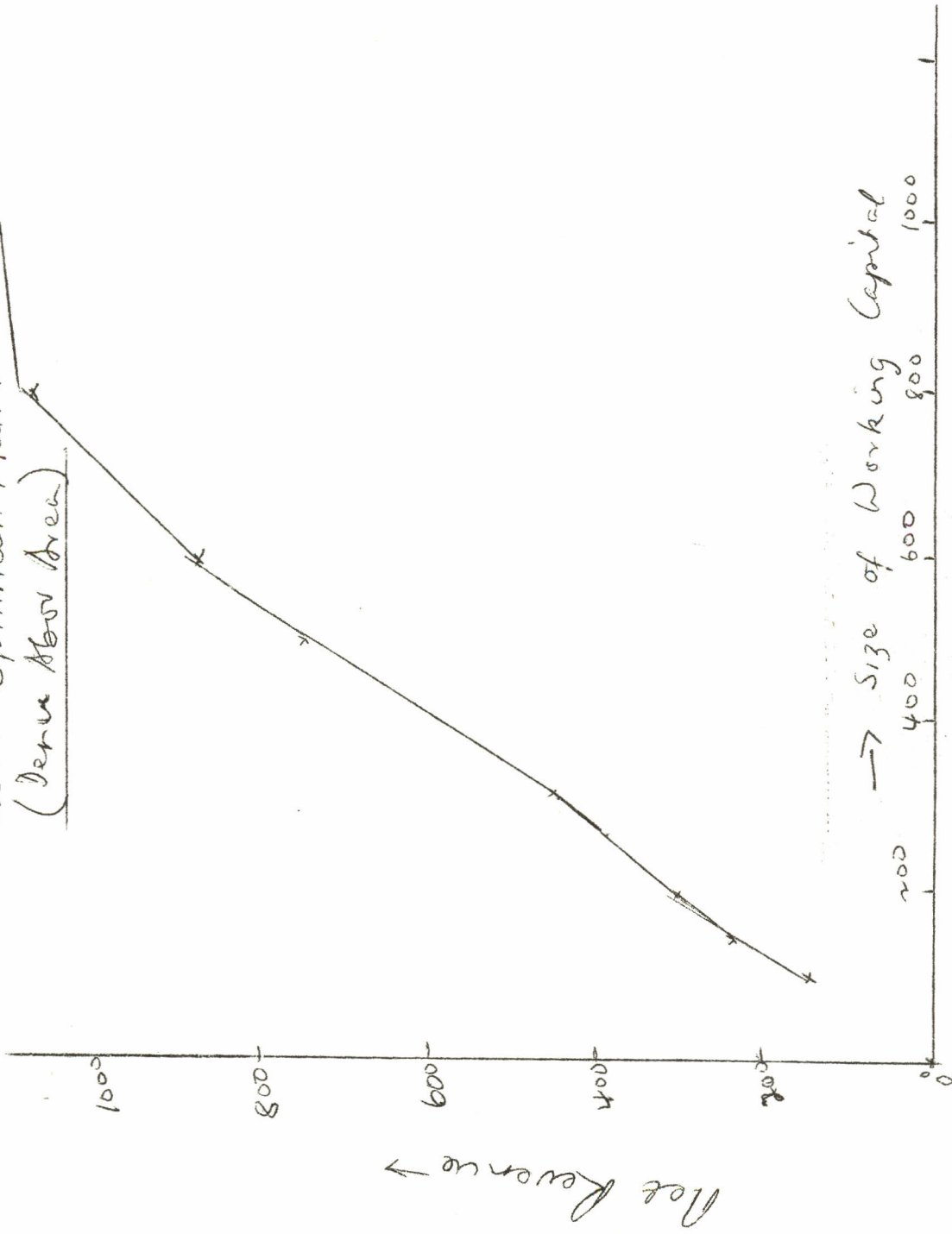
CHAPTER VIII

C O N C L U S I O N

A number of crops take precedence over cowpea in farmers' programmes in both survey areas. In the Navrongo-Bawku area, the reason is that the cultivation of cowpea (as a pure crop) is relatively un renumerative . However cowpea is one of the crops which compose the most profitable and optimum enterprise -millet/sorghum/cowpea intercrop - for investment by farmers in the area. Farmers are aware of the high food value of cowpea and would produce more if simple and economic means of improving their yields were made known and available to them. Such means could come in the form of a package deal comprising higher yielding cowpea varieties/ types accompanied by simple and inexpensive but proven crop protection and storage techniques.

Most farmers in the Navrongo-Bawku area are not getting the maximum possible returns their resource endowment could give them. This is because of over - diversification of crops or crop enterprises leading to misapplication of resources through (a) under-investment in the appropriate enterprises and (b) investment in enterprises which are relatively unrenumerative. The choice of millet/sorghum/cowpea (mixed enterprise) by the majority of the farmers in the area is rational economically although the threshold of investment for optimum returns is rarely reached.

In the Denu-Abor area cowpea is accorded the third place after cassava and maize in the programmes of the farmers/cultivate it, although if returns maximization were the objective cowpea (pure crop) should be the best enterprise for investment. Cassava and maize take precedence over cowpea because they are the chief staples and require little attention while farmers are not certain about the crop calander for cowpea and are therefore generally afraid to invest in the crop.

APPENDIX TABLE I

ESTIMATED OUTPUT OF COWPEA BY
REGIONS - 1974

REGION - DISTRICT		OUTPUT - Metric Tonnes
Upper Region		1,750
- Navrongo/Bolgatanga	750	
- Bawku	450	
- Other Districts	550	
Northern Region		550
Brong Ahafo		200
Volta Region		200
Eastern Region		150
Ashanti Region		100
Central and Western Regions		20
TOTAL GHANA		2,970

* Compiled from the Various files at Ministry of
Agriculture Regional and Districts Offices.

APPENDIX TABLE 2*

NUMBER OF CATTLE _ MID 1970 & END 1970

REGION OF DISTRICT	NUMBER OF CATTLE	
	AS AT MID-'70	AS AT END_ '70
Western Region)		
Central Region)	9000	6,000
Ashanti Region)		
Eastern region	150,000	167,000
Volta Region	48,000	42,000
Brong Ahafo Rgion	13,000	20,000
Nothern Region	260,000	182,000
- Yendi	90,000	50.000
- Tanale	72,000	61,000
- Other Areas	98,000	71,000
Upper Region	446,000	486,000
- Navrongo-Bolgatanga	92,000	106,000
- Bawku	79,000	80.000
- Other Areas	275,000	300,000
TOTAL GHANA	926,000	903,000

* SOURCE :   Culled from - Report on Ghana Sample Census of Agriculture 1970
        Vol. 1 p.57 By Ministry of Agriculture.

APPENDIX 3

FARMS (ENTERPRISES) ECOUNTERED
IN THE DENU-ABOR AREA

TYPE	No. of Farms	Total Ac.[1]	Hect.[2]	TYPE	No. of Farms	Total Ac.	Hec.
1. Pure Corp.							
Cassava	41	170	(68.8)	Okro	2	2	(0.8)
Maize	39	105	(42.0)	Sugar Cane	3	4	(1.6)
Cowpea	11	24	(9.7)	Groundnut	2	5	(2.0)
Tobacco	9	11	(4.4)	Pepper	3	2	(0.8)
Yam	2	13	(5.2)	Shallot	1	.3	(−)
Oil Palm	3	66	(26.7)	Sweet Potatoe	1	.3	(−)
2. Two-Crop Mixture							
Cassava/Maize	125	429	(173.6)	Cass./Tob.[5]	1	1.5	(.6)
Cassava/Cow[4]	24	83	(33.6)	Okro/Toma	1	4	(1.6)
Cass[3]/Groundnut	4	18	(7.3)	Maize/Tob	1	4	(1.6)
Maize/Cow	3	71	(28.7)	Cass/S'Pot[6]	1	3	(1.2)
Yam/Cow	1	5	(2.0)	Oilpalm/C.	1	4	(1.6)
Okro/Pepper	1	8	(3.2)				
3. Three Crop Mixture							
Cas/Maize/Cow	9	52	(21.0)	Cass/Tob/Cow	1	4	(1.6)
Cass/Maize/Groundnut	6	44	(17.8)	Tomatoe/Okro/Pepper	1	0.8	(0.3)
Cass/Maize/S'Potatoes	3	23	(9.3)	G'nut/Tob/S'Potatoe	1	2	(0.8)
Cass/Cow/G'nt[7]	1	12	(4.9)				
Cass/Maize/Okro	111	6	(2.4)	Tob/Pepper/Tomatoe	1	3	(1.2)
4. Four & More Crop Mixture							
Cass/S'Pot/Cow/G'nt.	1	4	(1.6)				
Cass/Maize/Cow/Maize	1	11	(4.4)				
Cass/Maize/Cow/Maize	3	10	(4.0)				

1	Ac.	=	Acreage	4.	Cow	=	Cowpea
2.	Hect.	=	Hectare	5.	Tob.	=	Tobacco
3.	Cass	=	Cassava	6	S'Pot.	=	Sweet Potatoes
				7.	G'nt	=	Groundnut.

APPENDIX 4

TYPE	No. of Farms	Total Acr.	Hect.	TYPE	No. of Farms	Total Acr.	He
1							
1. Pure Crop.							
Rice	24	198.0	(80.0)	Kenaf	2	7.0	(
Groundnut	12	26.0	(10.5)	Cotton	2	6.0	(
Millet	6	12.	(4.8)	Cowpea	1	0.6	(
2. Two-Crop. Mixt.							
Millet/Cowpea	12	62.0	(25.0)	Sorghum/Cowpea	5	33.0	(1
Millet/Sorghum	5	53.0	(21.4)	Sorghum/G'nut	1	6.0	(
Millet/Groundnut	2	6.0	(2.4)	Sorghum/Rice	1	3.0	(
Groundnut/Bambara	5	12.0	(4.9)	Groundnut/Rice	1	2.0	(
Groundnut/Cowpea	7	47.0	(19.0)				
3. Three-Crop. Mixture							
Millet/Sorghum/Cowpea	38	107	(4.3)	Millet/Sorghum/Okro	1	6	(2
Millet/Groundnut/Cowpea	7	12	(4.4)	Millet/Maize/Cowpea	1	1	(0
Millet/Sorghum/Groundnut	1	3	(1.2)	Rice/Maize/Kenaf	1	.6	(0
4. Four-Crop. Mix.							
Millet/Sorghum/Bambara/Cowpea	3	4.5	(1.8)				
Millet/Sorghum/Groundnut/Cowpea	2	10.0	(4.0)				

APPENDIX TABLE 5

PRODUCTION COSTS PER ACRE OF PURE CROP ENTERPRISES

(NAVRONGO-BAWKU AREA)

ENTERPRISE	RICE				GROUNDNUTS	
	Rice$^{F(1)}$		Rice$^{NF(2)}$		GD^F	
ITEMS/OPERATIONS	Input MD(3)	Cost ¢	Input	Cost ¢	Input MD	Cost ¢
- Land Preparation	–	–	–	–	–	–
Tractor/Bullock/Labour	–	15.00	–	15.00	–	18.00
- Seeds	–	9.00	–	9.00	–	6.00
- Sowing	6	7.20	6	7.20	6	7.20
- Fertilizer	–	4.20	–	–	–	4.20
- Application	2	2.40	–	–	2	2.40
- Ist Under Cultivation	8	9.60	8	9.60	8	9.60
- 2nd Under Cultivation	8	9.60	8	9.60	8	9.60
- Harvesting	10	12.00	6	7.20	9	10.80
TOTAL	34	69.00	28	57.60	33	67.80

1 - F = With fertilizer

2. - NF = Without Fertilizer

3 - MD = Mandays of Labour

ACRE OF PURE CROP ENTERPRISES

(BAWKU AREA)

	GROUNDNUTS				COWPEA$^{(NF)}$		MILLET$^{(NF)}$	
Rice$^{NF(2)}$	GD^F		GD^{NF}		-			
t Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢
-	-	-	-	-	-	-	-	-
15.00	-	18.00	-	18.0	-	14.40	2	12.00
9.00	-	6.00	-	6.0	-	10.00	-	.50
7.20	6	7.20	6	7.20	4	4.80	4	4.80
-	-	4.20	-	-	-	-	-	-
-	2	2.40	-	-	-	-	-	-
9.60	8	9.60	8	9.60	7	8.40	7	8.40
9.60	8	9.60	8	9.60	7	8.40	7	8.40
7.20	9	10.80	8	9.60	6	7.20	6	7.20
57.60	33	67.80	30	60.00	26	53.20	24	41.30

APPENDIX TABLE 5

PRODUCTION COSTS PER ACRE OF PURE CROP ENTERPRISES
(NAVRONGO-BAWKU AREA)

ENTERPRISE	RICE				GROUNDNUTS	
	Rice$^{F(1)}$		Rice$^{NF(2)}$		GD^F	
ITEMS/OPERATIONS	Input MD(3)	Cost ¢	Input	Cost ¢	Input MD	Cost ¢
- Land Preparation	-	-	-	-	-	-
Tractor/Bullock/Labour	-	15.00	-	15.00	-	18.00
- Seeds	-	9.00	-	9.00	-	6.00
- Sowing	6	7.20	6	7.20	6	7.20
- Fertilizer	-	4.20	-	-	-	4.20
- Application	2	2.40	-	-	2	2.40
- Ist Under Cultivation	8	9.60	8	9.60	8	9.60
- 2nd Under Cultivation	8	9.60	8	9.60	8	9.60
- Harvesting	10	12.00	6	7.20	9	10.80
TOTAL	34	69.00	28	57.60	33	67.80

1 - F = With fertilizer

2. - NF = Without Fertilizer

3 - MD = Mandays of Labour

PRODUCTION COSTS PER ACRE OF PURE CROP ENTERPRISES

(NAVRONGO-BAWKU AREA)

RICE			GROUNDNUTS				COWPEA (NF)		MILLET (NF)	
$Rice^{F(1)}$	$Rice^{NF(2)}$		GD^{F}		GD^{NF}		-		.	
Cost ¢	Input	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢
-	-	-	-	-	-	-	-	-	-	-
15.00	-	15.00	-	18.00	-	18.0	-	14.40	2	12.00
9.00	-	9.00	-	6.00	-	6.0	-	10.00	-	.50
7.20	6	7.20	6	7.20	6	7.20	4	4.80	4	4.80
4.20	-	-	-	4.20	-	-	-	-	-	-
2.40	-	-	2	2.40	-	-	-	-	-	-
9.60	8	9.60	8	9.60	8	9.60	7	8.40	7	8.40
9.60	8	9.60	8	9.60	8	9.60	7	8.40	7	8.40
12.00	6	7.20	9	10.80	8	9.60	6	7.20	6	7.20
69.00	28	57.60	33	67.80	30	60.00	26	53.20	24	41.30

andays of Labour

APPENDIX
TABLE 6

PRODUCTION COST PER ACRE OF COMPOSITE ENTERPRISES
(Navrongo-Bawku Area)

Enterprise Items/Operations	Cowpea/Millet (NF)[1]		Groundnuts/Cowpea (F)[2]		(NF)	
	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢
- Land Preparation	-	-	-	-	-	-
Tractor/Bullock/Labour	12	14.40	3	15.60	3	15.60
- Seeds	-	-	-	-	-	-
Millet	-	.40	-	-	-	-
Sorghum	-	-	-	-	-	-
Cowpea	-	1.00	-	4.00	-	4.00
Groundnuts	-	-	-	3.00	-	3.00
Sowing	4	4.80	6	7.20	6	7.20
Fertilizer	-	-	-	2.80	-	-
Application	-	-	2	2.40	-	-
- 1st Undercultivation	7	8.40	8	9.60	8	9.60
- 2nd Undercultivation	7	8.40	8	9.60	8	9.60
- Harvesting	7	8.40	8	9.60	3	3.60
T O T A L	37	45.80	35	62.60	28	52.60

1 NF = Without Fertilizer   3 MD = Manday

2 F   = With Fertilizer.

APPENDIX
TABLE 6 Continued:

| | Millet/Sorghum/Cowpea | | | | Millet/Groundnut/Cowpea | | | |
| | (F) | | (NF) | | (F) | | (NF) | |
	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢	Input MD	Cost ¢
	-	12.00	-	12.00	-	-	-	-
	1	13.20	1 1	13.20	2	20.40	2	20.40
	-	-	-	-	-	-	-	-
	-	50	-	50	-	40	-	40
	-	50	..	50	-	-	-	-
	-	1.50	-	1.50	-	1.00	-	1.00
	-	-	-	-	-	4.00	-	4.00
	4	4.80	4	4.80	4	4.80	4	4.80
	-	8.40	-	-	-	5.60	-	-
	4	4.80	-	-	2	2.40	6	-
	7	8.40	7	8.40	7	8.40	7	8.40
	7	8.40	7	8.40	7	8.40	7	8.40
	8	9.60	8	9.60	8	9.60	8	9.60
TOTAL	31	60.10	27	46.90	30	65.00	28	57.00

APPENDIX TABLE 7

CROP YIELDS (LB) PER ACRE (Kg/HECTARE) IN THE NAVRONGO-B.

CROP	PURE CROP ENTERPRISES		Millet/Cowpea		Cowpea/Groundnut		COMPOSITE (Millet, S.
	F^1	NF^2	F^1	NF^2	F^1	NF^2	F^1
Rice	1260(1415)	720(809)	--	--	-	-	-
Groundnut	900(1011)	520(584)	--	--	200(225)	320(359)	-
Cowpea	-	310(348)	--	70(79)	170(191)	20(22)	120(135
Millet	-	950(1067)	-	210(236)	-	-	800(899)
Sorghum	-	-	-	-	-	-	270(303)

*1F = Enterprise with Fertilizer

*2NF = Enterprise with No Fertilizer

DS (LB) PER ACRE (Kg/HECTARE)IN THE NAVRONGO-BAWKU AREA

a	Cowpea/Groundnut		Millet, Sorghun/Cowpea		Millet/Groundnut/Cowpea	
^{2}	F[1]	NF[2]	F[1]	NF[2]	F[1]	NF[2]
-	-	-	-	-	-	-
	200(225)	320(359)	-	-	600(674)	540(607)
79)	170(191)	20(22)	120(135	120(135)	170(191)	70(79)
236)	-	-	800(899)	570(640)	420(472)	250(281)
	-	-	270(303)	340(382)	-	-

COMPOSITE (MIXED) ENTERPRISES

r

APPENDIX *

TABLE 8   OPERATIONS COSTS OF & RETURNS FROM ENTERPRISES PER ACRE

(Navrongo-Bawku Area)

ENTERPRISES	Av. Total Labour Used (Mandays) A	Av. Total Production Cost ₵ B	Av. Total Value of paid Inputs ₵ C
Millet NF[1]	24	41.30	
Cowpea NF	26	53.20	
Rice F[2]	34	69.00	
Rice NF	28	62.40	
Groundnut F	33	67.80	
Groundnut NF	30	60.00	
Cowpea/Millet NF	37	45.80	
Cowpea/Groundnut F	35	62.60	
Cowpea/Groundnut NF	28	52.60	
Mill/Sor/Cowpea F	31	60.10	14.40
Mill/Sor/Cowpea NF	27	46.90	14.40
Mill/G'dnut/Cowpea F	30	65.00	
Mill/G'dnut/Cowpea NF	28	57.00	

*cont'd on next page

*1NF   Without Fertilizer   *Sor   = Sorghum

*2F   With Fertilizer   *G'dnut = Groundnut

                                    *Mill   = Millet

APPENDIX
TABLE 8 Continued

ENTERPRISES	Total Non-Labour Cost ¢ D	Gross Output ¢ E	Net Returns ¢ F	Return to one Manday Labour. $\frac{E-D}{A}$
Millet NF[1]	12.50	108.00	66.70	3.98
Cowpea NF	12.00	56.25	3.05	1.70
Rice F[2]	28.20	126.00	57.00	2.87
Rice NF	24.00	72.00	9.60	1.71
Groundnut F	28.20	50.00	7.80	0.69
Groundnut NF	24.00	30.00	-30.00	0.20
Cowpea/Millet NF	1.40	32.00	-13.80	0.82
Cowpea/Groundnut F	21.80	66.90	4.30	1.28
Cowpea/Groundnut NF	19.00	22.70	-29.90	0.13
Millet/Sorghum/Cowpea F	22.90	133.30	73.20	3.56
Millet/Sorghum/Cowpea NF	14.50	113.50	66.60	3.66
Millet/Groundnut/Cowpea F	29.00	99.90	34.90	1.55
Millet/Groundnut/Cowpea NF	23.40	66.90	9.90	1.33

* 1 NF Without Fertilizer

*2 F With Fertilizer.

APPENDIX

TABLE 9

RESOURCE INPUT AND PER ACRE PRODUCTION
COSTS OF PURE CROP ENTERPRISES

(Denu-Abor Area)

Enterprise Operation	CASSAVA		MAIZE		COWPEA		GROUNDNUT		TOBACCO	
	Labour MD1	Cost	Labour MD	Cost	Labour MD	Cost	Labour MD	Cost	Labour MD	Cost
Land Preparation	12	15.60	11	14.30	12	15.60	12	15.60	5	(*15.40) (6.50)
Seed	-	3.50	-	2.70	-	3.75	-	6.00	-	12.00
Sowing	4	5.20	4	5.20	6	7.80	10	13.00	8	10.40
Fertilizer (bags)	-	-	-	-	-	-	-	-	4	16.00
Fertilizer Application	-	-	-	-	-	-	-	-	5	6.50
1st under Cultivation	9	11.70	7	9.10	9	11.70	8	10.40	5	6.50
2nd under Cultivation	9	11.70	-	-	-	-	8	10.40	5	6.50
3rd under Cultivation	10	13.70	-	-	-	-	-	-	-	-
Harvesting	9	11.70	5	6.50	15	19.50	12	15.60	27	35.90
Total	53	72.40	27	37.80	42	58.35	50	71.00	55	114.90

*1 MD   - Manday

*2 MD   - Cost of tractor services - Ploghing, Harrowing
and Ridging.

APPENDIX
TABLE 10

RESOURCE INPUT AND PER ACRE PRODUCTION
COST OF MIXED CROP ENTERPRISES

(Denu-Abor Area)

Enterprise Operations	Cassava/ Maize		Cassava/ Cowpea		Cassava/Maize/ Cowpea		Cassava/Maize/ Groundnut	
	Labour MD*	Cost ¢	Labour MD	Cost ¢	Labour MD	Cost ¢	Labour MD	Cost ¢
Land Preparation	13	16.90	13	16.90	13	16.90	13	16.90
Maize								
Seeds (ibs)	–	2.00	–	–	–	1.60	16	1.30
Sowing	4	5.20	–	–	3	3.90	2	2.60
Harvesting	6	7.80	–	–	4	2.20	5	6.50
Cassava								
Sticks	–	1.50	–	1.50	–	2.00	–	2.00
Planting	4	5.20	3	3.90	4	5.20	4	5.20
Harvesting	6	7.80	4	5.40	5	6.50	2	2.60
Cowpeas								
Seeds (lbs)	–	–	6	1.56	3	0.80	–	–
Sowing	–	–	3	3.90	2	2.60	–	–
Harvesting	–	–	10	13.00	3	3.90	–	–
Groundnuts								
Seeds (lbs)	–	–	–	–	–	–	1	2.00
Sowing	–	–	–	–	–	–	2	2.60
Harvesting	–	–	–	–	–	–	4	5.20
1st under Cultivation	9	11.70	8	10.40	7	9.10	6	7.80
2nd " "	9	11.70	8	10.40	7	9.10	6	7.80
3rd " "	9	11.70	8	10.40	7	9.10	6	7.80
Total	60	81.50	57	77.16	55	73.90	50	70.30

*MD – Manday

APPENDIX

TABLE 11

CROP YIELDS PER ACRE IN DENU-ABOR AREA

CROPS	Pure Crop Enterprises		Yields Mixed Crop Enterprises							
	lbs	(long tong)	Cassava/ Maize lbs	(long ton)	Cassava/ Cowpea lbs	(long ton)	Cassava/ Cowpea/ Maize lbs	(long ton)	Cassava/ Maize lbs	(long ton)
Cassava	7565	(3.38)	3275	(1.46)	2492	(1.11)	4272	(1.91)	1780	(0.79)
Maize	720	(0.32)	672	(0.30)	—	—	144		432	(0.19)
Cowpeas	480	(0.21)	—	—	200	(0.09)	100		—	
Groundnuts	600	(0.27)	—	—	—		—		200	(0.09)
Tobacco	202	(0.09)	—	—	—	—	—		—	—

APPENDIX
TABLE 12   <u>SUMMARY OF   PER ACRE OPERATION COSTS</u>
<u>AND RETURNS FROM ENTERPRISES</u>

(<u>Denu-Abor Area</u>)

Enterprises	Labour Requirement in Mandays	Total Operation Cost ¢	Labour Cost as % of Total Cost	Total Non-Labour Cost ¢	Gross (Output) Revenue ¢	Gross Margin ¢	Return to Labour/ Manday ¢
Cassava	53	72.40	95	3.50	170.00	97.60	3.14
Maize	27	37.80	93	2.70	54.00	16.20	1.30
Cowpea	42	58.35	94	3.75	146.40	88.05	3.40
Groundnuts	50	71.00	91	6.00	138.00	67.00	2.64
Tobacco	55	114.90	60	46.00	202.00	87.10	2.84
Cassava/Maize	60	81.50	96	3.50	126.80	45.30	2.06
Cassava/Cowpea	57	77.16	96	3.06	117.00	39.84	2.00
Cassava/Maize/ Cowpea	55	75.00	95	3.50	137.90	62.90	2.44
Cassava/Maize/ Groundnut	50	70.30	92	5.30	120.00	49.70	2.29

APPENDIX TABLE 13   PER ACRE MONTHLY LABOUR REQUIREMENT OF
ENTERPRISES - NAVRONGO - BAWKU AREA

MONTH ENTERPRISES	JAN.	FEB	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
- Millet^{NF1}	0	0	0	0	4	7	0	0	0	0	13	0	24
- Cowpea^{NF}	0	0	0	0	6	7	0	0	0	7	6	0	26
- Rice^{F2}	0	0	0	0	3	10	3	0	0	6	12	0	24
- Rice^{NF}	0	0	0	0	3	8	3	0	0	6	8	0	28
- Groundnut^{F}	0	0	0	0	14	2	0	0	0	7	10	0	33
- Groundnut^{NF}	0	0	0	0	14	0	0	0	0	7	9	0	30
Cowpea/Millet^{NF}	0	0	0	0	6	10	7	0	0	5	9	0	37
Cowpea/Groundnut^{F}	0	0	0	0	6	13	0	0	0	10	6	0	35
Cowpea/Groundnut^{NF}	0	0	0	0	6	11	0	0	0	8	3	0	28
Miller/Sorghum/Cowpea^{F}	0	0	0	1	8	7	0	0	0	2	13	0	31
Millet/Sorghum/Cowpea^{NF}	0	0	0	1	4	7	0	0	0	2	13	0	27
Millet/Sorghum/Groundnut^{F}	0	0	0	2	6	7	0	0	0	2	13	0	30
Millet/Sorghum/Groundnut^{NF}	0	0	c	2	4	7	0	0	0	2	13	0	28

*1 NF   =   Without Fertilizer

*2 F   =   With Fertilizer.

APPENDIX TABLE 14 - ORIGINAL PROBLEM MATRIX/SIMPLEX TABLEAU

Enterprise Non-Zero Level	Resource of Enterprise Level	May L P_1	June L P_2	July L P_3	Oct L P_4	Nov L P_5	WK P_6	LN P_7	M^{NF} ¢ P_8	C^{NF} ¢ P_9	$R^{(F)}$ ¢ P_{10}	R^{NF} ¢ P_{11}	$G^{(F)}$ ¢ P_{12}	G^{NF} ¢ P_{13}
	Z-C	0	0	0	0	0	0	0	-¢3.98	-¢3.05	-¢57.00	-9.60	+7.80	+28.8
May L	207	1	0	0	0	0	0	0	4	6	5	5	0	0
June L	198	0	1	0	0	0	0	0	7	7	9	7	14	12
July L	207	0	0	1	0	0	0	0	0	0	2	2	2	2
Oct L	207	0	0	0	1	0	0	0	0	7	6	6	12	11
Nov. L	242	0	0	0	0	1	0	0	13	6	12	8	2	2
*WK	¢100.00	0	0	0	0	0	1	0	¢41.30	¢53.20	¢69.00	¢62.40	¢67.80	¢62.40
LN	16.7 Acres	0	0	0	0	0	0	1	1	1	1	1	1	1

KEY: M = Millet; C = Cowpea; R = Rice; G = Groundnut NF (Wit

LN = Land

*Vary WK Working Capital to ¢150; ¢200.00; ¢300.00; ¢500.; ¢800; & ¢

TABLE 14 - ORIGINAL PROBLEM MATRIX/SIMPLEX TABLEAU

WK P_6	LN P_7	M^{NF} ¢ P_8	C^{NF} ¢ P_9	$R^{(F)}$ ¢ P_{10}	R^{NF} ¢ P_{11}	$G^{(F)}$ ¢ P_{12}	G^{NF} ¢ P_{13}	C/M ¢ P_{14}	$CG^{(F)}$ ¢ P_{15}	$CG^{(NF)}$ ¢ P_{16}	$MSC^{(F)}$ ¢ P_{17}	MSC ¢ P_{18}	$MG\text{-}?^{(F)}$ ¢ P_{19}	MGC^{NF} ¢ P_{20}
∅	∅	-¢3.98	-¢3.05	-¢57.00	-9.60	+7.80	+28.80	+13.80	-4.30	+29.90	-73.20	-66.60	-34.90	-9.90
0	0	4	6	5	5	∅	∅	6	6	6	8	4	6	4
0	0	7	7	9	7	14	12	10	13	11	7	7	7	7
0	0	∅	∅	2	2	2	2	7	∅	∅	∅	∅	∅	∅
0	0	∅	7	6	6	12	11	5	10	8	2	2	2	2
0	0	13	6	12	8	2	2	9	6	3	13	13	13	13
0	0	¢41.30	¢53.20	¢69.00	¢62.40	¢67.80	¢62.40	¢45.80	¢62.60	¢52.60	¢60.10	¢46.90	¢65.00	¢57.00
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Cowpea; R = Rice; G = Groundnut NF (Without Fertilizer; F = With fertilizer

¢150; ¢200.00; ¢300.00; ¢500.; ¢800; & ¢1000.00

APPENDIX TABLE 15   PER ACRE MONTHLY LABOUR REQUIREMENTS OF CROP ENTERP

DENU--BOR AREA

Month Enterprise	JAN	FED	MAR	APR	MAY	JUNE	JULY	AUG
Cassava	6	6	2	8	11	1	Ø	9
Maize	6	5	2	2	3	4	Ø	5
Cowpea	6	6	6	Ø	Ø	9	Ø	15
Groundnut	Ø	6	6	10	8	Ø	8	12
Tobacco	Ø	Ø	5	Ø	4	9	5	17
Cassava/Maize	Ø	7	8	8	8	5	2	4
Cassava/Cowpea	Ø	7	6	8	10	0	5	9
Cassava/Maize/Cowpea	Ø	6	10	5	7	6	2	5
Cassava/Maize/Groundnut	Ø	7	6	6	8	2	5	6

R ACRE MONTHLY LABOUR REQUIREMENTS OF CROP ENTERPRISES

DENU-ABOR AREA

FED	MAR	APR	MAY	JUNE	JULY	AUG.	SEPT	OCT	NOV	DEC	TOTAL
6	2	8	11	1	∅	9	∅	∅	∅	10	53
5	2	2	3	4	∅	5	∅	∅	∅	∅	27
6	6	∅	∅	9	∅	15	∅	∅	∅	∅	42
6	6	10	8	∅	8	12	∅	∅	∅	∅	50
∅	5	∅	4	9	5	17	15	∅	∅	∅	55
7	8	8	8	5	2	4	9	∅	2	7	60
7	6	8	10	0	5	9	4	∅	∅	8	57
6	10	5	7	6	2	5	7	∅	∅	7	55
7	6	6	8	2	5	6	4	∅	∅	6	50

APPENDIX TABLE 16   ORIGINAL PROBLEM MATRIX/SIMPLEX TABLEAU

(For Optimum Enterprise Mix Denu-Abor Area)

Enterprise of Non Zero Level	Resource/ Enterprise Level	DISPOSAL ACTIVITIES											REAL
		P1 Feb. L	P2 Mar. L	P3 Apr. L	P4 May L	P5 Aug. L	P6 Sept. L	P7 WK	P8 LN	P9 CA	P10 M	P11 CO	P12 G
	Z - C	∅	∅	∅	∅	∅	∅	∅	∅	-97.00	-16.20	-88.05	-67.0∅
Feb. L	120 MDS	1	∅	∅	∅	∅	∅	∅	∅	6	5	6	6
March L	132 "	∅	1	∅	∅	∅	∅	∅	∅	2	2	6	6
April L	132 "	∅	∅	1	∅	∅	∅	∅	∅	8	2	∅	5
May L	126 "	∅	∅	∅	1	∅	∅	∅	∅	11	3	∅	5
August L	126 "	∅	∅	∅	∅	1	∅	∅	∅	9	5	15	8
September L	132 "	∅	∅	∅	∅	∅	1	∅	∅	∅	∅	∅	12
WK	¢100.00	∅	∅	∅	∅	∅	∅	1	∅	72.40	37.80	56.35	71.0
Land	11.6 Acres	∅	∅	∅	∅	∅	∅	∅	1	1	1	1	1

KEY:

CA = Cassava   G. = Groundnut

M = Maize   TO = Tobacco

CO = Cowpea   WK = Working Capital

PROBLEM MATRIX/SIMPLEX TABLEAU

mum Enterprise Mix Denu-Abor Area)

CTIVITIES				REAL ACTIVITIES								
P5 Aug. L	P6 Sept. L	P7 WK	P8 LN	P9 CA	P10 M	P11 CO	P12 G	P13 TO	P14 CA/M	P15 CA/CO	P16 CA/M/CO	P17 CA/M/G
∅	∅	∅	∅	-97.∅∅	-16.2∅	-88.∅5	-67.∅∅	-87.1∅	-45.3∅	-39.84	-62.9∅	-49.7∅
∅	∅	∅	∅	6	5	6	6	∅	7	7	6	7
∅	∅	∅	∅	2	2	6	6	5	8	6	10	7
∅	∅	∅	∅	8	2	∅	5	∅	8	9	5	7
∅	∅	∅	∅	11	3	∅	5	4	8	9	7	7
1	∅	∅	∅	9	5	15	8	17	4	9	5	6
∅	1	∅	∅	∅	∅	∅	12	15	9	4	7	4
∅	∅	1	∅	72.4∅	37.8∅	56.35	71.∅∅	114.9∅	81.5∅	77.16	75.∅∅	70.3∅
∅	∅	∅	1	1	1	1	1	1	1	1	1	1

a

G	=	Groundnut		LN	=	Land
TO	=	Tobacco		MDS	=	Mandays
WK	=	Working Capital				

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