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A Consultant Report on the Project
"Improved Utilization of Feed Resources
for the Egyptian Livestock Sector"

for

Catholic Relief Services, Cairo, Egypt

and

United States Agency for International Development,
Cairo, Egypt

POTENTIAL FOR ON-FARM FEED PRODUCTION AND UTILIZATION BY THE EGYPTIAN SMALL FARM SECTOR

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PREFACE

The Winrock International team appreciates the support and assistance from Egyptian Government Officials, leaders in the private sector, staff personnel of the international organizations and the small farmers surveyed for this study. Without the cooperation by this wide cross-section of people the study could not have been conducted.

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Conversion Factors

Product	Units	Weight (Kilograms)
Seed cotton	Kantar	157.5
Lint cotton	Kantar	50.
Cotton seed	Ardeb	120.
Wheat, grain	Ardeb	150.
Barley, grain	Ardeb	120.
Maize, grain	Ardeb	140.
Sorghum, grain	Ardeb	140.
Rice, paddy	Dariba	1000.
Horsebeans, grain	Ardeb	155.
Crushed beans	Ardeb	144.
Lentils	Ardeb	160.
Crushed lentils	Ardeb	148.
Fenugreek	Ardeb	155.
Chickpea	Ardeb	150.
Groundnuts, (In shells)	Ardeb	75.
Berseem seed	Ardeb	157.
Onion	Kantar	45.
Straw load	Hemel	225.
Stover, stem, etc. load	Camel load	250.

Other Conversions:

1 Feddan = 1.03805 acres = 0.42 hectares
1 Feddan = 24 kirats
1 Ardeb = 12 kaila (or kala) = 5.62 bushels (U.S.)
1 Egyptian Pound (L.E.) = 1.43 U.S. dollars ($)
10 Donkey loads (earth manure) = 1 cubic meter

Reported Changes in Prices and Cropping Patterns from June 1979 - June 1980

Input or Output	Current Price (LE)	Winrock Report (LE)
1 kg milk	0.35	0.15
1 m^3 earth manure	2.0	0.50
Cotton seed cake	100% higher than government price	
1 ardeb lentils	45.0	30.0
1 ardeb sorghum	16.0	9.0
1 ardeb wheat	16.0	9.50
1 kantar cotton	45.0	30.0
1 ardeb horsebeans	35.0	25.0
Agricultural wages/day	1.75-2.0	1.25

The winter season (1979-1980) cultivation of lentils has dropped drastically as yields were down to 1-2 ardeb per feddan, not 3.3 as reported in our report. Chick-peas and horsebeans were substituted as winter crops.

Source: Dr. Mohamed Riffat Othman, personal communication, April 28, 1980.

CHAPTER I

SUMMARY AND IMPLICATIONS FOR DEVELOPMENT ACTIVITIES

Introduction

The United States Agency for International Development (USAID) in collaboration with Catholic Relief Services (CRS) requested Winrock International Livestock Research and Training Center (Winrock International) to conduct a study of the feed and ruminant livestock resources of the Egyptian small farmer. The goal of this study was to assess possibilities for increasing the feed resource base and making more efficient use of available feed resources to increase ruminant animal production on Egyptian small farms. The study team, an agricultural economist and animal nutritionist, were in Egypt from June 6th to September 24, 1979 and were assisted by an agronomist during the initial period of the study. A case study approach was used and two villages were studied intensively during this period. The data were compiled and analyzed and a draft completed March 1, 1980. A preliminary report was presented to USAID and Catholic Relief Services in Cairo on March 14, 1980. Final editing was completed in May, 1980 by Winrock Agricultural Economist, Dr. A. J. De Boer.

Scope and Nature of the Study

The specific objectives for studying these small farm operations were to (1) determine the feed and ruminant livestock resources available to the small farmer and current levels of productivity, (2) identify the constraints and potentials for increased livestock production/productivity with particular emphasis on feed resources, and (3) develop recommendations for improved livestock production using a variety of alternative feeding systems.

A survey of 403 randomly selected small farms was conducted at two sites, the Assiut Governorate village of Musha and the Behera Governorate villages of Zawiet Ghazal and Ezeb Kabeel (ZGEK). A small farmer was defined as cultivating 5 feddans or less and holding fewer than 4 livestock units.

The survey results were supplemented with information gathered on visits to Agricultural Credit Banks, Veterinarians, public and private sector livestock production stations, feed processing plants, central government ministries, universities and published research. The survey and supplemental information enabled this input-output data to be analyzed using descriptive statistics and a linear programming model. The survey results were used to describe the structure and performance of the small farms and assess the impact of government policy decisions, management alternatives, and alternative enterprises on the small farmer. The study concentrated on feed and livestock resources as part of the whole farm system rather than as distinct activities.

Survey Results

Primary feeds utilized were berseem clover, crop residues and byproducts, purchased commercial feeds, stubble, thinnings and strippings of maize or sorghum, and weeds. Buffalo, cattle and donkeys constituted the primary livestock resource with sheep and goats playing a minor role in both villages.

Musha Village

Livestock are fed rations dominated by berseem in winter and by various straws in summer. Table I.1 summarizes the proportion of total nutrients supplied by source. Feeds were purchased from the subsidized government market (10%) and the free market (90%).

The ruminant livestock population is dominated by buffalo cows which are kept for milk, meat and manure production. Sheep and goats are kept

Table I.1. Contribution or Available Feeds to Total Nutrients Supplied, Musha, 1979.

Available Feeds	January-April Berseem Season		May-December Nonberseem Season	
	% TDN Supplied	% DP Supplied	% TDN Supplied	% DP Supplied
Crop Production				
Wheat bran	.4	.5	2.7	5.7
Wheat straw	2.8	.1	32.4	3.5
Horsebean straw	.7	.2	7.9	5.3
Lentil straw	1.2	.2	14.	6.2
Berseem straw	.8	.2	9.8	4.3
Berseem forage	86.5	91.3	-	-
Purchased Feeds				
Government ration	2.0	2.1	10.9	26.3
Wheat bran	3.5	3.2	19.0	40.6
Horsebeans	-	-	1.6	5.2
Cottonseeds	-	-	1.6	2.8
Sorghum	2.1	2.2	.1	.1
Total	100.0	100.0	100.0	100.0

primarily for meat production. Very little animal draft power is used. Ruminant livestock performance traits are summarized in Table I.2.

During the nonberseem season (May through December) about 95% of the energy and 78% of the protein requirements of the ruminant livestock and donkeys were supplied. The condition of the livestock would indicate the deficit is made up by the feeding of green forages such as sorghum thinnings and weeds as well as grazing. During berseem season the livestock are well fed receiving 106 and 209 percent of their energy and protein requirements, respectively.

Zawiet Ghazal - Ezeb Kabeel

As in Musha, the feed resource base is dominated by berseem in winter and straw in summer. The energy and protein contribution of various feedstuffs used are summarized in Table I.3. The small farmer was unable to obtain either the government subsidized mixed ration or wheat bran but were able to obtain yellow maize directly from the government and small amounts of mixed ration and wheat bran from the free market.

Table I.2. Performance Traits and Productivity of the Ruminant Livestock in Musha.

Performance Traits	Buffalo	Cattle	Sheep	Goats
Age at first calving, mo[1/]	36-40	36-47	18-24	18-24
Calving interval, mo	15	13	12	12
Calving rate, %	70-80	70-80	40-60	40-60
Mortality:				
calves, %	25	18	25	25
1-2 years, %	4	4	8	8
adults, %	4	4	8	8
Milk yield, kilograms/day	4.5	3.6	-	-
Milk yield, number of days	220	210	-	-
Rate of gain, grams/day	280	350	60	60

1/ Calving is replaced by lambing and kidding in the case of sheep and goats, respectively.

Table I.3. Contribution or Available Feeds to Total Nutrients Supplied, ZGEK, 1979.

Available Feeds	January-April Berseem Season		May-December Nonberseem Season	
	% TDN Supplied	% DP Supplied	% TDN Supplied	% DP Supplied
Crop Production				
Wheat bran	-	-	3.3	10.8
Wheat straw	-	-	37.6	6.2
Berseem forage	87.7	87.7	-	-
Purchased Feeds				
Government ration	-	-	8.	29.7
Wheat bran	-	-	6.6	21.5
Yellow maize	-	-	7.4	10.3
Horsebeans	-	-	2.6	12.7
Barley	-	-	1.5	3.0
Wheat straw	-	-	32.5	5.4
Others 1/	-	-	.5	.4
Berseem forage	12.3	12.3	-	-
Total	100.0	100.0	100.0	100.0

1/ Others includes rice screenings and hulls.

These feedstuffs support a livestock population dominated by buffalo and cattle which are kept for milk, meat, manure and draft power. In contrast to Musha, these large animals are often jointly held with larger farmers. The performance traits of the ZGEK ruminant livestock are summarized in Table I.4.

During the nonberseem season the ruminant livestock and donkeys are supplied only 51% of the energy and 32% of the protein required. However, some of this deficit is supplied by green forages whose contribution to feed supplies was not measured; primarily deneba grass (a weed in rice fields) and maize strippings. During the berseem season, the animals receive about 195 and 400 percent of their energy and protein requirements, respectively.

Normative Farm Planning Results

Small farmer welfare depends upon the alternatives open to him and his choices made within those alternatives. Alternatives are limited by marketing quotas and pricing policy as well as the resource base. In Musha nearly one-third of the summer and winter land are occupied by crops under government procurement while in ZGEK, two-thirds of the summer land is occupied by cotton and rice, both procured by the government. At both sites, the small farmers preferences for cultivating a staple crop means that between 30-40% of the winter land is planted in wheat. In addition, constraints were found to exist in requiring animals for draft power and transport.

Given these constraints, the study examined a range of alternatives potentially available to the small farmer using a linear programming model. The most promising alternatives are discussed below:

(1) Provided adequate water and nitrogen fertilizer are available, most small farmers could make up their summer feed deficits and significantly decrease expenditures on commercial feeds by

Table I.4. Performance Traits and Productivity of the Ruminant Livestock in ZGEK

Performance Traits	Buffalo	Cattle	Sheep	Goats
Age at first calving, mo[1/]	48-59	48-59	18-24	18-24
Calving interval, mo	19	17	12	12
Calving rate, %	40-50	40-50	40-50	40-50
Mortality:				
calves, %	25	18	25	25
1-2 years, %	4	4	8	8
adults, %	4	4	8	8
Milk yield, kilograms/day	4.8	3.4	-	-
Milk yield, number of days	200	170	-	-
Rate of gain, grams/day	280	350	60	60
Draft use, hours/year	310	310	-	-

[1/] Calving is replaced by lambing and kidding in the case of sheep and goats, respectively.

cultivating .1 feddans (2.4 kirats) of elephant grass (Pennisetum purpureum) or .5 feddans (12 kirats) of forage sorghum. In Musha, the forage crops competed with fallow land in summer and horsebeans in winter. In ZGEK, they competed with maize in summer and berseem in winter.

(2) Provided that a feed grade urea will become available through the nitrogen fertilizer plants under construction, part of the cottonseed meal used in the government mixed ration could be replaced by feed grade urea. While the mixed ration would not be suitable for livestock on a high roughage diet, i.e. small farm livestock, this substitution would enable the replaced cottonseed meal to become available to the small farmer.

(3) Making berseem hay for summer season feed proved to be of minor importance. This was due to additional labor required to prepare the hay and the nutrient and wastage losses of making the hay.

(4) If the feed resource base was increased by (1) or (2) above, then the small farmers would be able to support improved dairy cattle which would enable the annual milk and meat offtake to increase by nearly 3 fold. This scheme is best suited to areas where ruminant livestock are no longer required for draft power.

(5) If the feed resource base were to remain unchanged, then the small farmer could increase his net income by trading his buffalo or baladi cattle for improved dairy goats. The improved dairy goat would decrease his feed cost and provide essentially the same milk offtake as his buffalo or baladi cattle cow and still provide an adequate supply of milk for home consumption. However, the farmers would almost never give up his large ruminant for a dairy goat because of prestige factors.

Development Possibilities

From its analysis of alternatives, the study team concluded that the most promising areas of opportunity for increasing the ruminant livestock production/productivity and hence increase small farmers income are:

(1) Provide encouragement to appropriate government officials to utilize feed grade urea in the government mixed fattening and dairy rations. If this were made available to the small farmers at the intergovernmental transfer price (plus a transportation and handling fee), then it would make a significant contribution to village feed resources if adequate supervision and extension was initially provided.

(2) Provide training and financial assistance to small farmers for growing sorghum forage and elephant grass. The extension effort for taking elephant grass from the research farms and using it on small farms might best be carried out by an outside agency in collaboration with appropriate Ministry of Agriculture (MOA) extension personnel. Technical assistance could be provided by the Animal Production Research Institute.

(3) Provide training and financial assistance to small farmers for keeping improved dairy cattle. The apparent superior livestock management skills of Musha would make this village an excellent site for a pilot project of this nature. The project would be appropriate only under the condition that either (1) the Agricultural Credit Bank will enable the farmer to enter the insurance program and thus receive regular allotments of mixed ration and wheat bran and (2) that current feed supplies are supplemented with the forementioned forage crops.

(4) Technical assistance in Musha could be provided by a CRS staff person, Dr. Mohammed Riffat and his local and Governorate

veterinarian contacts. Again, the extension effort for a pilot project scheme could be initiated by an outside agency in collaboration with MOA extension personnel.

(5) Provide training and financial assistance to small farmers for keeping improved dairy goats. In cases where the feed resource base remains very limited, an improved dairy goat can provide adequate milk production for household use. Technical assistance of the sort that might be provided by Dr. Aboul Naga of the Animal Production Research Institute would be required.

(6) For development activities in the Nile Delta area such as ZGEK, it would be necessary to work with existing or planned small farm mechanization programs. The cattle currently used for draft power would be replaced by selected high production milking buffalo or crossbred cattle, again in conjunction with an improved forage/feedstuff base.

(7) Potential impacts on current small farm structures and operations needs careful consideration and planning. The companion report on Rural Sociology sets out several of these issues. Increased production in the livestock sector would involve a shift from a semi-subsistence to a more commercial type of enterprise. Beef fattening, milking operations, and small ruminant growing-out all would involve regular participation in the market. This may require some changes in existing marketing systems and may increase the control of men over family finances. Currently, women handle the petty cash derived from the occasional sale of dairy products or poultry products but this would probably change under more commercialized production. There is also a good possibility that women's labor contribution for feed production, animal care, and milking could increase. While family income could go up,

the economic burden on village women could increase as well. Some type of acceptable sharing of returns may have to be discussed and institutionalized before any large scale implementation program could proceed.

CHAPTER II

INTRODUCTION AND STUDY APPROACH

Background and Statement of Problem

The nutritional and economic status of Egypt's rural population is of major concern to the government. Total population is now approaching 40 million and pressure on the limited cultivated land (less than six million feddans) has emphasized the need to increase total productivity of an already intensive agricultural system. Despite intense use of arable land, Egypt supports a significant and, in some cases, expanding livestock popultion (Table II.1).

Table II.1. Egyptian Livestock Population (000 head)

Type of Livestock	1960	1966	1970	1974	1975	1976	1978
Cattle	1,867	1,608	2,115	2,119	2,102	2,079	2,080
Buffaloes	1,781	1,855	2,009	2,170	2,204	2,236	2,320
Sheep	2,220	1,855	2,006	1,965	1,926	1,878	1,890
Goats	1,583	787	1,155	1,293	1,321	1,349	1,410
Camels	184	175	127	109	105	101	100
Pigs	22	11	15	15	15	15	20
Horses	47	n.a.	35	32	n.a.	n.a.	n.a.
Mules	10	n.a.	6	5	n.a.	n.a.	n.a.
Donkeys	1,010	n.a.	1,362	1,400	n.a.	n.a.	n.a.

n.a. = Values not available.
Source: Ministry of Agriculture, Agricultural Economics Research Institute.

These livestock, along with poultry and fish plus sizeable beef imports (over 100,000 tons) supply the Egyptian population with an average per capita consumption of animal protein that is less than one half of the world average and less than one fifth of the per capita consumption of the U.S.A. Average per capita daily consumption of red meat in Egypt appears to be between 25-30 grams per day and the rural sector, approaching 20 million population, consumes significantly less than the

urban sector. In addition, rapid increases in animal products imports (Table II.2) accentuate the need to examine opportunities for increased output from the domestic livestock sector.

Table II.2. Value of Imports of Animal Products, 1975 and 1977

Product	Millions US$ 1975	1977
Meat, fresh, frozen	11.5	57.9
Milk	32.2	63.5
Butter	2.8	26.7
Cheese	4.8	15.4
Total	51.3	163.5

Source: FAO Trade Yearbook, 1978.

Livestock ownership rests primarily with the small landholders. This reflects the land management patterns, where about 85% of all farmers farm less than five feddans. Since Egypt does not possess a significant amount of pasture or rangelands that are suitable for grazing on a permanent basis, almost all livestock are held in the irrigated lands of the Nile Valley.

Animals are managed by the small holders in a confined and/or semi confined system. Confinement need not imply the use of a pen or corral but may refer to animals being tied or tethered to a stake in the immediate shade of a tree or farm building. Many small ruminants are village scavengers and roam village garbage dumps and ditch banks/roadsides. Some herding of sheep and goats does take place in the northern coastal areas and seasonally all types of livestock are herded on fields following harvest.

Generally the larger animals have their feed carried to them for a variety of reasons, among which are better and more complete utilization

of feed, easy accumulation of manure for daily or periodic composting, restricting animals from wandering and feeding on planted fields, and avoiding the risk from theft and injury. In some villages, large animals are used for draft, for lifting water with the sakias or Persian water wheels and threshing with the norag or threshing sled.

Disadvantages of the confinement system include the absence of free choice grazing, high labor input required for feeding just one or two animals, and certain types of animal health problems.

Production Constraints

The livestock industry in Egypt has a series of animal health constraints from diseases such as brucellosis, tuberculosis and some mastitis in cattle and buffalos. Rift Valley fever has been reported in Egypt. Both internal and external parasites are problems that persist. Low fertility from non-selective breeding and poor nutrition are constraints to efficient animal production.

The major constraint to animal production in Egypt, however, is the seasonal deficit in both the quantity and quality of feedstuffs. From December-May, berseem clover is grown in sufficient quantity and quality to provide both the energy and protein needs for the ruminant animals in Egypt.[1/] The June to November season is when feedstuffs are in serious deficit for the national livestock herds. Kotb et. al.[2/] reports 38.5% of the energy and 36.8% of the digestible protein necessary for growth are available, on average for all Egyptian livestock in the summer-fall period. These figures are of concern to both the animal scientists and agricultural planners. If these figures are correct it would appear that there is little chance for growth in the livestock sector, and in

1/ This huge use of resources for berseem is at the cost of other uses for the scarce cropland. This study examines ways to increase returns from this scarce land resource.

2/ Kotb, R. A., Youssef, M.S.S., Makky, A. M., and Afifi, Y. A. Nutritional Status of Livestock in Egypt. Agric. Res. Rev. Vol. 52, June 1974.

reality the livestock populations are in serious jeopardy with the present seasonal shortages. Such a pronounced deficit in feed demand-supply balance could result from overestimation of the animal population or unreported sources of feed. The concept that Egypt has developed superior animals capable of surviving prolonged periods of feed stress is another possibility but very doubtful in the opinion of most nutritionists.

Consequently, this study considered the animal-feed resources relationship in Egypt to determine the nature and extent of this problem. Concurrent with a sample inventory of animals and feed resources, animal scientists and economists determined nutritional needs of the existing animals and balanced these against traditional and non-traditional sources of feed to determine if there are opportunities for increased animal production.

Research Approach

The Project Survey was initiated by Catholic Relief Services (CRS) as part of its ongoing assistance to the agricultural sector in Egypt. CRS had earlier been involved in minor village level animal projects and was seeking additional funds from USAID for expansion in scope and magnitude of such projects. USAID offered to contribute a portion of the funds for a detailed village level survey that would provide a more reliable basis for subsequent funding of village level livestock projects. Winrock International agreed to provide CRS with technical services for this survey and subsequent analysis. The American University at Cairo (AUC) provided technical services for the social component of livestock and feed use as they affect the producer and his family. CRS provided logistical and administrative support for the project survey and assisted in the design and development of the survey.

Project Objectives

Specific project objectives for the two areas under analyses included:

- Determine the current feedstuffs used, the animal resources involved and the product flow from the animal resource.

- Identify the constraints and potentials for increased livestock production/productivity.

- Develop recommendations for improved livestock production systems using new or currently available feed resources.

USAID project reviewers suggested that more social data with respect to family structure and attitudes relevant to animals and animal husbandry should be included as part of the overall study. Inasmuch as Winrock International did not, in this case, have accessibility to bilingual sociological researchers it was agreed that the A.U.C. would provide this information and submit a separate report. This team of rural sociologists would provide baseline information on farmer's attitudes to livestock feeding and the potential for success for any subsequent development of a new scheme involving animal feeding.

A secondary objective was to evaluate the feasibility of possible development projects aimed at increasing production from small farm livestock.

Methodology

Primary and secondary data were utilized during the course of this study. Primary data were obtained through direct interviews of 403 small farmers while secondary data came from village cooperatives, government and private sector livestock production stations, government and private sector processing plants, central offices of Government Ministries, Universities, Development Agency Projects and published documents.

Primary Data Collection

Three sites for the village survey were tentatively selected -- two in the delta and one in the valley. The Governorates of Alexandria, Assiut and Sharkia were initially selected as representative of agricultural systems typifying vegetable-fruit farming, traditional Upper Egypt cotton-sorghum-wheat rotation, and traditional delta rice-maize-wheat-cotton-berseem rotation, respectively. Each of these Governorates had an agricultural university to draw upon for support.

Upon further evaluation of survey needs, the relatively few animals held by small land holders in the urban Governorate of Alexandria suggested dropping that site and selecting a more central delta location in the Governorate of Behera. Consultations with local officials, including the Governors, resulted in the selection of the village of Musha in Assiut (upper Egypt) and the villages of Zawiet Ghazal and Ezeb Kabeel (ZGEK) in Behera Governorate (lower Egypt) as survey units.

A four-month period (June 1-October 1) was selected as the survey time frame. This period represents the greatest seasonal shortage of feed-stuffs.

The survey was directed towards the small farmer population. The sampling criteria used was to select only those farmers farming less than five feddans and holding fewer than four large animals.

A questionnaire was developed utilizing several survey instruments as models. The primary questionnaire was modelled after the Food and Agricultural Organization (FAO) Farm Management Survey and modified to include Egyptian conditions. Other survey instruments used were the Ford Foundation's Egyptian Government Farm Management Survey, the Livestock Survey Data and Marketing Model utilized in the Tanzanian Livestock-Meat Subsector study by Texas A&M University and other survey models designed and implemented by Winrock International staff members.

The English version was translated into Arabic and prepared for implementation by Catholic Relief Services with technical assistance from University and Ministerial contacts. The survey schedule was tested, modified and the field survey conducted by a professional counterpart and four enumerators chosen from their respective governorates.

Dr. Mohamed Riffat, veterinarian with the Department of Veterinary Medicine in Assuit, participated in the survey as a professional counterpart and interpreter. Four University of Assuit, Faculty of Agriculture students were employed as enumerators to conduct the farmer interviews in the village of Musha. Dr. Riffat also accompanied the Winrock International team to Behera and assisted in the start-up. Mr. Adbel Monam Badawy, Manager of Rural Development Department of Behera, served as interpreter and counterpart for Behera. He was assisted by Dr. Abdel Aziz El Samahy, Chief Inspector of Statistical Department for Behera. The enumerators were employees of the statistical department.

The information collected at the two representative sites included (1) an inventory of farm animals; (2) inventory of feed resources by month with reference to cost, quantity, and type; (3) cropping patterns that influence feed resources; (4) land tenure patterns that influence feed resources and animal populations; (5) human resources; (6) marketing structures and their influence on livestock and feed supplies; (7) government policy and regulations that influence animal populations and feed resources; and (8) similiarities and differences between the survey sites.

The sample used for the field survey administered to small farmers was randomly selected from village Cooperative Society records. A total of 403 interviews were conducted with 56 of these used in questionnaire testing and enumerator training in each region. Of the remaining 347 survey questionnaires obtained, 147 were from the village of Musha and 200 from ZGEK.

The interviews were generally conducted after the normal field work hours. A representative of the cooperative notified the designated farmers of the interview time and place. The purpose of the interview was explained and they were assured of confidentiality. In addition to the questionnaire, additional information was obtained in group interviews using the counterpart as an interpreter. Visits were made to a sample of the farmers homes during the day to observe where the animals were kept, how they were managed and fed, and where the feed was stored. Sample weights were taken of actual feed fed to the animals to verify reported feeding levels.

Secondary Data Sources

Various agencies and individuals were contacted to assess services available for farmers. Information on credit availability and government supplied animal feed and fertilizers was obtained from the Agricultural Credit Banks. The Cooperatives supplied information on Government crop procurement and crop and animal management. Animal health programs were discussed with the Veterinarians in the Governorate offices and with the village veterinarians. Major health problems and programs for vaccination were identified. Visits were also made to several government and private sector livestock production stations to compare animal productivity and feeding practices. Two government companies, the Bannimorr dairy and Hawatika fattening station, were visited in the Assiut Governorate. In Behera, two other government companies, the North Tahrir dairy and Edko fattening station were visited along with two private sector companies, the Meliha dairy and Komhamada fattening station.

In addition to the farm level information obtained about feed productior and availability, many visits were made to public and private sector processing plants. Information in regard to quantity of by-product fron cottonseed and soybeans and feed formulation was obtained at the processing plants in Bannimorr and Damanhour. The availability of whea bran was determined by visits to the large wheat flour milling facili

ties in Assiut and Damanhour.[3/] A large proportion of this wheat is imported. Visits were also made to small flour mills in the villages where much of the producer retained wheat is processed and animal feed obtained. Information on the by-product of rice processing was determined through visits to the large rice processing plant in Abu Homus and small processors in Damanhour. Additional information was obtained from the starch processing plant in Alexandria.

Sources of some of the non-traditional feedstuffs were investigated for quality and availability. Information on the quantity and use of by-products from the winery at Gianaclis was obtained at the winery. Visits to the Edfina Company fruit and vegetable processing plant at Alexandria provided information on the quantity of by-products available by season. Molasses is also used as an animal feed. Information in regard to location of plants, quantity of production, present uses of molasses and future projections were obtained from the Sugar Companies of Egypt in Cairo. The utilization of bagasse as fuel, in paper production and as animal feed was discussed. Also, the use of rice straw and sugar cane bagasse in the production of paper was investigated through a visit to the Raoktta paper mill in Behera.

It was important to the study to know the government's attitudes and policies in regard to animal and feed production. Visits were made to several offices within the Ministry of Agriculture (Animal Production Research) in Cairo. Officials interviewed included Dr. Sayed Dessuki, Head Agricultural Research; Dr. A.M. Makky, Director Animal Production Research Institute; and personnel in charge of specific animal species. Production parameters under the government operated farms for cattle, water buffalo, sheep and goats were reviewed, opportunities and recommendations for the production of summer forages were stated and current research and future plans were outlined by those visited. Statistical information regarding prices paid and received by farmers was provided by Dr. A. K. Hindy, Director and Dr. Ahmed Geouli of the Agricultural Economics Research Institute.

3/ Damanhour is the large commercial center near the ZGEK village site. See Chapter 3.

Information has been developed in Egypt on feed values of many local feeds, both traditional and non-traditional. Additional data is currently being collected through several research projects. The Faculty of Agriculture, University of Alexandria is currently doing research on many non-traditional feed sources and on chemical and biological treatment of some feeds. Production research of water buffalo, goats and sheep is currently underway at Ain Shams University, Faculty of Agriculture, in Cairo. The University of Assiut, Faculty of Agriculture, has ongoing research programs with cattle and buffalo and relatively large projects in poultry and rabbits. Agricultural economists at the Universities of Assiut and Alexandria were contacted for the purpose of discussing the overall agricultural sector. Indirect contact was also made with Zagazig University through the Egyptian Water Use and Management Project. Information was obtained from the U.S. Agency for International Development in Cairo in regard to agricultural finance.

A variety of sources were used to estimate nutrient content of local feedstuffs. These included Tropical Feeds from the Food and Agriculture Organization publications, Nutritional Data on U.S. and Canadian Feeds by the National Academy of Sciences, Arab and Middle East Tables of Feed Composition by The International Feeds Institute (Utah State University) and The League of Arab States (Damascus, Syria), and Egyptian University publications. Information regarding the procedure, value, costs and constraints of chemical treatment of straw to improve the digestibility and palatability was obtained from a publication, Treating Straw for Animal Feeding, by FAO and from personal communication with Dr. Terry Klopfenstein, University of Nebraska, Lincoln, Nebraska.

Much work has been done to determine the daily nutrient requirements of cattle and sheep and, to a lesser extent, for goats. Very little has been done with water buffalo and donkeys. For the purpose of this report, the nutrient requirements for cattle and buffalo were estimated from Nutrient Requirements of Cattle, prepared by The National Research Council of the National Academy of Sciences, Washington D.C. Nutrient

Requirements of Sheep was used to estimate requirements of sheep and goats. Requirements of donkeys were taken from a bulletin, Nutritional Status of Livestock in Egypt, by H. Razung Kotb and others, 1974.

To estimate the additional energy requirements due to work by the animals, a formula adapted by Winrock International derived from Bioenergetics and Growth by Samuel Brody, 1944, was used.

Information was collected on alternative uses of by-products utilized as animal feed or classified as waste. The major sources of information were The Soil and Water Research Institute, currently investigating the utilization of animal and crop waste as fertilizer and fuel, and the High Institute of Public Health in Alexandria, currently investigating urban waste disposal.

Organization of Study Results

Survey results for Musha village, Assiut Governorate (lower Egypt) are presented in Chapter III while Chapter IV provides these results for ZGEK village, Behera Governorate (upper Egypt). These data provide the physical and economic characteristics of the small farm sector within these villages. Some secondary data is also included to fill out descriptive details on the villages.

Descriptive statistics, while providing details of the existing livestock-feedstuff situation, do not generally provide quantatitive measures for recommendations on improved resource allocation. To examine the impact of a wide range of alternatives available to the small farmer, an analytical framework capable of handling production activities as well as resource constraints is required. For this purpose, a linear programming model was employed. Chapter V develops this methodology and presents farm plans derived under a variety of assumptions. These plans provide guidelines for improving small farm livestock production and these are discussed in terms of possible follow-on development activi-

ties. This Chapter also identifies some unsolved issues which must be considered before any large scale development activities are initiated.

CHAPTER III

SURVEY RESULTS FOR MUSHA VILLAGE

General Description

The village of Musha is 15 kilometers south of Assiut in lower Egypt. The village has around 35,000 inhabitants concentrated near the center of the 5000 feddans in Musha's ziman, or village land holdings. The climate is warm and dry with mean annual temperature of 23 C and average annual rainfall of 1 mm. Consequently, the village is totally dependent upon irrigation water supplied from the Nile River for its agricultural sector.

The agricultural sector is the primary employer in the village. Of the 7000 families in Musha, 1435 are registered Cooperative Society members indicating they either own or rent agricultural land. Eighty-six percent of these registered members hold 5 feddans or less and cultivate 52% of the total land area. The remaining 14% of the farm families hold more than 5 feddans and cultivate the remaining 48%. The largest land holdings by one family were those of the traditional village leader, the omda. Table III.1 summarizes the distribution of land holdings in Musha.

Table III.1. Distribution of Farm Numbers and Total Land by Farm Size in Musha, 1979

Land Cultivated	Number of farms by size class	% of farms by size class	Total land by size class (feddans)	% Land by size class
0-1 Feddan	362	25.2	290	5.8
1.1-2	437	30.5	760	15.2
2.1-3	185	12.9	475	9.5
3.1-4	135	9.4	515	10.3
4.1-5	115	8.0	575	11.5
5.1-10	133	9.3	1145	22.9
10.1-20	55	3.8	905	18.1
20+	13	.9	335	6.7
TOTALS	1435	100.0	5000	100.0

Some 5565 families are not Cooperative Society members and consequently not land holders. Of the remaining families, 700 are officially listed as destitute, thus leaving nearly 4865 families which are neither destitute nor landowning. The A.U.C. sociology team concluded that these families, representing some 30,000 people, were primarily agricultural workers.

The farming activities in Musha include both crop and livestock enterprises. The major crops include the winter crops of wheat (*triticum aestivum*), berseem clover (*trifolium alexandrium*), horsebeans (*vicia faba*) and lentils (*lens culinaris*) and the summer crops of cotton (*gossypium barbadense*) and sorghum (*sorghum halapense*). The primary livestock held are buffaloes and donkeys with smaller numbers of baladi cattle, sheep and goats.

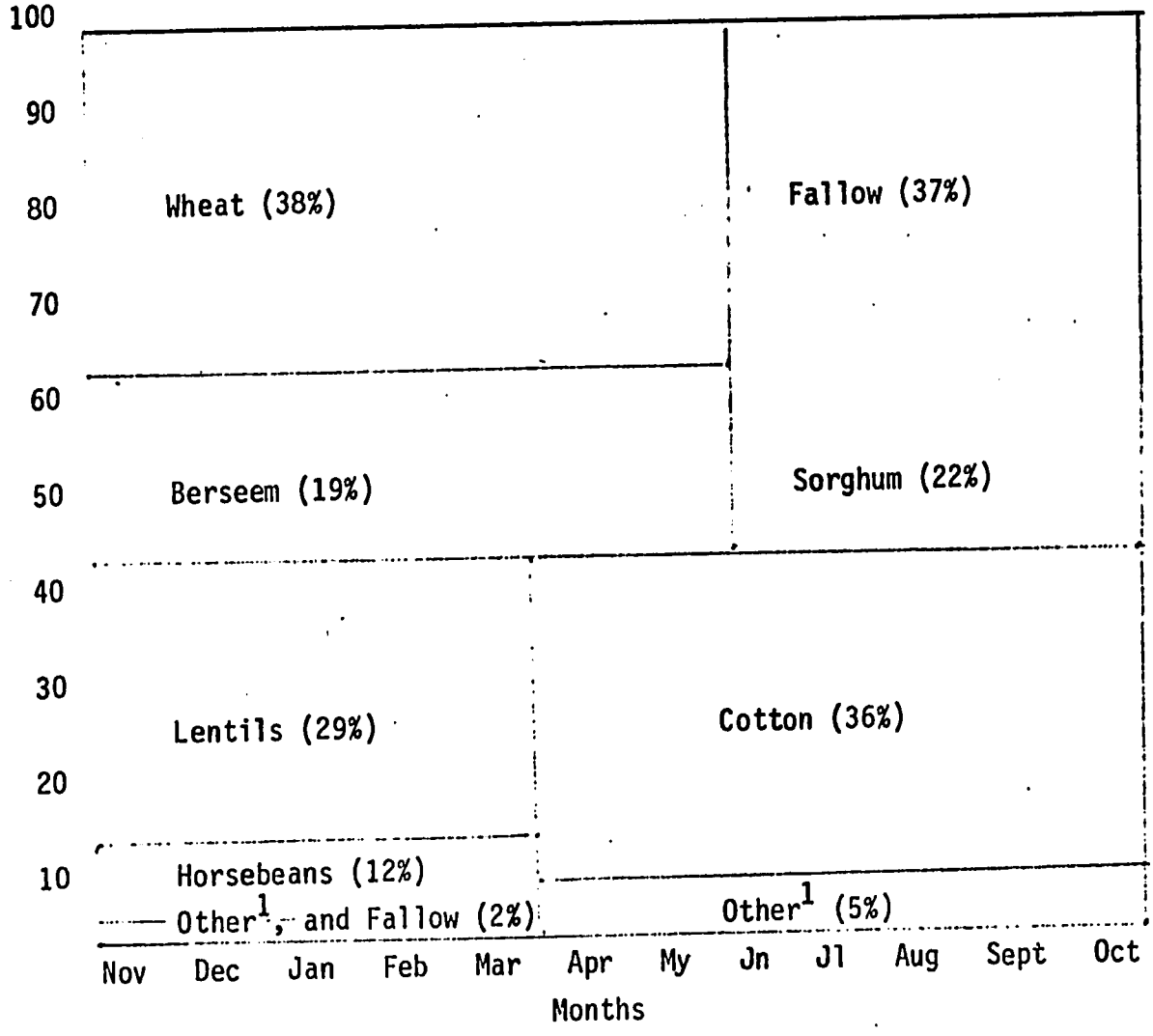
Crop Production

The crop enterprises generate cash income and products for household and animal consumption. Essentially all of the land area is planted in winter with only 63% of the land area planted in the summer implying a cropping intensity of 1.6. The typical rotations are (1) wheat followed by sorghum, (2) horsebeans or lentils followed by cotton, and (3) berseem clover followed by fallow or a vegetable crop. Figure III.1 depicts the land area devoted to specific crops throughout the agricultural year (November 1 to October 31).

Many crop planting decisions are influenced by government procurement. Quotas are imposed on part or all of the following major crops products in Musha: seed cotton, wheat, horsebeans and lentils. The quotas were actively enforced for seed cotton but less so for horsebeans and lentils. Appendix A gives additional information on area and marketing quotas for crops.

Winter Crops - Wheat was planted on 39% of the survey farmers land. The grain is ground into flour yielding approximately 70% white flour and

Figure III.1. Proportion of the Land Area Cultivated by Small Farms Devoted to Specific Crops in Musha.



[1] Primarily vegetables, maize and fruit trees in summer and vegetables and fruit trees in winter.

20% offal, the latter consisting of fine and coarse bran and germ. The grain is ground at one of the two private mills for LE 0.75-0.80 per ardeb. The flour, germ and 1/3 of the bran is utilized for human consumption. The remaining bran and the straw is available for livestock feed.

Berseem is the major fodder crop in Egypt because of its high nutritional value, excellent yield potential and limited management input. Berseem is cut 3 to 4 times with a small proportion of land reserved for seed production since it is utilized as an annual crop. Discussions with farmers indicate that berseem will provide around 18 tons per feddan of green fodder from January through April. Berseem seed and straw are harvested in June. The average seed yield is 1 ardeb per feddan with less than 1 ton of straw as residue. The seed is kept for planting in the fall and the straw is used as livestock feed.

Horsebeans and lentils are the other significant winter season crops and are grown primarily for human consumption with the brokens and straw being utilized as livestock feed. Stewed beans, bean cakes, lentil soups and mixtures with rice and wheat bread constitute a significant part of the rural diet. Discussions with farmers indicated that disease problems such as chocolate spot, rust and broomrape were responsible for yield reduction. For every ton of horsebeans and lentils harvested, around 50 kg of brokens and over 1 ton of straw are available for livestock feed.

Summer Crops - Cotton and sorghum were the only two major crops grown in the summer. These two crops occupied 58% of the surveyed summer land leaving 42% for minor crops (5%) and fallow (37%).

Cotton yields seed cotton and stems, the latter being grazed by sheep and goats in October and November. The remaining coarse stems are gathered and burned as fuel. Sorghum provides grain, green animal fodder and stover. The grain is for human consumption with large

amounts also utilized as animal feed. The thinning and feeding of overseeded sorghum is a common practice. Survey estimates on the number of days thinnings are fed and from weighing sorghum fodder being carried into the village indicate that around 200 kg of green fodder are fed per feddan of sorghum grown. Dry stover is utilized as fuel in the household. Table III.2 summarizes the major crop yields of primary and secondary products.

Table III.2. Major Crop Yields for Primary and Secondary Products, Musha 1979.

Crop Product	Units	Units per Feddan	Kilograms Per Unit	Kilograms Per Feddan
Seed Cotton	Kantar	6	157.5	950
Cotton Stems	Camel load	6	250	1500
Wheat	Ardeb	6.4	150	960
Wheat straw	Hemel	6.3	225	1420
Sorghum	Ardeb	7.9	140	1110
Sorghum stover	Camel load	9.1	250	2280
Horsebeans	Ardeb	5.4	155	840
Horsebean straw	Hemel	4.6	225	1040
Lentils	Ardeb	3.0	160	480
Lentil straw	Hemel	3.1	225	700
Berseem seed	Ardeb	1.0	157.5	160
Berseem straw	Hemel	3.7	225	830
Berseem forage	Tons	18	1000	18000

Source: Winrock International Survey Data

Detailed budgets and input-output coefficients for the major crop activities in Musha are presented in Appendix A as well as a description of crop marketing practices.

Livestock Production

Putting the livestock population on a livestock unit (l.u.) basis, the small farmer holds an average 0.75 l.u. per feddan with buffalo being the most significant species. Table III.3. summarizes the livestock population.

Table III.3. Total Livestock Holdings by the Small Farmers Surveyed and the Total Small Farmer Population

Livestock Species/Age	Survey[1/] Population n	Small Farmer Total Livestock Population[2/] n	Livestock Unit Equivalency[3/]	Total Livestock Units	Percentage of Total Units %
Buffalo, 2 years old	96	807	1.0	807	41
Buffalo, < 2 years old	34	286	.6	172	9
Cattle, 2 years old	20	168	.8	134	7
Cattle, < 2 years old	16	134	.5	67	3
Sheep, 1 year old	43	361	.1	36	2
Sheep, < 1 year old	16	134	.06	8	.5
Goat, 1 year old	76	639	.1	64	3
Goat, < 1 year old	22	185	.06	11	.5
Donkeys, all	99	832	.8	666	34

1/ This survey included 11.9% of Musha's small farmers.

2/ As estimated by Musha cooperative records.

3/ Source: The livestock numbers are from the survey data. The equivalency factors were from H. A. El Tobgy's Contemporary Egyptian Agriculture with adjustments made for young livestock. Livestock units are based on the average annual nutrient demand of each livestock species by age.

Livestock, including buffaloes, cattle, sheep, goats and donkeys are owned by 80% of the small farmers. Excluding donkeys from this group, 75% of the farmers own at least one species of ruminant. Table III.4 summarizes the mix of livestock species held.

Table III.4. Livestock Holdings by Sample Farmers, Musha 1979

Livestock Held	Number of Farmers (N)	Farmers with that species (%)
Buffalo only	55	37
Cattle only	6	4
Sheep and goats only	17	12
Buffalo and cattle	6	4
Buffalo, sheep and goats	19	13
Cattle, sheep and goats	4	3
Buffalo, cattle, sheep & goats	4	3
No livestock, excluding donkeys 1/	36	24
TOTAL	147	100

1/ Eight of the farmers included in this group hold donkeys, therefore 20% of the farmers hold no livestock.

Source: Winrock International Survey Data.

The government participates in the livestock sector by supplying a mixed ration and wheat bran to buffalo and cattle owners and indirectly by crop procurement. In Musha, both types of government supplied feeds were available to the small farmers through the Agricultural Credit Bank. The mixed ration is a government prepared feed containing 42% cottonseed cake, 25% wheat bran, 22% corn, 5% rice bran, 3% molasses, 2% limestone and 1% salt. Wheat bran is produced by government mills and distributed to bakers as a bread base and to farmers as an animal feed. If the Agricultural Credit Bank receives its full allocation, each milking buffalo or baladi cow is allocated 15 kg of the mixed ration per month and each buffalo or baladi calf held for fattening is allocated 150 kg of the mixed ration and 50 kg of wheat bran each month for up to 6 months. The mixed ration is sold for LE 35 per ton and the wheat bran for LE 40. The farmer faces two options after purchasing subsidized government feeds - (1) feed it to his animals; or (2) sell it in the free market at approximately 50% above the purchase price. Discussions with farmers indicated the middlemen in the free market were either

larger farmers who re-sold some feed while also utilizing feed in their operations, or specialists generating their income operating from the free market. The end result is an active and readily accessible free market for the mixed ration and wheat bran.

The small farmers allocated some of their limited cash reserve to purchasing livestock feed. Approximately 85% of the sample farmers which held a mature buffalo or baladi cow entered the government and/or free market to purchase the mixed ration, wheat bran, horsebeans, cottonseeds and sorghum. Assuming that all eligible animals in the village received their full government allocation, the total supply of government subsidized feed purchase would be about 100 tons of the government mixed ration and 70 tons of wheat bran. Referring to total estimated feed purchased (Appendix Table D.1), the farmers acquired an additional 350 tons of government mixed ration and 575 tons of wheat bran on the free market as well as 33 tons of horsebeans, 29 tons of cottonseed and 1.6 tons of sorghum. In value terms, less than 10% of cash expenditures for concentrates went to the government.

Buffalo - Buffalo are kept for meat, milk and manure production. Farmers either raise a calf for replacement when cows approach culling age or purchase a replacement. The survey found 83% of the small farmers purchasing their replacement stock at an average age of 4.5 years. Typically, small famers sell their calves to larger farmers for rearing and re-purchase mature animals when the need arises. Age at first calving averages slightly over 3 years with a 15 month calving interval. Culling occurs at 10-12 years. Seventy percent of the buffalo calves are born between October 1st and March 1st. This is due to several factors, including the need for cows to freshen during berseem season and to be in good physical condition for breeding late in the berseem season. Calves are weaned at 30-45 days and the buffalo cow is milked for an average of 190 additional days yielding 4.25 kg per day. Buffalo calves not retained are sold at 1-2 months to either local farmers or butchers. Calf prices averaged LE 45 but by 1980 had reached LE 100.

Manure is used as fertilizer and fuel. Berseem season manure (1/3 total) is used primarily as fertilizer while summer produced manure (2/3 total) is used as fuel. Manure used as fertilizer is mixed with soil and applied to the field. This mixture has a market value of LE 0.03 per donkey load or LE .30 per cubic meter (assuming 10 donkey loads = 1 cubic meter).

The buffalo cow in Musha is relatively well fed year round. During the berseem season the cow is supplemented with small amounts of straw and concentrate at night. Straw, wheat bran and concentrates are fed during the non-berseem period. Farmers reported feeding milking buffalo an average daily ration of 5.8 kg of straw, 2.75 kg of wheat bran and 2 kg of concentrate. The cows were in good condition during the time of this survey. Breeding services are provided by farmers with larger herds who retain a breeding male.

Veterinary services are provided free of charge by the government. Buffalo are vaccinated for all infectious diseases including hemorrhagic septicemia, the clostridial infections, cattle plague and foot and mouth. Internal parasites are a problem but regular control is not practiced.

Table III.5 and III.6 summarize the performance traits and general livestock budgeting information for the buffalo cow. Assigning market prices to animals, capital and feed but making no charge for farmer labor results in a small net loss for buffalo although there is no apparent net cash loss from buffalo keeping.[2/] Rather the loss is the negligible or negative return to farm family labor used for buffalo. The magnitude of this apparent misallocation indicates that small farmers held buffalo for reasons other than maximizing profit since the operator is acting to satisfy a variety of needs within the complex crop-livestock system.

2/ Additional data for budgets relevant to all livestock enterprises are as follows: Berseem = LE 6.67/ton fresh; Tibben = LE 35.00/ton; Wheat bran (free market) = LE 70/ton, government price = LE 40/ton; Mixed ration (free market) = LE 75/ton, government price = LE 35/ton; Labor = LE 0.20/man-hour; Amortized shelter costs for 2 cattle or 2 buffalo = LE 15.25/year.

Table III.5. Performance Traits of Musha Livestock

Item	Unit	Buffalo Cow	Baladi Cow	Sheep	Goats	Donkey
Age at first parturition	mos.	36-47	36-47	18-24	18-24	-
Parturition interval	mos.	15	13	12	12	-
Birth rate	%	70-80	70-80	40-60	40-60	-
Calf mortality rate						
0-1 mo.	%	15	10	-	-	-
0-2 mo.	%	18	12	15	15	-
0-6 mo.	%	21	15	-	-	-
0-12 mo.	%	25	18	25	25	-
12-24 mo.	%	4.0	4	-	-	-
Adult mortality rate	%	4.0	4	8	8	-
Daily milk yield	kg	4.25	3.6	-	-	-
Lactation length	days	220	210	-	-	-
Avg. productive life	yrs	7-8	5-6	3-4	3-4	8
Culling ages	yrs	11	9	5	5	10
Immatures:						
Ave. birthwt.	kg	40	25	3.5	2.5	-
Ave. age at sale	mos.	2	-	2-3	2-3	-
Ave. wt. at sale	kg	57	90	7-9	6-8	-
Ave. rate of gain	gms	280	350	60	60	-
Mature animal wt.	kg	550	400	40	35	175
Production/breeding animal equivalent:						
Immature (meat)	kg	28	51	3.4	3.0	-
Cull mature (meat)	kg	73	73	11	10.0	-
Immature animal manure	kg	750	1120	790	745	-
Mature animal manure	kg	17280	14080	12960	12960	15480
Wool produced	kg	-	-	2-3	-	-

Table III.6. Inputs, Outputs and Prices for Musha Livestock

Item	Unit	Buffalo Cow	Baladi Cow	Sheep	Goats	Donkey
Feed/adult/yr:						
Berseem	tons	8.6	6.75	0.75	.75	1.5
Tibben	tons	1.4	1.25	.13	.13	.74
Wheat bran	tons	.66	.53	-	-	-
Mixed ration	tons	.48	.43	.50	.50	.60
Capital inputs:						
Animal depreciation	LE	8.30	11.10	6.00	3.0	1.50
Int. on investment	LE	15.90	12.75	1.50	1.05	1.10
Breeding fee	LE	1.00	1.0	-	-	-
Maintenance	LE	2.50	2.50	1.00	1.0	1.50
Facilities depreciation	LE	15.25	15.25	-	-	-
Labor inputs:						
Woman (feed & water)	hrs	180	180	-	-	-
Man (gather fodder, exercise)	hrs	60	60	-	-	60
Child (exercise)	hrs	180	180	90	90	-
Shepherd (herding)	LE	-	-	4.0	4.0	-
Output Prices/kg:						
Milk	LE	0.15	0.12	-	-	-
Culls meat (l.w.)	LE	1.00	1.00	1.00	1.00	-
Wool	LE	-	-	1.0	-	-
Manure (per ton)	LE	.50	.50	.50	.50	.50
Ave. days worked	days	-	-	-	-	265

Notes on Tables III.5 and III.6

1. Manure output for young animals estimated on the basis of liveweight relative to mature animals. Manure priced as the mixture with soil, not as raw manure. Calf manure calculated as 9% of cow manure production.

2. Animal replacement and culling costs:

   a. Buffalo cows replacement cost = LE 250, cull price = LE 125, and culling age = 11 years.

   b. Baladi cow replacement cost = LE 200, cull price = LE 100, and culling age = 11 years.

   c. Ewe replacement cost = LE 35, cull price = LE 5 and culling age = 5 years.

   d. Doe replacement cost = LE 20, cull price = LE 5 and culling age = 5 years.

   e. Donkey replacement cost = LE 20, cull price = LE 5 and culling age is 10 years.

3. Shepherd labor - For sheep and goats, the females are herded by a shepherd from mid-May to mid-July, offspring being slaughtered for the Bairam feast. Remaining ewes and does are again tended by shepherds from October-December. The total charge is LE 0.50 per head of adults per one year cycle.

4. Value of donkey transportation is calculated on the basis of 265 three-hour work days walking 2.5 km/hr paid LE 0.03/km or an average of LE 60 per year.

5. To put production on an annual basis for the linear programming model, the following calculations were made:

   (a) Annual milk output = [milk yield (lactation length = 332)] x (12 ÷ calving interval)(calving rate)

   (b) Annual veal or beef production = (calf weight) (12 ÷ calving interval)(calving rate)(1-calf mortality rate)

   (c) Annual cull meat production = (mature animal weight) (1÷ culling age)

   (d) Annual manure production = cow manure production + (avg. calf weight ÷ cow weight) x (12 ÷ calving interval) (calving rate)(1-calf mortality).

Cattle - The cattle population consisted of 20 cows and 16 calves. Females are either purchased at 1-2 years of age or raised as replacements from birth and bred to calve at 3 years of age. Calving intervals average 13 months. Cows are usually culled at about 9 years of age. Cattle are kept for meat, milk and manure production. In a few isolated cases, cattle are used as draft animals to pull a norag over horsebeans and lentils. Calves are either sold at 6 months of age, held as replacements, or grown out for meat. Cows will produce an average of 3.6 kg of milk per day over 210 days with the first 30 days milk going to the calf. Cattle manure is utilized in the same manner as buffalo manure. The baladi cow produces about 0.8 of the manure produced by the buffalo cow because of lower feed intake. The same veterinary program exists for cattle as for buffalo. Breeding services are provided by bulls owned by large producers. Opportunities for crossing with Freisian bulls are available.

The cows are fed a ration dominated by berseem clover in the berseem season and are fed an average daily ration of 5.2 kg of straw, 2.2 kg of wheat bran and 1.8 kg of concentrate mix during the non-berseem season. Table III.5 and III.6 summarize the production traits and general budgeting information for the baladi cow. The lower risk of a young calf dying and its ability to gain at a faster rate make the baladi calf a popular animal for growing out. By Egyptian standards, the cattle and buffalo in Musha, are well managed. In this management system, the baladi cattle appear to produce close to their biological limits. Even so, budgets indicated very low returns to household resources utilized for cattle production.

Sheep and Goats - Sheep and goats are used mainly as scavengers to glean fields, roadways and ditch banks. Most of the sheep and goats are managed by a shepherd 6 to 7 months of the year and by the owner for the remaining 5-6 months. A shepherd tends a flock of 75 to 100 sheep and goats from mid-May through mid-July and again from October through December. The owner tends the sheep during berseem season and during

the cotton spraying times of August and September when the owner feeds straw with a small amount of concentrate. The shepherd acts as a custom operator charging a flat fee per animal per month of LE 0.50. The shepherd collects the animals from each farmer in the morning and returns them in the evening. This allows the animals to graze 8-10 hours each day. The grazing in May, June, and July is on residues of wheat and berseem and on grass and weeds found on the canal banks. The grazing in October, November and December is on cotton stems and leaves and the dry stovers and leaves remaining in the field from the sorghum harvest. The shepherds were free to graze the animals on all village lands. The shepherd not only herds the small ruminants but also arranges to have the animals vaccinated, keeps a male or two for service of the herd females, shears the sheep and milks the ewes and does. Sheep and goats were vaccinated by the government veterinarian for Clostridia infections once a year at no cost to owner or shepherd. The shepherd usually keeps one male for every 50 females for breeding purposes. A breeding fee is included in the LE 0.50 per month charge. The shepherd shears the sheep for an additional charge of LE 0.25 to LE 0.50 per head, the price varying according to animal size. In most cases, the wool is given back to the owner who will either sell it for LE 1.0 per kg to a local weaver or make something from it himself. A few of the sheep and goats are milked in cases where the young animals have perished. In these cases the shepherd is free to milk the animal and either sell the milk for LE 0.10 per kg or consume it.

Sheep and goats are kept either for breeding or meat. Sheep are highly prized animals for feasts and thus are fattened specifically for those occasions. Goats carry no seasonal significance and hence no premium price. A sheep weighing 20-25 kg will sell between LE 25 and LE 50 while a goat of the same weight will sell for LE 10 to LE 15. The skins of the slaughtered animals are used as floor covering and sell for LE 1 per skin. The rumen of the animals are used as water containers and sell for LE 3 each.

Table III.5 and III.6 summarize the performance traits and general budgeting information for sheep and goats. This survey data would indicate that small farmers spend less management effort with their sheep and goats than with their buffalo and cattle since the apparent productivity gap for small ruminants is greater than for the large ruminants.

Donkeys - Donkeys make up one-third of the total livestock units in the village. They are used for packing, riding and pulling small carts. The small farmer will typically purchase donkey replacements and will keep the donkey until it dies. The income generated by the donkey is estimated from transportation fees charged for hauling earth manure. This transport service could only rarely be replaced by custom or mechanical power. The very nature of Egypt's small scale irrigated agriculture necessitates that any field-farm transport must be by donkeys or camels since wheeler vehicles are impractical for transport along bunds and narrow paths. The donkey remains an important element on the small farm and its replacement will be very slow. Table III.5 and III.6 summarize the production traits and general budgeting information for the donkey.

Livestock Marketing

Livestock and livestock products may be marketed through established marketing channels. Organized live animal markets for camels, buffalo and cattle in Assiut (15 km north) and for sheep and goats in Shotb (4 km southeast) were held weekly. Slaughterhouses were active in Musha with larger operations found in and around Assuit. Public and private sector dairies purchased milk in Musha and transported it to Assiut for processing.

Few livestock products were marketed outside the confines of the village. Individual producers were able to produce only small amounts of milk or meat, thus attracting neither public or private sector purchases. Also, the village is not only physically a significant distance

from Assiut, but traditionally the Musha farmer has not participated in the Assiut livestock markets. The Shotb sheep and goat market remains the only major outside market used by the Musha small farmer. Approximately 20% of the sheep and goats traded were purchased or sold in the Shotb market.

The livestock markets in Assiut and Shotb were well organized. Farmers wishing to sell an animal on the market grounds were required to pay a marketing fee of LE 0.25 for all animals. Brokers or commission agents (employed as intermediaries between sellers and buyers) were licensed by the government and allowed to charge a fee for their services. Government authorities were present to settle disputes. The market was an important social gathering with many more observers than participants.

Table III.7 summarizes the proportions of livestock and livestock products used in the household or sold. Livestock sales were confined to sales within the village to farmers or middlemen and sales outside the village. Livestock purchased by local farmers, for the most part, were for growing out. Those purchased by middlemen were for immediate slaughter. The sheep and goats marketed outside the village were largely sold at the Shotb market.

Table III.7. The Marketing of Livestock Products in Musha

	Utilized in the Household %	Sold to Local Farmers %	Portion to Local Middleman[1/] %	Sold Outside the Village %
Buffalo, milk	90	10		
Buffalo, calf		70	25	5
Cattle, milk	90	10		
Cattle, calf		75	25	
Sheep & Goats, meat	40	30	10	20
All Manure	85	15		

1/ The middleman refers to local butchers and other retailers.

Table III.8 summarizes the distribution of livestock sales by selling age for livestock less then 1½ years of age in this survey. The small farmers will typical carry over around 10% of their buffalo and baladi cattle calves and 25-35% of their lambs and kids as replacements. Since few small farmers participate in growing out programs, their young livestock are marketed before 18 months of age.

Table III.8. Distribution of Livestock Sold Between Birth and 18 Months of Age.

Age	Buffalo Calves n = 61	Baladi Cattle Calves n = 7	Sheep (lambs) n = 15	Goats (kids) n = 27
0 - 1 month	21	0	0	0
1 - 2 months	47	10	75	60
2 - 6 months	17	75	20	35
6 - 12 months	10	15	5	5
12 - 18 months	5	0	0	0

Source: Survey Data

The price received for all livestock species and ages varied widely. The variation reflected the season of the sale, the livestock purchaser, the condition of the animal, etc. Live animal prices for buffalo and baladi calves less than 24 months were around LE 1 per kg. Sheep and goats up to 1 year of age also sold for around LE 1 per kg. However, sheep and goats over 1 year of age sold on a per head basis with sheep and goats selling for an average price of LE 25 and LE 15 per head, respectively. Culled livestock were assumed to sell for the following average prices: buffalo - LE 125; baladi cattle - LE 100; sheep, goats and donkey - LE 5. If the small farmer was participating in a growing out program, then he would be obligated to grow out calves in pairs, selling one to the government and one on the free market. The government procurement price was around one half the free market price. This program entitled the farmer to receive subsidized concentrate and wheat bran.

Milk was sold on the free market. Discussions with larger farmers indicated private sector dairies were paying from LE 0.20 to LE 0.25 per kg for raw buffalo milk and from LE 0.15 to LE 0.20 per kg for raw baladi cattle milk. The small farmer, unable to enter the private sector dairy market with his small, irregular amounts of milk, received an average price of LE 0.15 (range between LE 0.12 and LE 0.18) for buffalo milk and LE 0.12 (range between LE 0.10 - LE 0.17) for baladi cattle milk.

Manure enters the free market as a fertilizer and fuel product. Manure sold as fertilizer is dried and mixed with soil and sold as an earth manure while manure sold as fuel is dried into cakes for burning and then sold. Thus estimates of the quantity of manure available were on a total solids (87.5% of dry matter) basis. The price utilized for manure is the marginal value product of manure (LE .008/kg) generated by the linear programming model (see Chapter V). Discussion with farmers indicated that dry manure sold for around LE 5 - LE 15 per ton or LE .005 - .015/kg, well within the range of the estimated value.

Feeds and Feeding

Nutrients are supplied to the livestock from two principal sources -- crop production and commercial feeds. Additional nutrients are supplied from grazing, the thinning and strippings of sorghum and maize and other sources such as grazing. Extrapolating from the survey results, Table III.9 summarizes the livestock nutrients available from crop enterprises and purchased feeds during the berseem and nonberseem seasons for Musha's small farmers. This table is thus an estimate of aggregate feed supplies for all small farmers in Musha, in metric tons. The berseem and by-products of wheat and berseem clover make the most significant contribution of total TDN and DP supplied in nonberseem and berseem seasons, respectively. Table III.10 summarizes the contributions of each available feed to the total TDN and DP supplied in each period.

Table III.9. Animal Nutrient Available in Berseem and Nonberseem Periods to the Small Farmer, Musha, 1979

Available Feeds	Berseem* (Jan-April) TDN Available (T)	Berseem* (Jan-April) DP Available (T)	Nonberseem (May-Dec.) TDN Available (T)	Nonberseem (May-Dec.) DP Available (T)
Crop Production:				
Wheat bran	5.0	1.0	45.2	8.7
Wheat straw	28.7	.3	545.7	5.3
Horsebean straw	6.9	.4	131.9	8.0
Lentils straw	12.4	.5	235.0	9.5
Berseem straw	8.6	.4	164.2	6.6
Berseem forage	889.2	195.6		
Subtotal	950.8	198.2	1122.0	38.1
Purchased Feeds:				
Government ration	20.3	4.5	182.5	40.0
Wheat bran	35.5	6.9	319.9	61.9
Horsebeans			26.7	7.9
Cottonseeds			26.2	4.3
Sorghum, grain			1.2	.1
Berseem	21.5	4.7		
Subtotal	77.3	16.1	556.5	114.2
Total	1028.1	214.3	1678.5	152.3

* Approximately 10% of the wheat bran and government ration and 5% of the straws are fed during berseem production period.

Table III.10. Contribution of Available Feeds to Total Nutrients Supplied, Musha, 1979

Available Feeds	January-April Berseem Season % TDN Supplied	January-April Berseem Season % DP Supplied	May-December Nonberseem Season % TDN Supplied	May-December Nonberseem Season % DP Supplied
Crop Production:				
Wheat bran	.4	.5	2.7	5.7
Wheat straw	2.8	.1	32.4	3.5
Horsebean straw	.7	.2	7.9	5.3
Lentil straw	1.2	.2	14.	6.2
Berseem straw	.8	.2	9.8	4.3
Berseem forage	86.5	91.3	-	-
Purchased Feeds:				
Government ration	2.0	2.1	10.9	26.3
Wheat bran	3.5	3.2	19.0	40.6
Horsebeans	-	-	1.6	5.2
Cottonseeds	-	-	1.6	2.8
Sorghum	2.1	2.2	.1	.1
Total	100.0	100.0	100.0	100.0

Total digestible nutrients and DP requirements of the animals held by the farmers in Musha were estimated using as a basis the reported production levels. Details are reported in Appendix D. Requirements were estimated on a monthly basis to enable assessment of feeding programs during the berseem and nonberseem seasons. These requirements are summarized by species of livestock and season of feeding in Table III.11 again by extrapolating survey results to obtain estimates for all small farmers in Musha.

These tables indicate that the livestock are fed at levels adequate to maintain good condition. During the 4 month berseem period, TDN and DP supplies exceed livestock requirements by 6% and 109%, respectively. During the 8 months of nonberseem, TDN and DP are below requirements by 5% and 22.0%, respectively. However, it is estimated that this shortfall is provided to the animals by grazing ditch banks and roadways, by the thinning and stripping of sorghum and maize, and by weeds cultivated from crops. The contribution from these latter sources of feed could not be accurately estimated by the survey methods used.

Feedstuffs are in short supply throughout the nonberseem season. Unlike ZGEK, however, no critical time frames were identified. The shortest supply period occurs just prior to berseem season when straws and concentrates are depleted. Another critical period is in mid-summer (late July to mid-September) coinciding with cotton spraying. During this period no fresh green forages are fed and all livestock must exist on straws and concentrate feeds.

Table III.11. TDN and DP Requirements by Species in the Berseem and Nonberseem Seasons, Musha

Specie	Berseem		Nonberseem	
	TDN (T)	DP (T)	TDN (T)	DP (T)
Buffalo	559.2	54.6	1081.7	103.9
Cattle	84.5	8.4	160.5	14.8
Sheep	56.5	3.9	62.3	4.0
Goats	90.3	8.4	96.9	8.7
Donkeys	181.8	27.1	369.7	55.0
Total	972.3	102.4	1771.1	186.4

CHAPTER IV

SURVEY RESULTS FOR ZAWIET GHAZAL - EZEB KABEEL VILLAGE

General Description

The adjacent villages of Zawiet Ghazal and Ezeb Kabeel, identified here as ZGEK, are 5 kilometers west of Damanhour in Behera Governorate, upper Egypt. Zawiet Ghazal is inhabited by 830 families and 5000 people while Ezeb Kabeel is comprised of 1080 families and 6500 population. The largest single non-agricultural employer is an electric power station in the village. Agriculture remains the primary employer with 1465 feddans under cultivation in Zawiet Ghazal and 1185 feddans cultivated in Ezeb Kabeel. The climate is similar to that of Musha except rainfall is much higher at an annual average of 93.6 mm. However, the village remains dependent upon irrigation water supplied from the Nile River for its agricultural sector. Water is supplied by canals and then lifted by traditional sakia's and diesel or electrial pumps.

The largest employer in the village is the agricultural sector. Of the 1910 families, 980 are registered Cooperative Society members which indicates they either own or rent agricultural land. Ninety percent of these farm families hold 5 feddans or less and cultivate 50% of the total land area. The remaining 10% of the farm families hold more than 5 feddans and cultivate the remaining 50% of the total land area. Table IV.1 summarizes the land holdings in ZGEK.

Table IV.1. Distribution of Farm Numbers and Total Land by Farm Size in ZGEK, 1979

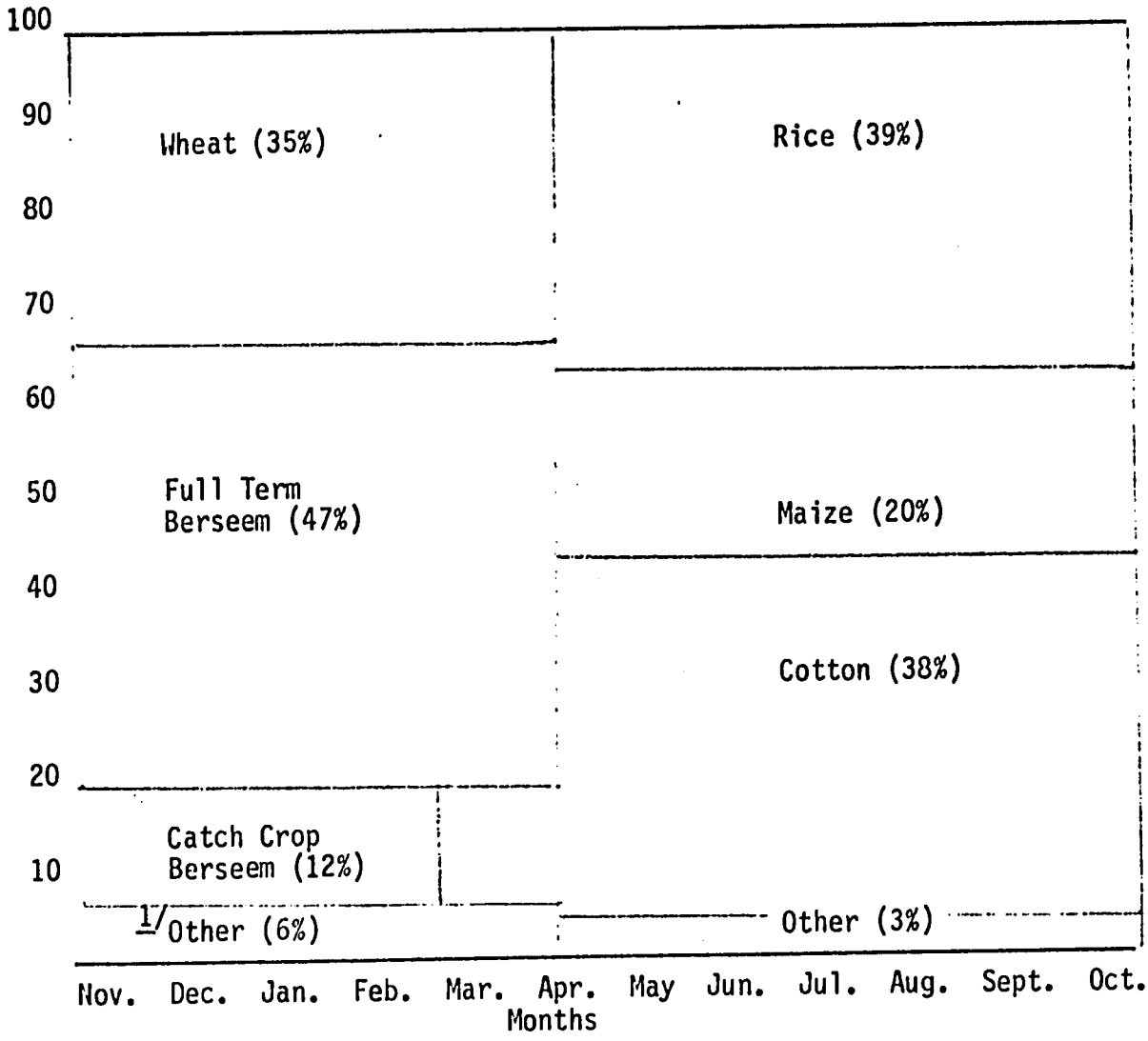
Land Area Cultivated	Total Farmers		Land Cultivated	
	Farmers	%	Feddans	%
0-1 Feddan	246	25.0	144	5.9
1.1-2	338	34.3	427	17.5
2.1-3	215	21.8	407	16.7
3.1-4	70	7.1	205	8.4
4.1-5	13	1.3	46	1.9
5.1-10	46	4.7	254	10.4
10.1-20	28	2.9	327	13.4
20.1+	28	2.9	630	25.8
TOTALS	984	100.0	2440	100.0

Assuming the proportion of destitute families is similar to that of Musha (about 10%), then nearly 40% of the villages' families remain as neither destitute nor landowning. This group, defined as the landless laborers, are employed as agricultural or industrial workers.

Crop Production

The small farmers cultivate almost all their land in both summer and winter seasons and thus have a cropping intensity of nearly 2.0. The typical one-year crop rotations are catch crop berseem followed by cotton, full term berseem followed by rice or cotton, and wheat followed by rice or maize. Diagram IV.1 depicts the land area devoted to specific crops throughout the agricultural year, November 1 to October 31. The diagram confirms observations by the Cooperative Society and Agricultural Credit Bank officials' that over 2/3 of the cotton is planted late. These villages represent the traditional Nile Delta wheat-cotton-rice agriculture.

Diagram IV.1. Proportion of Total Land Area Devoted to Specific Crops, ZGEK 1979



1/ Others includes fruit trees, winter and summer vegetables and other leguminous winter crops.

The government plays an active role in determining crop allocations in ZGEK. Quotas are actively enforced on cotton and rice, which together occupy nearly 80% of the summer land. Thus, only the winter season cropping decisions are left to the farmer.

Winter Crops - Full term and catch crop berseem occupy 59% of the cultivated winter land. Berseem is planted as soon as summer crops can be removed from the fields. Some berseem is planted in late September but most goes in during October-November. The first cutting is 45 days after planting. Typically full term berseem is cut 4 times while catch crop berseem is cut only once. Approximately 6 tons of berseem are harvested per feddan per cutting. Only a small portion of the land area planted into berseem is left to produce seed. Wheat is the staple crop. The grain is processed either at small mills or in the household. The use of the residues and byproducts is the same as in Musha. The remaining land area is occupied by fruit trees, winter vegetables and fallow land. The Behera Governorate produces over 2/3 of the country's citrus fruits and grapes; however, the small farmer has yet to participate actively in fruit and vegetable production. While fruits and vegetables offer high potential returns, relatively unstable farmgate prices and inadequate transportation and marketing networks prevent the small farmer from cultivating them.

Summer Crops - Rice is the most important crop, occupying 39% of sample farmers land area. The paddy rice is either sold to the government or used in the household. Milling of paddy rice produces the following by-products: hulls 18%, bran 10%, polishings 3%, brokens 1-17% and polished rice 50-70%.

The hulls are utilized for brick making and shoe soles and are marketed by the local mills. The bran, containing 12-13% fat, is marketed to soapmaking firms for extraction of the fats. The soapmaking firm, in turn, sells the remaining 87-88% of solid material to government livestock feed preparation companies. The polishings and brokens are sold

to starch manufacturers. Polished rice is sold on the domestic and foreign markets. The only product remaining on the farmstead is the straw, which is used primarily as fuel. Each ton of paddy rice produces 0.6 tons of straw.

Cotton follows either berseem or wheat and occupies 38% of the summer land. As in Musha, the seed cotton is sold to the government leaving the stems and leaves as residue on the farm (refer to the Musha discussion for details on uses of the seed cotton and cotton byproducts). Maize is utilized for human and animal feed. Ninety percent of farmers growing maize reported stripping leaves for animal feed. The remaining by-products, stover and cobs, are utilized as fuel. Each ton of maize grain results in 1.5 tons of stover and 300 kg of cobs which are used for animal feeds. Table IV.2 summarizes the average yields for the various products derived from the primary and secondary crop products within the villages. Appendix A provides further details on crop enterprises.

Table IV.2. Major Crop Yields for Primary and Secondary Products, ZGEK, 1979

Crop, Product	Units	Units Per Feddan	Kilograms Per Unit	Kilograms Per Feddan
Seed Cotton	Kantar	6.1	157.5	960
Cotton Stems	Camel Ld.	4.	250.	1000
Wheat	Ardeb	7.2	150	1080
Wheat Straw	Hemel	6.9	225.	1550
Maize	Ardeb	8.2	140.	1150
Maize Stover	Camel Ld.	6.3	150.	1575
Maize Cobs	Kg.	350.	1.	345
Rice	Dariba	2.1	1000.	2100
Rice Straw	Hemel	5.3	225.	1200
Berseem	Tons	23.0	1000.	23000

Source: Survey Data

Livestock Production

Buffalo and cattle are kept for milk, meat and manure production plus draft power. As in Musha, livestock depend upon crop residues and byproducts and some purchased concentrate feeds for maintenance. The breakdown by animals is given in Table IV.3 while the distribution of livestock ownership by type is presented in Table IV.4.

Table IV.3. Total Livestock Holdings by the Small Farmers Surveyed and the Total Small Farmer Population

Livestock Species/Age	Survey Population n	Small Farmer Total Livestock Population[1/] n	Livestock Unit Equivalency	Total Livestock Units[2/] l.u	Percentage of Total Units %
Buffalo, 2 years old	122	533	1.0	533	29
Buffalo, < 2 years old	8	35	.6	21	1
Cattle, 2 years old	163	712	.8	570	31
Cattle, < 2 years old	44	192	.5	96	5
Sheep, 1 year old	48	210	.1	21	1
Sheep, < 1 year old	9	39	.06	2	-*
Goat, 1 year old	6	26	.1	3	-
Goat, < 1 year old	2	9	.06	-	-
Donkeys, all	169	738	.8	590	32
TOTAL				1836	100

1/ This survey included 22.9% of ZGEK small farmers.

2/ Source: The livestock numbers are from the survey data. The equivalency factors were from H. A. El Tobgy's Contemporary Egyptian Agriculture with adjustments made for young livestock. Livestock units are based on the average annual nutrient demand of each livestock species by age.

* The blank spaces account for 1 percent or less of total livestock units.

Table IV.4. Livestock Holdings by Sample Farmers, ZGEK 1979

Livestock Held	Numbers of farmers	Percentage of all farmers with that class of livestock
Buffalo only	50	25
Cattle only	77	39
Sheep and goats only	0	0
Buffalo and Cattle	33	17
Buffalo, Sheep and Goats	5	2
Cattle, Sheep and Goats	11	6
Buffalo, Cattle, Sheep and Goats	11	5
No Livestock	12	6

Source: Survey Data

Buffalo and/or cattle are held by all farmers that keep livestock. Sheep and goats are kept by only 13% of the small farmers. Sheep and goat meat is supplied to the village by specialists (other than small farmers) growing out large numbers of sheep and goats, as well as buffalo and cattle.

Crop residues and byproducts supplemented by purchased concentrates constitute the primary animals feed. In ZGEK, neither the government supplied mixed ration nor wheat bran was directly allocated to the small farmer. The Governorate officials had declared that only those farmers owning insured animals were eligible to receive the government allotments. In order to qualify for the insurance program, the farmer must own 5 or more mature animals, thus effectively leaving the small farmer out of the insurance and consequently the feed programs. In a few isolated cases small farmers, usually related to one another, would organize themselves under one name to obtain insurance and an allotment of the government supplied feeds. If the Agricultural Credit Bank received its allotment of the subsidized mixed ration, then each mature buffalo or baladi cow was allocated 90 kg/month from June through December and 120 kg/month from January through May. The mixed ration was

allocated to milking animals at LE 42/ton and to growing out animals at LE 34/ton. If the Agricultural Credit Bank received its wheat bran allotment, then each buffalo or baladi cow for milking was allocated 70 kg per month and each growing out animal allocated 50 kg per month. Wheat bran was sold at LE 36/ton for both milking and fattening animals. As in Musha, once the feed is received, the farmer can either feed or sell it. Discussions with government officials and farmers indicate that a free market does exist, but it is relatively inactive.

The Agricultural Credit Bank also sold yellow maize. Uninsured farmers could purchase an unrestricted amount of yellow maize at LE 60 per ton while insured farmers could purchase the maize for LE 55/ton. Even though the free market for feed was not as active as in Musha, 80% of the small farmers entered the government or free market to purchase the mixed ration, wheat bran and yellow maize in addition to occasional purchases of barley and dry beans.

Buffalo and cattle are of major importance to the small farmer. The small farmer typically shares[1/] the ownership of these animals with a larger farmer. The joint ownership arrangement requires that only income from the sale of offspring be shared equally, thus allowing the small farmer to utilize the milk, draft and manure outputs. These returns constitute the payment to the farmer for his care of the animal. Approximately 76% of the buffalo and 85% of the cattle held are used for draft power. Buffalo and cattle are both utilized an average of 31[illegible] hours annually (range 10-1000 hours). The wide range in hours of use is explained by varying crop rotation, land area, sharing responsibilities and the degree of mechanization of the employer.

Table IV.5 indicates that there is little difference in the type and quantity of draft supplied by the buffalo and cattle. The significan

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[1/] The Rural Sociology survey found sharing arrangements existed for about one-half the large ruminants (Hopkins, et al., 1979)

draft power tasks are planking, ditching and irrigation. In this survey, essentially all of the plowing was accomplished by a tractor pulling a chisel plow. Assuming a 1.75 meter chisel plow is pulled at 3.5 kilometers per hour with 70% field efficiency, .5 feddans can be plowed per hour. The standard custom rate is LE 2 per hour. A draft animal team can accomplish the task of plowing one feddan in roughly 14-16 hours. Apart from the time saved, evidence from secondary data sources indicates higher rates of germination and consequently higher yields are attained from the better seedbed preparation achieved with the tractor and plow.[2/] Land planking and ditching are still done by animals most of the time. Land planking is done with a two animal team pulling a 2 meter plank over the field. This task requires 2 to 2½ hours per feddan for the two animal team or one-half hour per feddan for a tractor pulling the same implement. Ditching for cotton and corn is carried out by a team pulling the plow as a ditcher. This task requires from 6-7 hours per feddan.

Table IV.5. Buffalo and Cattle Hours Worked by Task, ZGEK, 1979

Task	Buffalo use by task (%)	Average hrs worked/ buffalo/yr	Cattle use by task (%)	Avg. hours worked/ cow/yr
Land preparation only	7.7	142	10.8	235
Irrigation only	11	503	8.5	482
Planking only	27.5	172	13.8	181
Land preparation and irrigation	17.6	430	30.8	459
Land preparation and planking	23.1	250	22.3	207
Planking and irrigation	4.4	540	2.3	830
Land preparation, irrigation and planking	8.8	427	11.5	361

2/ ERA, 2000. pp. X., 38-48 and XIV, 10.

The most demanding draught task is water pumping. Diesel and electric pumps were utilized by 60% of the farmers leaving 40% of the farmers utilizing traditional sakias. The sakia is driven by 1 or 2 animals depending on the pumping depth and efficiency of the sakia. The number of hours the animal/ or animals is worked per feddan varies with the crop. Based on a single animal sakia the following pumping requirements were estimated:[3/]

Cotton	= 4.8 hours/feddan
Wheat	= 4.2 hours/feddan
Maize	= 3.9 hours/feddan
Berseem	= 3.5 hours/feddan
Rice	= 3.2 hours/feddan

Despite the importance of draft animals in ZGEK, discussions with farmers indicated that milk was the most important product with draft, meat and manure being of secondary importance. The relative importance of milk and draft meant that 75% of the buffalo and 85% of the cattle were utilized for both activities. This survey, which relied on farmers recall for estimates of average milk production and hours of draft use, found no significant correlation between the quantity of milk produced per day (or per annum) with the hours of draft use per day (or per annum). When the total annual milk production and draft use were grouped into irrigation and nonirrigation related uses, then a slightly higher level of milk production was indicated for animals not utilized for irrigation. Table IV.6 summarizes this grouped data.

[3/] The estimate for cotton, wheat, maize and berseem were provided by the Food Research Institute at Stanford University and the estimate for rice taken from survey data. The basal pumping rate was 100 m^3/hr.

Table IV.6. A Comparison of Total Annual Hours Worked and Total Annual Milk Production for Draft Animals Utilized for Water Pumping and those not Utilized for Water Pumping.

Task	Species	Average Number of Hours Worked	Average Milk Production
Water Pumping	Buffalo	460	770
	Cattle	460	450
No Water Pumping	Buffalo	200	900
	Cattle	150	490

Buffalo - A total of 98% of the farmers reported keeping their mature buffalo primarily as milk producers with only two percent being held solely for the production of meat. However, of the 98% held for milk production, 78% were also used as draft animals. Of the 130 buffalo reported only 8 were less than 2 years of age. Calves are typically sold at 1 or 2 months of age. Thus virtually all survey farmers purchased their replacements.

The average buffalo cow is milked for 200 days and produces 4.8 kg of milk daily. The average daily production is the same as reported at large dairies but the days milked in the village are about 50 days less. The milk produced by the small farmers was largely consumed at home. Of the 117 cows 3 years and older, 93 (79%) had produced at least one calf. The average calving interval of those that had calved was 19 months. Seventy two percent of the buffalo calves were born between December 1st and May 1st (berseem season).

luring the berseem season, farmers fed little other than berseem. They eported feeding their buffalo an average of 5.5 kg of straw, 0.25 kg of heat bran, 0.46 kg of concentrate mix and 0.32 kg of various grains laily during the non-berseem time. In addition to leaf strippings from naize and weeds cultivated from the fields, animals are allowed to graze for one hour each day during this time. The animals were in fair to noderate condition during the time of this survey.

Veterinary services are provided at no cost to the farmer by the Government including vaccinations for all infectious diseases. The major health problems reported by the Governorate Veterinary Department are nutrition related. Ketosis is prevalent during first cutting berseem and phosphorous deficiency is a problem during the second and third cuttings of berseem. Vitamin A is reported to be deficient in the summer.

Breeding of cows in ZGEK is done by males from herds of larger producers. It was reported that 20,000 buffalo cows are bred artificially in all of Behera but artificial insemination was not used on buffalo or cattle held by the small farmers included in the sample.

Table IV.7 and IV.8 summarize water buffalo characteristics in ZGEK.[4/]

4/ Additional data relevant to all livestock enterprises are as follows: Berseem = LE 6.67/ton, Wheat straw = LE 31/ton, Wheat bran = LE 70/ton, free market price, Yellow maize = LE 60/ton, Labor = LE 0.17/man-hour, Amortized shelter costs for 2 cattle or 2 buffalo = LE 2.50.

Table IV.7. Performance Traits of ZGEK Livestock

Item	Unit	Buffalo Cow	Baladi Cow	Sheep	Goats	Donkey
Age at first parturition	mos.	48-59	48-57	18-24	18-24	-
Parturition interval	mos.	19.3	16.8	12	12	-
Birth rate	%	40-50	50-60	40-50	40-50	-
Calf mortality rate						
0-1 mo.	%	15	10	-	-	-
0-2 mo.	%	18	12	15	15	-
0-6 mo.	%	21	15	20	20	-
0-12 mo.	%	25	18	25	25	-
12-24 mo.	%	4	4	-	-	-
Adult mortality rate	%	4	4	8	8	-
Daily milk yield	kg	4.8	3.4	-	-	-
Lactation length	days	200	170	-	-	-
Avg. productive life	yrs	6-7	4-5	3-4	3-4	8
Culling ages	yrs	11	9	5	5	10
Immatures:						
Ave. birthwt.	kg	40	25	3.5	2.5	-
Ave. age at sale	mos.	2	6	6	6	-
Ave. wt. at sale	kg	57	90	15	13	-
Ave. rate of gain	gms	280	350	60	60	-
Mature animal wt.	kg	550	400	40	35	175
Production/breeding animal equivalent:						
Immature (meat)	kg	23	30	5	5	-
Cull mature (meat)	kg	85	89	11	10	-
Immature animal manure	kg	352	670	1080	1030	-
Mature animal manure	kg	17280	14080	12960	12960	15480
Wool produced	kg	-	-	2-3	-	-
Draft use	hrs	310	310	-	-	-

Table IV.8. Inputs, Outputs and Prices for Musha Livestock

Item	Unit	Buffalo Cow	Baladi Cow	Sheep	Goats	Donkey
Feed/adult/yr:						
Berseem	tons	9.4	7.5	.75	.75	1.5
Wheat straw	tons	1.16	.99	.07	.46	.74
Wheat bran	tons	.06	.05	-	-	-
Mixed ration	tons	.25	.21	.07	.09	.06
Capital inputs:						
Animal depreciation	LE	7.95	6.95	6.0	3.0	1.50
Int. on investment	LE	9.05	6.9	1.49	1.05	1.10
Breeding fee	LE	1.00	0.5	-	-	-
Maintenance	LE	1.00	1.00	1.00	1.00	1.50
Facilities depreciation	LE	2.5	2.5	-	-	-
Labor inputs:						
Woman (feed & water)	hrs	240	240	-	-	-
Man (gather fodder, exercise)	hrs	30	30	-	-	60
Child (exercise)	hrs	200	200	180	180	-
Output Prices/kg:						
Milk	LE	0.15	0.15	-	-	-
Immatures meat (l.w.)	LE	1.00	1.00	1.0	1.0	-
Culls meat (l.w.)	LE	.25	.25	.15	.15	-
Wool	LE	-	-	1.00	1.00	-
Manure (per ton)	LE	.50	.50	.50	.50	.50
Draft power (per hr)	LE	3-5	-	-	-	-
Ave. days worked	days	-	-	-	-	265

Notes on Tables IV.7 and IV.8

1. Manure output for young animals estimated on the basis of liveweight relative to mature animals. Manure priced as the mixture with soil, not as raw manure. Calf manure estimated as 9% of cow manure output.

2. The investment cost of cattle and water buffalo are typically shared between larger farmers and the small farmers, both of whom have certain ownership rights to the animal.

3. Animal replacement and culling costs:

   a. Buffalo cow replacement (unbred) = LE 300, Cull price = LE 125.
   b. Baladi cow replacement (unbred) = LE 225, Cull price = LE 100, Culling age = 9 years.
   c. Donkey: replacement cost = LE 20, Cull price = LE 5, Culling age = 10 years.

4. Value of donkey transportation is calculated on the basis of 265 three hour work days waling 2.5 km/hr paid LE 0.03/km or an average of LE 60 per year.

5. Refer footnote 5, p. 36.

Cattle - Cattle use and management is essentially the same as for buffaloes. Only those production parameters and management practices that differ are discussed in this section. The baladi cows produce an average of 3.4 kg of milk daily for 170 days. Of the 147 cows 3 years of age and older, 128 (87%) had produced at least one calf. The average calving interval was 16.8 months. Calving patterns were similar to buffalo with most of the cows conceiving around the end of berseem season. In contrast to the buffalo, thirty five percent of the young animals were kept for growing out or as replacement stock and nearly 80% of the cattle owned were raised from birth, rather than purchased. The average daily ration fed to the producing cow in the non-berseem season was reported to be 4.7 kg of straw, C.22 kg of wheat bran, 0.37 kg of concentrate mix and 0.26 kg of various grains. Cows were observed to be in fair condition at the time of this study.

Tables IV.7 and IV.8 summarize baladi cattle characteristics. Because of the relatively low milk yield of the baladi cow, cattle generated a lower economic return than the buffalo. Discussions with small farmers indicated that baladi cattle are preferred to the buffalo as draft animals but the enterprise budgets are unable to capture this preference. Survey data indicated that small farmers utilized baladi cattle and buffalo for the same tasks and approximately the same number of hours per year. The faster working speed of cattle is probably the main factor.

The small farmer is often a joint livestock owner with a larger farmer so decisions as to what livestock species to keep are often made by the larger farmer. The sharing arrangement requires dividing receipts from calf sales. Under the assumptions employed in the budgets, the average annual income generated by meat production is higher in the baladi cow enterprise than in the buffalo cow enterprise. The large farmer in the sharing arrangement would definitely benefit by encouraging the partner to keep a baladi cow. Both this survey and the companion Rural Sociology (Hopkins, et. al., 1979) indicated that water buffalo were the

preferred large ruminant in ZGEK and farmers would prefer more buffalo and fewer cattle. However, the need for cattle as draft animals and, for shared animals, the preference of the absentee owner for cattle because of quicker reproduction meant that large numbers of cattle were still held. This is despite the villagers preference for the buffalo which produced more and richer milk for home use.

Sheep and Goats - Sheep and goats were kept exclusively for meat production with the fattening schedule designed for the "Bairam" feast.[5/] Traditionally, sheep and goats are raised by fattening specialists holding numerous sheep, goats, buffalo and cattle. As in Musha, the sheep and goats graze on cotton and wheat residue and are maintained on berseem in the winter season. However, grazing of large flocks of sheep and goats in ZGEK was not common. This is largely a result of the winter cropping pattern which leaves no land idle for more than a few days each year. Tables IV.7 and IV.8 summarize the characteristics of sheep and goats in ZGEK. The sheep and goats held for fattening are usually owned by specialists who keep up to 75-100 head.

Donkeys - Donkeys were held by 80% of the farmers surveyed and used primarily for transportation. The donkeys were worked an average of 265 days per year and at current prices for mechanical replacements, the observed pattern of donkey ownership and use will continue. The donkey is maintained on the poorest diet of all the livestock and is relatively well fed only during berseem time. Tables IV.7 and IV.8 summarize the production traits and general budgeting information for the donkey.

5/ This feast was scheduled for October during the survey year. However, it is a movable feast following the Muslim calendar and advances 11 days each year.

Livestock Marketing

Livestock markets were available in the villages of Zawiet Ghazal and Ezeb Kabeel and the urban center, Damanhour. The paved road, readily available transportation and physical closeness of Damanhour made it a logical marketing center for the small farmer. Two small butcher shops operated in ZGEK with much larger slaughterhouses in and around Damanhour. Several dairies operated in Damanhour and some milk was being supplied to them from ZGEK farmers. However, as in Musha, the existence of the marketing network was of minor importance to the small, semi-subsistence, farmer.

Table IV.9 summarizes the utilization of surveyed farmers livestock and livestock products retained in the household and sold in the market. Calves sold to other farmers were largely for growing out operations. Those sold to middlemen were utilized as vealers. In contrast to Musha, sheep and goat meat is largely home consumed.

Table IV.9. The Marketing of Livestock Products in ZGEK

Livestock Product	Utilized in the Household %	Sold to Local Farmers %	Sold to local Middlemen* %	Sold outside the Village %
Buffalo, milk	85	3	7	7
Buffalo, calf		24	58	18
Cattle, milk	95	5		
Cattle, calf		39	41	20
Sheep & Goats, Meat	80	5	15	
All Manure	95	5		

*The middlemen refers to local butchers and other retailers.

Table IV.10 summarizes the distribution of livestock sales by selling age. The buffalo and cattle calves selling ages appeared to be related to the high mortality rates and season of birth.[6/] The risk associated with the high mortality rates of the buffalo calves remained the principle reason for marketing the calves at 1-2 months of age. Baladi calves had lower mortality rates and were traditionally kept from 4 to 16 months longer than buffalo calves. The faster gaining baladi calves were typically kept to take advantage of the excess feed supply in the berseem season. Berseem season also influenced sheep and goat sales. The small farmer would purchase a sheep or goat prior to berseem season and slaughter or sell it when berseem was depleted. Sheep are raised for special religious observances and thus command a premium price during those times of the year.

Table IV.10. Distribution of Livestock Sold Between Birth and 18 Months of Age

Age	Buffalo Calves n = 62	Baladi Calves n = 79	Sheep* Lambs n = 10	Goats* Kids n = 10
0 - 1 months	21	5	0	0
1 - 2 months	56	22	30	30
2 - 6 months	11	38	70	70
6 - 12 months	12	25	0	0
12 - 18 months	0	10	0	0

* Estimates from farmers discussions.

Feeds and Feeding

As in Musha, nutrients are supplied primarily by crop production and purchased feeds. Additional nutrients are supplied from grazing, the thinning and stripping of sorghum and maize, deneba grass cultivated from rice fields and other sources of green fodder. The main berseem season extends from early December through April with the nonberseem season extending from May through November. Extrapolating from the survey results, Table IV.11 summarizes the livestock nutrients available from the crop enterprises and purchased feeds during the berseem and nonberseem seasons for all the small farmers of ZGEK.

[6/] The more general reasons for selling calves relate to limited and high cost feed resources, need for family milk consumption, cash requirements for summer cropping, and favorable prices on a weight-for-value basis.

Table IV.11. Animal Nutrients Available in Berseem and Nonberseem Periods to the Small Farmers, ZGEK, 1979

Available Feeds	Berseem TDN Available (T)	Berseem DP Available (T)	Nonberseem TDN Available (T)	Nonberseem DP Available (T)
Crop Production:				
Wheat bran			25.9	5.0
Wheat straw			294.3	2.9
Berseem forage	1588.2	349.4		
Subtotal	1588.2	349.4	320.2	7.9
Purchased Feed:				
Government ration			62.9	13.8
Wheat bran			51.6	10.
Yellow maize			57.7	4.8
Horsebeans			20.1	5.9
Barley			11.8	1.4
Wheat Straw			255.	2.5
Others*			4.2	.2
Berseem forage	222.7	49.0		
Subtotal	222.7	49.0	463.3	38.6
Total	1810.9	298.4	783.5	46.5

* Includes rice screenings and hulls.

Wheat residues and by-products plus berseem clover make the most significant contribution to the total TDN and DP supplied. Table IV.12 summarizes the % contribution of each available feed to the total TDN and DP supplied for each of the two periods. Total digestible nutrients and digestible protein requirements of the animals kept by the interviewed farmers were estimated based on the production levels reported. The same procedure was followed as in Musha and the computations are detailed in Appendix D. These requirements are summarized by type of livestock and season in Table IV.13. In ZGEK, the average monthly TDN requirements during the nonberseem period (172 tons) are slightly higher than during the berseem period (166 tons) for buffalo and cattle. This indicates that the added work of the animals in summer offsets the lower requirements due to fewer animals producing milk. Conversely, the monthly requirements of sheep and goats are essentially one-half during the nonberseem season since nearly all sheep and goats are dry in the summer.

The livestock population is well fed during berseem season which allows the animals to enter the nonberseem season in good condition. During berseem season around 169% of the TDN and nearly 400% of DP required are supplied. During the nonberseem season 50% of the TDN and 30% of DP required are supplied. The unquantifiable activities such as grazing and weeds (principally deneba grass) will narrow this requirement-supply gap somewhat.

The two most critical feed deficits occur in late April to early May when the berseem is finished and wheat straw is not available, and in late November and early December, when the stored feeds are in short supply just prior to berseem season. Discussions with farmers indicated each of these periods vary from 2-4 weeks. The spring is especially critical for draft animals which are entering a high energy demand period with land preparation and water pumping required from April throughout the summer.

Table IV.12. Contribution of Available Feeds to Total Nutrients Supplied, Musha, 1979

Available Feeds	December-April Berseem Season		May-November Nonberseem Season	
	% TDN Supplied	% DP Supplied	% TDN Supplied	% DP Supplied
Crop Production:				
Wheat bran			3.3	10.8
Wheat straw			37.6	6.2
Berseem forage	87.7	87.7		
Purchased Feeds:				
Government ration			8.	29.7
Wheat bran			6.6	21.5
Yellow maize			7.4	10.3
Horsebeans			2.6	12.7
Barley			1.5	3.0
Wheat straw			32.5	5.4
Others*			.5	.4
Berseem forage	12.3	12.3		
Total	100.0	100.0	100.0	100.0

* Includes rices screenings and hulls.

Table IV.13. Total TDN and DP Requirements of Reported Livestock during Berseem and Nonberseem Seasons, ZGEK

Type	Berseem (Dec.-April)		Nonberseem (May-Nov.)	
	TDN (T)	DP (T)	TDN (T)	DP (T)
Buffalo	404.6	34.2	584.1	48.9
Cattle	424.6	36.0	621.2	52.3
Sheep	37.4	3.4	32.0	2.7
Goats	4.2	.4	3.5	.3
Donkey	202.8	27.9	287.4	39.5
Total	1073.6	101.9	1528.2	143.7

CHAPTER V

ANALYSIS OF FEED PRODUCTION AND LIVESTOCK DEVELOPMENT OPTIONS

Introduction

The village profiles and summary data led to the general impression of heavy pressure on existing feed resources and very low returns to resources allocated to livestock production. A considerable amount of research has been carried out in Egypt and other countries facing similar problems in the feed-livestock sector. This Chapter attempts to assess the potential improvements which could be made in the Egyptian small farm feed-livestock sector by the application of improved production practices and technology. Any such assessment must take detailed account of the various uses made of livestock and their products as well as the constraints facing the small farmer. Therefore, any approach used to systematically assess development possibilities must take full account of the physical and financial flows within the Egyptian small farm and thus be able to capture the utilization of crop and animal by-products for feed, fuel, fertilizer and direct sources of income. Two approaches are routinely used to construct models of this type for use in policy analysis: simulation modelling and operations research. The former approach offers great flexibility and permits detailed description of system elements but is time consuming, difficult to replicate by other researchers since each model has a structure unique to the problem at hand, and does not provide optimal solutions. Operations research models are relatively easy to construct, follow the same basic format and provide an optimal solution given a set of assumptions regarding farmer behavior.

This study utilizes the operations research technique; more specifically linear programming. This approach is widely used in farm planning, has been used in numerous studies of small farms in developing countries,

and allows the examination of a wide range of price, technical and policy alternatives at a reasonable cost. The approach can be applied to the planning of individual farms or groups of "representative" farms where average levels of productivity for the group of farms is used. Given the reasonably homogenous nature of most of the small farms within the villages, the latter approach is used here and an average farm situations are depicted for Musha and the Zawiet Ghazal-Ezeb Kabeel. The usual assumption is that the farmer attempts to maximize his net returns or (gross revenue less variable costs of production). To achieve greater realism, some modifications are introduced to reflect farmer preferences for producing his own wheat, maintaining a large ruminant, and keeping a donkey.

Model Structure and Specification

The model formalizes the physical and financial flows found to exist on the farms. These flows are detailed in Appendix E for each village. The next step is to formally represent these relationships within the framework of a linear programming model. The overall objective is to maximize the farm gross margin subject to restrictions on available land and household fuel requirements. Labor, animal feeds, fertilizer, and fuel can be purchased through the input markets. Family food consumption requirements were not specifically considered as constrainting factors on the farm output mix; however, most model runs were made with wheat production forced in at 0.8 feddans since farmers had a strong preference to produce their own supply of wheat rather than produce other cash crops with which to purchase wheat on the open market. In a similar vein, several livestock enterprises were forced into the model solution.

Formally we wish to

(1) Maximize

$$Z = C_J X_j$$

subject to

$$X_j a_{ij} \leq b_i$$

where

Z = total gross margin per farm

C_j = gross margin for the jth activity

X_j = level of the jth activity

a_{ij} = resource requirements of ith resource for the jth activity and b_i = availability of the ith resource.

Included within the model are a number of transfer activities which permit crop and livestock products to be sold, the by-products and residues to be sold or consumed on the farm, fuel transfers, and feed transfers between summer and winter seasons.

A separate matrix was constructed for each of the two farming areas. The coefficients represents the a_{ij}'s above while the constraints represent the b_i items. The blocks of activities are linked together by the transfer activities. A positive sign for a coefficient represents an activity which is demanding a rescurce or flow of product from the rows while a minus sign indicates the activity is supplying a resource or product flow within that respective row. Each activity has a production cost (negative coefficient) or selling price (positive coefficient) associated with it (as prevailed in June, 1979). The labor requirements are represented as balances with labor supplied into these rows through family labor or hired labor. The maximum number of available man-days

for a representative farm household is specified as the family labor constraint. The various crops are eligible to receive specific quantities of fertilizer from the government at subsidized prices. Thus the crops do not "supply" fertilizer, but supply the "right" to receive fertilizer at a lower price than that available through commercial channels. Commercial fertilizer purchases are also included. The yield coefficients are in kilograms and most activities supply a primary product as well as crop residues and by-products. The forage and fodder producing activities have an additional dimension; that of supplying nutrients directly into the livestock feed rows. The units are total digestible nutrients (TDN), digestible protein (DP) and dry matter (DM) and are expressed in percentage points. Quantities produced are thus multiplied by these coefficients to determine the supply of nutrients available for animal consumption. In addition, these forages supply some nitrogen and phosphorus if recycled as well as BTU's if used as fuel. The fertilizer and labor rows follow the same interpretation as for the crop sector. The fertilizer nutrients available from the major crop and livestock by-products are given in Appendix C.

Livestock activities produce revenue through sales of milk, wool, live animals, and manure. All activities except donkeys are composite in nature and consist of producing milk, meat, or wool as well as young animals. The nature of these activities was detailed earlier. In Musha, the cattle and buffalo activities entitle the producer to receive allocations of subsidized government concentrate feed mixture and subsidized wheat bran. Nutrient requirements for TDN and DP are broken into summer and winter periods.

Selling and buying activities allow the farmer to sell his products and buy additional inputs. The coefficients under the activities represent selling and buying prices per unit. Selling activities supply the yields into the balance-transfer rows while the buying activities supply additional resources into the respective balance-transfer rows. The +1 coefficients for certain buying activities represent the use of govern-

ment subsidized supplies of feed and fertilizer. The selling prices for forage and fodder products were reduced to force most of these feeds to be utilized on the farm. This conformed more closely to the actual situation. Although fresh berseem forage and chopped wheat straw were occasionally sold, there was not a large, regular market for these products. Thus it was felt that allowing the farmer to sell all of his forage and fodder at these prices was not realistic since the market for such feeds was small and sporadic. The programming results do provide marginal value product estimates for these feeds in alternative uses based on their nutrient value as animal feed, BTU value as a fuel source, and plant nutrient value for recycling.

A variety of transfer activities are needed to represent flows of inputs and outputs within the villages. For feed transfers, the supplies of nutrients from concentrate feeds and roughages transferred to the livestock requirements and the possibility of storing feed in one period and transferring it to the other is also allowed. The fodders can be transferred or stored over from one season to the next by summer to winter (S-W) feed transfers or winter to summer (W-S) feed transfers.

Fuel demand can be met by various sources and fertilizer demand can be met by crop residues, commercial market fertilizer, government subsidized fertilizer and manure. Household fuel requirements are detailed in Appendix B. Labor is available from family sources and from hiring. Once the total family labor available for a given period is exhausted, then labor is hired as long as it is profitable through the unconstrained labor hiring activities. The crucial labor constraint in October necessitated treating that month individually while all other labor supply-demand is carried out on a bi-or tri-monthly basis. Labor supply and labor requirements were developed by ILO studies (Hansen, 1964).

In ZGEK, crops which are not widely grown such as tomatoes, horsebeans and lentils are also included in consideration of those scenarios where

cropping situations are varied. The experimental crops of soybean and sunflower are also included for these scenarios. Another difference in ZGEK is the use of catch crop berseem as a short season forage crop. The production costs also differ from those of Musha because land preparation activities in Zawait Ghazal are not considered as a direct cash cost but are provided by the draft animal activity which in itself has certain costs associated with its use. Therefore, direct cash costs of the cropping activities in Zawait Ghazal are somewhat lower than in Musha.

Two major changes should be noted in the livestock activities between ZGEK and Musha. The ZGEK area does not benefit from the government subsidy plan for concentrate feed and wheat bran. However, to consider the impact on farming activities of the introduction of this scheme into this area, these activities were included for use in some of the hypothetical scenarios. Therefore, the first two rows of the matrix were not included in the runs representing current conditions in the village.

The actual matrices used in deriving the farm plans are given in Tables V.1 and V.2 for Musha and Tables V.3 and V.4 for Zawiet Ghazal-Ezeb Kabeel. Specifications of the rows, columns and coefficients enables the entire matrix to be reassembled or entered directly into a computer data file.

able V.1 Musha Linear Programming Matrix Columns and Rows

ol. No.		Col. Name	Obj. Coeff.	Col. No.	Col. Name	Obj. Coeff.	Row No.	Row Name	R.H.S.
1		Cotton	-54.00	70	Buy Govt. P.	-0.03	1	Winter Cropland	≤2.1
2		Wheat	-29.00	71	Buy Mkt. N.	-0.08	2	Summer Cropland	≤2.1
3		Sorghum	-24.00	72	Buy Mkt. P.	-0.06	3	Seed Cotton	0
4		Horsebeans	-44.00	73	Concentrate S	0	4	Wheat Grain	0
5		Lentils	-54.00	74	Concentrate W	0	5	Sorghum Grain	0
6		Soybeans	-46.00	75	Horsebeans S	-0.015	6	Horsebeans	0
7		Sunflower	-64.00	76	Horsebeans W	-0.016	7	Lentils	0
8		Tomatoes	-87.90	77	Sorghum S	-0.015	8	Cotton Stems	0
9		Berseem 1	-49.00	78	Sorghum W	-0.016	9	Wheat Bran	0
10		Berseem 2	-47.65	79	Cotton Stems W-S	-0.025	10	Wheat Straw	0
11		El.Grass-Bers.1	-17.00	80	Cotton Stems S-W	-0.026	11	Sorghum Stover	0
12		El.Grass-Bers.2	-17.00	81	Wheat Bran W-S	0	12	Horsebean Straw	0
13		Forage Sorghum	-17.00	82	Wheat Bran S-W	0	13	Lentil Straw	0
14		Sudan Grass	-17.00	83	Wheat Straw W-S	0	14	Sorghum Forage	0
15		Elephant Grass	27.0	84	Wheat Straw S-W	0	15	Soybean Grain	0
16		Alfalfa	-15.0	85	Sorg.Stover W-S	-0.017	16	Soybean Straw	0
17		Donkey	- 7.0	86	Sorg.Stover S-W	-0.018	17	Sunflower Seed	0
18		Sheep	-13.50	87	Bean Straw W-S	0	18	Sunflower Stems	0
19		Goats	- 9.0	88	" " S-W	0	19	Tomatoes	0
20		Buffalo 1	-46.0	89	Lentil Straw W-S	0	20	N Requirement	0
21		Buffalo 2	-46.50	90	Lentil Straw S-W	0	21	P Requirement	0
22		Buffalo 3	-49.50	91	Berseem Straw W-S	0	22	Gov't. N Allocation	0
23		Buffalo 4	- 6.0	92	S-W	0	23	Gov't. P Allocation	0
24		Cattle 1	-38.50	93	Berseem Hay W-S	-0.006	24	Labor: Jan-Feb	0
25		Cattle 2	-38.50	94	Sorghum Fodder W-S	0	25	Mar-Apr	0
26		Cattle 3	-41.50	95	Berseem Forage S-W	0	26	May-June	0
27		Cattle 4	- 6.00	96	Soybean Straw	0	27	July-Sept.	0
28		Sell Cotton	.222				28	Oct.	0
29		Sell Wheat	.0635	97	Cotton Stems Fuel	0	29	Nov.-Dec.	0
30		Sell Sorghum	.065	98	Cotton Stems Fert.	-.017	30	Berseem Seed	0
31	Sell	Horsebean	.1293	99	Wheat Straw Fuel	0	31	Berseem Straw	0
32	Sell	Lentils	.21875	100	Wheat Straw Fert.	0	32	Berseem Forage	0
33	Sell	Berseem Seed	.241	101	Sorghum Stover Fuel	0	33	Grass Forage	0
34	Sell	Cotton Stems	.002	102	Sorghum Stover Fert.	-.017	34	TDN	0
35	Sell	Wheat Bran	.065	103	Horsebean Straw, Fuel	0	35	DP	0
36	Sell	Wheat Straw	.044	104	Horsebean Straw Fert.	0	36	DM	0
37	Sell	Sorghum Stover	.002	105	Berseem Straw, Fuel	0	37	N	0
38	Sell	Horsebean Straw	.03	106	Berseem Straw, Fert.	0	38	P	0
39	Sell	Soybeans	.2	107	Lentil Straw Fuel	0	39	BTU's	19×60^6
40	Sell	Soybean Straw	.04	108	Lentil Straw Fert.	0	40	Supply Govt. Conc.	0
41	Sell	Sunflower Seed	.4	109	Diesel Fuel Fuel	0	41	Supply Govt.Wheat Bran	0
42	Sell	Sunflower Stem	.002	110	Cattle-buffalo manure		42	Winter Energy	0
43	Sell	Tomato Fruit	.062	111	Cattle-buffalo Fuel	0	43	Winter Protein	0
44	Sell	Lentil Straw	.053	112	Cattle-buffalo Fert.	0	44	Summer Energy	0
45	Sell	Berseem Straw	.022	113	Sheep-Goat Manure Fuel	0	45	Summer Protein	0
46	Sell	Berseem Forage	.0067	114	Sheep-Goat Manure Fert.	0	46	Buffalo Milk	0
47	Sell	Sorghum Forage	.01	115	Donkey Manure Fuel	0	47	Beef	0
48	Sell	Buffalo Milk	.15	116	Donkey Manure Fert.	0	48	Cattle Milk	0
49	Sell	Veal	1.0	117	Commercial N. Fert. Fert.	0	49	Cull Meat	0
50	Sell	Beef	.75	119	Soybean Straw-Fuel	0	50	Veal Meat	0
51	Sell	Cattle Milk	.12	120	Soybean Straw-Fert.	0	51	Sheep Meat	0
52	Sell	Lamb	1.00	121	Sunfl. Stem-Fuel	0	52	Goat Meat	0
53	Sell	Goat	.50	122	Sunfl. Stem-Fert.	0	53	Sheep Wool	0
54	Sell	Wool	1.00	123	Jan-Feb Fam. Labor	0	54	Cattle-Buffalo manure	0
55	Sell	Cull Meat	.25	124	Mar-Apr Fam. Labor	0	55	Sheep-Goat manure	0
56		Buy Gov.t Conc.	-0.035	125	May-June Fam. Labor	0	56	Donkey Manure	0
57		Buy Market Conc.	-0.075	126	July-Aug.Fam. Labor	0	57	Lamb	0
58		Buy Govt Wheat Bran	-0.04	127	Sept-Oct.Fam. Labor	0	58	Commercial Fuel	0
59		Buy Mkt Wheat Bran	-0.07	128	Nov-Dec.Fam.Labor	0	59	Commercial N	0
60		Buy Horsebeans	-0.139	129	Jan-Feb Hired Labor	-1.0	60	Commercial P	0
61		Buy Sorghum	-0.075	130	Mar-Apr Hired Labor	-1.0	61	Concentrated Feed	0
62		Buy Cotton Seed	-0.20	131	May-June Hired Labor	-1.0	62	Sorghum Fodder	0
63		Buy Cotton Stem	-0.0065	132	July-Aug.Hired Labor	-1.0	63	Family Labor Jan-Feb	50
64		Buy Wheat Straw	-0.049	133	Sept.Oct.Hired Labor	-1.0	64	Fam. Labor, Mar-Apr	50
65		Buy Sorghum Stover	-0.0065	134	Nov-Dec Hired Labor	-1.0	65	Fam. Laobr,May, June	50
66		Buy Berseem Forage	-0.01	135	Cotton Seed S.	-.015	66	Fam. Labor,July-Aug	50
67		Buy Sorghum Fodder	-0.015	136	Cotton Seed W.	-.016	67	Fam. Labor,Sept.Oct.	50
68		Buy Diesel Fuel	-0.025				68	Fam. Labor,Nov-Dec.	50
69		Buy Govt. N.	-0.04				69	Diesel Fuel	0

Table V.2 Musha Linear Programming Matrix Input-Output Coefficients

Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.
1,2	1	5,23	-100	10,34	-.42	14,27	6	17,56	-1548		
1,3	-950										
1,8	-1500	5,24	13	10,35	-.017	14,33	-4800	18,24	10	21,43	47
1,20	144	5,25	20	10,36	-.92	14,34	-.114	18,25	10	21,44	1378
1,21	28	5,28	5	10,37	-.009	14,35	-2028	18,26	5	21,45	136
1,22	-200	5,29	4	10,38	-.001	14,36	-.20	18,28	10	21,46	-479
1,23	-100	6,2	1	10,39	-5260	14,37	-.002	18,42	156	21,49	-73
1,25	47	6,15	-900	11,1	1	14,38	-.0002	18,43	14	21,50	-33
1,26	28	6,16	-900	11,2	1	14,39	-1100	18,44	175	21,54	-2250
1,27	10	6,20	63	11,20	184	15,2	1	18,45	15	22,24	30
1,28	25	6,21	16	11,21	32	15,1	1	18,49	-11	22,25	30
1,29	7	6,22	-200	11,23	-100	15,20	184	18,51	-8	22,26	30
2,1	1	6,23	-100	11,24	18	15,25	3	18,53	-2	22,27	30
2,4	-880	6,25	11	11,25	3	15,26	20	18,55	-1720	22,28	30
2,9	-80	6,25	17	11,26	20	15,27	28	19,24	10	22,29	30
2,10	-1420	6,27	29	11,27	28	15,28	9	19,25	10	22,40	-100
2,20	95	7,2	1	11,28	9	15,29	8	19,26	5	22,41	-80
2,21	23	7,17	-700	11,29	21	15,33	-80,000	19,28	10	22,42	843
2,22	-100	7,18	-3500	11,32	-12,000	15,34	-.15	19,42	141	22,43	83
2,23	-200	7,20	95	11,33	-80,000	15,35	-.02	19,43	13	22,44	1330
2,24	3	7,21	16	11,34	-.15	15,36	-.24	19,44	153	22,45	121
2,25	2	7,25	2	11,35	-.02	15,37	-.001	19,45	14	22,46	-479
2,26	26	7,26	47	11,36	-.24	15,38	-.002	19,49	-10	22,47	-84
2,29	6	7,27	46	11,37	-.001	15,39	-1100	19,52	-7	22,49	-73
3,2	1	8,2	1	11,38	-.0002	16,2	1	19,55	-1720	22,54	-2350
3,5	-1110	8,19	-5600	11,39	-1100	16,1	1	20,24	30	23,24	30
3,11	-2280	8,20	126	12,34	-.1	16,21	34	20,25	30	23,25	30
3,14	-200	8,21	78	12,35	-.022	16,24	2	20,26	30	23,26	30
3,20	110	8,22	-300	12,36	-.157	16,25	5	20,27	30	23,27	30
3,21	31	8,23	-100	12,37	-.001	16,26	12	20,28	30	23,28	30
3,22	-200	8,26	7	12,38	-.0002	16,27	18	20,29	30	23,29	30
3,26	19	8,27	39	12,39	-1100	16,28	8	20,40	-100	23,40	-900
3,27	22	8,28	11	13,2	1	16,29	2	20,41	-80	23,41	-300
3,28	33	8,29	25	13,20	110	16,33	-6,000	20,42	708	23,42	180
4,1	1	9,2	1	13,21	31	16,34	-.1	20,43	71	23,43	16
4,6	-840	9,21	47	13,25	12	16,35	-.028	20,44	1150	23,44	360
4,12	-1040	9,23	-100	13,26	10	16,36	-.17	20,45	104	23,45	32
4,20	32	9,24	19	13,27	6	16,37	-.001	20,46	-479	23,47	-84
4,21	31	9,25	11	13,33	-15,000	16,38	-.0002	20,49	-73	23,54	-330
4,22	-25	9,26	25	13,34	-.123	16,39	-1100	20,50	-33	24,24	30
4,23	-100	9,29	3	13,35	-.02	17,24	10	20,54	-2250	24,25	30
4,24	4	9,30	-160	13,36	-.21	17,25	10	21,24	30	24,26	30
4,25	28	9,31	-830	13,37	-.002	17,26	10	21,25	30	24,27	30
4,29	24	9,32	-18000	13,38	-.0002	17,27	10	21,26	30	24,28	30
5,1	1	9,34	-.1	13,39	-1100	17,28	10	21,27	30	24,29	30
5,7	-480	9,35	-.022	14,2	1	17,29	10	21,28	30	24,40	-100
5,13	-700	9,36	-.157	14,20	110	17,42	276	21,29	30	24,41	-80
5,20	16	9,37	-.001	14,21	31	17,43	30	21,40	-100	24,42	528
5,21	31	9,38	-.0002	14,25	12	17,44	552	21,41	-80	24,43	53
5,22	-25	9,39	-1100	14,26	10	17,45	60	21,42	552		

Table V. 2 Musha Linear Programming

Col. Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col. Row	Coeff.	Col, Row	Coef
				68,58	-1	-	-	108,7	1	123,63	1
				69,59	-1	-	-	109,69	1	123,24	-1
24,44	861	27,43	14	71,59	-1	136,43	-.15	111,54	1	124,64	1
24,45	76	27,44	312	70,60	-1	80,43	-.021	112,54	1	124,25	-1
24,48	-451	27,45	29	72,60	-1	82,43	-.2	113,55	1	125,65	1
24,49	-51	27,47	-104	69,22	1	84,43	-.004	114,55	1	125,26	-1
24,50	-24	27,54	-330	70,23	1	86,43	-.015	115,56	1	126,66	1
24,54	-1830	38,3	1	73,61	1	88,43	-.026	116,56	1	126,27	-1
25,24	30	29,4	1	74,61	1	90,43	-.019	117,59	1	127,67	1
25,25	30	30,5	1	75,6	1	92,43	-.017	118,60	1	127,28	-1
25,26	30	31,6	1	76,6	1	95,43	-.022	97,39	-8530	128,68	1
25,27	30	32,7	1	77,5	1	96,43	-.015	99,39	-6260	128,29	-1
25,28	30	33,30	1	78,5	1	73,44	-.58	101,39	-6260	129,24	-1
25,29	30	34,8	1	135,3	1	75,44	-.80	103,39	-6260	130,25	-1
25,40	-100	35,9	1	136,3	1	77,44	-.74	105,39	-6260	131,26	-1
25,41	-80	36,10	1	79,8	1	135,44	-.91	107,39	-6260	132,27	-1
25,42	426	37,11	1	80,8	1	79,44	-.37	109,39	-32340	133,28	-1
25,43	36	38,12	1	81,9	1	81,44	-.62	111,39	-6990	134,29	-1
25,44	1017	39,15	1	82,9	1	83,44	-.41	113,39	-6990		
25,45	99	40,16	1	83,10	1	85,44	-.48	115,39	-6990		
25,48	-451	41,17	1	84,10	1	87,44	-.43	119,39	12650		
25,49	-51	42,18	1	85,11	1	89,44	-.47	98,20	-.005		
25,50	-24	43,19	1	86,11	1	91,44	-.42	100,20	-.003		
25,54	-1830	44,13	1	87,12	1	93,44	-.078	102,20	-.011		
26,24	30	45,31	1	88,12	1	94,44	-.123	104,20	-.009		
26,25	30	46,32	1	89,13	1	73,45	-.127	106,20	-.009		
26,26	30	47,14	1	90,13	1	75,45	-.237	108,20	-.009		
26,27	30	48,46	1	91,31	1	77,45	-.06	112,20	-.01		
26,28	30	49,50	1	92,31	1	135,45	-.15	114,20	-.01		
26,29	30	50,47	1	93,32	1	79,45	-.021	116,20	-.01		
26,40	-100	51,48	1	95,32	1	81,45	-.12	117,20	-.315		
26,41	-80	52,57	1	94,62	1	83,45	-.004	120,20	-.009		
26,42	646	53,52	1	86,16	1	85,45	-.015	98,21	-.001		
26,43	63	54,53	1	74,42	-.58	87,45	-.026	100,21	-.001		
26,44	1173	55,49	1	76,42	-.80	89,45	-.019	102,21	-.001		
26,45	105	56,61	-1	78,42	-.74	91,45	-.017	104,21	-.001		
26,47	-104	57,61	-1	136,42	-.91	93,45	-.014	106,21	-.001		
26,48	-451	58,9	-1	80,42	-.37	94,45	-.02	108,21	-.001		
26,49	-51	59,9	-1	82,42	-.62	97,8	1	112,21	-.015		
26,54	-1930	60,6	-1	84,42	-.41	98,8	1	114,21	-.015		
27,24	30	61,5	-1	86,42	-.48	99,10	1	116,21	-.015		
27,25	30	62,3	-1	88,42	-.43	100,10	1	118,21	-.155		
27,26	30	56,40	1	90,42	-.47	101,11	1	120,21	-.001		
27,27	30	59,41	1	92,42	-.42	102,11	1				
27,28	30	63,8	-1	95,42	-.10	103,12	1				
27,29	30	64,10	-1	96,42	-.33	104,12	1				
27,40	-900	65,11	-1	74,43	-.127	105,31	1				
27,41	-300	66,32	-1	76,43	-.237	106,31	1				
27,42	156	67,62	-1	78,43	-.06	107,7	1				

Table V.3 Zawiet Ghazal-Ezeb Kabeel Linear Programming Matrix
Columns and Rows

Column Name	Obj. Coeff	Col. No.
Cotton	-20.0	1
Wheat	-25.0	2
Maize	- 8.0	3
Rice	-33.0	4
Fallow	- 4.0	5
Soybeans	(-30.00)	6
Sunflower	(-55.00)	7
Tomato	(-66.00)	8
Horsebeans	(-30.00)	9
Lentils	(-47.00)	10
Berseem, Full-term	-15	11
Berseem, Catch crop	-15	12
Forage Sorghum	- 5	13
Sudan Grass	- 5	14
Elephant Grass	-11	15
Elephant Berseem	-29	16
Grass	0	17
Alfalfa	- 4	18
Donkey	- 7.0	19
Sheep	-13.5	20
Goats	- 9.0	21
Buffalo 1	-58.0	22
Buffalo 2	-58.0	23
Buffalo 3	-62.0	24
Buffalo 4	- 6.0	25
Cattle 1	-38.0	26
Cattle 2	-38.0	27
Cattle 3	-43.0	28
Cattle 4	-6.0	29
Cotton Stem	.008	30
Wheat Bran	.065	31
Wheat Straw	.031	32
Maize Stover	.008	33
Maize Cobs	.024	34
Rice Straw	.0089	35
Soybean Straw	.04	36
Horsebean Straw	.03	37
Lentil Straw	.053	38
Maize Fodder	.01	39
Sunflower stems	.008	40
Buffalo milk	.15	41
Veal	1.0	42
Beef	.75	43
Cattle milk	.15	44
Lamb	1.0	45
Goat	.5	46
Wool	1.0	47
Cull meat	.25	48
Draft power irrigation	-.4	49
Draft power land prep.	-.1	50
Gov't. Dairy Conc.	-.034	51
Gov't. Fatten Conc.	[illegible]	52
Market Conc.	[illegible]	53
Gov't Wheat Bran	-.04	54
Market Wheat Bran	-.07	55
Barley	-.08	56
Berseem Forage	-.011	57
Maize Forage	-.011	58
Diesel Fuel	-.025	59
Gov't. N.	-.04	60
Gov't. P.	-.03	61
Market N.	-.08	62
Market P.	-.06	63
Concentrate S.	0	64
Concentrate W.	0	65
Horsebean S.	0	66
Horsebean W.	0	67
Wheat Bran S.	0	68
Wheat Bran W.	0	69
Maize S.	0	70
Maize W.	0	71
Barley S.	0	72
Barley W.	0	73
Maize Stover W-S	-.01	74
Maize Stover S-W	-.01	75
Maize Cobs W-S	-.01	76
Maize Cobs S-W	-.01	77
Rice Straw W-S	-.01	78
Rice Straw S-W	-.01	79
Berseem Hay W-S	-.001	80
Berseem Hay S-W	-.001	81
Maize Fodder W-S	0	82
Maize Fodder S-W	0	83
Soybean Straw W-S	0	84
Soybean Straw S-W	0	85
Horsebean Straw W-S	0	86
Horsebean Straw S-W	0	87
Lentil Straw W-S	0	88
Lentil Straw S-W	0	89

Row Name		Row No.
Winter Cropland	2 ≥	1
Summer Cropland	2 ≥	2
Seed Cotton	0	3
Wheat Grain	0	4
Maize Grain	0	5
Rice Grain	0	6
Soybean Grain	0	7
Cotton Stem	0	8
Wheat Bran	0	9
Wheat Straw	0	10
Maize Stover	0	11
Maize Cob	0	12
Rice Straw	0	13
Soybean Straw	0	14
Maize Fodder	0	15
Sunflower Seeds	0	16
Sunflower Stems	0	17
Tomato Fruit	0	18
Horsebean	0	19
Horsebean Straw	0	20
Lentil	0	21
Lentil Straw	0	22
N. requirement	0	23
P. requirement	0	24
Govt. N. allocation	0	25
Govt. P. allocation	0	26
Labor requirement (labor pool) Jan-Feb.	0	27
Mar-Apr.	0	28
May-June	0	29
July-August	0	30
Sept-Oct	0	31
Nov-Dec.	0	32
Land prep.-hrs.	0	33
Irrigation-hrs.	0	34
TDN	0	35
DP	0	36
DM	0	37
N	0	38
P	0	39
BTU's	0	40
Berseem Forage	0	41
Fresh Forage	0	42
Supply Gov't.Conc.	0	43
Supply Gov't Wheat	0	44
Winter energy	0	45
Winter protein	0	46
Summer energy	0	47
Summer protein	0	48
Buffalo milk	0	49
Buffalo meat	0	50
Cattle milk	0	51
Cull meat	0	52
Veal meat	0	53
Sheep meat (lamb)	0	54
Goat meat	0	55
Sheep wool	0	56
Cattle-buffalo manure	0	57
Sheep-goat manure	0	58
Donkey manure	0	59
Animal Power Supply	0	60
Beef	0	61
Draft power-irrigation	0	62
Draft power-land prep.	0	63
Concentrate feed	0	64
Barley	0	65
Maize forage	0	66
Commercial fuel	0	67
Commercial N.	0	68
Commercial P.	0	69
Berseem hay	0	70
Berseem straw	0	71
Diesel Fuel	0	72
Energy Demand	19×10^6	73
Crop Demand, N	0	74
Crop Demand, P	0	75
Family Labor:		
Jan-Feb	50	76
Mar-April	50	77
May-June	50	78
July-August	50	79
Sept-Oct.	50	80
Nov-Dec.	50	81

Berseem Forage W-S	-.001	90
Berseem Forage S-W	-.001	91
Cotton Stems W-S	-.012	92
Cotton Stems S-W	-.012	93
Wheat Straw W-S	-.002	94
Wheat Straw S-W	-.002	95
Cotton Stems Fuel	0	96
Cotton Stems Fert.	-.017	97
Wheat Straw Fuel	0	98
Wheat Straw Fert.	0	99
Rice Straw Fuel	0	100
Rice Straw Fert.	0	101
Maize Stover Fuel	0	102
Maize Stover Fert.	0	103
Horsebean Straw Fuel	0	104
Horsebean Straw Fert.	0	105
Berseem Straw Fuel	0	106
Berseem Straw Fert.	0	107
Sunflower Stems Fuel	0	108
Sunflower Stems Fert.	0	109
Lentil Straw Fuel	0	110
Lentil Straw Fert.	0	111
Cattle-Buffalo Manure Fuel	0	112
Cattle-Buffalo Manure Fert.	0	113
Sheep-Goat Manure Fuel	0	114
Sheep-Goat Manure Fert.	0	115
Donkey Manure Fuel	0	116
Donkey Manure Fert.	0	117
Commercial N.Fert. Fert.	0	118
Com. P. Fert. Fert.	0	119
Family Labor Activities		
Jan-Feb.	0	120
Mar-Apr.	0	121
May-June	0	122
July-Aug.	0	123
Sept.-Oct.	0	124
Nov.-Dec.	0	125
Hired Labor Activities		
Jan-Feb.	-1.0	126
Mar-Apr.	-1.0	127
May-June	-1.0	128
July-Aug.	-1.0	129
Sept.-Oct.	-1.0	130
Nov-Dec.	-1.0	131

Table V.4 Zawiet Ghazal Linear Programming Matrix
Input-Output Coefficients

Col., Row.	Coeff.	Col., Row.	Coeff.	Col., Row	Coeff.
1,2	1	4,33	70	11,1	1
1,3	-960	4,34	141	11,41	-23
1,8	-1000	5,2	1	11,35	-.1
1,23	90	6,2	1	11,36	-.022
1,24	20	6,7	-900	11,37	-.157
1,25	-150	6,14	-900	11,38	-.001
1,26	-100	6,23	63	11,39	-.0002
1,28	15	6,24	16	11,40	-1100
1,29	18	6,28	11	11,23	20
1,30	13	6,29	17	11,24	20
1,31	38	6,30	29	11,27	14
1,33	64	6,33	64	11,28	12
1,34	39	6,34	28	11,32	8
2,1	1	7,2	1	11,33	28
2,4	-990	7,16	-700	11,34	28
2,9	-90	7,17	-3500	12,1	1
2,10	-1550	7,23	95	12,41	-6000
2,23	70	7,24	16	12,35	-.1
2,24	20	7,28	2	12,36	-.022
2,25	-150	7,29	47	12,37	-.157
2,26	-100	7,30	46	12,38	-.001
2,27	2	7,33	42	12,39	-.0002
2,28	2	7,34	24	12,40	-1100
2,29	23	8,2	1	12,23	20
2,31	1	8,18	-5600	12,24	20
2,32	7	8,23	126	12,27	7
2,33	42	8,24	78	12,32	8
2,34	24	8,30	22	12,33	28
3,2	1	8,31	28	12,34	11
3,5	-1150	8,32	25	13,2	1
3,11	-1575	8,33	64	13,42	-15000
3,12	-345	8,34	48	13,35	.126
3,15	-200	9,1	1	13,36	.014
3,23	100	9,19	-840	13,37	.21
3,24	40	9,20	-1050	13,38	.011
3,25	-200	9,23	32	13,39	.001
3,28	9	9,24	31	13,40	-1100
3,29	14	9,27	4	13,23	110
3,30	17	9,28	28	13,24	31
3,33	46	9,32	24	13,29	12
3,34	28	9,33	64	13,30	10
4,2	1	9,34	20	13,31	6
4,6	-2100	10,1	1	13,33	28
4,13	-1200	10,21	-480	13,34	32
4,23	50	10,22	-700	14,2	1
4,24	20	10,23	16	14,42	-4800
4,25	-90	10,24	31	14,35	.114
4,26	-100	10,27	13	14,36	.028
4,28	2	10,28	20	14,37	.20
4,29	40	10,31	5	14,38	.011
4,30	12	10,32	4	14,39	.001
4,31	23	10,33	28	14,40	-1100
4,32	8	10,34	8	14,23	110

Table V. 4 Zawiet Ghazal Linear Programming Matrix
Input-Output Coefficients

Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.	Col., Row	Coeff.
14,24	31	18,27	2	22,46	106	25,48	28
14,29	12	18,28	5	22,47	1053	25,50	-140
14,30	10	18,29	12	22,48	87	25,57	-330
14,31	6	18,30	12	22,49	-820	25,27	30
14,33	28	18,31	14	22,52	-85	25,28	30
14,34	32	18,32	2	22,53	-55	25,29	30
15,1	1	18,33	28	22,57	-2250	25,30	30
15,2	1	18,34	28	22,27	30	25,31	30
15,42	-80,000	18,37	.17	22,28	30	25,32	30
15,35	.15	18,38	.009	22,29	30	26,43	-100
15,36	.02	18,39	-.001	22,30	30	26,44	-80
15,37	.24	18,40	-1100	22,31	30	26,45	677
15,38	.009	19,45	348	22,32	30	26,46	64
15,39	.001	19,46	38	22,60	-310	26,47	736
15,40	-1100	19,47	480	23,43	-100	26,48	55
15,23	184	19,48	52	23,44	-80	26,51	-475
15,28	3	19,59	-1548	23,45	712	26,52	-89
15,29	20	19,27	10	23,46	57	26,53	-35
15,30	19	19,28	10	23,47	1458	26,57	-1830
15,31	18	19,29	10	23,48	145	26,27	30
15,32	8	19,30	10	23,49	-820	26,28	30
15,34	32	19,31	10	23,52	-85	26,29	30
16,41	-12,000	19,32	10	23,53	-55	26,30	30
16,35	-.1	20,45	158	23,57	-2250	26,31	30
16,36	-.022	20,46	13	23,27	30	26,32	30
16,37	-.157	20,47	124	23,28	30	26,60	-310
16,38	-.001	20,48	12	23,29	30	27,43	-100
16,39	-.0002	20,52	-11	23,30	30	27,44	-80
16,40	-1100	20,54	-8	23,31	30	27,45	551
17,1	1	20,56	-2	23,32	30	27,46	43
17,2	1	20,58	-1720	23,60	-310	27,47	916
17,42	-80,000	20,27	10	24,43	-100	27,48	83
17,35	.15	20,28	10	24,44	-80	27,51	-475
17,36	.02	20,29	10	24,45	1225	27,52	-89
17,37	-.24	20,30	10	24,46	122	27,53	-35
17,38	.009	20,31	10	24,47	1368	27,57	-1830
17,39	.001	20,32	10	24,48	115	27,27	30
17,40	-1100	21,45	132	24,49	-820	27,28	30
17,23	184	21,46	12	24,50	-140	27,29	30
17,24	31	21,47	103	24,52	-85	27,30	30
17,27	18	21,48	8	24,57	-2350	27,31	30
17,28	3	21,52	-10	24,27	30	27,32	30
17,29	20	21,55	-7	24,28	30	28,43	-100
17,30	19	21,58	-1720	24,29	30	28,44	-80
17,31	18	21,27	10	24,30	30	28,45	833
17,32	21	21,28	10	24,31	30	28,46	79
17,34	44	21,29	10	24,32	30	28,47	1009
18,1	1	21,30	10	24,60	-310	28,48	80
18,2	1	21,31	10	25,43	-900	28,50	-150
18,42	-6,000	21,32	10	25,44	-300	28,51	-475
18,35	.1	22,43	-100	25,45	225	28,52	-89
18,36	.028	22,44	-80	25,46	20	28,57	-1930
18,24	34	22,45	1045	25,47	315	28,27	30

Table V.4 Zawiet Ghazal Linear Programming Matrix
Input-Output Coefficients

Col., Row	Coeff.
28,28	30
28,29	30
28,30	30
28,31	30
28,32	30
28,60	-310
29,43	-900
29,44	-300
29,45	195
29,46	18
29,47	273
29,48	25
29,50	-150
29,57	-330
29,27	30
29,28	30
29,29	30
29,30	30
29,31	30
29,32	30
1,3	1
2,4	1
3,5	1
4,6	1
6,7	1
7,16	1
8,18	1
9,19	1
10,21	1
30,8	1
31,9	1
32,10	1
33,11	1
34,12	1
35,13	1
36,14	1
37,20	1
38,22	1
39,15	1
40,17	1
41,49	1
42,53	1
43,61	1
44,51	1
45,54	1
46,55	1
47,56	1
48,52	1
49,62	1
50,63	1
51,64	-1
51,43	-1
62,64	-1

Col., Row	Coeff.
52,43	-1
53,64	-1
54,9	-1
54,44	-1
55,9	-1
3,5	-1
9,19	-1
56,65	-1
30,8	-1
32,10	-1
33,11	-1
34,12	-1
35,13	-1
57,41	-1
58,66	-1
59,67	-1
60,68	-1
60,25	1
61,69	-1
61,26	1
62,68	-1
63,69	-1
64,64	1
64,47	-.58
64,48	-.127
65,64	1
65,45	-.58
65,46	-.127
66,19	1
66,47	-.80
66,48	-.237
67,19	1
67,45	-.80
67,46	-.237
68,9	1
68,47	-.62
68,48	-.12
69,9	1
69,45	-.62
69,46	-.12
70,5	1
70,47	-.81
70,48	-.067
71,5	1
71,45	-.81
71,46	-.067
72,65	1
72,47	-.74
72,48	-.09
73,65	1
73,45	-.74
73,46	-.09
74,11	1

Col., Row	Coeff.
74,47	-.51
74,48	-.02
75,11	1
75,45	-.51
75,46	-.02
76,12	1
76,47	-.42
77,12	1
77,45	-.42
78,13	1
78,47	-.41
78,48	-.024
79,13	1
79,45	-.41
79,46	-.024
80,70	1
80,47	-.078
80,48	-.014
81,70	1
81,45	-.078
81,46	-.014
82,15	1
82,47	-.167
82,48	-.01
83,15	1
83,45	-.167
83,46	-.01
84,14	1
84,47	-.33
84,48	-.015
85,14	1
85,45	-.33
85,46	-.015
86,20	1
86,47	-.43
86,48	-.019
87,20	1
87,45	-.43
87,46	-.01
88,22	1
88,47	-.47
88,48	-.019
89,22	1
89,45	-.47
89,46	-.019
90,41	1
91,41	1
91,45	-.1
91,46	-.022
92,8	1
92,47	-.37
92,48	-.021
93,8	1

Col., Row	Coeff.
93,45	-.37
93,46	-.021
94,10	1
94,47	-.41
94,48	-.004
95,10	1
95,45	-.41
95,46	-.004
96,8	1
96,73	-8530
97,8	1
97,74	-.005
97,75	-.001
98,10	1
98,73	-6260
99,10	1
99,74	-.003
99,75	-.001
100,13	1
100,73	-6260
101,13	1
101,74	-.005
101,75	-.001
102,11	1
102,73	-6260
103,11	1
103,74	-.011
103,75	-.001
104,20	1
104,73	-6260
105,20	1
105,74	-.009
105,75	-.001
106,71	1
106,73	-6260
107,71	1
107,74	-.009
107,75	-.001
108,17	1
108,73	-6260
109,17	1
109,74	-.009
109,75	-.001
110,22	1
110,73	-6260
111,22	1
111,74	.009
111,75	.001
59,72	1
59,73	-32340
112,57	1
112,73	-6990
113,57	1

Table V.4 Zawiet Ghazal Linear Programming Matrix
Input-Output Coefficients

Col., Row	Coeff.
113,74	-.039
113,75	-.007
114,58	1
114,73	-6990
115,58	1
115,74	-.039
115,75	-.007
116,59	1
116,73	-6990
117,59	1
117,74	-.039
117,75	-.007
118,68	1
118,74	-.315
119,69	1
119,75	-.155
120,76	1
120,27	-1
121,77	1
121,28	-1
122,78	1
122,29	-1
123,79	1
123,30	-1
124,80	1
124,31	-1
125,81	1
125,32	-1
126,27	-1
127,28	-1
128,29	-1
129,30	-1
130,31	-1
131,32	-1

Scenarios for Analysis

The data generated from the survey and selected secondary sources were organized into a programming framework for analysis. This section outlines the government policies, management decisions, feed resource and livestock production/productivity alternatives considered for both survey sites.

Feed Resources Alternatives

1. The evaluation of government actions to vary the quantity of government supplied wheat bran and mixed ration available to the small farmer. In the Musha model each feed allotment program is increased by 100% in the first case and eliminated in the second. In the ZGEK model, since no feed allotment program exists, the feed allotment program currently available to the larger producers holding insured livestock was introduced as being available to the small farmer.

2. The evaluation of variations in the quantity of government supplied fertilizer which may influence the cropping pattern and thus the feeding program of the small farmer. At both sites, fertilizer allotment programs for nitrogen and phosphate fertilizers were increased by 100% in the first case, and eliminated, in the second case.

3. The evaluation of government policy with respect to the distribution of yellow maize. In Musha, no yellow maize is supplied to any farmers. To consider this possibility, the model allowed a minimum of 100 kilograms per month up to unrestricted quantities of yellow maize to be purchased at LE60 per ton (the delivered price currently paid by the government feed processing companies). In ZGEK, a yellow maize distribution program was in operation allowing the small farmer to purchase an unrestricted quantity at LE60 per

ton, so only a restricted program limiting the small farmer to 100 kg per month was introduced.

4. The evaluation of processing currently utilized or potential animal feedstuffs. This set includes a carryover scheme for berseem from the winter to summer season and the processing of sorghum and maize stovers, cotton crop residues and rice straw for animal feed.

A carryover program for berseem is considered under the following assumptions: (1) Since berseem forage is currently fed using a cut and carry system, the only additional costs of making hay is a storage charge of LE1/ton and labor charge of LE 5/ton of berseem forage carried over. (2) The process of drying the hay will cause a TDN decrease (from 10% to 9.2%), a DP decrease (from 2.2% to 1.7%) and an increase in the dry matter content from 15.7% to 89%. (3) Five percent of the berseem forage will be lost due to the drying and additional handling. On an "as fed" basis, berseem hay is 51% TDN and 9.7% DP.

Sorghum and maize stovers and cotton crop residues require chopping to be utilized as animal feed. The chopping activity will require hiring a chopper at LE 2.50/hour, labor at LE1.25 (LE 1.00 in ZGEK) per man day and transportation at LE .5 per camel load to carry the stovers to a central area for chopping. Assuming one ton of stovers require 2.5 machine hours, 5 man-days of labor and 8 camel loads of transport service, a processing charge of LE17/ton is assessed on this activity in Musha (and LE16/ton in ZGEK). If the stovers are processed and carried over from one period to the next a LE1/ton storage fee is added on.

The processing of rice straw for animal feed is considered only for ZGEK, since there is no rice straw available in Upper Egypt. Rice straw requires chopping to prepare it for additional processing to be utilized as animal feed. The additional processing considered

here is sodium hydroxide treatment. The following processing assumptions were generated with the assistance of Drs. Nour and Naga at University of Alexandria: (1) The capital investment will require purchasing for LE 50 two large tubs and miscellaneous equipment. (2) Five man-days of labor at LE 1.00 per man day and 50 kg of sodium hydroxide purchased at LE 50/ton to create a 10% sodium hydroxide solution and LE5 for transportation service to carry the straw to a central location will be required per ton of straw processed. Under these assumptions, a charge of LE 23.5/ton is assessed for the processing and treatment of rice straw. An increase in TDN from 45.2% to 54.3% and a decrease in DP from 2.7 to 2.0%, on a dry matter basis, is assumed to be the result of the straw treatment. The highly caustic nature of the sodium hydroxide dictated that its use only be considered by a custom operator.

5. The evaluation of several cropping alternatives considered for introduction into the small farmers cropping pattern. These cropping alternatives include the forage crops of forage sorghum, sudan grass, elephant grass and alfalfa; and cash crops of soybeans, sunflowers and tomatoes. Two additional cash crops, horsebean and lentils, are considered in ZGEK. Table V.5 summarizes the assumed yields, selling prices and nutrient composition of various feedstuff alternatives. Refer to Appendix I for assumptions with regard to the quantity and prices of the inputs employed.

   Since these forage crops are introduced as feed alternatives, the selling prices act only as an outlet to sell excess forage and thus are artificially low. The yield estimates are taken from two primary sources; Heath, Metcalfe and Barnes (1975) and Piper (1921).

Table V.5. The Assumed Yield, Selling Price and Nutrient Composition of Alternative Cash and Forage Crops, Musha and ZGEK, 1979

Crop	Yield (kg/feddan)	Selling Price (LE/kg)	As Fed Basis TDN (%)	DP (%)	DM (%)
Forage Sorghum	15000	.001	.12	.02	.157
Sudan grass	4800	.001	.114	.028	.20
Elephant grass	80000	.001	.15	.02	.24
Alfalfa	6000	.001	.1	.028	.17
Soybeans	900	.20	.831	.341	.909
- Straw	900	.01	.33	.015	.876
Horsebeans	840	.129	.80	.237	.89
- Straw	1050	.035	.43	.026	.89
Lentils	480	.219	.756	.196	.885
- Straw	700	.058	.47	.019	.89
Sunflowers	700	.4	.45	.268	.897
- Stems	3500	.002	.04	.02	.87
Tomatoes	5600	.06	-	-	-

6. The evaluation of residues and byproducts currently classified as nonconventional animal feed resources. The analysis attempts only to determine that if these feedstuffs were available, what would be their value to the small farmer utilizing them as animal feed. The agroindustrial wastes or byproducts considered are produced by firms engaging in fruit and vegetable dehydration and canning, in yeast, starch, wine and beer manufacturing, and in sugar, rice, and milk and meat processing. Details on these feedstuffs are provided in Appendix F.

7. The evaluation of using feed grade urea as a supplement in government prepared feeds. The risks associated with urea use by the small farmer dictated that its use be considered only where adequate quality control could be exercised. This case considers the substitution of urea for a portion of the cottonseed meal in the government mixed ration. Since feeds containing urea would not be suitable for livestock on a high roughage diet (i.e. small farmer livestock) we focus on the use of the potentially increased cottonseed cake supply on the small farm.

Livestock Production/Productivity Alternatives

1. The evaluation of two present production practices: (1) the selling of calves 30-45 days after birth and (2) the birth of calves prior to or following the berseem season. Case 1, labeled BUF 1 and CAT 1, considers a buffalo or baladi cow calving in January with the offspring sold 30 days after birth. Case 2, labeled BUF 2 and CAT 2, considers a buffalo or baladi cow calving in May with the offspring sold 30 days after birth. Case 3, labeled BUF 3 and CAT 3, considers a buffalo or baladi cow calving in January with the calf sold at 1 year of age. In Musha, the mature buffalo cows are assumed to weigh 550 kg and produce 4.25 kg of milk per day over 220 days. The mature baladi cows are assumed to weigh 400 kg and produce 3.6 kg per day for 210 days.

   The mature buffalo cow in ZGEK is assumed to weigh 550 kg, produce 4.8 kg of milk over 200 days and provide 310 hours of draft power per year. The baladi cows are assumed to weigh 400 kg, produce 3.4 kg of milk per day over 140 days and provide 320 hours of draft power per year.

   In the above cases, the first 30 days milk is allocated to the calf. The only remaining production parameter considered is manure. Estimates of manure production were calculated using conversion factors from University of Alexandria and Agricultural Engineers Handbook, 1979. The mature buffalo and baladi cow were assumed to produce 2160 and 1730 kg of manure, respectively, with adjustments made for younger animals.

   Case 3 considers buffalo and baladi calves born on the small farm and sold at 1 year of age. The buffalo calves have a birth weight of 40 kg, gain 280 g per day and are sold at 140 kg. The baladi calves have a birth weight of 24 kg, gain 350 g per day and ar sold at 150 kg.

Case 4, labeled BUF 4 and CAT 4 considers a calf growing program where young calves are purchased by the small farmer at two months of age and are grown out to selling weights of 140 and 150 kg for buffalo and baladi calves, respectively. This case enables the farmer to grow calves under the government program. Under this program the farmer must sell one calf to the government at 50% of the free market price and can then sell the other calf on the free market.

2. The evaluation of small ruminants in the small holder system. Sheep and goats are held as breeding stock with the offspring sold or utilized for household consumption. The mature ewe is assumed to weigh 40 kg and produce a lamb in January each year. The lambs are assumed to have a birth weight of 3.5 kg, gain 60 g per day and are sold at 15 kg. The mature doe is assumed to weigh 35 kg and produce a kid in January each year. The kids are assumed to have a birth weight of 2.5 kg, gain 60 g per day and are sold at 15 kg.

3. The evaluation of an improved dairy cow, i.e. Jersey introduced into the present farming system. This "improved" dairy cow has the following production traits:[1/]

Birth weight, kg	25-30
Adult body weight, kg	450
Annual milk yield, kg	2300-2800
Lactation period, days	332
Age at first calving, mo.	33
Calving interval, mo.	15
Calf crop, %	40-50
Mortality rate, 3 years, %	33
Mortality rate, adults, %	4

1/ The calving interval, calf crop and mortality rate were taken from Ragab and Asker, 1959; Ragab and Souror, 1963; and Ragab, Abdel-Aziz and Morad, 1973.

The calf will be given the first 30 days milk and will be sold at 1 month of age. The capital value of the animal is assumed to be the same as the animal it replaces. In Musha, this would be a buffalo and in ZGEK it would be a baladi cow. This method of introduction assumes the improved animal can be traded for the replaced animal on an even basis.

4. The evaluation of an improved dairy goat introduced into the present farming system. The improved dairy goat is assumed to weigh 50 kg, produce 2.5 kg per day over 200 days, and produce an offspring in January which is marketed at 15 kg.

The nutrient demand and the production parameters for these scenarios are summarized in Tables V.6 and V.7. Separate tables are presented for Musha and ZGEK because their berseem seasons are of different lengths.

Table V. 6. Nutrient Demands and Production Parameters for Musha Livestock Scenarios

LIVESTOCK ALTERNATIVES

Demand/ Supplies		BUF 1	BUF 2	BUF 3	BUF 4	CAT 1	CAT 2	CAT 3	CAT 4	Sheep	Goats	Donkeys	Improved Dairy Cow	Improved Dairy Goat
TDN, winter 1/	kg	708	552	843	180	528	426	646	156	140	119	276	683	229
DP, winter	kg	71	47	83	16	53	36	63	14	12	11	30	77	21
TDN, summer	kg	1150	1378	1330	360	861	1017	1173	312	116	116	552	1492	350
DP, summer	kg	104	136	121	32	76	99	105	29	13	8	60	156	32
Milk, kg.		800	800	800	-	650	650	650	-	-	-	0	2075	500
Meat, kg.		55	55	140	140	35	35	150	150	8	7	15	30	8
Cull meat, kg.		73	73	73	-	73	73	73	-	11	10	-	100	14
Manure, kg.		2250	2250	2350	2350	330	1830	1830	330	1720	1720	1548	2250	1720

1/ Winter season = January through April
Summer season = May through December.

Table V. 7 Nutrient Demands and Production Parameters for ZGEK Livestock Scenarios

LIVESTOCK ALTERNATIVES

Demand/ Supplies	BUF 1	BUF 2	BUF 3	BUF 4	CAT 1	CAT 2	CAT 3	CAT 4	Sheep	Goats	Donkey	Improved Dairy Cow	Improved Dairy Goat
TDN, winter[1/]	1045	712	1225	225	677	551	833	195	158	132	348	854	287
DP, winter	106	57	122	20	64	43	79	18	13	12	38	96	27
TDN, summer	1053	1458	1368	315	736	916	1009	273	97	103	480	1322	293
DP, summer	87	145	115	28	55	83	80	25	12	8	52	137	26
Milk, kg.	820	820	820	-	480	480	480	-	-	-	-	2075	500
Meat, kg.	55	55	140	140	35	35	150	150	8	7	-	30	8
Cull meat, kg	85	85	85	-	89	89	89	-	11	10	-	100	14
Draft Power, hrs.	310	310	310	-	310	310	310	-	-	-	-	-	-
Manure, kg.	2250	2250	2350	330	1830	1830	1930	330	1720	1720	1548	2250	1720

1/ Winter Season = December through April
Summer Season = May through November

Results of Scenario Analysis

The government policy, management and feed resource and livestock production/ productivity alternatives were analyzed utilizing the linear programming model. This section summarizes these results and provides conclusions for the various scenarios.

1. Government pricing policy - The most notable change between the representative farm plan (that followed most closely by farmers) and the unrestricted farm plans is the very large sacrifice in net returns from producing wheat for home consumption. This 0.8 feddan allocation to wheat in the representative farm plan causes a quite different pattern of farm production compared to the profit maximizing solution which never includes wheat because of the extremely low prices received. Instead, farmers produce cotton and fodder crops, the latter which can be profitably sold in the market. Thus we find a situation where farmers are producing forage and fodder crops for sale to livestock and the subsequent sale of livestock products at uncontrolled market prices. This also allows farmers to make a profit since livestock production entitles the owner to a government subsidized allocation of concentrate feed and wheat bran, some of which can be resold at free market prices since the increased production of good quality fodder crops reduces the farmers need for these concentrates.

2. Feeds and feeding practices - The consistent inclusion of high-yielding forage and fodder crops in the farm plans (particularly the unconstrained farm plans) indicates that this is an area which requires further work both at the research and farm implementation level. Elephant grass and forage sorghum looked particularly promising. A system which is gaining acceptance in some small farm situations in the tropics is to maintain a small plot of elephant grass under a continuous cutting regime. Manure is carried from the household to the plot for fertilization, supplemented by nitro-

gen as needed. This green fodder supplies the base TDN requirement supplemented by small amounts of concentrates, straws, urea and molasses. The winter feed deficit occurring when elephant grass growth stops is met by berseem under the traditional pattern. Given the very limited land resources facing Egyptian farmers, a forage crop must be able to produce large quantities of dry matter on a daily basis and elephant grass would seem ideal. The above system could be tested at the farm level almost immediately. Changes in labor use patterns and allocation of tasks by sex could be as crucial to success as the technological aspects (Hopkins et. al., 1980).

3. Selling fodder appears to be a more profitable alternative than feeding it to the farmer's animals. This is simply a reflection of the budgeting results for animal enterprises which showed very low or negative rates of return to resources used in livestock production. Since market prices for fodder considerably exceeded their on-farm value for feeding to livestock, the model allocated crop-residues and by-products to the selling activity.

   This result appears paradoxical for two reasons. First, the observed behavior of farmers was to feed farm produced residues and by-products despite the apparent unprofitability of this practice. Second, despite the low or negative returns to feeding ruminants, there was a market for many crop residues and by-products (particularly wheat straw) and farmers were apparently willing to allocate small amounts of their very limited cash resources to purchase feeds at prices which, by all indications, exceeded their returns when fed to animals.

4. Although improved dairy cattle and improved dairy goats were introduced as livestock alternatives, the possibilities for improved water buffalo were not considered. This is recognized as a potentially serious omission since some high producing strains of buffa-

lo are available in Egypt and several excellent milk breeds are available in the Indian subcontinent. The higher calf mortality and slower growth rate of buffalo were frequently mentioned by farmers as serious constraints to fattening buffalo. However, research on water buffalo in Egypt and elsewhere tends to indicate no marked superiority of cattle over water buffalo in tropical areas under medium to poor feeding and husbandry conditions. In general, introducing an improved milking buffalo activity with productivity levels similar to the improved milk cow activity would give roughly comparable results since the efficiency of feed conversion into milk is similar between the species. The question then becomes one of farmer preference between species, the availability of improved stock, and the adaptability of the animals to Egyptian village conditions. In the latter aspect, buffalo would have a considerable advantage over Holstein or Holstein crosses if milk production levels were comparable.

Musha Results

Government policy and farmer preferences combine to make up the "representative" farm in Musha. Government quotas dictate that about 30% of summer area goes to cotton and 40% of winter land is used for horsebeans or lentils. The family consumption of wheat requires 0.8 feddans of winter cropland. Thus about two-thirds of summer cropland and one-third of winter cropland is free for allocation by the farmer. The typical animal holdings are a buffalo cow and calf plus a donkey.[2/] Remaining winter cropland grows berseem to support the animals while summer cropland supports grain sorghum or is left fallow.

The various scenarios for examining potential improvements in farm income begin from this representative farm described above. Land which is free to allocate by the farmer can be used to change his cash crop/

[2/] This totals 2.4 livestock units, a higher figure than the average of 1.5 lu's found on small farms. The lower figure results from many farmers having only small ruminants, only a donkey or no animals at all. The model thus looks at farmers who have the maximum animal inventory generally considered feasible.

forage crop mix and livestock production can also be changed. The first scenario looks at what can be done by changing the feed base with the above livestock taken as given, the second looks at possible changes in the livestock sector with given feed resources, and the third looks at both sectors being variable.

Feed Resource Scenario - Feed production alternatives introduced into the linear programming model included annual forage crops of forage sorghum and sudan grass, perennial crops of elephant grass (with and without berseem intercropped) and alfalfa, and carrying over some berseem as hay for use in the summer season and the processing of maize, sorghum, cotton and rice byproducts for animal feed. In addition, the use of corn for feeding and the introduction of soybeans, sunflower, and tomatoes into the small farm were considered in terms of their impact on farm income. Livestock production and productivity were fixed so any excess feed generated was used as fuel or sold. The fixed animal enterprises are a donkey used for transportation and a buffalo cow calving in January with the calf sold at 30 days of age weighing 45 kg.

1. Impact of annual and perennial forage crops - All forage crops except sudan grass produced significant improvements in farm income even at current levels of livestock productivity. The best results occurred with elephant grass which required high inputs of water and nitrogen but provided adequate summer roughage on only 0.1 feddans of land. Forage sorghum required 0.5 feddans to feed the livestock. This reduced cash income from grain sorghum plantings which had to be reduced. Grain sorghum also produced fodder for fuel so fuel purchases also increased following introduction of forage sorghum.

2. Making berseem hay - This alternative provided only a small increase in gross income. Labor use increased due to hay making. The decreased feeding value of berseem hay also reduced its value as a summer feed.

3. The processing of maize and sorghum stovers, cotton residues and rice straw provided no significant increase in the farmers income. Their best use still appears to be for fuel with any excess used as animal feed.

4. Feeding yellow maize - At present, this grain is not available to the farmers. If this corn were available at LE 60 per ton, it would substitute for wheat bran and mixed ration purchased on the free market and would significantly reduce feed costs.

5. Introduction of new cash crops - All enterprises considered were able to substantially increase farm income. Soybean straw was the only new feed utilized by village animals. Soybeans and sunflowers are being cultivated on test plots but are new crops to the farmer while tomatoes are produced on a small scale for the free market where large price fluctuations are common.

Livestock Production Scenarios - Feed resources are specified as in the representative farm model where the farmer has a choice of allocating land only to his traditional crops. Current cattle and water buffalo activities did not appear profitable under current management practices of selling calves at 30-45 days of age. Therefore, an alternative practice of growing out calves was considered in addition to possibilities for the introduction of improved dairy cattle, improved dairy goats, and holding larger herds of sheep and goats.

High calf mortality rates is the single most important reason given by the farmers as to why they do not grow their own calves and do not purchase calves to grow-out. The simplest system is for the farmer to grow his calves to about 150 kg. This showed good returns if the farmer has adequate capital to hold the animal over the summer season and purchase concentrate feed. An alternative calf growing plan is that sponsored by the government where farmers purchase a 30-45 day old calf and raise it to 200-250 kgs. Two calves must be kept to qualify for the government allocation of the mixed concentrate feed and wheat bran. One

calf must then be sold to the government at about one-half the free market price and the other sold at free market prices.

Farmers consider baladi calves as faster growing than buffalo calves and prefer them for this scheme. The model results from the growing-out scheme were good, the major drawback being the need to sell the milking animal since roughage was not adequate under the fixed cropping pattern assumption.

The highest income was obtained by use of improved milk cows or dairy goats. Since Musha animals are not used for draft power, the higher returns from milking all accrue to the farmer. Replacing one-half of the milking buffalo population (800 kg/year average milk yield) with improved dairy cattle (2000 kg/year average milk yield) would result in considerable surplus milk for which a cash market would have to be developed. Feed resources would generally be adequate to support this higher yielding herd if government and free market supplies of concentrates were available. A regular market outlet would be required, however, as very little milk enters marketing channels at present.

An alternative farm plan has dairy goats providing the family milk supply through improved dairy goats (500 kg/year average yield) and the feed previously allocated to buffalo now being used for cattle feeding. However, the farmers have strong prestige preferences for buffalo and prefer its milk and meat. Sheep and goats are not held because there is not a strong and regular demand for their milk or meat. The model indicated good returns from either breeding or fattening schemes for sheep and goats but traditional farmer preferences imply that cattle or buffalo enterprises which show comparable returns should be emphasized.

Scenarios with Feed Resources and Livestock Production Variable - The unrestricted model has only sunflowers as the summer crop and berseem as the winter crop with all output marketed. Thus no livestock was held. This obviously unrealistic result is reflected by the restrictions

showing government procurement quotas and farmers preferences for his own production of wheat and milk. When both sectors were allowed to vary within the constraints set by government procurement policies and the farmers preference for producing his own wheat, the improved forage program had the most influence on farm incomes. In particular, elephant grass combined with improved dairy cows offers the highest net return within the above constraints. This assumes adequate irrigation water and nitrogen fertilizer for elephant grass and a remunerative outlet for surplus milk.

ZGEK Results

Government policy and farmer preferences combine to make up the "representative" small farm in ZGEK. The role in which government policy, management decisions, feed resources and livestock production/productivity might improve farm profits was analyzed by starting with the constraints which characterized the "representative farm", i.e., 0.70 feddans of cotton; 0.70 feddans of rice; 0.70 feddans of wheat; one baladi cow used for milk, meat, draft power and manure; and one donkey used for transport.

The model solution has all cotton crop residues and rice straw being burned as fuel. Rice bran is retained by the mill and is not purchased by the local farmer for livestock feed. Thus wheat and maize byproducts are the major feed inputs. This cropping pattern also requires substantial cash outlays for maize and wheat bran to provide the minimum cost ration.

Government procurement quotas produce a negative impact on the system. The most notable change between unrestricted and "representative" farm plan results occurs through enforcement of the quota for rice, a relatively unprofitable crop. Taken together, procurement quotas on cotton and rice dedicate about 70% of summer cropland to these crops and restricts the potential utilization of land for high producing forage and fodder crops.

Wheat remains the primary staple crop grown for household consumption. Farmers appear unwilling to substitute more profitable crops for this staple crop, even though the financial cost of this policy is high. The government purchase price for wheat is LE 0.064/kg while production costs require a LE 0.070/kg breakeven price. To maintain low urban prices for bread, the government maintains a very low wheat procurement price so farmers produce only enough for household requirements. Their preference for producing their own wheat on the farm implies that substituting other winter crops for wheat is unrealistic and much of the livestock rations will continue to be based on wheat by-products and residues.

Feed Resource Scenarios - Alternative feeding patterns were generated by introducing possibilities for transferring fodder between seasons and by introducing new forage and cash crops into the system. Forage crops which appeared most promising were elephant grass, elephant grass intercropped with berseem, and forage sorghum. High yielding elephant grass could support the forage requirements of the cow and donkey on 0.1 feddans of elephant grass. This program reduced purchased feed crops substantially, but increased labor requirements by utilizing a cut and carry system for the forage.[3/] The intercropped berseem plan gave basically the same results except for a slight improvement in winter forage production. The slower growth of elephant grass in the winter was balanced to some extent by winter berseem production. Forage sorghum also performed well but required 0.5 feddans to produce summer feed

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3/ The question of who would cut and carry forage could be crucial in any development effort. Based on current work patterns, it would probably be women in ZGEK and men in Musha. A substantial proportion in Musha could be hired labor, given the tendancy to hire a large proportion of farm labor in that area. A regular cut and carry system would need to be socially acceptable and compatible with existing patterns of labor utilization. Using large amounts of hired labor for cut and carry forage production could well reduce the expected economic benefits. For a discussion of the possible impact on village women, see Chapter I, "Development Possibilities and Impacts" section.

requirements for the livestock. This reallocated some land from maize production and caused maize stover and cobs to be replaced by purchased fuel. Fodder transfer was considered by drying and storing excess winter berseem. Costs incurred were labor for drying and storing fresh-cut hay and some deterioration in feed quality going from fresh-cut berseem to berseem hay. Berseem hay had trouble competing with the high producing forage crops outlined above, however, and the optimal model solutions indicated only small quantities of berseem carried over.

Livestock Production Scenarios - The model results indicated some sensitivity on the animal draft power side. The cattle produce milk, meat, manure and draft power. Using animals for land preparation and water pumping was indicated by model results. However, if higher crop yields could be obtained by using tractor power, draft power was no longer utilized and cattle could not compete for feed resources by producing only meat, milk and manure.

The introduction of enterprises representing improved dairy cattle, improved dairy goats, and cattle feeding did not have the same result on farm profitability as was found in Musha. This was due to the loss of animal draft power and the high cost of replacing this power by tractors. By contrast, Musha was not using animal draft power so improved animal enterprises impacted directly on livestock output. Therefore, improved dairy animals must take a dual purpose approach to provide an acceptable draft animal. Improved dairy goats offered a slight increase in farm income but replacing the baladi cow with dairy goats would cause the same problems caused by the loss of animal draft power.

The most significant improvement in farm income appeared to be through calf growing-out as opposed to the traditional practice of selling calves at 30-45 days. Animals are often held in joint partnership with larger farmers and the larger farmers have the decision as to when to sell offspring. The model showed that at mortality rates of up to 20%, it paid to grow-out the young animals up to 125-150 kg. The provision

of a better summer feed supply by intensive forage cropping helped remove the constraint on feeding out the young calves. If some experimental growing out program could be shown to provide improved profits to both partners, the traditional practice of selling young calves off the farm could perhaps be reversed.

Water buffalo are not preferred by ZGEK farmers despite their better milk producing ability and the provision of draft power comparable to baladi cows. The problem which depresses returns to the buffalo enterprise is the higher mortality rate and slower growth rate of buffalo calves.

Scenarios with Both Feed Resources and Livestock Production Variable - The previous two scenarios considered varying feed resources with a fixed livestock population and varying livestock enterprises with the feed resources fixed. This section attempts to find more profitable farm plans with both sectors variable. The feed resource scenarios are as discussed earlier with the exception of carry over berseem which was marginal. Livestock innovations included 12 month calf feeding, improved dairy cows and improved dairy goats.

The most promising alternatives are a combination of elephant grass alone or with berseem intercropping and improved milking animals. Either water buffalo or improved dairy cattle offer higher returns with the above forages. However, for the improved milking cow to compensate for the loss of draft power, milk produciton must be considerably higher than at present levels while the buffalo already competes quite well as a dual purpose animal producing high fat milk. High producing dairy goats were not as promising and cut and carry feeding of a coarse forage such as elephant grass to goats can lead to high wastage.

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APPENDIX A - CROP PRODUCTION DETAILS

General

The small farmers in this survey were largely mixed farmers, cultivating crops and holding livestock. The decision of crops to be cultivated, for the most part, is a decision of the local Cooperative Society acting on directives from the Governorate. The government has established area or quantity procurement quotas for cotton, wheat, rice, onions, horsebeans and groundnuts. Cotton is procured by an area quota with all production going to the public sector cotton companies. Wheat, rice, onions, lentils, horsebeans and groundnuts are procured by quantity quotas. The government quotas for both Governorates are summarized in Table A.1. However, farmers avoid quotas regularly and these changes are not always recorded in the cooperative records, particularly for minor crops such as onions, lentils, horsebeans, and groundnuts.

Table A.1. Government Procurement Quotas in Assiut and Behera Governorates, 1979

Product	Assiut Ton/Feddan	Behera Ton/Feddan
Seed cotton	area quota	area quota
Wheat	.9	.75
Rice, paddy	-	1.5
Winter onions	7.0	-
Lentils	.32	.32
Horsebeans	.3875	-
Groundnuts	-	.15

Source: Ministry of Agriculture, Cairo, Egypt.

The only major crops in the survey not subject to procurement by th government were the cash crops, maize and sorghum, and the forage crop berseem clover. The procurement quotas on rice, cotton, and wheat wer

regularly enforced while procurement of lentils and horsebeans was less rigorous. The procurement quotas in the case of the other crops meant only that if the farmer chose to sell his product, then a cash market was available.

Table A.2 summarizes average reported yields from this survey compared to the Ministry of Agriculture (MOA) Statistics. The MOA data are taken from average yield data between 1972 and 1974 in the Assiut and Behera Governorates.

Table A.2. Survey and Ministry of Agriculture Yield Data for Assiut and Behera Governorates.

Governorate/Crop	Survey Yield Kg./Feddan	MOA Yield Kg./Feddan
Musha:		
Seed cotton	945 ± 218	980
Wheat	960 ± 263	1200
Sorghum	1100 ± 253	1700
Horsebeans	840 ± 296	1000
Lentils	480 ± 139	800
Berseem	18000	18000
Berseem seed[1/]	160	n.a.
ZGEK:		
Seed cotton	960 ± 223	760
Wheat	1080 ± 249	1300
Maize	1150 ± 288	1600
Rice	1985 ± 465	2200
Berseem	24000	24000

Source: Survey data and Ministry of Agriculture, Cairo, Egypt.

1/ Only a portion of a feddan is allowed to mature as berseem seed, therefore 160 kg. represents a modal value. Approximately 10-15% of the berseem planted is allowed to mature as seed.

The crops grown by the small farmer are either sold to the government, sold on the free market or utilized for household consumption. The proportions going to each are summarized in Table A.3.

Table A.3. Utilization of Crop Enterprise Products in the Villages of Musha and ZGEK.

Region/Crop	Sold to Government %	Sold on Free Market %	Utilized in the Household %
Musha:			
Cotton	100		
Cotton stems			100
Wheat	1	5	94
Wheat bran		20	80
Wheat straw	1	28	72
Sorghum		15	85
Sorghum stover			100
Horsebeans	10	5	85
Horsebean straw		23	77
Lentils	5	5	90
Lentil straw		20	80
Berseem		10	90
Berseem seed		20	80
Berseem straw		4	96
ZGEK:			
Seed Cotton	100		
Cotton stems			100
Wheat	5	5	90
Wheat bran			100
Wheat straw	1		99
Maize	0	14	86
Maize stover			100
Maize cobs			100
Rice	70	1	29
Rice straw			100

Two prices are relevant to the farmer when marketing his crop, the government procurement price and the free market farmgate price. Table A.4 summarizes these prices for 1979.

Table A.4. Prices Received by Small Farmers in Assiut and Behera Governorates.

Price	Government Procurement Price LE/Ton	Free market Price LE/Ton
Seed cotton	222.22	n.a.
Wheat	63.35	-
Sorghum	-	65.00*
Horsebeans	129.30	n.a.*
Lentils	218.75	n.a.
Berseem forage 1/	-	7.00
Berseem seed 2/	-	240.00
Maize	-	71.40*
Rice	65.00	n.a.

* Farmgate price as reported by the Ministry of Agriculture.

1/ Berseem is sold by the land unit, Kirat. The average price per kirat is LE 5 for 3 cuttings. Assume a yield of 6T/feddan/cutting.

2/ The berseem seed price fluctuates between LE 200 and LE 350/ton from harvest to planting time.

The government is heavily involved in the pricing of inputs as well. The government, through the Agricultural Credit Banks, provides subsidized seed, fertilizer, and loans. Table A.5 summarizes the inputs available and the prices charged by the government for each project site. Assistance is also provided to the farmer for insect control on cotton. This assistance amounts to the government and the farmer evenly dividing the cost of manually picking eggs from the cotton plant and application of chemical insecticides.

Table A.5. Government Supplied Input Quantities and Prices for Each Governorate

Crop	Seed Quantity Kg	Seed Price LE/Kg	Nitrogen[1/] Fertilizer Kg	Phosphate[2/] Fertilizer Kg	Cash Loan LE	Value[3/] LE
			Assiut Governorate			
Cotton	75	.02	200	100	23.00	36.60
Wheat	75	.07	200	100		17.40
Sorghum	-	-	200	-		9.50
Horsebeans	75	.17	25	100		15.70
Lentils	80	.10	25	100		10.60
Berseem	-	-	-	100		2.60
			Behera Governorate			
Cotton	75	.02	150	100	23.00	35.10
Wheat	75	.07	150	100	-	15.80
Maize	-	-	200	-	-	10.60
Rice	60	.10	175[4/]	100	-	15.70
Berseem	-	-	-	-	-	-

1/ 33.5% nitrogen fertilizer sold at LE .0534/kilogram, except for rice.

2/ 15.5% phosphate fertilizer sold at LE .0256/kilogram.

3/ The seed, fertilizer, pesticides (if any) and cash loans are assessed a 4½% service charge at the time payment.

4/ The 175 kg, includes 25 kg of 46% nitrogen (urea) and 150 kg of 20.6% nitrogen (ammonium sulphate) sold at LE .0732 and LE .0356 per kilogram, respectively.

Musha Crop Enterprises

Musha is a highly mechanized village with 100 privately owned and 2 Cooperative Society tractors. A typical custom operator would own a tractor, plow, plank and possibly a drum thresher and wagon. The custom rates were plowing - LE 2/hr, planking - LE 2/hr and threshing - LE 2.50/hr. Custom hauling remains important to village farmers for trans-

portation. Camels are the primary transport animal hauling primarily field crop products and soil. Camel populations have decreased in the past decade as tractor drawn carts are proving to be adequate substitutes. The fee for camel transportation is charged on the basis of the load and the distance.

The standard rate was LE .50 per load of straw per kilometer and LE 1 per load of soil or bricks per kilometer. Donkeys are important transport vehicles for lighter and less bulky loads. The donkey is utilized for soil, manure, brick and crop residue transportation. The donkey transport fee is LE .05 per load of earth manure delivered up to 1 kilometer.

Labor Inputs

Labor inputs account for the most significant production costs in the crop enterprise budgets. Labor inputs for the crop enterprise are provided by the men and younger family members. Women are not involved in fieldwork, being fully occupied in the household caring for the family and their livestock. Labor supply was estimated in discussions with farmers while labor demand was estimated from operation schedules developed with the enterprise cost studies.

A benchmark for family labor supply employed in recent studies has been the International Labor Office estimate of 25 days per working family member per month. Discussions with farmers found this to be a valid approximation for the year except during the summer months June through August, when less land is under cultivation and the summer heat descends on upper Egypt. During this time period, 20 days were assumed to be available for agricultural work by each working family member. In Musha, an average of just over 1 family member per household supplies labor to the crop enterprise. The added labor supplied by school children on vacation in summer warranted an adjustment of 5 days per month during this time period, thus leaving Musha with an aveage of 25 days of family labor supplied each month throughout the year.

The labor input not provided by the family members is provided by hired labor. Hired labor inputs accounted for approximately 80% of the total value of labor employed on crop enterprises. Even on the very small farms, labor would be hired, rather than employing family members. The farmers complained of a labor shortage while the agricultural laborers complained of too little work. Large quantities of hired labor are employed for ditching, cultivating weeds, and harvesting crops. Thus, Musha relies heavily on wage labor as indicated by the sociology component of this project which estimated there are nearly 5000 landless laborers in the village. The standard man day wage is LE 1.25, plus in-kind payments in the form of tea, cigarettes, etc. To arrive at man day equivalents, this study followed the Egyptian practice of considering one man day equal to two boy days. Boy day rates are nearly 50% of man day rates, thus allowing the equivalency to reflect actual wages paid. Boy labor is substitutable for man labor in most tasks in the crop enterprise. The large quantities of laborers hired for weed cultivating and harvest are groups of boys.

Labor demand estimates are relatively straightforward. The estimates are derived from operation schedules developed for the crop budgets. Three labor demand peaks can be identified. The first occurs in April when the horsebeans and lentils are harvested and cotton is planted. The second peak occurs in June when the wheat and berseem seed are harvested and sorghum is planted. The third peak occurs in October when the cotton and sorghum are harvested and the winter crop land preparation begins. Table A.6 summarizes the quantities of labor demanded on each feddan of a given crop cultivated.

Table A.6. Quantity of Labor Demanded for Producing One Feddan of Each Major Crop, Musha 1979.

Crop	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cotton			12	35	18	10	6	2	2	25	7		117
Wheat	1	2	1	1	15	11					5	1	37
Sorghum					7	12	12	8	2	33			74
Horse-beans	2	2	28								12	12	56
Lentils	13		20							5	4	0	42
Berseem, seed	10	9	1	10	2	23					3	0	58

The largest single labor effort is the picking of the cotton leaf worm eggs. In Musha groups of children, often 10-15 in a group, were employed for this task. Each child is paid LE .25 for the 4 to 5 hour work day. This task is considered as a seperate element in the crop budgets.

Rates of Application

Seed, fertilizer and irrigation water are provided to the small farmer through the Government and/or the free market. As discussed above, seed and fertilizer allotments are made to farmers growing particular crops, and active free markets exist for buying or selling these inputs. Irrigation water is supplied by the Government to all farmers at no cost. Table A.7 summarizes seed and fertilizer application rates. Fertilizer is divided into three categories: commercial nitrogen, commercial phosphorus and earth manure. Commercial nitrogen purchases included urea (46% nitrogen) and calcium nitrate (31.5% nitrogen). Since the majority of nitrogen purchased was as calcium nitrate, other N sources were converted to this basis. Commercial phosphate fertilizer included only superphosphate (15.5% phosphate). The earth manure is a mixture of soil and manure applied to the field. This mixture is from 15-25% manure. An analysis of earth manure mixtures at three Egyptian

Water Use and Management Project sites produced the following analysis: 2.05% organic carbon, 3.52% organic matter, .24% nitrogen, 1.09 ppm. available phosphorus and .30% potassium. The earth manure applied in Musha is on cotton. Earth manure application rates are expressed in donkey loads. For this study, ten donkey loads equals one cubic meter. A unit of earth manure has a delivered market price of LE .50 per cubic meter.

Table A.7. Seed and Fertilizer Application Rates Per Feddan for Major Crops, Musha 1979.

Crop	Seed (kg.)	Fertilizers[1/] Nitrogen (kg.)	Phosphorus (kg.)	Earth Manure[2/] (m3)
Cotton	75	375	150	30
Wheat	75	300	150	-
Sorghum	35	350	200	-
Horsebeans	75	100	200	-
Lentils	120	50	200	-
Berseem	40	-	300	-

1/ The nitrogen fertilizer is on a 31.5% N basis and the phosphate fertilizer is on a 15.5% P_2O_5.

2/ The Soil and Water Research Center, estimates that a kilogram of manure is 1 percent available nitrogen and 1.5% available phosphorus. Conversations with Dr. Eladin, September 1979.

Active free markets exist for commercial fertilizer and operate much the same as the commercial feed markets. Fertilizers purchased from the Agricultural Credit Bank at subsidized prices are either utilized by the farmer on the designated crop (or other crops) or sold onto the free market at approximately 50% above the government price. A comparison between government supplied fertilizer and fertilizer application rates indicates substantial amounts of fertilizer are purchased from the free market.

Irrigation water is delivered to the village at no charge to the farmer. However, the farmer must pay a pumping charge to lift the water from the canal onto his land. Musha has 73 fixed diesel pumps providing this service. Standard pump charges are assessed on the number of times a farmer is supplied water. This fee is LE 1.00 per irrigation for all crops except cotton where the fee is LE 1.50 per irrigation. The price differential is caused by the relatively short supply of water in summer. Table A.8 summarizes the water demand for the major crops grown. The water requirements are taken from El Tobgy (1976) with the distribution of water determined by the crop budget time schedules.

Table A.8. Water Requirements for the Major Crops by Month, Musha, 1979.

	Major Crops Water Demands (m^3/Feddan)					
Month	Cotton (m^3)	Wheat (m^3)	Sorghum (m^3)	Horsebeans (m^3)	Lentils (m^3)	Berseem (m^3)
January		340		270		380
February		340		270		380
March		340		270		380
April	880	340				380
May	880	340	510			760
June	880		510			1140
July	880		510			
August	880		1020			
September	880		1020			
October		510				
November			270	270		
December				270	270	

Source: Contemporary Egyptian Agriculture by H. A. El Tobgy (1976) and Survey data.

The small farmers of Musha cultivated 2600 of the 5000 feddan in Musha zinam. The land is either owned or rented with 40% owned and 60% rented. The crop budgets are based on an annual rental fee of LE 40 which applies to land leased for several years. Recent leasing arrange-

ments have pushed land rents to the legal limit[1/] and above. Table A.9 summarizes the distribution of land owned and/or rented by the survey farmers.

Table A.9. Distribution of Land Owned and/or Rented by Small Farmers, Musha 1979

Cultivated	Total Land Owned		Total Land Rented		Total Land Owned & Rented	
	No.	%	No.	%	No.	%
0-1 Feddan	14	43.8	14	36.8	15	19.5
1.1-2	12	37.5	14	36.8	26	33.8
2.1-3	4	12.5	4	10.5	14	18.2
3.1-4	1	3.1	4	10.5	11	14.3
4.1-5	1	3.1	2	5.4	11	14.3
Total	32	100.	38	100.	77	100.

If the parcel of land is owned rather than leased then the land costs is based on the land tax of LE 9-11 plus the opportunity cost of the land investment. If the land were sold at LE 2500 and the money loaned at 8½% rate of interest, LE 212.50 could be generated annually by that money. In the case of static land values, this approach is adequate but in Musha land prices have risen from a fixed price of LE 500 to LE 3500 and LE 2500 for first and second class land, respectively. Assuming the first years increase in land values was a compensatory increase from LE 500 to LE 1500, land prices have risen nearly 20% per year from 1975-1978. This means that rural land prices are moving slightly ahead of the 15% rural inflation rate. The appreciating value of the land yields positive economic returns to the land owner. These returns are not enterprise related as they accrue to the land owner regardless of whether the land is cultivated. The land costs represent the only significant fixed cost in the crop enterprise budgets although the

1/ The legal limit is equal to seven times the annual land tax rate. In 1979, this was LE 9-11 per feddan in Musha.

typical farmer does own small tools, and containers to store grains and byproducts utilized in the household. The small tools include a sickle for berseem harvest, 2 hoes for cultivating weeds and ditching, a winnowing fork, a sift for cleaning grain and other small tools.

Crop Budget Summary

Table A.10 summarizes the crop enterprise budgets for each major crop grown in Musha with all inputs priced at market levels. With the exception of wheat and berseem, a negative economic return is reported. These returns indicate less than market returns accruing to some resources. The most significant cost item is labor which is assigned a cost per man day regardless of whether family or hired labor is employed. The second most significant item is the fixed cost, land rent. In the case where land is owned, rather than leased, the fixed cost would be reduced to LE 9-11 per feddan per year, or less than one-third of the land rent.

Table A.10. Crop Budget Summary, Musha 1979.

Item	Cotton	Wheat	Sorghum	Horsebeans	Lentils	Berseem
Revenue	213.00	129.40	79.30	138.20	141.00	176.30
Variable Costs:						
Nonharvest	181.23	52.95	101.24	85.52	82.93	63.32
Harvest	44.50	45.25	49.50	44.25	35.00	71.00
Total	225.73	98.20	150.74	129.77	117.93	134.32
Return over Variable Cost	(-12.73)	31.20	(-71.44)	(-8.43)	(-23.07)	41.98
Fixed Cost	30.00	26.64	19.98	19.98	19.98	26.64
Total Cost	255.73	124.84	170.72	149.75	137.91	160.96
Return over Total Cost	(-42.73)	4.56	(-91.42)	(-11.55)	(-3.09)	15.34

Any cost of production estimate must be treated with caution because of the problem of inputing economic rent and the treatment of fixed costs such as household labor inputs. These budgets also depict each crop enterprise in isolation for other crop and livestock enterprises. The analyses of a representative farm modelled in a linear programming

framework allow each crop and livestock enterprise to be considered in an integrated system. The crop budgets provide the basis for the linear programming model crop activities and returns. Detailed budgets for each individual crop for Musha are given in Tables A.11 - A.16. The yields, variable costs, fertilizer inputs and labor requirements are entered directly into the linear programming matrix for those respective crop activities.

Table A.11. Irrigated Cotton Budget,[1/] Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Seed cotton	Kantar	35.00	6.0	210.00
Cotton stems	Camel loads	.50	6.0	3.00
Total Income				213.00
Variable Costs/				
Manure, applied	Donkey Ld.	.05	300	15.00
Custom Plow & Smooth	Feddan	7.50	1	7.50
Seed	Kala	.25	6	1.50
Fertilizer, 0-15.5-0	Kilogram	.0264	100	2.64
	Kilogram	.0528	50	2.64
Fertilizer, 31.5-0-0	Kilogram	.0475	200	9.50
	Kilogram	.0950	175	16.63
Irrigation, pump charge	Times	1.50	12	18.00
Pest Control	m-d	1.25	12	15.00
Non harvest labor	m-d	1.25	73	91.25
Int. on operating capital				1.57
Non harvest V.C.				181.23
Harvest Labor	m-d	1.25	32	40.00
Hauling	Camel Lds.	.50	9	4.50
Harvest V.C.				44.50
Total Variable Costs				225.73
Return over Variable Costs				(-12.73)
Fixed Costs/				
Land Rent	Months	3.33	9	30.00
Total Fixed Costs				30.00
Total Costs				$255.73
Return over Total Cost				(-42.73)

1/ This feddan is inclusive of ditches, roads, etc. Only 20 of 24 kirats are cultivated.

Table A.12. Irrigated Wheat Budget,[1/] Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Wheat, grain	Ardebs	9.50	6.4	60.80
Wheat, straw	Hemel	10.00	6.3	63.00
Wheat, bran	Kilograms	.07	80.0	5.60
Total Income				129.40
Variable Costs/				
Custom Plow	Feddan	3.75	1	3.75
Fertilizer, 0-15.5-0	Kg.	.0264	100	2.64
Fertilizer, 0-15.5-0	Kg.	.0528	50	2.64
Seed	Kala	.90	6	5.40
Fertilizer, 31.5-0-0	Kg.	.0475	200	9.50
Fertilizer, 31.5-0-0	Kg.	.095	100	9.50
Irrigation, pump charge	Times	1.00	5	5.00
Nonharvest Labor	m-d	1.25	11	13.75
Int. on operating k				.77
Nonharvest V.C.				52.95
Custom Chopping	Hours	2.50	4	10.00
Custom Hauling	Camel Lds.	.50	6	3.00
Harvest Labor	m-d	1.25	25	31.25
Custom Hauling	Donkey Lds.	.05	20	1.00
Harvest V.C.				45.25
Total Variable Cost				98.20
Return over V.C.				31.20
Fixed Costs/				
Land Rent	Months	3.33	8	26.64
Total Fixed Costs				26.64
Total Cost				124.84
Return over Total Cost				(4.56)

1/ 1 Feddan is inclusive of ditches, roads, etc. Only 20 of 24 kirats are cultivated.

Table A.13. Irrigated Sorghum Budget,[1/] Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Sorghum, grain	Ardebs	9.1	8	72.80
Sorghum, stover	Camel Lds.	.50	9	4.50
Sorghum, thinnings	Kg.	0.1	200	2.00
Total Income				79.30
Variable Costs/				
Custom plow-smooth	Feddan	3.75	1	3.75
Fertilizer, 0-15.5-0	Kg.	.0528	200	10.56
Fertilizer, 31.5-0-0	Kg.	.0475	200	9.50
Fertilizer, 31.5-0-0	Kg.	.0950	150	14.25
Seed	Kala	.75	3	2.25
Irrigation, pump charge	Times	1.00	8	8.00
Nonharvest Labor	m-d	1.25	42	52.50
Int. on operating k				.43
Non harvest V.C.				101.24
Custom chopping	Hour	2.50	2	5.00
Custom hauling	Camel Lds.	.50	8	4.00
Custom hauling	Donkey Lds.	.05	10	.50
Harvest Labor	m-d	1.25	32	40.00
Harvest V.C.				49.50
Total Variable Cost				150.74
Return over Variable Cost				(-71.44)
Fixed Costs/				
Land Rent	Months	3.33	6	19.98
Total Fixed Cost				19.98
Total Cost				170.72
Return over Total Cost				(-91.42)

1/ The 1 feddan is inclusive of roads, ditches, etc. Only 20 of 24 kirats are cultivated.

2/ An ardeb of soybean grain = 140 kg.
A camel load of sorghum stover = 250 kg.

Table A.14. Irrigated Horsebean Budget,[1/] Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Horsebeans, grain	Ardeb	20.00	5.3	106.00
Horsebeans, straw	Hemel	7.00	4.2	32.20
Total Income				138.20
Variable Costs/				
Custom plow - smooth	Feddan	7.50	1	7.50
Fertilizer, 0-15.5-0	Kg.	.0264	100	2.64
, 0-15.5-0	Kg.	.0528	100	5.28
Fertilizer, 31.5-0-0	Kg.	.0475	25	1.19
, 31.5-0-0	Kg.	.0950	75	7.13
Seed	Kala	2.10	6	12.60
Irrigation, pump charge	Times	1.00	5	5.00
Spraying, Malathion	Liter	1.67	1	1.67
Spraying, Landine	Liter	2.00	1	2.00
Spraying, rental charge	Day	3.00	1	3.00
Int. on operating k				1.26
Nonharvest Labor	m-d	1.25	29	36.25
Nonharvest V.C.				85.52
Custom Hauling	Camel Ld.	.50	5	2.50
Custom Hauling	Donkey Ld.	.05	10	.50
Custom Chopping	Hour	2.50	3	7.50
Harvest Labor	m-d	1.25	27	33.75
Harvest V.C.				44.25
Total Variable Cost				129.77
Return over Variable Cost				(-8.43)
Fixed Cost/				
Land Rent	Months	3.33	6	19.98
Total Fixed Costs				19.98
Total Costs				149.75
Return over Total Costs				(-11.55)

1/ 1 feddan is inclusive of roads, ditches, etc. Only 20 of 24 kirats are cultivated

2/ An ardeb of horsebeans = 155 kg.
A hemel of horsebean straw = 225 kg.

Table A.15. Irrigated Lentils Budget, Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Lentil, grain	Ardeb	35.00	3.0	105.00
Lentil, straw	Hemel	12.00	3.0	36.00
Total Income				141.00
Variable Costs/				
Custom Plowing	Feddan	3.75	1	3.75
Fertilizer, 0-15.5-0	Kg.	.0264	100	2.64
, 0-15.5-0	Kg.	.0528	100	5.28
Fertilizer, 31.5-0-0	Kg.	.0475	25	1.19
, 31.5-0-0	Kg.	.095	25	2.38
Seeds	Kala	2.75	9	24.75
Irrigation, pump charge	Times	1.00	2	2.00
Spray, Malathion	Liter	1.67	2	3.34
Spray, Endrin	Liter	2.87	1	2.87
Spray, Rental	Day	3.00	2	6.00
Nonharvest Labor	m-d	1.25	22	27.50
Int. on operating k				1.23
Nonharvest V.C.				82.93
Custom Hauling	Camel Lds.	.50	4	2.00
Custom Hauling	Doneky Lds.	.05	10	.50
Custom Chopping	Hours	2.50	3	7.50
Harvest Labor	m-d	1.25	20	25.00
Harvest V.C.				35.00
Total Variable Cost				117.93
Return over Variable Cost				(-23.07)
Fixed Cost/				
Land Rent	Months	3.33	6	19.98
Total Fixed Cost				19.98
Total Cost				137.91
Return over Total Cost				(3.09)

Table A.16. Irrigated Full Term Berseem, Musha

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Berseem, Forage	Cuttings	40.00	3	120.00
Seed, Seed	Kala	3.15	12	37.80
Seed, Straw	Hemel	5.00	3.7	18.50
Total Income				176.30
Variable Costs/				
Custom Plow	Feddan	3.75	1	3.75
Fertilizer, 0-15.5-0	Kg.	.0528	200	10.56
	Kg.	.0264	100	2.64
Seed	Kala	6.25	3	18.75
Irrigation, pump charge	Times	1.00	10	10.00
Nonharvest Labor	m-d	1.25	14	17.50
Int. on operating k				.12
Nonharvest V.C.				63.32
Hauling Forage	Donkey Lds.	.05	120	6.00
Custom Chopping	Hours	2.50	3	7.50
Hauling, seed prod.	Camel Lds.	.50	4	2.00
Hauling, straw	Donkey Lds.	.05	10	.50
Harvest Labor	m-d	1.25	44	55.00
Harvest V.C.				71.00
Total Variable Cost				134.32
Return over Variable Cost				41.98
Fixed Costs/				
Land Rent	Months	3.33	8	26.64
Total Fixed Costs				26.64
Total Costs				160.96
Return over Total Costs				15.34

Zawiet Ghazal - Ezeb Kabeel
Crop Enterprises

In contrast to Musha, draft power still exists in ZGEK although a majority of the traditional draft livestock tasks of land preparation and water pumping are accomplished by hired mechanical equipment. The typical custom tractor operator, of which there are 12 private and 1 Cooperative Society, would own a tractor, plow and plank. In unusual cases he may also own a drum thresher and possibly a hand powered winnower. The standard custom rates are plowing - LE 2/hr, planking - LE 1.75/hr, threshing - LE 1/hr, and winnowing - LE 2/hr. Custom transportation is provided by camels and donkeys. Camels remain the primary transport vehicle for field crops and their residues and heavier loads such as soil and brick. The camel transport fee is determined on the basis of the load and distance. The standard fee for bulky loads (i.e. straw) is LE .50/kilometer and for heavier loads is LE 1.00/ kilometer. The donkey is utilized for lighter, less bulky loads. Most small farmers own a donkey but if required, the rental fee is LE .50/kilometer.

Labor Inputs

Labor is the single most significant crop enterprise input. In ZGEK, average family size was 5.9 members[2/] with all family members participating in crop and livestock enterprises. However, as in Musha, a majority of the labor employed was hired labor. Labor supply was determined using the International Labor Office estimates with labor demand estimated from operations schedules developed as a part of the enterprise cost studies. The benchmark of 25 working days per family member by the International Labor Office was found to adequately depict

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2/ Family size is dependent upon the definition of a family unit and also upon who the informant was. Our estimate is close to Egyptian Census estimates for rural areas while the Rural Sociology survey recorded average family size of 7.3 in Musha and 8.8 in Zawiet Ghazel.

family labor availability in ZGEK. In contrast to Musha, both men and women supplied labor to crop and livestock enterprises. The participation by women in the crop enterprise meant that family labor supplied about 30% of total labor used.

The agricultural sector was in direct competition with the industrial sector (primarily electrical generation) for labor. The sociology component of this study estimated about 1000 agricultural laborers lived in the villages. The standard man day wage is LE 1.00, which is inclusive of a cash wage and in-kind payments in the form of tea, cigarettes, etc.

Labor demand estimates were derived from the crop operation schedules. Two labor demand peaks are evident. The first in May when the wheat is harvested, and the rice is planted and the second in September when the cotton and rice are harvested. Table A.17 summarizes the quantities of labor demanded per feddan cultivated of a given crop.

Table A.17. Quantity of Labor Demanded for the Major Crops by Month, ZGEK, 1979

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Cotton			10	5	7	11	9	4	33	5			84
Wheat	1	1	1	1	23					1	4	3	35
Rice				2	26	14	5	3	13	10	8		81
Maize				9	8	6	17						40
Berseem:													
Full term	7	7	7	5							3	1	30
Catch crop	7	7									3	1	18

Rates of Application

Seed, fertilizer and irrigation water are supplied to the small farmer through the government and/or free market. The same conditions exist here as in Musha with active free markets for seed and fertilizer and irrigation water provided at no cost to the farmer. Earth manure is

utilized more extensively and hence commercial fertilizers are utilized less than in Musha. The majority of commercial nitrogen fertilizer is 33.5% nitrogen and other nitrogen fertilizers included in the crop budgets are converted to this basis. All phosphate fertilizers are converted to a superphosphate (15.5% P_2O_5) basis. Fertilizer prices are virtually the same as in Musha. Application rates are given in Table A.18.

Table A.18. Seed and Fertilizer Application Rates Per Feddan for the Major Crops, ZGEK, 1979

Crop	Seed (kg)	Fertilizers[1/] Nitrogen (kg)	Phosphorus (kg)	Earth Manure (m^3)
Cotton	75	200	150	300
Wheat	75	150	100	200
Maize	35	200	100	400
Berseem	40	-	100	200

1/ The nitrogen fertilizer is on a 33.5% basis and the phosphate fertilizer is on a 15.5% P_2O_5 basis.

Irrigation water is supplied to the farmers at no charge but the farmer must lift the water from the canal onto his land. In ZGEK, approximately 40% of the water lifting is accomplished with traditional sakias with the remaining 60% lifted by diesel or electric pumps. Sakias are held by groups of farmers because a single sakia has the potential of irrigating between 10-15 feddans. The farmers sharing a sakia contribute to the operation and maintenance costs of the sakia in proportion to their land area irrigated by the sakia. Discussions with farmers indicated the replacement cost of the sakia (inclusive of the well, gear, wheel, yoke and labor) to be from LE 250 to LE 300. The annual maintenance costs are around LE 5/sakia, or LE .35, per feddan. One hour of child labor valued at LE .05/hour is required to watch the animal during pumping.

The mechanical pumps are largely moveable diesel pumps. While the sakia lifts around 100 m^3 per hour, the diesel pump will lift around 150 m^3 per hour. The standard charge for renting a mechanical pump was LE 1.50 per irrigation. The survey found no farmers renting cattle or buffalo for water pumping or for land preparation tasks.

Table A.19 summarizes the water requirements for the major crops. The water requirements are estimated by current water use which is estimated by assuming the sakia pumps 100 m^3 per hour and cotton, wheat, rice, maize and berseem require 4.8, 4.2, 3.2, 3.9 and 3.5 hours per irrigation, respectively.[3/]

Table A.19. Water Requirements for the Major Crops by Month, ZGEK, 1979.*

	Major Crops Water Demands (m^3/Feddan)					
Month	Cotton (m^3)	Wheat (m^3)	Rice (m^3)	Maize (m^3)	Full term Berseem (m^3)	Catch crop Berseem (m^3)
January		290			500	250
February		290			500	
March	340	290			500	
April	340	290	140	270		
May	340		220	540		
June	340		3360	540		
July	680		3360	540		
August	680		3360	540		
September						
October						
November		290			250	250
December		290			250	250

Source: Survey data and Food Research Institute, Stanford University.

* These estimates assume water lifted by sakia is distributed to the field with 70% efficiency.

3/ Food Research Institute, Stanford University supplied the sakia pumping information for all the crops except rice which was estimated from survey data.

Small farmers in ZGEK cultivated half of the total land area (2500 feddans), held by the two villages. In contrast to Musha, land holding arrangements were not clearly delineated into land ownership and rental classifications. The practice whereby leasees are given rights to cultivate the land at a fixed rental rate for an unlimited time period prompted a share cropping system to evolve. The typical share cropper divides the costs and returns with the land owner. Table A.20 summarizes the distribution of land holdings.

Table A.20. The Distribution of Land Owned and/or Shared by the Small Farmer, ZGEK 1979

Total Land Cultivated	Land Owned		Land Rented		Land Owned and Rented	
	Farmers	%	Farmers	%	Farmers	%
0-1 Feddan	40	35.4	12	15.4	1	11.2
1.1-2	42	37.2	32	41.0	3	33.3
2.1-3	20	17.7	25	32.0	3	33.3
3.1-4	11	9.7	8	10.3	0	0
4.1-5	0	0	1	1.3	2	22.2
TOTALS	113	100.0	78	100.0	9	100.0

Source: Survey Data

The share cropping arrangement makes the land payment crop specific. Therefore, under the assumption employed in the budgets, cotton, wheat and berseem would be the only enterprises assessed a land charge. While the share crop arrangement does exist and annual shares are paid at the time of cotton harvesting the land rent must be spread across all enterprises. Assuming that land rent is paid on the crop with highest return over costs, an annual rent rent of LE 50 is assumed across all crops to capture the fixed cost in each enterprise.

The land cost represents the only significant fixed cost in the crop enterprise. In cases where custom land preparation, water pumping and transportation do not apply, then the fixed costs associated with these draft and transportation animals apply. The typical small farmer owns

small tools and containers to store grains and byproducts utilized in the household. The small tools include a sickle for berseem harvesting, 2 hoes for ditching and weed cultivation and other supplies.

Crop Budget Summary

Table A.21 summarizes the crop enterprise budgets for each major crop grown in ZGEK. The crop budget assumes that all land preparation, water pumping and transportation is accomplished by custom operators. The budgeting procedure assigns a cost to all labor employed equal to the wage rate of LE 1.0 man day. The land rent is one half the return over variable cost. The return over total costs represents the return to share cropper management.

The budget assumes the crop enterprise exists in isolation under a given set of assumptions. While the budgets address the "typical" farmer they do not provide information on variations in the systems described above. Variations in the employment of draft power and custom operators for land preparation and irrigation task, of the quantities of other inputs employed and land rental arrangements, can significantly affect the return to the small farmer. The budgets provide a format for assessing the potential of a crop enterprise and they are especially helpful when assessing an individual farmers potential. Table A.22 - A.27 summarize individual crop budgets.

Table A.21. Crop Budget Summary, ZGEK 1979

Item	Cotton (LE)	Wheat (LE)	Rice (LE)	Maize (LE)	Full term Berseem (LE)	Catch crop Berseem (LE)
Return	221.50	116.70	147.10	105.20	160.00	40.00
Variable Costs:						
Nonharvest	108.54	55.56	138.21	84.44	58.12	45.62
Harvest	39.50	43.00	58.50	19.80	28.50	9.00
Total	148.04	98.56	196.71	104.24	86.62	54.62
Return over variable costs	73.46	18.14	(-49.61)	.96	73.38	(-14.62)
Fixed costs	17.50	17.50	17.50	10.00	15.00	7.50
Total Cost	165.54	116.06	214.48	114.24	101.62	62.12
Return over Total Cost	55.96	.64	(-67.11)	(-9.04)	58.38	(-22.12)

Table A.22. Irrigated Cotton Budget, ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Cotton, raw	Kantar	35	6.1	213.50
Cotton stems	Camel loads	2.00	4.0	8.00
Total Income				221.50
Variable Costs/				
Manure	Donkey loads	.05	300	15.00
Custom Plowing	Feddan	7.00	1	7.00
Custom Harrowing	Feddan	.50	1	.50
Custom ditching	Animal day	.50	1	.50
Seed	Kala	.25	6	1.50
Fertilizer, 33.5-0-0	Kg.	.0534	150	8.00
Fertilizer, 33.5-0-0	Kg.	.1068	50	5.34
Fertilizer, 0-15.5-0	Kg.	.0256	100	2.56
Fertilizer, 0-15.5-0	Kg.	.0512	50	2.56
Pest Control	m-d	1.00	12	12.00
Irrigation, pump charge	Times	1.50	8	12.00
Nonharvest Labor	m-d	1.00	40	40.00
Int. on operating k				1.58
Nonharvest V.C.				108.54
Harvest Labor	m-d	1.00	35	35.00
Transportation	Camel Loads	.50	9	4.50
Harvest V.C.				39.50
Total Variable Costs				73.46
Return over Variable Costs				69.96
Fixed Costs/				
Land Rent	Months	2.50	7	17.50
Total Fixed Costs				17.50
Total Costs				165.54
Return over Total Costs				55.96

Table A.23. Irrigated Wheat Budget, ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Wheat, grain	Ardeb	9.50	7.2	68.45
Wheat, straw	Hemel	7.00	6.9	48.30
Total Income				116.70
Variable Costs/				
Manure	Donkey loads	.05	200	10.00
Custom Plowing	Feddans	6.00	1	6.00
Seed	Kala	.90	6	5.40
Fertilizer, 33.5-0-0	Kg.	.0534	150	8.00
Fertilizer, 0-15.5-0	Kg.	.0256	100	2.56
Irrigations, pump charge	Times	1.50	6	9.00
Nonharvest Labor	m-d	1.00	14	14.00
Int. on operating k	Feddan			.60
Nonharvest V.C.				55.56
Harvest Labor	m-d	1.00	23	23.00
Custom Chopping	Hours	2.00	4	8.00
Custom Winnowing	Hours	2.00	4	8.00
Custom Hauling	Camel Lds	.50	6	3.00
Custom Hauling	Donkey Lds	.05	20	1.00
Harvest V.C.				43.00
Total Variable Cost				98.56
Return over V.C.				18.14
Fixed Costs/				
Land Rent	Months	2.50	7	17.50
Total Fixed Costs				17.50
Total Costs				116.06
Return over Total Costs				(-.63)

Table A.24. Irrigated Rice, ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Rice, grain	Dariba	65.00	2.1	136.50
Rice, straw	Camel Lds	2.00	5.3	10.60
Total Income				147.10
Variable Costs/				
Transplanting stage				
Manure	Donkey Lds	.05	40	2.00
Custom Land Prep.	Hours	2.00	1.5	3.00
Seeds	Kala	1.00	6	6.00
Fertilizer, 46-0-0	Kg.	.0732	25	1.83
Irrigation, pump charge	Hours	.50	10	5.00
Labor	m-d	1.00	7.25	6.25
Transplant Costs				24.08
Paddy Stage				
Custom Land Prep.	Feddan	7.00	1	7.00
Fertilizer, 20.6-0-0	Kg.	.0356	150	5.34
Fertilizer, 0-15.5-0	Kg.	.0256	100	2.56
Irrigations, pump charge	Times	1.50	41	61.50
Nonharvest Labor	m-d	1.00	37	37.00
Int. on operating k	Feddan			.73
Nonharvest V.C.				114.13
Harvest Labor	m-d	1.00	31	31.00
Custom Separating	Hours	2.00	4	8.00
Custom Winnowing	Hours	2.00	4	8.00
Custom hauling	Camel Lds	.50	20	10.00
Custom hauling	Donkey Lds	.05	30	1.50
Harvest Variable Costs				58.50
Total Variable Cost				196.71
Return over Variable Cost				(-49.61)
Fixed Cost				
Land Rent	Months	2.50	7	17.50
Total Fixed Costs				17.50
Total Cost				214.48
Return over Costs				(-67.11)

Table A.25. Irrigated Maize, ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Maize, Grain	Ardebs	10.00	8.2	82.00
Maize, stover	Camel Lds.	2.00	6.3	12.60
Maize, cobs	Kg.	.025	345.0	8.60
Maize, strippings	Kg.	.01	200.0	2.00
Total Income				105.20
Variable Costs/				
Manure	Donkey Lds	.05	400	20.00
Custom Plow & Smooth	Feddan	6.50	1	6.50
Ditching	Animal day	.50	1	.50
Seeds	Kala	1.20	3	3.60
Fertilizer, 0-15.5-0	Kg.	.0512	100	5.12
Fertilizer, 33.5-0-0	Kg.	.0534	200	10.68
Irrigation, Pump charge	Times	1.50	7	10.50
Nonharvest Labor	m-d	1.00	27	27.00
Int. on operating k				.54
Nonharvest V.C.				84.44
Harvest Labor	m-d	1.00	15	15.00
Custom hauling	Camel Lds	.50	8	4.00
Custom hauling	Donkey Lds	.05	16	.80
Harvest V.C.				19.80
Total Variable Cost				104.24
Return over Variable Cost				(0.96)
Fixed Costs/				
Land Rent	Months	2.50	4	10.00
Total Fixed Cost				10.00
Total Cost				114.24
Return over Total Cost				(-9.04)

Table A.26. Irrigated Berseem (full-term), ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Berseem Clover	Cutting	40.00	4	160.00
Total Income				160.00
Variable Costs/				
Manure	Donkey Lds	.05	200	10.00
Land Preparation	Feddans	4.00	1	4.00
Seeds	Kala	5.00	3	15.00
Fertilizer, 0-15.5-0	Kg.	.0512	100	5.12
Irrigation, pump charge	Times	1.50	8	12.00
Nonharvest Labor	m-d	1.00	12	12.00
Nonharvest V.C.				58.12
Harvest Labor	m-d	1.00	22	22.00
Custom hauling	Donkey Lds	.05	130	6.50
Harvest V.C.				28.50
Total Variable Cost				86.62
Return over Variable Cost				73.38
Fixed Costs/				
Land Rent	Months	2.50	6	15.00
Total Fixed Costs				15.00
Total Costs				101.62
Return over Total Cost				58.38

Table A.27. Irrigated Berseem (catch-crop), ZGEK

Item	Units	Price or Cost/Unit L.E.	Quantity	Total Income or Costs L.E.
Income/				
Berseem Clover	Cutting	40.00	1	40.00
Total Income				40.00
Variable Costs/				
Manure	Donkey lds.	.05	200	10.00
Custom plow and harrow	Feddan	4.00	1	4.00
Seeds	Kala	5.00	3	15.00
Fertilizer, 0-15.5-0	Kg.	.0512	100	5.12
Irrigation	Times	1.50	3	4.50
Nonharvest labor	m-d	1.00	7	7.00
Nonharvest V.C.				45.62
Harvest labor	m-d	1.00	7	7.00
Custom hauling	donkey lds.	.05	40	2.00
Harvest V.C.				9.00
Total Variable Costs				54.62
Return over variable costs				(-14.62)
Fixed Costs/				
Land Rent	month	2.50	3	7.50
Total Fixed Costs				7.50
Total Costs				62.12
Return over Total Cost				(-22.12)

APPENDIX B - HOUSEHOLD ENERGY REQUIREMENTS

Livestock and crop byproducts provide fuel for cooking and heating. Manure, cotton stems, rice straw, maize cobs and maize and sorghum stovers are widely utilized as fuel. Fuel requirements per household for the linear programming model were estimated from present fuel use at the ZGEK site. This section will present a description of the household fuel use in the village.

Table B.1 presents the approximate heat values of some agricultural and fuel products. Notice these values assume that the fuel is dry basis and burned with 100% efficiency. These values were adjusted by assuming all byproducts were 90% dry matter and burned with 55% efficiency. Fuel oil and electricity were assumed to be utilized with 75% efficiency. These efficiency and dry matter assumptions were suggested in the Report of the First World Straw Conference (Eugene, Oregon) 1975. The heating values of the agricultural and fuel products were generated from a host of sources identified in the footnotes to Table B.1. Fuel sources not utilized in this study are included for future references.

Table B.1. Approximate High Heat Values of Some Agricultural and Fuel Products[1/]

Product	Heating Value BTU/Kg. (Dry Basis)	Reference[3/]
Agricultural Products:		
Sugarcane bagassee	17600 - 19140	1
Blood	23360	7
Buckwheat hulls	16500	7
Coffee (ground)	22130	7
Corn cobs	17160	6
Cotton ball hulls	17340	5
Cottonseed hulls	15570	5
Cotton lint	16510	5
Cotton rags	13130	7
Dung oil	33000	3
Fats (animal)	37620	7
Garbage	15400 - 23100	1
Hamp hurds	17560	7
Lard (swine)	36740	1
Linen rags	15690	7
Manures:		
Beef	14140	2
Chicken	12810	2
Dairy	15640	2
Horse	15360	2
Sheep	16870	2
Swine	16080	2
Turkey	12770	2
Newspaper	17340	7
Cottonseed oil	36740 - 37620	1
Pasteboard	13130	7
Peanut shells	19560	7
Peanut skins	22950	7
Pecan shells	19570	7
Rice hulls	14300	6
Sawdust briquets	17820	7
Straw - stover	11000 - 14300	1
Wool rags	19530	7
Woods:		
Ash	18660	7
Beech	18900	7
Birch	18890	7
Douglas Fir	19910	7
Elm	18720	7
Hemlock	18960	7
Oak	18300	7
Poplar[1/]	17240	7
Redwood	20280	7

Table B.1 (Continued)

Product	Heating Value BTU/Kg. (Dry Basis)	Reference[3/]
Fuel Products:		
Alcohol (Methyl)	25300	3
Alcohol (Ethyl)	36740	3
Bituminous coal	28600 - 35200	4
Butane	46690	3
Charcoal	17500	7
Diesel, (No. 1)	43120	3
Fuel oil, (No. 2)	44330	3
Gasoline	44660	3
Kerosene	43630	3
Lignite	24200 - 26400	3
Methane	52490	3
Natural Gas	49360	3
Propane	47500	3
Electricity	3413/kilowatt hour	7

1/ The primary source for the values and references is "Fuel Heat Values of Poultry Litter and other Farm Wastes" by R. D. Mayo (Msc. Thesis, University of Arkansas), 1977.

2/ Poplar is used as a proxy for cotton stems.

3/ The data were taken from the references following this appendix.

The typical small farmer uses gas and electricity for lighting, and gas complemented with cotton stems, rice straw, maize stover and cobs, and manure for cooking and heating. The contribution of each agricultural fuel and electrical product utilized are reviewed in Table B.2.

Table B.2. Contribution of Agricultural, Fuel and Electrical Products Utilized in the ZGEK Households

Product	Contribution to Household Energy Requirement %
Cotton stems	29
Rice straw	4
Maize stover	8
Maize cobs	4
Manure	7
Gas, fuel oil	48
Electricity 1/	-
Total	100

1/ Electricity accounts for less than 1% of the energy supplied.

Utilizing the unadjusted B.T.U. values of Table B.2 the small farmers surveyed were found to utilize 38 million BTU per household. Adjusting this figure for dry matter content and efficiency, the small farm household utilized 19 million BTU's, or approximately 6.5 million BTU's per capita per year.1/ The household estimate of 19 million BTU's is utilized as the energy requirement for both sites.

1/ An Energy Consultant to Control Data Corporation, Dr. Richard Jordon, in a seminar at Winrock International in December, 1979 indicated that approximately 6 million BTU's were utilized per capita in third world countries.

Fuel oil, available at a government fixed price of LE .025 per liter, is relatively inexpensive and consequently widely utilized as fuel for cooking and lighting. Essentially all the cotton stems, rice straw, manure and maize stovers and cobs are utilized as fuel, contributing over half of the fuel requirements. In Musha, only sorghum stovers, cotton stems and manure are utilized for fuel and, as in ZGEK, contribute a majority of the fuel supplied.

The most recent change for both villages is a fairly reliable source of electricity. While it remains an insignificant energy source among small farmers, it is a significant energy source in the village as a whole. It is currently supplied to the villages for LE .03 per kilowatt hour.

REFERENCES - APPENDIX B

1. Agricultural Engineer's Handbook by C. W. Richey. McGraw-Hill Book Company, Inc. 1961, p.626.

2. Azvedo, J., and Stout, P.R., Farm Animal Manures: An Overview of their Role in the Agricultural Environment, University of California Agricultural Experiment Station, Manual 44. p. 86.

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6. Horsefield, B., et al. "Drying Energy from Corn Cobs: A Total System", and "Producers Gas Generation", Manuscripts from the Department of Agricultural Engineering, University of California, Davis, 1976.

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APPENDIX C

FERTILIZER NUTRIENTS IN SELECTED CROP AND LIVESTOCK BYPRODUCTS

Livestock and crop byproducts, currently utilized as fuel or livestock feed, can potentially be used as fertilizer. It is outside of the scope of this study to include a discussion and analysis of composting and other methods employed to make crop residues and manure available as fertilizer. The data provided by the Soil and Water Research Institute in Cairo presents the nitrogen and phosphate available as fertilizer from the major village crops. Table C.1 summarizes these data. The use of crop byproducts as fertilizer must compete against its use as fuel and animal feed. In the linear programming model, even with no processing and application costs, the optimal solutions found none of the crop byproducts utilized as fertilizer. Commercial fertilizers, available from the government and the free market, plus manure supply the required plant nutrient. The opportunity cost for these crop byproducts to be used as fertilizer ranged from a low of LE 36 per ton for sorghum stovers to a high of LE 50 per ton for wheat straw. A substantial increase in the price of fertilizer would be necessary to make their use as fertilizer economically feasible.

The organic matter of the manure is a quality not captured by this model. Egyptian soils tend to be low in organic matter. The high temperatures quickly reduce the available organic matter. In Musha, manure is applied only to cotton while in ZGEK manure is applied to all crops. Its use as fertilizer successfully competes against its use as fuel. In fact, only half of the farmers in Musha and two-thirds of the farmers in ZGEK indicated that manure is still utilized as fuel.

Table C.1. Nutrients Available from Livestock and Crop Byproducts on an "As Utilized" Basis.[1/]

Byproduct	Available Nitrogen	Available Phosphate
Berseem Straw	.9	.1
Cotton Stems	.5	.1
Horsebean Straw	.9	.1
Lentil Straw	.9	.1
Maize Stalks	1.1	.1
Manures:		
Cattle (dried)	1.0	1.5
Horse (dried)	2.0	1.5
Sheep (dried)	2.3	1.5
Poultry (dried)	5.0	3.0
Rice Straw	.5	.1
Sorghum Stover	1.1	.1
Wheat Straw	.3	.1

[1/] These estimates were supplied by the Soil and Water Research Institute, Senior Researcher of Soil Microbiology, Dr. Alaa El-Din.

APPENDIX D

LIVESTOCK NUTRIENT SUPPLY AND DEMAND CALCULATIONS

The supply of nutrients from crop enterprises and purchased feeds is estimated from survey data. The supply of nutrients from crop enterprises is calculated by multiplying the number of feedans times the yield per feddan times the TDN and DP available per kilogram of each feedstuff. The supply of nutrients from purchased feeds is calculated by multiplying the quantity of feed purchased times the TDN and DP available per kilogram. These estimates are extrapolated over the small farmer population, thus depicting the quantity of nutrients supplied by small farms to the livestock. Tables D.1 and D.2 summarize the quantities of nutrients available from crops and purchased feedstuffs in Musha and ZGEK, respectively.

Table D.1. Contribution of the Crop Enterprises and Purchased Feeds to Livestock Nutrition, Musha, 1979

Feedstuff	Total Feddans	Supply Per Feddan (T)	Total Supply (T)	As Fed Basis TDN (%)	As Fed Basis DP (%)	TDN Supplied (T)	DP Supplied (T)
Crop Production:							
Wheat Bran	988	.082	81.0	62	12	50.2	9.7
Wheat Straw	988	1.418	1401.0	41	004	574.4	5.6
Horsebean Straw	312	1.035	322.9	43	026	138.8	8.4
Lentil Straw	754	.698	526.3	47	019	247.4	10.0
Berseem Straw	494	.833	411.5	42	017	172.8	7.0
Berseem Forage	494	18.000	8892.0	10	022	889.2	195.6
Subtotal						2072.8	236.3
Purchased Feeds:							
Mixed Ration			349.45	58	127	202.8	44.5
Wheat Bran			574.29	62	12	355.4	68.8
Horsebeans			33.34	80	237	26.7	7.90
Cotton Seeds			28.82	91	15	26.2	4.3
Sorghum			1.60	74	06	1.2	.10
Berseem Forage			215.00	10	022	21.5	4.7
Subtotal						633.8	130.3
TOTAL						2706.6	366.6

Table D.2. Contribution of Crop Enterprises and Purchased Feeds to Livestock Nutrition, ZGEK 1979

Feedstuff	Total Feddans	Supply Per Feddan (T)	Total Supply (T)	As Fed Basis TDN (%)	As Fed Basis DP (%)	TDN Supplied (T)	DP Supplied (T)
Crop Production:							
Wheat Bran	463	.09	41.7	62	12	25.9	5.0
Wheat Straw	463	1.58	717.7	41	004	294.3	2.9
Berseem Forage 3/	622/159	24./6.	15882.0	10	022	1588.2	349.4
Subtotal						1908.4	357.3
Purchased Feeds:							
Mixed Ration			108.4	58	127	62.9	13.8
Wheat Bran			83.2	62	120	51.6	10.0
Yellow Maize			71.2	81	067	57.7	4.8
Horsebeans			25.1	80	237	20.1	5.9
Barley			15.9	74	087	11.8	1.4
Wheat Straw			621.9	41	004	255.0	2.5
Others 2/			5.6	75	031	4.2	.2
Berseem Forage 1/			2227.1	1	022	222.7	49.0
Subtotal						686.0	87.6
TOTAL						2594.4	444.9

1/ Assuming the kirat of berseem in based for 4 cuttings with 6 tons of berseem per cutting.

2/ Other includes primarily rice screenings.

3/ Berseem forage is produced either as full term or catch crop. In this village 622 feddans of full term and 159 feddans of catch crop berseem are utilized.

Nutrient Requirements

The nutrient demand side is estimated for each livestock species. The produciton parameters employed to estimate nutrient demand were generated from survey information. This section will discuss the production parameters and the basic format used to compute nutrient requirements.

Buffalo and cattle are the most significant livestock holdings in the two villages. In Musha and ZGEK mature buffalo and cattle are classified as being in lactation, gestation or maintenance. The distribution is summarized in Tables D.3 - D.5. In Musha, buffalo and cattle are utilized for meat, milk and draft power production. Diagrams D.1 - D.4 depict the distribution of lactation milk yields at both sites. Diagrams D.5 and D.6 depict the distribution of hours of draft power supplied in ZGEK.

In Musha and ZGEK the nutrient requirements for mature buffalo and cattle are estimated from the parameters summarized for Musha and ZGEK livestock production traits. Daily nutrient requirements are estimated using Nutrient Requirements for Dairy Cattle, National Research Council. The nutrient requirement for work utilized the following widely used formula:[1/]

$$ME_w, \text{ Mcal/day} = 1.640 \times 1.27 \times HP \times Hr$$

where

ME_w, = metabolizable energy for work
Mcal = mega calories
HP = horse power
Hr = hours

Mcal per day is coverted to TDN by dividing it by 3.65. Estimates of the horse power exerted by cattle and buffalo were taken from The Employment of Draught Animals in Agriculture, (FAO 1972). Cattle and buffalo are assumed to produce .5 and .7 horsepower and are assumed to work 310 hours per year with 30% of the draft time in berseem season.

1/ Nguyen, T.D. and H.A. Fitzhugh, Winrock Model. Unpublished Manuscript. Winrock International Livestock Research and Training Center, Morrilton, Arkansas, 1977.

Table D.3. Percentage of Mature Buffalo and Baladi Cattle in Lactation, Gestation1/ and Maintenance by Month-MUSHA2/

	Lactation	Gestation	Maintenance
January	54	16	30
February	62	8	30
March	63	7	30
April	63	7	30
May	57	7	36
June	55	7	38
July	49	6	45
August	34	13	53
September	25	15	60
October	30	15	55
November	32	28	40
December	39	30	31

1/ Last 60 days of Gestation.

2/ Data from Farmer Interviews.

Table D.4. Percentage of Mature Buffalo Cows in Lactation, Gestation1/ and Maintenance by Month-ZGEK2/

	Lactation	Gestation	Maintenance
January	24	12	64
February	30	14	56
March	31	12	57
April	40	4	56
May	38	4	58
June	39	6	55
July	37	4	59
August	32	4	64
September	23	5	72
October	24	5	71
November	14	13	73
December	17	17	66

1/ Last 60 days Gestation

2/ Data from Farmer Interviews

Table D.5. Percentage of Mature Balady Cows in Lactation, Gestation1/ and Maintenance by Month-ZGEK2/

	Lactation	Gestation	Maintenance
January	18	14	68
February	20	24	56
March	28	21	51
April	41	9	50
May	45	7	48
June	45	7	48
July	42	5	53
August	40	3	57
September	32	4	64
October	19	5	76
November	15	10	75
December	15	12	73

1/ Last 60 Days of Gestation

2/ Data from Farmer Interviews

Diagram D.1 Distribution of lactation milk yield by 250 kilogram interval for 92 lactating Buffalo in ZGEK, 1979.

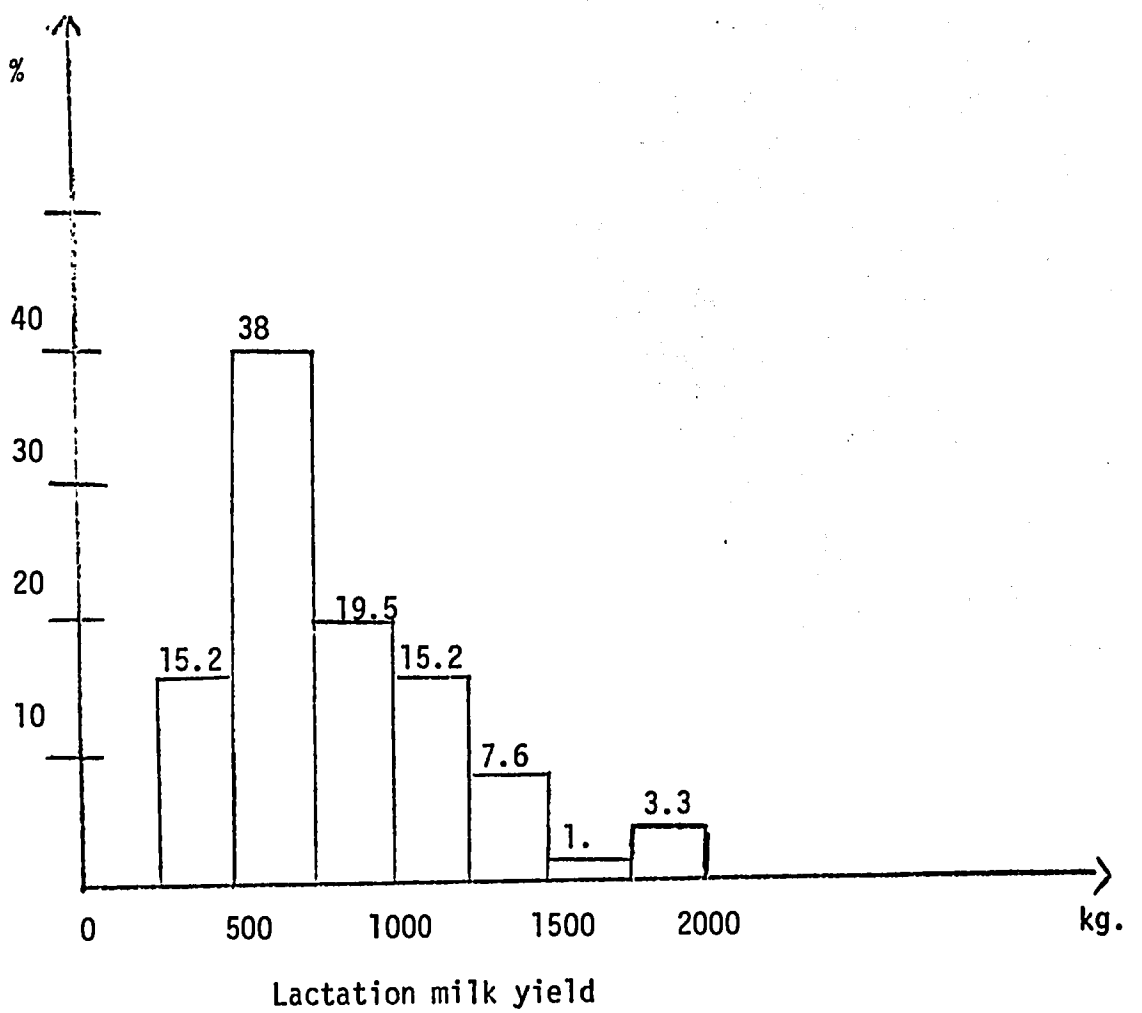


Diagram D.2. Distribution of lactation milk yield by 250 kilogram interval for 137 lactating Baladi cattle in ZGEK, 1979.

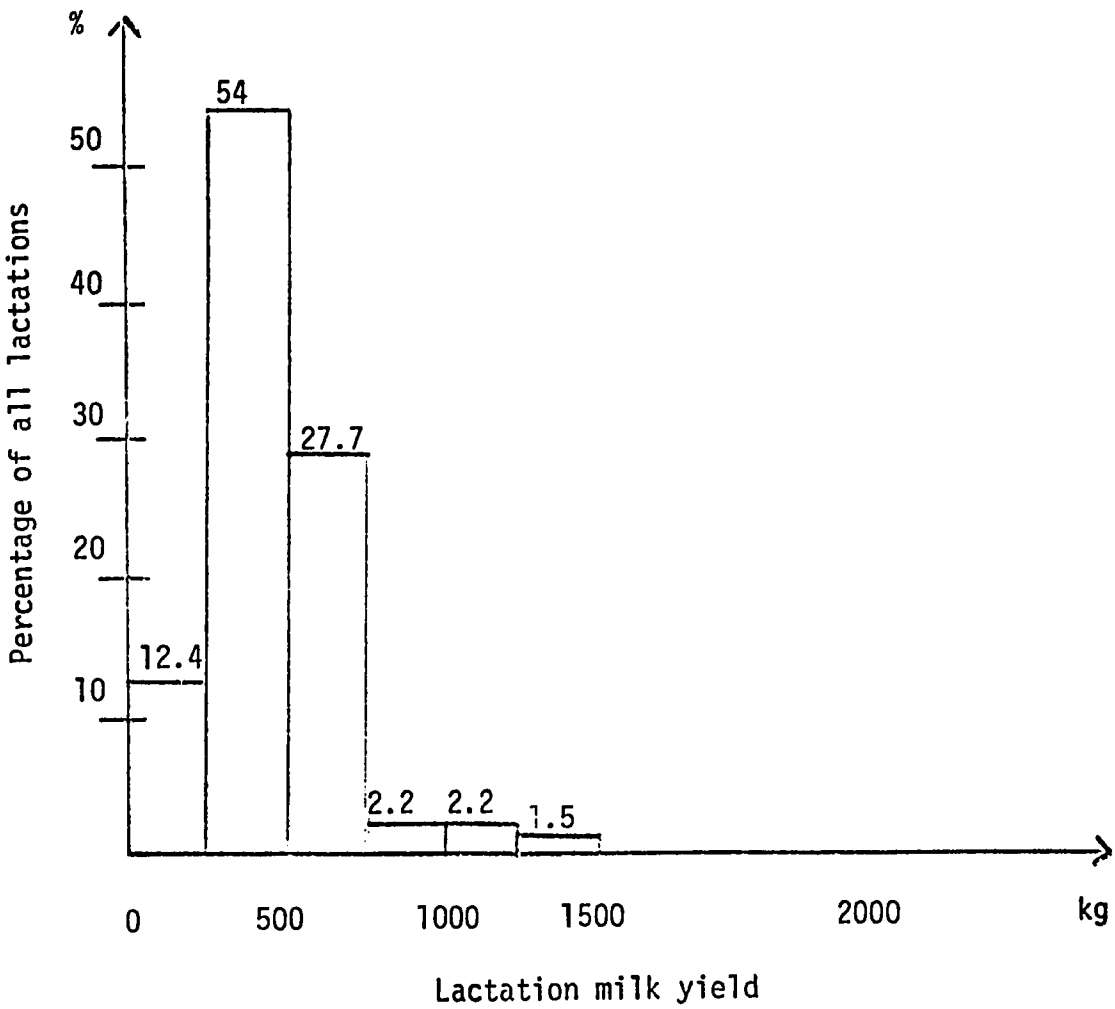


Diagram D.3 Distribution of lactation milk yield by 250 kilogram interval for 76 lactating Buffalo in MUSHA, 1979.

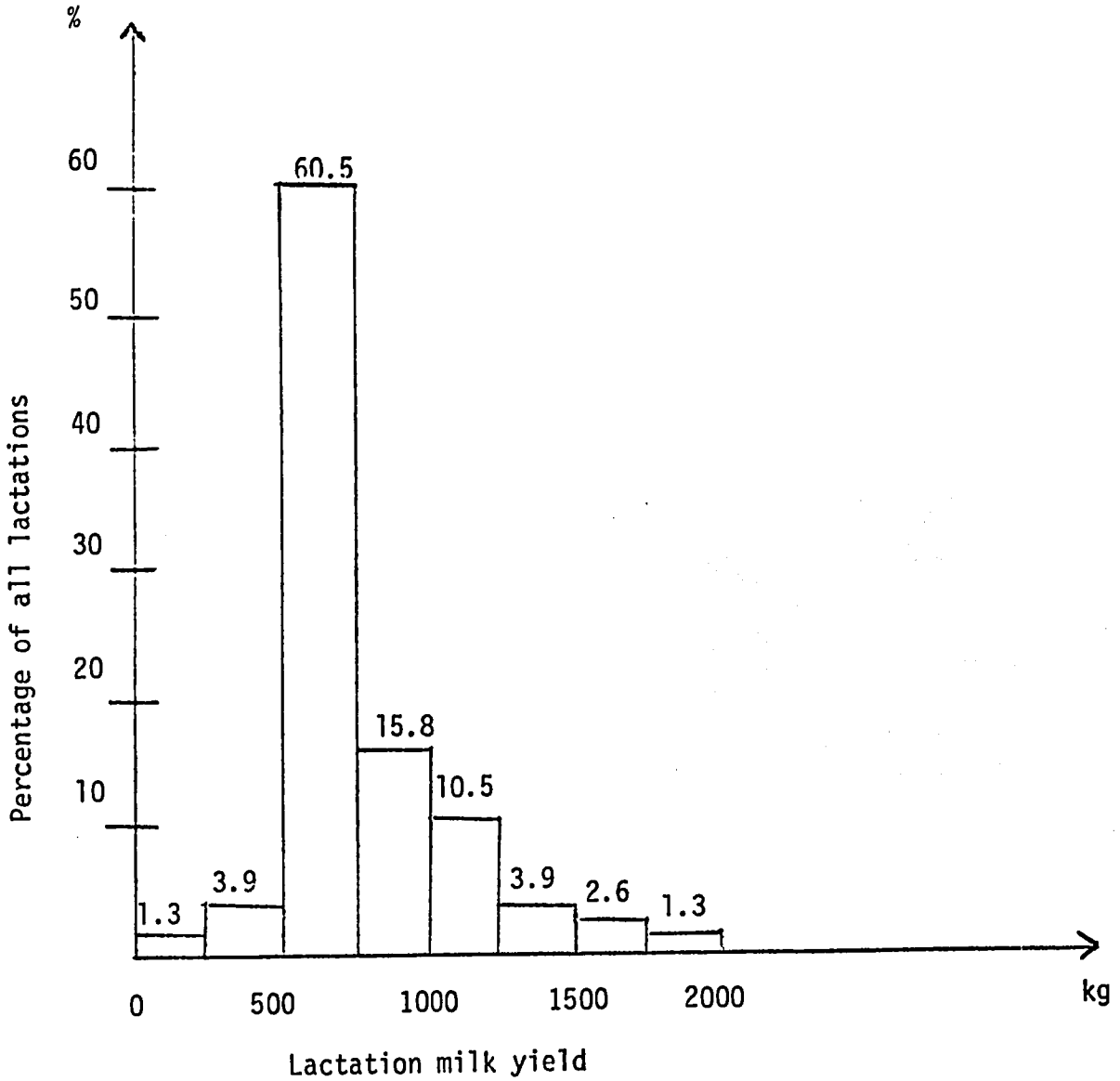


Diagram D.4 Distribution of lactation milk yield by 250 kilogram interval for 12 lactating Baladi cattle in MUSHA, 1979.

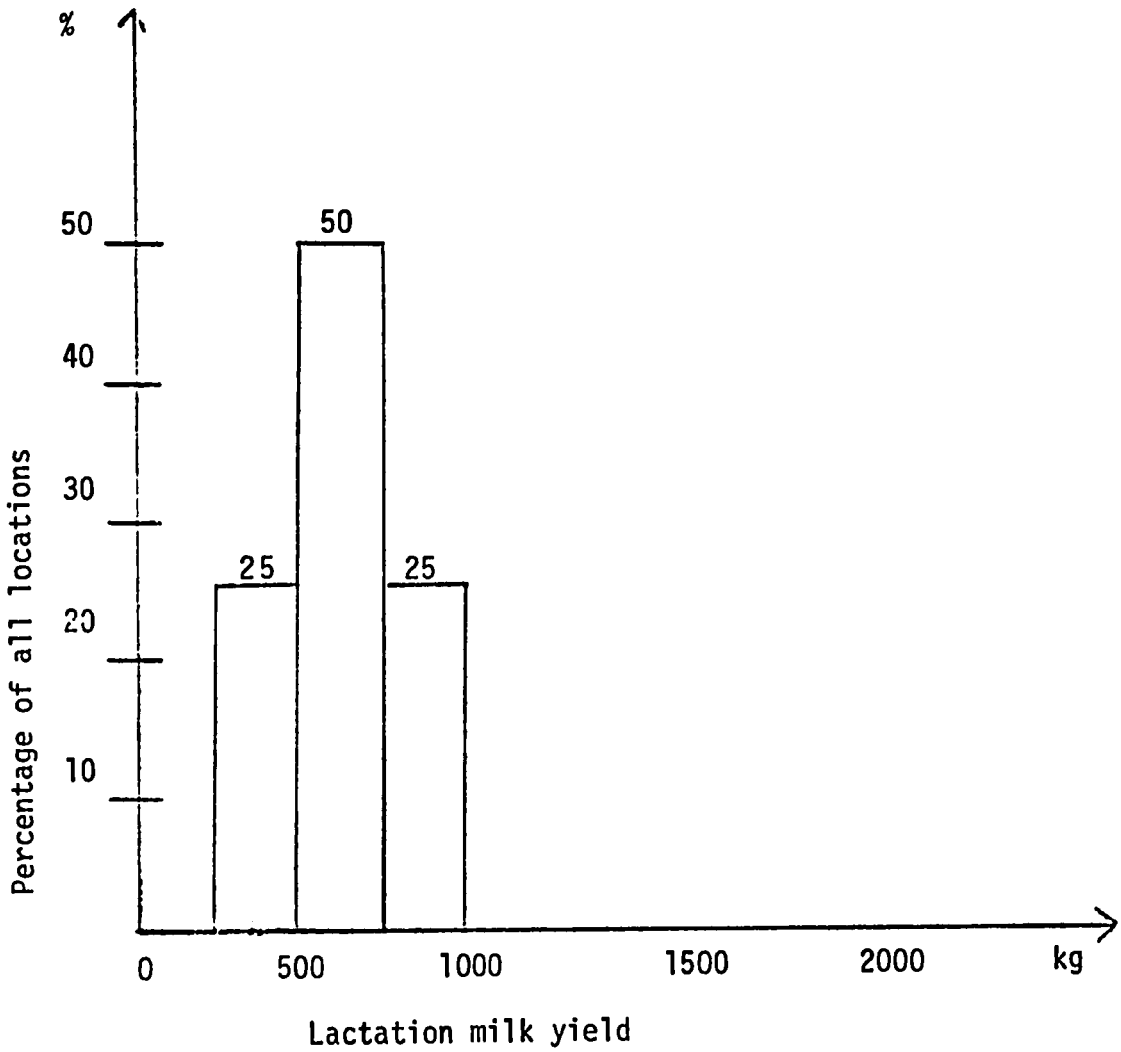


Diagram D.5 Distribution of the hours of draft use supplied by buffalo in 100 hour intervals in ZGEK, 1979.

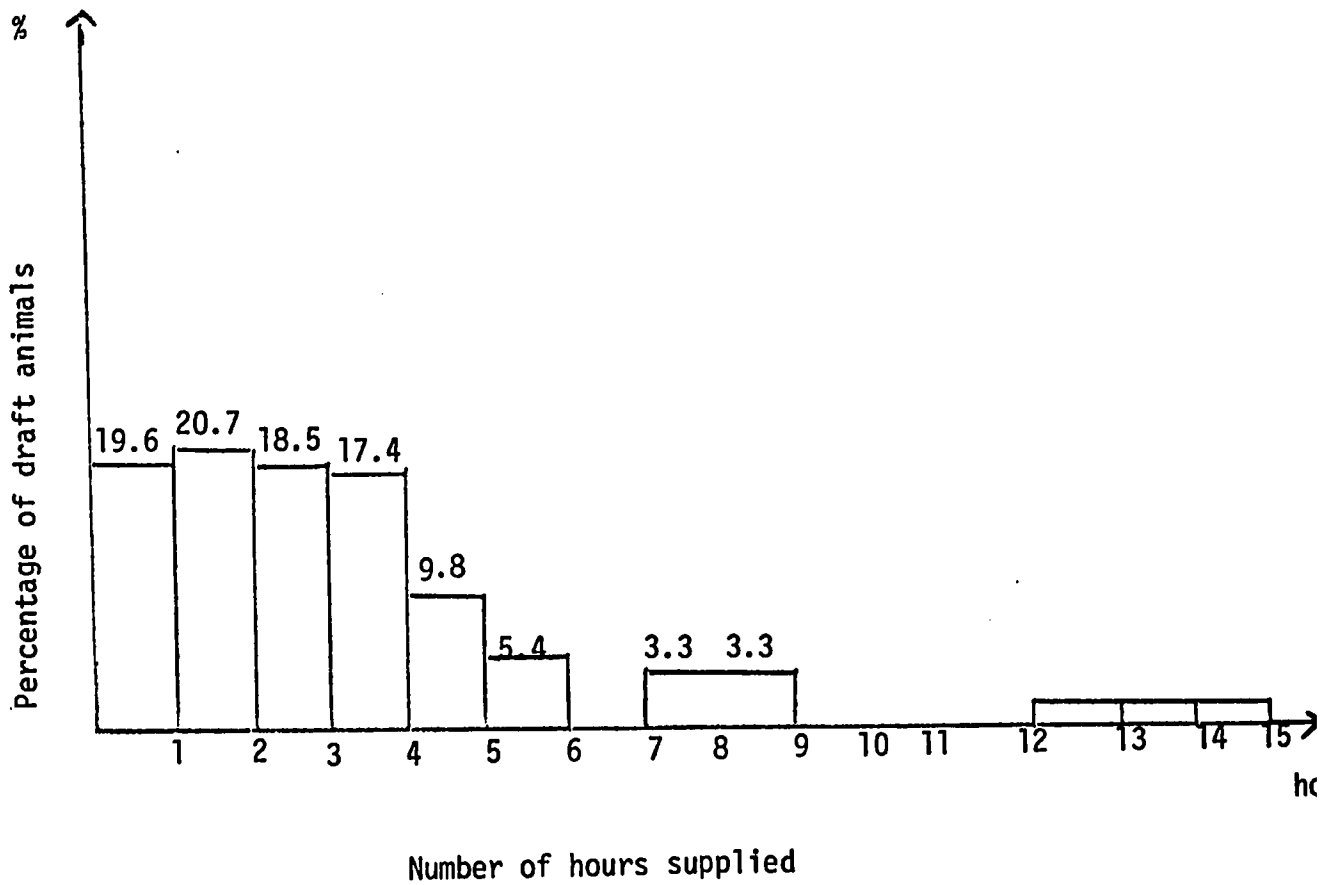
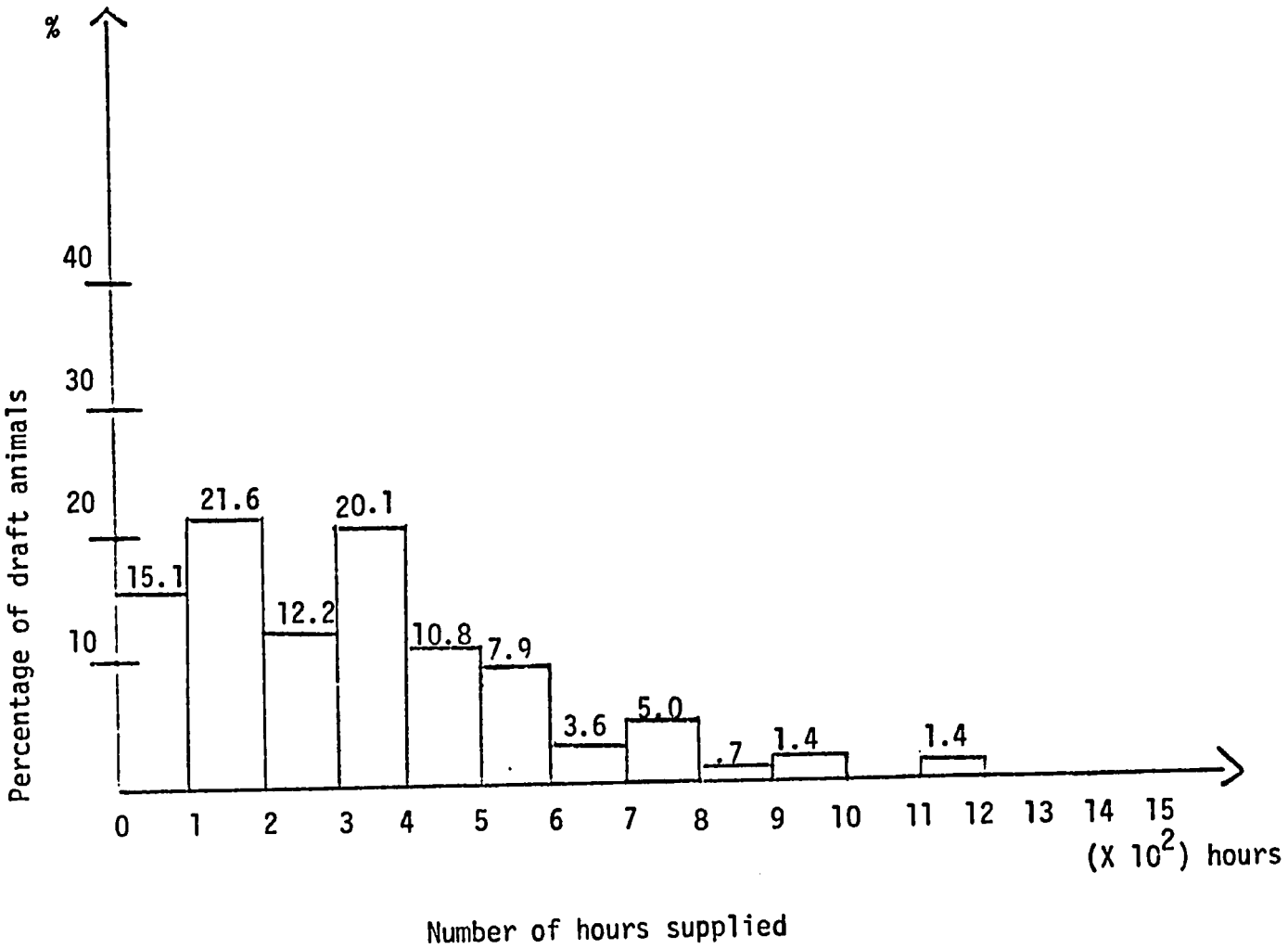


Diagram D. 6 Distribution of the hours of draft use supplied by Baladi cattle in 100 hour intervals in ZGEK, 1979.



1/ This includes only animals used for draft, therefore, 0-250 includes no animals not used for draft power.

Donkeys

Daily nutrient requirements of donkeys were estimated using two primary sources, (1) The Employment of Draught Animals in Agriculture FAO, 1972 and (2) estimates from the Nutritional Status of Livestock in Egypt, by H. R. Kotb and others, 1974. A donkey weighting 225 kg, requires 1.8 kg of TDN and .27 kg of DP daily.

Sheep and Goats

Requirements for Total Digestible Nutrients (TDN) and Digestible Protein (DP) for sheep and goats were estimated using tables from Nutrient Requirements of Sheep, 1975, National Academy of Sciences. The mature ewe sheep was estimated to weigh 40 kg., produce young in early berseem time, (Mid-February), and be bred in late summer. Goat requirements were estimated on the basis of a mature goat equalling a 35 kg doe. The requirements are summarized in Table D.6.

Table D.6. Daily TDN and DP Requirements of Sheep and Goats on a Monthly Basis.

	40 Kg Ewe		Stage of Production	35 Kg Doe	
	TDN (kg)	DP (kg)		TDN (kg)	DP (kg)
January	.89	.08	Gestation	.86	.07
February	1.19	.10		1.05	.095
March	1.39	.12		1.21	.11
April	1.19	.10	Lactation	1.05	.095
May	.89	.08		.86	.07
June	.5	.05		.42	.03
July	.5	.03		.42	.03
August	.5	.03	Maintenance	.42	.03
September	.5	.03		.42	.03
October	.61	.04		.44	.03
November	.61	.04	Early Gestation	.44	.03
December	.61	.04		.44	.03

APPENDIX E

EGYPTIAN SMALL FARM SYSTEM

The Egyptian small farm system includes crop and livestock enterprises. The crop enterprises supply products for sale on the market, consumption in the household and use by livestock holding. The livestock enterprises supply milk, meat, manure, draft power and transportation to the household, crop enterprise and the market. This appendix will briefly discuss the interaction of the crop and livestock interprises at both village sites.

The crop enterprises account for a substantial portion of the total value of household consumption and cash returns. In Musha, mechanical power satisfies essentially all draft power needs, 80-90% of all fertilized is inorganic commercial fertilizer, 60-80% of the labor is hired, and all custom hauling needs are supplied by camels. In ZGEK, mechanical power satisfies around 60% of the draft power needs, applied fertilizer is 2/3 inorganic commercial fertilizer, 40-60% of the labor is hired and custom hauling needs are supplied by camels. Two primary differences were highlighted on the input side, i.e., the use of draft power in ZGEK and the relative importance of inorganic fertilizer in Musha.

The crop products flow to the market, household and livestock feed supply. The most significant flow is to the government procurement agencies, 85-90% of the crop sales. Flows to the household and feed supply were less well defined as products retained for the household and feeding sector are consumed or are used for in-kind payment to hired labor. As much as 50% of the total value of products retained for household may flow out as in-kind payments.

Livestock account for a less significant portion of the total value of household consumption and cash returns. In Musha, feed supplies from

the government account for 10-15% of the total expenditures on feed. Products grown on the farm account for 80 and 60% of the TDN and DP supplied to the livestock, respectively. In ZGEK, feed supplies from the government account for less than 10% of the total expenditures on feed. Products grown on the farm account for 65 and 48% of the TDN and DP supplied.

Milk is the most significant product in both villages accounting for over 40 and 30% of the value of livestock production in Musha and ZGEK, respectively. In Musha, meat and manure account for 35 and 25% of the total value of livestock production, respectively; while in ZGEK, meat, manure and draft power account for 36, 19 and 15% of the respective total value of livestock production.

APPENDIX F

NONCONVENTIONAL LIVESTOCK FEEDSTUFFS

Nonconventional Feedstuffs are those products currently not widely utilized as animal feeds. This section considers the potential of selected agroindustrial byproducts by attempting to quantify the resources available and determine their value to the small farmer, by calculating what the small farmer could afford to pay for these feeds.

Byproduct Availability

The agroindustrial byproducts considered in this study originate from sugar, rice, fruit, vegetable and livestock product processing. The most significant cources are the sugar and rice processing companies producing 90% of the potential TDN available by the agroindustrial firms selected in this study.

The availability of the various byproducts was generated from 4 primary sources: (1) Interviews with company officials, (2) Food and Agricultural Products Processing Industries in Arab Republic of Egypt by Dr. Mohmoad Ali Saleh, (3) FAO and (4) FAS statistics. The nutrient composition for these byproducts were taken from the sources indicated in the introduction and the Animal Production Department of the University of Alexandria.

The sugar processing plants processed an average of 4 million tons of raw sugar cane in 1978. Assuming this is an average processing figure, 11% and 5% of the weight of raw sugar cane is coarse and fine bagasse, respectively, and 3% is molasses. The bagasse is currently used as fuel in the sugar factories or sold to paper companies for making particle board. The molasses is transferred to the government feed processing companies or sold on the export market. The 1979 molasses export price, F.O.B. Alexandria, was LE66.50/Ton.

In 1978, the rice mills processed 2.2 million tons of paddy rice (FAO 1977). The byproducts, rice bran and rice hulls, constitute 2% and 18% of paddy rice weight, respectively. The rice bran is sold to the oil and soap companies where oil is extracted leaving from 80-90% of the bran as animal feed. It is currently utilized by the feed companies in producing animal feed. The rice hulls are currently utilized for fuel, brickmaking, shoe soles and as a cleansing agent. The rice mills visited indicated hulls were sold at LE10-15/ton. The hulls have potential as animal feed only after ensiling or treatment with alkali. A portion of the brokens from rice milling are sold to starch and yeast companies. Taking 1973 as an average production year, the starch and yeast companies processed 20,000 tons of rice of which 63% was starch and 10% useable gluten. The gluten is currently not being utilized and the starch and yeast company in Alexandria was stockpiling it. The fruit and vegetable canning companies processed 32,000 tons of fruits and vegetables in 1978. A weighted average of the products processed indicates that 46% of the processed fruits and vegetables is byproducts. Following a standard suggested by scientists evaluating the byproducts at the University of Alexandria, the byproducts are assumed to be 50% TDN, 10% DP (on a dry matter basis) and 15% DM. The byproducts are currently available to farmers at essentially no cost, but there remains unused supplies which are simply disposed as waste.

Wine production utilizes 25,000 tons of grapes in producing 20 million litres of wine annually. Winery pomace, the byproduct, is available and equal to 10% of the weight of the raw grapes. Currently the pomace is made available to local farmers for LE 15/ton.

Beer production utilizes grain in the production of 360,000 hectolires of beer in 1977. Assuming that 10 tons of dry spent grain and 400 kilograms of dry yeast are provided for every 1000 hectolitres of beer produced, 3600 tons of dry spent grain and 144 tons of dry yeast are made available. The brewers waste is currently made available to local farmers.

In 1977, 134,000 tons of white cheese were produced. Assuming 25% of the original raw milk is the white cheese product, over 400,000 tons of whey remains. The whey is largely unutilized with it being disposed as waste.

Slaughterhouse wastes provide potential for developing meat meal, blood meal, feather meal and bone meal. Utilizing coefficients generated for Africa on the percentage of meat, blood, feather and bone meal per kilogram of total carcass weight (Chesnust and Mayer, 1978), the following quantities are potentially available from the slaughter of all livestock in Egypt, which in 1976 totaled 406,000 tons (FAO, 1976) (carcass weight): 15600 T of meat meal, 3900 T of blood meal, 5200 T of feather meal and 9600 T of bone meal.

The above availability estimates warrant extreme caution. In all cases, the most recent production estimates were utilized. However, these estimates have wide fluctuation from year to year and from one source to another.

Table F.1 summarizes the quantities of the forementioned byproducts available and their respective livestock nutrient contribution. This selected set of agroindustrial byproducts indicates their significant quantities of livestock nutrients available. However, with exception of the livestock byproducts and rice gluten, these byproducts are currently being utilized as animal feeds, as fuel, or being exported. These figure give little, if any, indication of increases in nutritional value which could be possible through selected treatment/processing technologies. This was beyond the scope of this project.

Significant potential is available for utilizing meat, blood, feather and bone meal by the small farmer. The other resources have potential as animal feed, but where they are already utilized for fuel or export they cannot currently compete as livestock feed. The only exception to this case would be sugar cane bagasse, but bagasse must be ground before feeding. This cost alone would prevent it from most efficiently being utilized as animal feed.

Table F.1. Estimated Agroindustrial Byproduct Nutrient Availability, 1979

By-products/ Units	Quantity Available (T)	Dry Matter Content (%)	DM Matter (T)	TDN Content (%)	Total TDN (T)	DP Content (%)	Total DP (T)
Molasses	120,000	77	92400	96	88700	034	3140
Coarse bagasse	420,000	915	384000	281	107000	0	0
Fine bagasse	180,000	915	165000	281	46000	0	0
Rice bran	45,000	901	40545	756	30650	075	3040
Rice hulls	414,000	924	380000	11	42000	002	760
Rice gluten	2,200	91	2000	83	1700	049	100
Canning waste	15,000	15	2300	50	1700	10	230
Garlic skins	2,000	15	300	5	150	1	30
Onion waste	4,200	15	630	5	320	1	60
Winery pomace	2,500	13	325	4	130	022	10
Brewer's waste	3,700	24	890	67	600	168	150
Cheese whey	400,000	069	27600	87	24000	08	2200
Meat Meal	15,600	935	14586	76	11000	52	7500
Blood Meal	3,900	893	3480	659	2300	637	2200
Feather Meal	5,200	946	4900	657	3200	645	3160
Bone Meal	9,600	945	9070	-	-	086	780
Total					358950		23360

Table F.2. Comparison of Current Use Prices and the Shadow Prices of the Byproduct Potentially Available on Representative Farms, ZGEK

Byproduct	Shadow Price as Livestock Feed	Current Use Price	Current Use
	(LE/T)	(LE/T)	
Molasses	45.00	60.00	Export & Livestock Feed
Bagasse	12.00	9.50	Fuel
Rice bran	54.50	50.00	Livestock Feed
Rice hulls	5.00	14.00	Fuel
Rice gluten	50.00	n.u.	n.u.
Cannery Waste	9.00	0	Livestock Feed
Winery pomace[1/]	13.50	15.00	Livestock Feed
Brewer's Waste	21.00	n.a.	Livestock Feed
Whey	5.00	n.u.	n.u.
Meat meal	202.50	n.a.	n.u.
Blood meal	226.00	n.u.	n.u.
Feather meal	240.00	n.u.	n.u.
Bone meal	32.00	35.00	Livestock Feed

1/ DM - .5 of product sold.

n.a. = information is not available.

n.u. = the byproduct is not utilized.