ASSESSMENT OF FOOD PRODUCTION POTENTIAL: RESOURCES, TECHNOLOGY AND ENVIRONMENT-- A CASE STUDY OF KENYA

M.M. Shah
G. Fischer

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A-2361 Laxenburg, Austria

PREFACE

Understanding the nature and dimension of the food problem and the policies available to alleviate it has been the focal point of the Food and Agriculture Program at the International Institute for Applied Systems Analysis (IIASA) since the program began in 1977.

In the program we are not only concerned with policies over a 5 to 15 year time horizon, but also with a long term perspective to obtain a comprehensive understanding of the food problems of the world.

As we anticipate over the coming decades a technological transformation of agriculture which will be constrained by resource limitations and which could have serious environmental consequences, a number of important questions arise.

(a) What is the stable, sustainable production potential of the world? of regions? of nations?

(b) Can mankind be fed adequately by this stable, sustainable production potential?

(c) What alternative transition paths are available to reach desirable levels of this production potential?

(d) What are sustainable, efficient combinations of techniques of food production,

(e) What are the resource requirements of such techniques?

(f) What are the policy implications at national, regional global levels of sustainability?

Stability and sustainability are both desirable properties from the considerations of inter-generational equity as well as of political stability and peace.

We hold environmental considerations to be of critical importance in answering the questions posed.

This report presents the results of a case study of Kenya carried out as a part of the FAO/UNFPA Project INT/513, Land Resources for Populations of the Future, being carried out in collaboration with the Food and Agriculture Program, IIASA.

The results are preliminary and should be regarded as the first approximation. At the present time a detailed case study of Kenya (Phase 2, FAO/Kenya/IIASA Study) is being carried out. As understanding of the ecological and technological limits of food production is a critical part of agricultural development planning, this report highlights the results for Kenya and the methodology of evaluating agricultural production potential, population supporting capacity and soil degradation hazards. Policy relevance and implications for Kenya are briefly discussed.

This preliminary report in collaboration with the Land and Water Division of the FAO is the first of a series on the potentials and limits of food production in developing countries.

Kirit S. Parikh
Acting Program Leader
Food and Agriculture Program
IIASA

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CONTENTS

1. Introduction

Kenya became independent in 1962 and from the outset the use of natural resources, namely, climate and land has been an area of concern.

> *"While many of our domestic resources are not fully utilized, still others are being dissipated, wasted and in some cases destroyed. The use of outmoded farming techniques may result in erosion; the cutting of wind breaks and the burning of vegetation may turn fertile areas into desert".*
>
> *"The heritage of future generations depends on the adoption and implementation of policies designed to conserve natural resources......The thoughtless destruction of.....productive land threatens our future and must be brought under control. A national land-use policy must be created."*
>
> "African Socialism and its Application to Planning in Kenya", Government of Kenya Sessional Paper No.10, 1965.

Recent demographic estimates suggest that Kenya has one of the highest* population growth rates in the world. This coupled with the domestic requirements for food, industrial raw materials and export crops requires sound policies of agricultural land use especially if sustainability of production is to be ensured in the long run. What are the ecological potentials of agricultural production in Kenya? What are the levels of population that can be supported by the land and climate base? What trade patterns will be necessary to ensure that the food demand in the country will be met in the future? These are some of the central issues of agricultural development planning in Kenya.

The ecological potential production depends on a number of factors, namely, specific crops, level of input (management and technology), climate, rainfall, radiation, soil and associated characteristics, etc. The last four factors represent the natural resources under which agriculture is practiced. The evaluation of potential production should be based on the use of these natural resources for a specific use (crop) and under the assumption of alternative technologies. The Agro-ecological zone inventory (FAO, 1979) has been created specifically for this purpose. The features of this inventory will be described in Section 2.

1.1. Previous Work: Ecological Categorization in Kenya

Kenya has a land area of 575,000 sq. ha. and 8,000 sq. ha of open water. The country has a wide range of climatic, topographic and soil conditions. For example, conditions range from high rainfall tropical forests to afro-alpine areas to deserts. The wide range of conditions requires and at the same time makes it difficult to categorize the natural resources base into agro--climatic--ecological zones. One of the first and to date most widely used classifications is due to Pratt and Gwynne, 1965.

1.1.1. Ecological Zones (Pratt and Gwynne, 1965)

Six broad zones were categorized and the classification was based on moisture indices. The zones were also related to climate, vegetation and land-use. This zoning has been widely used in Kenya and a brief description of each of the zones is given below.

Zone I: This extends to some 800 km^2 at high altitude above the tree line. Vegetation is moorland or grassland, but barren land is common. (No agricultural potential).

Zone II. This covers about 53,000 km^2 and embraces the bulk of Kenya's indigenous and planted forests. The agricultural potential is high, particularly in the highlands. Tea, coffee and pyrethrum are important cash crops at higher altitudes; livestock can be kept intensively on leys with carrying capacity up to one stock unit per half ha. (High Agricultural Potential).

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* 3.9%, Economic Survey, 1979, Central Bureau of Statistics, Nairobi.

Zone III. This covers about 53,000 km^2. The zone contains most of the large scale mixed farming areas in which hybrid maize, wheat and barley are important crops. In smallholder areas, maize is the dominant crop; cotton, groundnuts, pulses and oilseeds are also grown, and have considerable potential for expansion and improved productivity. Livestock can be kept intensively on leys with carrying capacities similar to Zone II. (Medium Agricultural Potential).

Zone IV. This covers about 53,000 km^2. Commerical ranching on well managed natural pasture can support one stock unit on four ha or less. Subsistence crop farming and livestock are important in smallholder areas. Drought-escaping Katumani maize has been developed for this area but, like cotton, pulses and oilseeds which are grown in the area, the considerable expansion potential requires increased research. (Marginal Agricultural Potential).

Zone V. This covers just over 300,000 km^2. The zone is the focus of many of the present and proposed livestock development programs. Increasing subsistence - oriented shifting cultivation reflects population pressure on better lands, and the risk of crop failure is great. (Moderate range potential).

Zone VI. This zone extends to about 112,000 km^2 in northern Kenya. Sparse and erratic rainfall, giving flush growth of predominantly annual grass species, leads to the nomadism of the pastoral people of the zone. (Marginal range potential)

According to the above classification only about 7% of land area has "good" agricultural crop production potential, 4.5% has marginal potential and the rest is rangeland with large extents of semi-desert areas.

1.1.2. Agro-economic Zones, Ministry of Agriculture, 1978.

This categorization at the individual district level is presently being carried out. The aim here is to develop for each mixed farming district the agro-ecological zones based on rainfall and broad soil types and by identifying the farming system within these zones to arrive at agroeconomic zones. Since the work is being carried out for a number of selected districts the scope and extension to regional and national level analysis is limited. A comparison of these results for individual districts with the corresponding results from the Phase 2 Kenya Study will provide useful bases for agricultural planning at the district level.

The aim of the present paper is to report on the preliminary (first approximization) assessment of food production potential, degradation hazards and population supporting capacity of the natural resources (climate and land) under the assumption of various input (management and technology) levels. In Section 2 the methodology of the assessment is described and the results are given in Section 3. The policy relevance and implications of the results are discussed in Section 4 and we conclude Section 5 with an outline of the further work in progress.

2. Methodology of Resource Evaluation

Resource evaluation has to be in light of specific requirements and specific objectives. The deliberate choice to efficiently use resources on a sustained basis is the true meaning of efficient resource use, but this also includes enhancement of resources, as well as preservation, restoration and reclamation. Figure 1 shows the framework of the analytic approach to agricultural resource use. Here land is the fundamental resource. The land base provides a number of necessary and legitimate requirements. For example land is required for food production, industrial raw material production, forestry production (energy and paper products), urban settlements, rural settlements, infrastructure (roads) and recreation. As population increases and development progresses the land requirement for each of the above uses also increases. Land use planning is concerned with the "efficient" allocation among alternative requirements. Our primary interest in this study is concerned with the land that is available for rainfed production.

As shown in Figure 1, from the "requirements" and "resource availability" certain objectives are formulated and the aim is to "evaluate" how these objectives can be realized. The environmental conditions of the resource base change in time and space. If the resources are to be used on a sustained basis then conservation of the environment, in terms of basic resource as well as development (reclamation, restoration and enhancement) of degraded and new resources, is essential. All parts of this system are dynamic. The FAO Agro-ecological Zone Methodology, Figure 2, thus far developed is to analyze the agricultural production potential in a comparative static sense. (e.g. Year 2000). The multidisciplinary manpower, information and data for a country level dynamic analysis are immense. However starting with a static analysis and a step by step refinement of methodology and data base, a dynamic analysis can be aimed for in the long term.

2.1 FAO Agro-ecological Zone Methodology (FAO, 1979, a, b)

This methodology and computer programs (Shah and Fischer, 1979) for the assessment of agricultural production potential is based on principles (FAO, 1976) which are fundamental to any sound evaluation of land, namely,

- o Land suitability for specific crops.
- o Evaluation of production in respect to specified input levels, alternative crops and criteria of crop choice.
- o sustainability of production.

Figure 2 illustrates, in a simplified form, the methodology developed to assess land suitability and potential yield. This is applied for each of the eighteen food crops, Table 1. Note that the last crop, grassland, is used for the estimation of yield of livestock products, Blair Rains and Kassam (1979).

FIG 1. Analytical Approach : Resource Evaluation

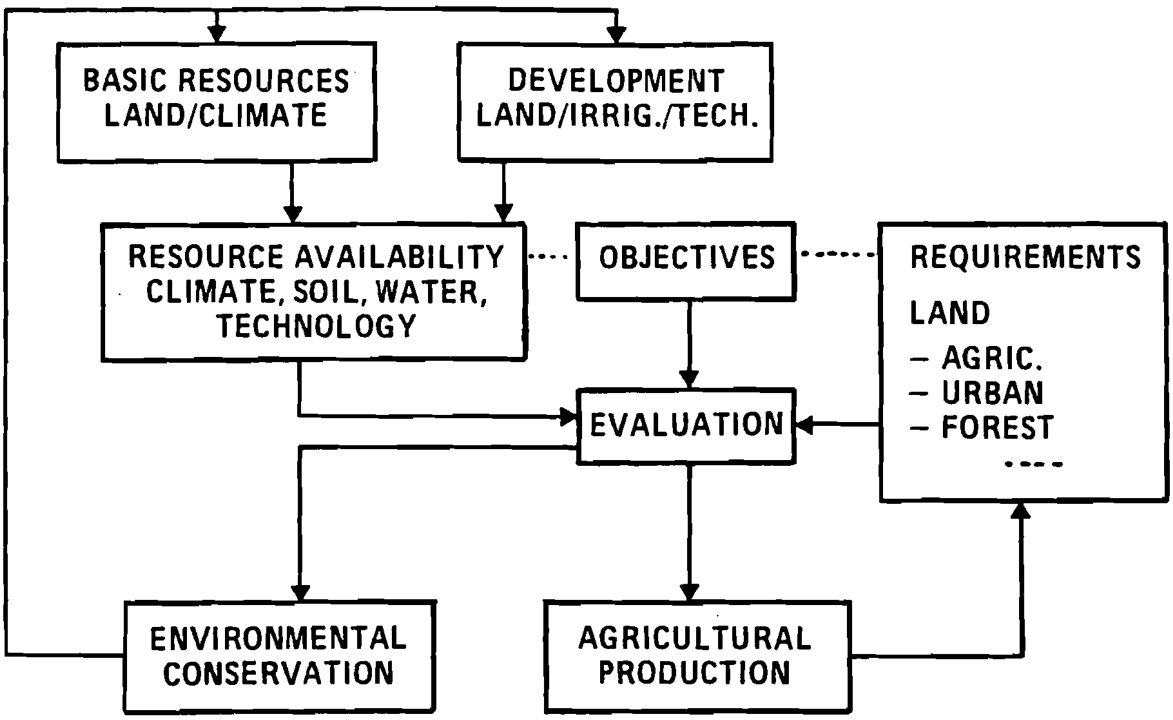


FIG. 2. FAO Agro ecological zone methodology for the assessment of production potential

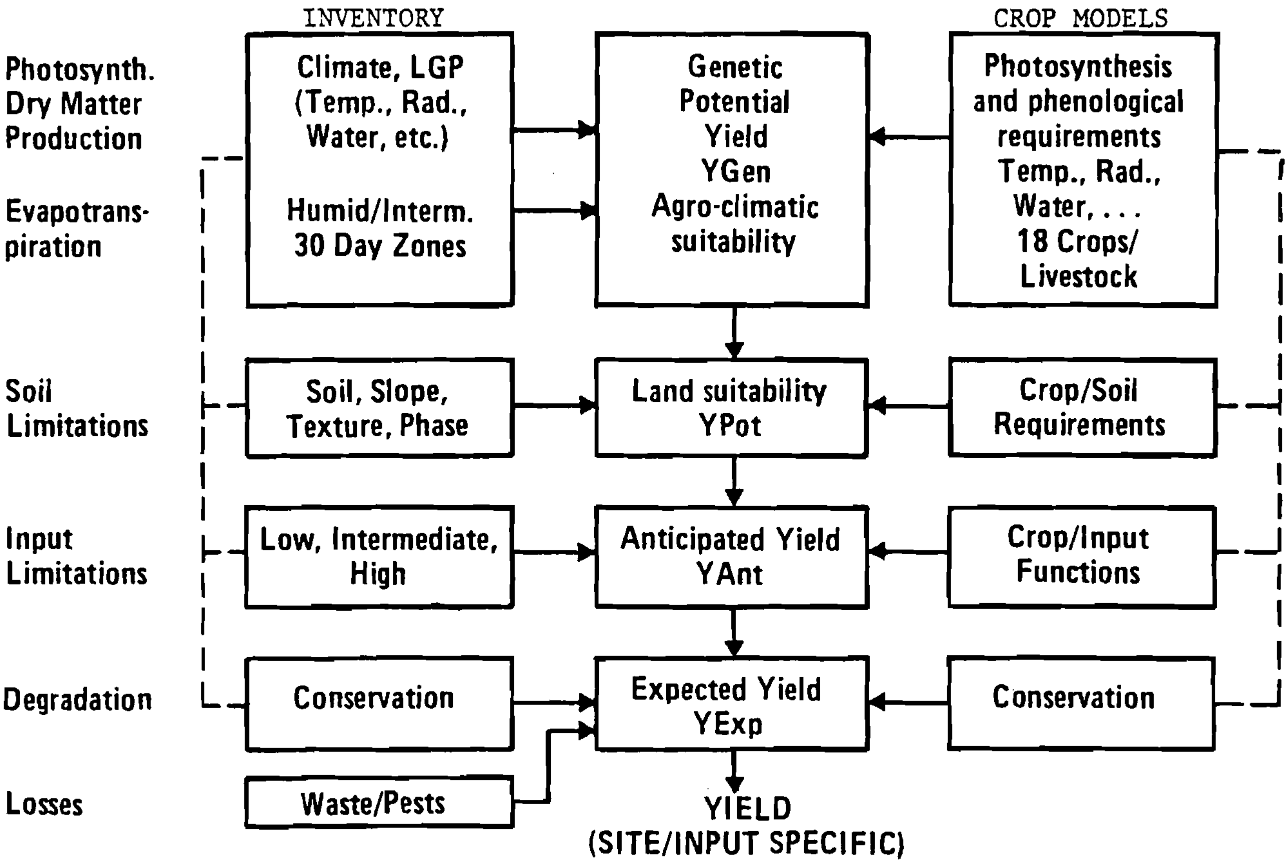


TABLE 1. CROPS OF THE ASSESSEMENT

CROP CODES		SEED Requirement* kg/Ha Dry weight
Nr.		
1.	Pearl Millet	20
2.	Sorghum	20
3.	Maize	30
4.	Soyabean	40
5.	Phaselous Bean	40
6.	Cotton**	
7.	Sweet Potato	135
8.	Cassava	0
9.	Bunded Rice	90
10.	Spring Wheat	85
11.	White Potato	300
12.	Winter Wheat	-
13.	Winter Barley	75
14.	Upland Rice	30
15.	Ground Nut	75
16	Banana and Plantain	0
17.	Sugarcane	350
18.	Oilpalm	0
19.	Grassland (livestock)	

* Waste is assumed to be 10% of production. In the detailed phase 2 Kenya Study, seed and waste assumptions are modified according to country data.

** Not included in the present study.

TABLE 2.

KENYA 1975

Population and Land Distribution by Major Climate and Length of growing Period

	Length of Growing Period (Days)	Population '000	Percentage Distribution	Area '000 Ha	Percentage Distribution	Population Density Persons/Ha
WARM TROPICAL CLIMATE	240-270	403	3.18	212	0.37	1.90
	210-240	777	6.12	401	0.70	1.94
	180-210	479	3.79	478	0.83	1.00
	150-180	755	5.95	1127	1.97	0.67
	120-150	863	6.06	2295	4.01	0.37
	90-120	1071	9.44	3202	5.59	0.33
	75- 90	592	4.66	3772	6.59	0.16
	0- 75	3718	29.29	31168	54.47	0.12
	0	156	1.23	5778	10.10	0.03
MODERATELY COOL TROPICAL CLIMATE	330-365	29	0.23	31	0.05	0.93
	300-330	99	0.78	210	0.37	0.47
	270-300	269	2.12	409	0.72	0.66
	240-270	290	2.28	500	0.87	0.58
	210-240	219	1.72	464	0.81	0.47
	180-210	384	3.03	992	1.73	0.39
	150-180*	446	3.52	691	1.21	0.64
	120-150*	443	3.49	560	0.98	0.79
	90-120	252	1.99	551	0.96	0.46
	75- 90	68	0.54	462	0.81	0.15
	0- 75	140	1.10	933	1.65	0.15
COOL TROPICAL CLIMATE	330-365	18	0.14	25	0.04	0.73
	300-330	50	0.39	105	0.18	0.48
	270-300	137	1.08	214	0.37	0.64
	240-270	144	1.14	251	0.44	0.57
	210-240	108	0.85	232	0.41	0.47
	180-210	193	1.52	496	0.87	0.39
	150-180*	223	1.76	353	0.62	0.63
	120-150*	223	1.76	289	0.50	0.77
	90-120	126	0.99	283	0.50	0.44
	75- 90	38	0.30	252	0.44	0.15
	0- 75	71	0.56	479	0.84	0.15
	TOTAL	12694	100.0	57216	100.00	0.22

* City of Nairobi (Population 1975, 862000) located in moderately cool/cool tropical climates and length of growing period 120 - 180 days

Basic to the assessment is the soil and climatic inventory. This inventory comprises overlay of a specially compiled climatic inventory on to the 1.5 million FAO/UNESCO Soil Map (FAO, 1971-79). The climatic inventory differentiates major climates and length of growing period zones at 30 day intervals (e.g. 120-150 days). Measurements of the unique agro-ecological zones resulting from this combination allows quantification of the land resources in terms of soil and climatic conditions. Table 2 shows the distribution of Kenya's 1975 population and land area by major climate and length of growing period. The population density for each length of growing period is also shown. Note that this density decreases as we move from wetter to drier areas except for the 120-180 day period in moderately cool and cool tropical climates. The latter is due to the location of the capital city of Nairobi in this area.

The first step in the methodology is to match the climate and LGP inventory with the specific crop requirements to assess the agro-climatic suitability in terms of genetic potential yield. The main features of the climatic inventory created by FAO for the assessment of agro-climatic crop suitability (Kassam 1977, 1979) are:

- Classification of crops into climatic adaptibility groups according to their fairly distinct photosynthesis characteristics.

- Classification of temperature and moisture requirements of crops. The quantification of heat attributes and moisture conditions is based on the actual temperature regime during the growing period and a water balance model comparing precipitation with potential evapotranspiration.

The data utilized for calculation of the water balance and for further climate-related calculations, comprises Kenyan meteorological records where extended data on rainfall, maximum and minimum temperatures, sunshine duration, vapour pressure, wind speed, etc., are available.

Individual crop productivity rules, (Kassam, 1979) as determined for each major climate and length of growing period zone, enable the assessment of agro-climatic crop yields. This is modified by next considering the soil limitations (Sys and Riquier, 1979). The resultant potential yield (land suitability) is adjusted according to the input level. Table 3 shows that attributes of each of the three input circumstances used in the assessment. Note that the assumption of only three discrete input levels is for simplicity and convenience. The crop yield and input functional relationship is continuous. Within the country there is a wide variation in the level of input (technology of production) applied to particular crops. The simple assumption of three input levels implies that each of these is applied to all crops throughout the country. It is unlikely that high input level (as specified in Table 3) can be implemented universally throughout Kenya in the short/medium term will be applied universally throughout Kenya. However this does enable us to estimate the "maximum" production potential in the light of presently known "high" technology.

Table 3. **ATTRIBUTES OF INPUT LEVELS**

ATTRIBUTE	LOW INPUT LEVEL	INTERMEDIATE INPUT LEVEL	HIGH INPUT LEVEL
Market Orientation	Subsistence	Subsistence/ Commercial	Commercial
Capital Intensity	Low	Intermediate	High
Labor Intensity	High	High	Low
Power Sources	Hand Tools	Improved Implements and/or Animal Traction	Complete Mechanization
Technology Employed	Local Cultivars No Fertilizer No Pest Control No Disease Control	Improved Cultivars "Sub-Optimum" Fertilizer Some Chemical Pest and Disease Control	High Yielding Cultivars "Optimum" Fertilizer Chemical Pest and Disease Control
Land Holdings	Small, Fragmented	Small, Fragmented/ Consolidated	Large Consolidated

Table 4. **IRRIGATED AREA – KENYA**

	IRRIGATED AREA 1000 Ha	
CLIMATE CLASSIFICATION	1975	2000*
Warm Tropical Climate	29	72
Moderately Cool Tropical Climate	12	23
Cool Tropical Climate	2	8
Total	43	103

*FAO AT2000 Projections

Fig. 3 METHODOLOGY OF DEGRADATION HAZARDS SOIL EROSION AND PRODUCTIVITY CHANGES

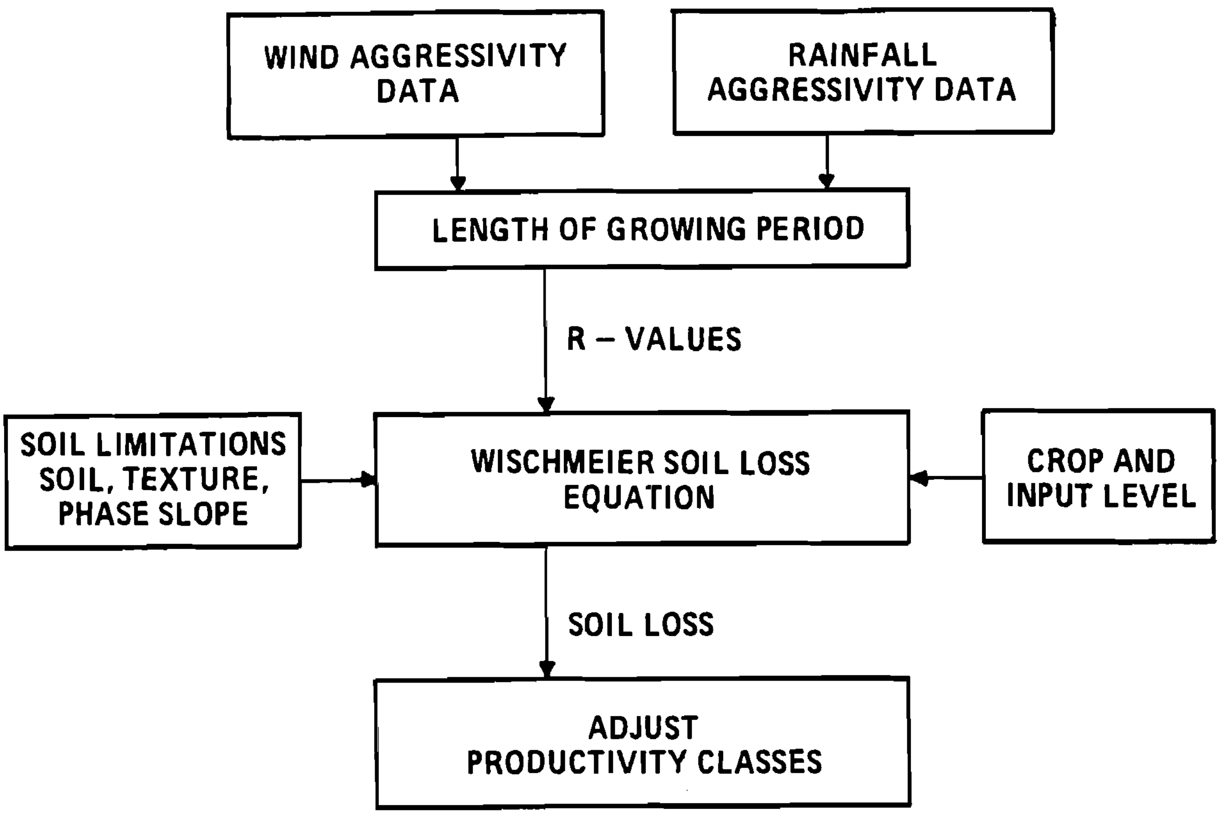
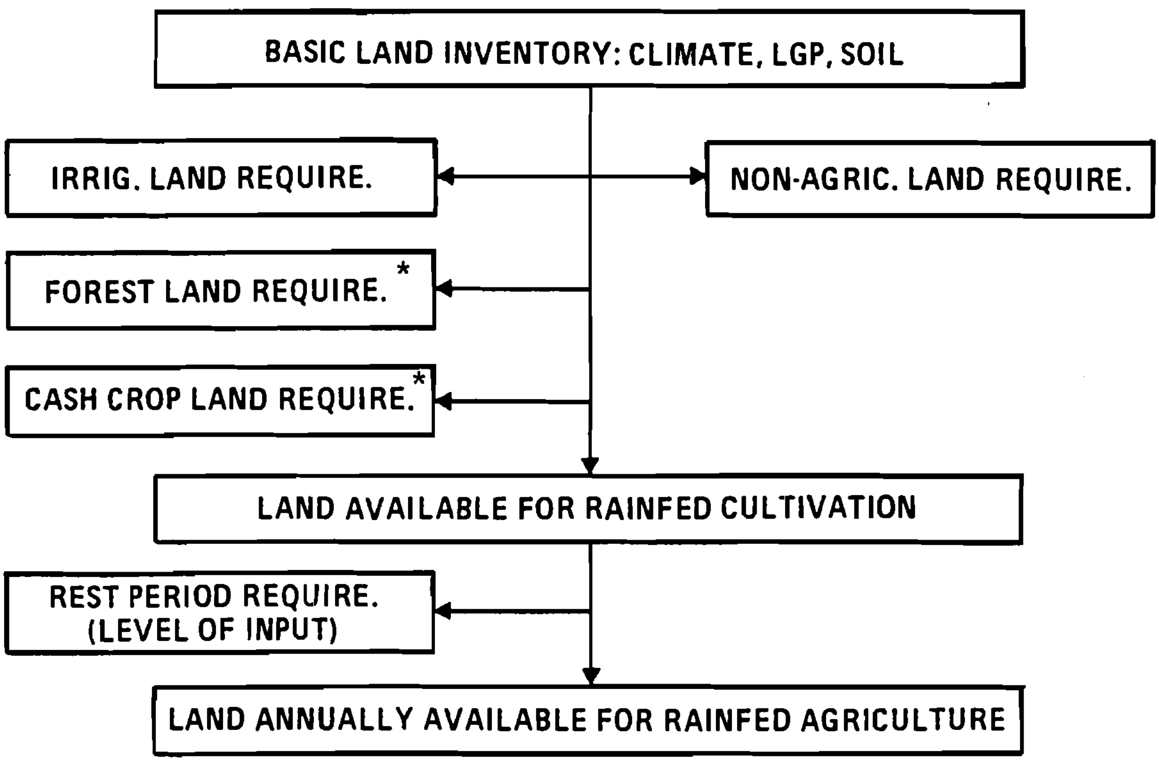


FIG. 4. LAND USE: LAND AVAILABLE FOR RAINFED AGRICULTURE (ANNUALLY)



* Not considered in the present study; phase 2 study will incorporate these requirements

The input limitations allows the quantification of the anticipated yield. The final step in the methodology is to take account of environmental degradation. The climate, length of growing period, soil characteristics (soil, slope, texture and phase) and input levels determine the environmental degradation in relation to a particular crop. Degradation of land takes place in many ways, water erosion and wind erosion being the most obvious in rainfed agricultural production. The productivity loss caused by the rate of soil loss under various climatic, soil and land use circumstances reveal the severity of the degradation hazard in the various agro-ecological zones, (Arnoldus 1980 and FAO/UNEP/UNESCO 1979). Figure 3 shows the framework of this degradation model. In the present study degradation hazard is taken into account after the other physical factors influencing productivity have been considered, and is applicable only to land found to be at least marginally productive.

The final step in the estimation of yield is the deductions for seed and waste. Table 1 shows the assumption for seed requirements. In the present study the loss due to waste has been assumed to be ten percent of production. In the detailed Phase 2 Kenya Study actual data on Kenya waste losses by crop will be used; for example according to the 1974/75 Integrated Rural Survey, Central Bureau of Statistics, Nairobi, the waste losses for maize may be as high as 20% to 30% of production.

The final "actual" yield is site and input specific. The methodology is applied to all units of annually available land, Figure 4, to assess the potential production of each crop under the assumption of three input levels and with and without degradation hazard (with degradation implies no conservation measures and without degradation implies that all necessary conservation measures are carried out).

2.2. Land Available for Rainfed Agricultural Production

The annually available land, Figure 4, for rainfed crop production is estimated by making appropriate allowances for non-agricultural requirements, irrigation land requirements (Table 4 shows the estimate of present and future irrigated area in Kenya) and rest period (fallow) land requirements. The latter is dependent on the level of the crop input level, soil and climatic conditions (Young and Wright, 1979). It is important to take account of rest periods for specific crops since land, especially in the tropics, cannot be continuously cultivated in it's natural state without undergoing degradation. The allowances of various land uses in Fig. 4 appears to be a simple accounting procedure; however considerable detailed analysis is necessary for this. For example, the land requirements for non-agricultural use entails projections e.g. growth and location of urban areas.

2.3 Crop Choice: Alternative Assessments of Potential Crop Production.

The application of the methodology, Figure 2, to each unit of available land, Figure 4, will result in a number of crops (less than eighteen) that can be potentially produced in each unit of land. Note that this unit of land is about 10000 ha in the present study; in the detailed Phase 2 Study, the unit of land will be about 400 ha. A decision regarding the crop choice for each unit of land depends on the criteria of choice. In the present study two alternatives are considered, namely:

- Maximize calories subject to a protein constraint at the national level, i.e., for each unit of land, choose the crop that gives maximum calories subject to the protein constraint.

- Maximize calories subject to the present crop mix constraint. The present cropping pattern in the country is dependent on the domestic and trade demands. This pattern cannot be radically changed in the short/medium term and hence the inclusion of this constraint enables an assessment under the assumption of the continuance of the present crop-mix pattern.

The aforementioned two alternative assessments and the crop-wise production potential assessment are considered for each of the three input levels, with and without conservation measures. The results are discussed in the next section.

3. Results

3.1. Assessment of Crop-wise Production Potential

The aim here is to evaluate the maximum production potential for each crop of the assessment. The information generated includes for each crop, the total suitable land, land productivity classes and production from each land class. The results for each of the crops, Table A1 to A16, are given in Appendix A. A summary of the total potential production and average yield for each of the crops is given in Table 5. The results show the tremendous increases in potential of all commodities as input level is increased and especially if conservation measures are implemented. Table 6 quantifies the percentage of loss in production and the responsible factor (wind and water erosion) in the absence of conservation measures. This type of information is useful in comparison with the future demand of particular crops in the sense that necessary levels of inputs and risks of degradation can be assessed.

		LOW INPUT				INTERMEDIATE INPUT				HIGH INPUT			
		WITH CONSERVATION		WITHOUT CONSERVATION		WITH CONSERVATION		WITHOUT CONSERVATION		WITH CONSERVATION		WITHOUT CONSERVATION	
		PRODUCTION '000	YIELD MT/Ha Dry Wt.	PRODUCTION '000	YIELD MT/Ha Dry Wt.	PRODUCTION '000	YIELD MT/Ha Dry Wt.	PRODUCTION '000	YIELD MT/Ha Dry Wt.	PRODUCTION '000	YIELD MT/Ha Dry Wt	PRODUCTION '000	YIELD MT/ha Dry Wt.
1.	Millet	741	0.384	178	.235	2843	1.049	836	0.676	6107	1.752	2604	1.069
2.	Sorghum	936	0.346	260	.254	3778	1.096	1414	0.883	7275	1.694	3542	1.199
3.	Maize	1300	0.487	339	.337	4804	1.425	1862	1.149	9855	2.295	4726	1.578
4.	Soybean	299	0.160	121	.111	1506	0.572	808	0.495	3126	0.905	1591	0.688
5.	Beans	618	0.196	200	.135	2639	0.697	1169	0.543	4910	1.059	2494	0.787
7.	Sweet Potato	609	0.482	260	.360	2727	1.352	1486	1.157	5872	2.165	3660	1.898
8.	Cassava	339	0.283	123	.283	1520	0.756	726	0.821	4141	1.472	2465	1.592
9.	Bunded Rice	188	0.217	172	.201	634	0.731	598	0.697	1098	1.311	1008	1.222
10.	Spring Wheat	761	0.593	275	.516	2208	1.783	1138	1.463	3299	2.796	1829	2.067
11.	White Potato	1010	0.996	271	.679	3330	2.887	1496	2.087	4648	4.031	2258	2.576
12.	Winter Wheat	-	-	-	-	-	-	-	-	-	-	-	-
14.	Upland Rice	271	0.180	161	.157	1062	0.529	755	0.489	2267	0.996	1658	0.849
15.	Groundnut	222	0.129	78	.081	1290	0.487	666	0.414	3018	0.874	1593	0.689
16.	Banana/Plantain	30	0.189	28	.190	61	0.378	56	0.380	87	0.569	82	0.571
17.	Sugarcane	45	0.242	35	.219	343	0.8 3	316	0.796	889	0.863	835	0.820
18.	Oil Palm	71	0.161	67	.161	199	0.451	185	0.448	195	0.458	184	0.454
19.	Livestock	9610	0.287	7532	.229	19248	0.575	16805	0.509	36042	1.218	32039	1.100

TABLE 5: ASSESSMENT OF POTENTIAL CROP PRODUCTION ('000 MT)
- THREE Input Levels : Low, Intermediate, High
- With and Without Conservation Measures

TABLE 6. PERCENT REDUCTION IN PRODUCTION POTENTIAL DUE TO SOIL EROSION

		LOW INPUT			INTERMEDIATE INPUT			HIGH INPUT		
		% Production Loss	% Loss Due to WATER EROSION	% Loss Due to WIND EROSION	% Production Loss	% Loss Due to WATER EROSION	% Loss Due to WIND EROSION	% Production Loss	% Loss Due to WATER EROSION	% Loss Due to WIND EROSION
1.	Millet	76	46	54	71	37	63	57	35	65
2.	Sorghum	73	74	26	63	61	39	51	62	38
3.	Maize	74	76	24	61	68	32	52	61	39
4.	Soybean	60	55	45	46	40	59	49	34	60
5.	Phasalous Beans	68	78	22	56	69	31	49	56	44
7.	Sweet Potato	57	80	20	46	70	30	38	62	38
8.	Cassava	64	69	31	52	71	29	41	69	31
9.	Bunded Rice	8	99	1	6	100	1	8	98	2
10.	Spring Wheat	64	91	9	48	91	9	45	86	14
11.	White Potato	73	94	6	55	93	7	51	90	11
14.	Upland Rice	41	75	25	29	80	20	27	81	19
15.	Groundnut	65	62	38	48	48	52	47	35	65
16.	Banana/Plantains	6	100	0	8	100	0	6	100	0
17.	Sugarcane	21	100	0	8	100	0	6	100	0
18.	Oil Palm	5	100	0	7	100	0	6	100	0
19.	Livestock	22	38	63	13	52	48	11	79	22

- THREE INPUT LEVELS : Low, Intermediate and High

TABLE 7. KENYA : POTENTIAL ARABLE* LAND '000 Ha

	GOOD AND MARGINAL LAND VH + H + M + L	GOOD LAND VH + H + M	'VERY 'GOOD LAND VH + H
WITH CONSERVATIVE MEASURES			
LOW INPUT	6362	2726	1037
INTERMEDIATE INPUT	6776	3736	1695
HIGH INPUT	6893	4688	2383
WITHOUT CONSERVATIVE MEASURES			
LOW INPUT	3170	908	257
INTERMEDIATE INPUT	4343	1529	597
HIGH INPUT	6146	2323	839

VH Very High Productive
H High Productive
M Moderate Productive
L Low Productive

*For VH + H + M + L calculated as Millet + Soybean (>240 days) + Rice + Highland Phaselons Beans
VH + H + M calculated as Millet + Sweet Potatoes (>240 days) + Rice + Highland Wheat

1975 Reported arable (Rainfed) Land, 3895 and 'good' arable land, 1787

AT2000 Estimates - Arable land, 6739 and 'good rainfall' arable land, 2020

3.2 Estimate of Potential Arable Land and Degradation Hazard.

Table 7 shows an approximation of the potential arable land in Kenya. This is based on the assumption that the agro-climatic requirements for pearl millet, soyabean/sweet potatoes, rice and highland phaselous beans/highland wheat, are different and hence an aggregate of the productive land for each of these crops (Table A1, A4-5, A7, A9-10, and A14) approximates the potential arable land.

Depending on the level of input the available potential arable land varies between 6.4 and 6.9 million ha. Soil conservation measures are critical especially at low and intermediate input levels. For example at low levels of inputs there would be an almost 50% loss of arable land in the absence of soil conservation measures. The corresponding percentage loss for intermediate and high input levels are of the order of 36% and 11% respectively. The present (1975) land use in Kenya suggest that arable land under cultivation is about 3.9 million ha. Kenya's population is likely to double by the end of the present century and consequently the possibility of land extensive agriculture in the long run is not feasible. This is especially critical in view of the large areas of marginal agricultural land in Kenya. As shown in the table the "good" agricultural land accounts for 43%, 55% and 68% of the total potential arable land for low, intermediate and high input levels respectively. Furthermore the need of soil conservation in the areas of "good" land is essential since in the absence of conservation measures loss (in terms of agricultural use) of these lands is as high as 67%, 59% and 50% for the low, intermediate and high input levels respectively. Note that the availability of "very" good land is even more limited.

Soil conservation as well as improvement in technology (higher levels of input) will be essential to ensure the satisfaction of the food and agriculture demands by the end of the century.

3.3. Assessment of Food Production Potential and Population Supporting Capacity

The results for the first alternative, i.e., Maximize Calorie Production Subject to National Protein Constraints are given in Table B1 to B6 of Appendix B. The corresponding results for the second alternative (with present crop mix constraint) are in Table B7 to B12.

The calorie and protein production for each of these two alternative assessments is translated into population supporting capacity. Here the Kenyan requirement is assumed to be 2,380 calories and 38.8 grams of protein per capita per day. The results for the population supporting capacity in terms of the ratio of potential to present population are given in Table 8.

TABLE 8. POPULATION SUPPORTING CAPACITY - KENYA

Total Population (1975) 12,694,000
Total Area (Ha) 56,991,000
Total Irrigated, 1975 (Ha) 43,000
Total Non-Ag. Land, 1975 (Ha) 633,000
1975 Overall Population Density (Persons/Ha) 0.223
1975 'Arable' land Population Density (persons/Ha) 3,259

Number of Climates 4
Number of Zones (LGP) 32

	LOW INPUT	INTERMEDIATE INPUT	HIGH INPUT
CONSERVATION			
POTENTIAL/PRESENT POPULATION			
MODE 1: MAXIMIZE CALORIES	0.824	2.302	4.509
MODE 3: PCMIX* CONSTRAINT	0.640	1.836	3.681
WITHOUT CONSERVATION			
POTENTIAL/PRESENT POPULATION			
MODE 1: MAXIMIZE CALORIES	0.366	1.181	2.481
MODE 3: PCMIX CONSTRAINT	0.309	0.986	2.107

*PCMIX : Present crop mix constraint

TABLE 9. Comparison of 1976 and 2000 Demand*** for main food commodities in Kenya with Agro-ecological potential production***

	KENYA DEVELOPMENT PLAN[1] (1979-83) 1976	FAO AT2000[2] 2000	IIASA KENYA STUDY[3] Alternative A 2000	IIASA KENYA STUDY[4] Alternative B	FAO-IIASA-KENYA AGROECOLOGICAL ZONE STUDY: INTERMEDIATE INPUT[5] WITH CONSERVATION PRESENT CROP MIX	FAO-IIASA-KENYA AGROECOLOGICAL ZONE STUDY: HIGH INPUT[6] WITH CONSERVATION MAXIMUM CALORIES
CEREALS						
Maize	1634	3823	3713	3254	3552	4693
Wheat	165	791	591	992	319*	995
Rice	23	104	87	161	53*	113
Millet and Sorghum	277	799	791	866	292*	3224
Pulses	248	482	407	585	272*	16*
Roots	514	941	805	707	1386	5498
White Potato	113		210	286	1196	2799
Sweet Potato	401		595	421	94*	922
Cassava					96*	1777
Livestock Products - Calorie** Equivalent	952	2281	1938	3358	11638	21296
Beef	128	314	258	543		
Mutton	65	84				
Pig Meat	3	11	194	373		
Poultry	28	209				
Milk	652	1912	1754	2647		

1. 1976 KENYA Food Balance Sheet, Development Plan 1979-83, Government of Kenya, Nairobi, 1979
2. FAO AT2000 Study, Rome, 1979
3.4. "Food Demand Projections Incorporating Income Distribution and Urbanization", IIASA, Laxenburg, 1979: Alternative *A* assumes likely growth (6% per annum) of per capita expenditure, high population growth (3.7%) and no change in income distribution. Alternative *B* assumes high growth (7.5% per annum) of per capita expenditure, high population growth (3.7%) and moderate change in income distribution
5.6. FAO-IIASA-KENYA Agro ecological zone study, Laxenburg, 1981
5. Here the assumptions are : intermediate level of input is applied soil conservation measures are implemented and the 1975 crop-mix pattern continues
6. Here the assumption are : High level of input is applied, soil conservation measure are implemented and the food (caloric) value is maximized.

* Expected 2000 Demand is not met for these commodities

** Units are Million Calories. The agroecological study estimates an aggregation of livestock and related products.

*** Metric tons dry weight.

In 1975 the overall population density was 0.223 persons per hectare; however the density per hectare of arable land was 3.259. The results show that food demand of the present population in Kenya cannot be satisfied under the assumption of low input level (all crops and throughout the country). To a lesser extent (98.6% of the population can be supported) this is also the case for the intermediate level of input without any conservation measures. In reality the input level in Kenya is between low input and intermediate input for some crops and higher for others. Also some soil conservation measures are practiced and this is likely to intensify in view of the government policy on environmental conservation. The results show that at least an intermediate level of inputs with soil conservation measures will be necessary for the national food demands of Kenya's population in the year 2000 (present population will double in size). Note that in estimating the population supporting capacity the irrigated production (calorie equivalent, Wood, 1979) is also taken into account.

Another interesting aspect of the results is that the population supporting capacity of the maximize calories alternative is higher than the continuing present crop-mix alternative. The implication of this is that some changes in the present crop mix will be necessary to increase levels of production of certain food crops (for example policies to encourage demand and production of sorghum and millet).

Table 9 shows a comparison of the present and future demand and agroclimatic potential (for the two above alternative assessments) for four food commodities in Kenya. The expected demand (year 2000) for wheat, rice, millet and sorghum, pulses, sweet potatoes and cassava is not met by the agro-climatic production from the assessment based on intermediate levels of inputs with conservation measures and a continuation of the present crop mix pattern. For sweet potatoes and cassava some of the land allocated to white potatoes could be used for production (the potential production of white potatoes is more than five times the expected demand). In a similar manner the production of some of the above mentioned crops could also be somewhat increased. This is feasible in view of the potential production (Appendix A) of these crops. Note that the level of production of livestock products is also more than five times the expected demand.

In comparison, for the high input level with conservation measures and maximization of food values (calories) the production levels are well above the expected demand for all commodities except pulses. The pulses production could be increased by using some of the area that has been allocated to maize and sorghum and millet.

The results of the assessment have been considered at the national level. However, in the study the potential area for each crop is identified in terms of its location in the country. This disaggregated information would enable further surveys and evaluation of particular crops on a regionalized basis.

3.4. Estimate of Land Degradation Hazard

In the above assessments it is clear that considerable reduction in potential production and population supporting capacity will occur if soil conservation measures are not implemented in Kenya. Table 10 quantifies the land availability, total and by land productivity class, under the assumption of with and without conservation measures, for each of the three input levels and the two alternative assessments. In both the alternatives,degradation would lead to substantial loss of total agricultural land and in particular the more productive land classes. For example more than 55% of the very high and high productivity land would be "lost" in the absence of conservation measures. Overall a change in crop mix, from present crop mix to maximize (calorie) production, also appears to reduce the risk of degradation. As in the case of the crop production, the national level estimates of land degradation can be disaggregated by location (regionalized) to identify the critical areas succeptible to soil erosion in the context of the agricultural crops and input levels.

4. Policy Relevance

The data and information generated in this study is useful for many aspects of Agricultural Development Planning. The present results should be regarded as a first approximation. The Phase 2 Kenya Study (based on the 1.1 million soil map of Kenya, i.e., basic land unit of 400 ha) will be more realistic and even at this level further regionalization and field analysis will be necessary to validate the results. The policy use and implications of the study are numerous. Here the discussion will be limited to some of the more pressing policy issues of agricultural development in Kenya.

4.1 Soil Erosion and Conservation Policy

> *"Agricultural production in Kenya still relies on the exploitation and consumption of natural resources.... Soil erosion has reached disquieting proportions, natural pastures are being degraded and the flow of water from the catchment areas is threatened. The soil of Kenya is a stock resource, irreplacable once destroyed and action is required to maintain it in a productive state for future generations".*

Kenya Development 1979-83, pp 208.

The study generates data on the location of areas where soil erosion may be critical. This erosion is a consequence of a number of factors, namely, natural conditions (climate, rainfall,soil, etc),crops, levels of inputs, etc. For a particular area, the analysis provides information on what crops and input levels would reduce the level of soil erosion. For example, tree crops (bananas and plantains) may be appropriate in some areas. The identification of the areas susceptible to soil erosion also enables an assessment of the conservation measures necessary. The latter can be translated

TABLE 10. DEGRADATION HAZARDS AND LAND PRODUCTIVITY: NATIONAL

LAND AREA (1000 Ha) BY PRODUCTIVITY CLASS

	TOTAL	VH	H	M	L	RANGE LAND
Present Crop-Mix without Conservation						
LOW	1871	53	187	381	1250	26117
INT.	2407	106	374	526	1401	26156
HIGH	3700	197	477	791	2235	22700
With Conservation						
LOW	3612	310	744	659	1899	24366
INT.	3882	442	814	947	1679	24374
HIGH	4850	614	1112	1269	1855	21027
Degradation Hazard (% Land Loss)	TOTAL	VH	H	M	L	RANGE LAND
LOW	48.2	82.9	74.9	42.2	34.2	- 7.2*
INT.	38.0	76.0	54.0	44.5	16.6	- 7.3*
HIGH	23.7	67.9	57.1	37.7	-20.5*	- 8.0*
Maximize Cals without Conservation						
LOW	2464	70	202	513	1679	26119
INT.	2782	165	434	488	1695	26152
HIGH	3812	223	484	735	2370	22734
With Conservation						
LOW	3974	343	973	1143	1515	24376
INT.	4115	590	1261	1276	988	24374
HIGH	4880	711	1689	1651	829	21037
Degradation Hazard (% Land Loss)						
LOW	38.0	79.6	79.2	55.1	- 10.8*	-7.2*
INT.	32.4	72.0	65.6	61.7	- 71.5*	-7.3*
HIGH	21.9	68.6	71.3	55.5	-185.9*	-8.1*

* Increase in area; this occurs (for the LOW productivity land and the rangeland) due to degradation of the more productive lands.

into labour requirements and linked to government policy on public works and employment during slack agricultural seasons as well as setting of farmers' incentives for conservation.

4.2 Migration and Food Distribution Policies.

Rural-Rural Migration Policy........

(i) to promote the productivity of land in every rural and pastoral area so that the economic pressures for migration elsewhere are reduced in magnitude;

(ii) to encourage migration to areas of the country where opportunities and productivity are increasing most rapidly;

(iii) to ensure that movements are not in such large numbers that they exceed the opportunities available, leading to frustration and dissatisfaction".

Kenya Development Plan, 1979-83, pp. 66.

In the study the potential production as well as the location of the land is identified. This data is useful for the formulation and analysis of policies as mentioned above. Also areas which are presently critical (levels of food production and corresponding inputs, e.g., labour requirements) or are likely to become critical in the future are identified. Policies on outmigration and/or alternative development are relevant here.

In contrast to the movement of people from areas, when the land base cannot produce the local food requirements, is to create alternative employment opportunities and/or transfer food from surplus areas. The latter aspect will necessitate investments in transporation and additional food storage capacity. Hence the policy on infrastructure development is also relevant in this context.

4.3 Agricultural Technology (level of input) Policy

"Technological change is a major driving force in agricultural and rural development. Increased emphasis.....for land use intensification in small holdings and on production techniques for areas of low and unpredictable rainfall, research on developing viable mixed crop and livestock systems for arid areas will be emphasized."

Kenya Development Plan, 1979-83, pp. 210.

The preliminary results of the study suggest that crops such as sorghum and millet and livestock production are viable in some of the drier areas. The latter are identified in relation to regional location. Of course there are crops and varieties (short yielding cereals) other than the ones considered in the present study which may be even more viable. The methodology is general in that such aspects can be incorporated.

4.4 Domestic Food Demand and Trade Policies

Relative prices, shifts in traditions, marketing systems and "development" has been largely the cause of changes in the domestic food demand. For example, there has been a decline in the demand for sorghum and millet, sweet potatoes and cassava etc. At the same time demand for wheat and white potatoes has increased. Does Kenya have the natural resources (climate, rainfall and land) to satisfy the increasing domestic demand for particular food crops. Preliminary data for the analysis of such issues is generated in the study. The results on potential production of individual crops can be incorporated in domestic food policies to "push" (increase demand) for crops with high production potential and "pull" (decrease demand) for crops with low production potential.

Kenya's agricultural export trade has been concerned basically with non-food crops. The potential production of some cereal crops, roots and livestock products suggest trade possibilities. Also there may be other crops which are in demand on the world market and for which Kenyan production is low or nil. Examples of such crops are cassava or soyabean respectively. The methodology enables an evaluation of this type of issue.

4.5 National Game Parks Policy

In Kenya there are some 30 existing national game parks and these account for 7.2% of the total land area. In addition a further 21 national reserves are proposed and this will amount to a further 4.5% of the land area. Many of these parks and reserves are situated in marginal areas; however there are some areas with a considerable agricultural potential. In 1978 producer prices, the value of production from national parks and proposed reserves, has been estimated, (Shah, 1980) to be as high as 83.7 and 20.1 million Kenyan pounds*. Interestingly the majority of the production is accounted for by two national parks and two proposed national reserves.

Kenya is committed to preserve the wildlife heritage (mankind's) but will the population of the next century be forced to reassess** this commitment?

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* £1 Kenyan = U.S. $2.8

** In how many regions has agriculture displaced (destroyed) wildlife?

5. Concluding Remarks and Further Work

The assessment of food production, degradation hazard and population supporting capacity has been discussed in this paper. The results should be regarded as a preliminary first approximation. We attempted to outline the type of information/ data that is produced and the relevance of this in terms of Agricultural Development in Kenya.

Detailed country analysis at a lower scale (much lower than the 1:5 million scale as in this Phase 1 Study) will be necessary for planning and policy analysis. The Phase 2, 1:1 million scale study, will contribute towards this but even at this scale, the results will need to be verified and modified from subsequent field studies.

Some aspects of the further work on the Kenyan Case Study are listed below:

- Detailed country case study with country specific crops and data (FAO/UNFPA/Kenya study in collaboration with IIASA).
- Methodology for crop choice developed on the basis of domestic food self-sufficiency and maximization of export earnings/profits.
- Quantification of soil conservation requirements in terms of labour, materials and related costs.
- Quantification of the input requirements, (labour, fertilizer, power, infrastructure, processing, etc.) and the assessment of the country's economy to meet these input levels. Some of these aspects will be analysed in conjuction with the general equilibrium model of Kenya being developed at IIASA.
- Refinement of the methodology and development of a dynamic model version for possible linkage with the IIASA Kenya Model.

Work on the above is in progress and will be the subject of future reports.

APPENDIX A - RESULTS

Assessment of LAND PRODUCTIVITY, POTENTIAL
CROP PRODUCTION and DEGRADATION LOSSES

TABLES A1 - A16

Area in '000 Hectares

Production in '000 Metric Tons Dry Weight

TABLE A1.

CROP : Pearl Millet	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	414	883	631	1928	741	0.38
INTERMEDIATE INPUT	822	1297	591	2710	2843	1.05
HIGH INPUT	1294	1498	693	3485	6107	1.75
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	44	129	584	757	178	0.23
INTERMEDIATE INPUT	135	317	785	1237	836	0.68
HIGH INPUT	263	726	1447	2435	2604	1.07

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		WIND EROSION	WATER EROSION		WIND EROSION	WATER EROSION
LOW INPUT	60.7	59.3	40.7	76.0	53.6	46.4
INTERMEDIATE INPUT	54.4	67.6	32.4	70.6	63.0	37.0
HIGH INPUT	30.1	68.0	32.0	57.4	65.3	34.7

1975 : Area 84000 Ha YIELD 1.45 MT/Ha

KENYA : PEARL MILLET PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A2.

CROP : SORGHUM	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '000MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	693	662	1411	2766	956	0.35
INTERMEDIATE INPUT	1023	839	1584	3446	3778	1.10
HIGH INPUT	1401	1150	1742	4293	7275	1.69
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	159	164	703	1026	260	0.25
INTERMEDIATE INPUT	348	316	937	1601	1414	0.88
HIGH INPUT	571	546	1838	2954	3542	1.20

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	62.9	40.3	59.7	72.8	26.3	73.7
INTERMEDIATE INPUT	53.5	52.2	47.8	62.6	38.8	61.2
HIGH INPUT	31.2	53.2	46.8	51.3	38.4	61.6

1975 : Area 210,000 Ha Yield 0.94 MT/Ha

KENYA : SORGHUM PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A3.

CROP : MAIZE	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '00C MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	582	589	1496	2667	1300	0.49
INTERMEDIATE INPUT	964	870	1538	3372	4804	1.42
HIGH INPUT	1307	1125	1862	4293	9855	2.30
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	74	179	752	1006	339	0.34
INTERMEDIATE INPUT	278	374	968	1621	1862	1.15
HIGH INPUT	397	641	1957	2995	4726	1.58

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	62.3	38.3	61.7	73.9	24.2	75.8
INTERMEDIATE INPUT	51.9	52.9	47.1	61.2	32.1	67.9
HIGH INPUT	30.2	55.4	44.6	52.0	38.6	61.4

1975 : Area 1513000 Ha, Yeild 1,6 MT/Ha

KENYA : MAIZE PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A4.

CROP : SOYBEAN	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '000MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	278	378	1218	1874	299	0.16
INTERMEDIATE INPUT	492	656	1483	2631	1506	0.57
HIGH INPUT	711	867	1877	3455	3126	0,91
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	57	121	914	1092	121	0,11
INTERMEDIATE INPUT	251	202	1180	1633	808	0.49
HIGH INPUT	242	419	1650	2311	1591	0.69

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	41,7	62,7	37,3	59,5	44,6	55,4
INTERMEDIATE INPUT	38.0	75,7	24,3	46,4	59.7	40.3
HIGH INPUT	33,1	84,0	16.0	49,1	66.1	33.9

1975 : No Production

KENYA : SOYBEAN PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A5.

CROP : PHASELOUS BEAN	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	820	675	1661	3157	618	0,20
INTERMEDIATE INPUT	1221	898	1665	3784	2639	0.70
HIGH INPUT	1470	1111	2054	4634	4910	1,06
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	179	305	1001	1485	200	0,14
INTERMEDIATE INPUT	480	432	1241	2153	1169	0,54
HIGH INPUT	632	621	1917	3170	2494	0,79

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	53,0	32,4	67.6	67.6	22,2	77.8
INTERMEDIATE INPUT	43.1	48.2	51.8	55,7	31.3	68.7
HIGH INPUT	31,6	65.2	34.8	49.2	43,7	56,3

1975 : Area 613,000 Ha, Yield 0.48 MT/Ha. includes other pulses

KENYA : PHASELOUS BEAN — PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A6.

CROP : SWEET POTATO	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	181	85	997	1263	609	0.48
INTERMEDIATE INPUT	318	99	1600	2017	2727	1.35
HIGH INPUT	215	381	2116	2713	5872	2.17
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	41	61	621	723	260	0.36
INTERMEDIATE INPUT	107	145	1031	1284	1486	1.16
HIGH INPUT	74	209	1645	1928	3660	1.90

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	42.7	40.3	59.7	57.3	20.3	79.7
INTERMEDIATE INPUT	36.3	56.8	43.2	45.5	29.9	70.1
HIGH INPUT	28.9	68.9	31.1	37.7	38.2	61.8

1975 : Area 52000 Ha Yield 2.95 MT/Ha

KENYA : SWEET POTATO PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A7.

CROP : CASSAVA	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	30	97	1070	1197	339	0.28
INTERMEDIATE INPUT	60	178	1774	2011	1520	0.76
HIGH INPUT	257	173	2385	2814	4141	1.47
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	4	29	402	435	123	0.28
INTERMEDIATE INPUT	14	72	798	884	726	0.82
HIGH INPUT	129	138	1281	1548	2465	1.59

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	63.6	57.0	43,0	63,6	30.8	69.2
INTERMEDIATE INPUT	56.0	64.8	35.2	52.2	29.2	70.8
HIGH INPUT	45.0	78.3	21.7	40.5	31.1	68.9

1975 ; Area 95000 Ha, Yield 2.94 MT/Ha

KENYA : CASSAVA PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A8.

CROP : BUNDED RICE	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	46	346	476	868	188	0.22
INTERMEDIATE INPUT	70	353	445	868	634	0.73
HIGH INPUT	105	346	386	837	1098	1.31
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	41	290	526	857	172	0.20
INTERMEDIATE INPUT	64	310	483	857	597	0.70
HIGH INPUT	87	303	436	825	1008	1.22

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	1,3	0.5	99.5	8,4	0,7	99.3
INTERMEDIATE INPUT	1.3	0.5	99.5	5.8	0.5	99.5
HIGH INPUT	1,4	1.0	99.0	8,2	1,7	98.3

Rice 1975 : Negligible rainfed production

KENYA : BUNDED RICE PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A9.

CROP : SPRING WHEAT	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	506	388	388	1283	761	0.59
INTERMEDIATE INPUT	670	297	271	1238	2207	1.78
HIGH INPUT	752	240	188	1180	3299	2.80
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	163	191	177	532	274	0.52
INTERMEDIATE INPUT	346	219	213	778	1138	1.46
HIGH INPUT	378	271	237	885	1829	2.07

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	58.5	3.0	97.0	63.9	9.4	90.6
INTERMEDIATE INPUT	37.2	3.0	97.0	48.4	9.0	91.0
HIGH INPUT	25.0	2.9	97.1	44.5	14.1	85.9

1975 : Area 110000 Ha, Yield 1.61 MT/Ha

KENYA : SPRING WHEAT PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A10.

CROP : WHITE POTATO	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	POTENTIAL: AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	483	297	234	1014	1010	1.00
INTERMEDIATE INPUT	692	322	139	1153	3329	2.89
HIGH INPUT	692	317	144	1153	4648	4,03
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	114	158	126	399	271	0,68
INTERMEDIATE INPUT	293	284	140	717	1496	2,09
HIGH INPUT	268	318	291	877	2258	2,58

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA: SOIL EROSION	% REDUCTION AREA: WATER EROSION	% PRODUCTION LOSS	% REDUCTION IN PRODUCTION: SOIL EROSION	% REDUCTION IN PRODUCTION: WATER EROSION
LOW INPUT	60.7	2,9	97,1	73.2	6,1	93.9
INTERMEDIATE INPUT	37,8	2.6	97,4	55.1	6.6	93,4
HIGH INPUT	24.0	2.5	97.5	51.4	10,5	89.5

1975 : Area 80,000 Ha, Yield 0.75 MT/Ha

KENYA : WHITE POTATO PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A11.

CROP : UPLAND RICE	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	52	48	1403	1503	271	0.18
INTERMEDIATE INPUT	101	85	1822	2008	1062	0.53
HIGH INPUT	190	236	1851	2277	2267	1,00
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	6	37	986	1030	161	0.16
INTERMEDIATE INPUT	46	74	1422	1542	755	0.49
HIGH INPUT	82	183	1688	1952	1658	0.85

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	31,5	41,2	58,8	40,5	24,9	75,1
INTERMEDIATE INPUT	23,2	41,8	58,2	29,0	20,1	79,9
HIGH INPUT	14,2	52,4	47,6	26,8	18,9	81,1

1975 : Negligble rainfed production

KENYA : UPLAND RICE PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A12.

CROP : GROUND NUT	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	235	362	1119	1716	222	0.13
INTERMEDIATE INPUT	244	633	1769	2646	1290	0.49
HIGH INPUT	411	1062	1982	3455	3018	0.87
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	43	106	814	963	77	0.08
INTERMEDIATE INPUT	105	147	1358	1610	666	0.41
HIGH INPUT	172	252	1887	2311	1593	0.69

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	43.9	60.1	39.9	65.0	37.7	62.3
INTERMEDIATE INPUT	39.2	72.1	27.9	48.4	52.4	47.6
HIGH INPUT	33.1	84.0	16.0	47.2	65.2	34.8

1975 : Area 12000 Ha, Yield 0.38 MT/Ha

KENYA : GROUND NUT PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A13.

CROP : BANANA PLANTAIN	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	3	-	157	160	30	0.19
INTERMEDIATE INPUT	3	-	157	160	61	0.38
HIGH INPUT	3	-	150	153	87	0.57
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	3	-	147	150	28	0.19
INTERMEDIATE INPUT	3	-	144	147	56	0.38
HIGH INPUT	3	-	140	143	82	0.57

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA: SOIL EROSION	WATER EROSION	% PRODUCTION LOSS	% REDUCTION IN PRODUCTION: SOIL EROSION	WATER EROSION
LOW INPUT	6.5	-	100.0	6.2	-	100.0
INTERMEDIATE INPUT	8.2	-	100.0	7.8	-	100.0
HIGH INPUT	6.1	-	100.0	5.8	-	100.0

1975 : Area 32000 Ha, Yield 2,57 MT/Ha

KENYA : BANANA/PLANTAIN PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A14.

CROP : SUGAR CANE	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	8	19	156	183	45	0,24
INTERMEDIATE INPUT	10	45	366	422	343	0,81
HIGH INPUT	13	71	946	1030	889	0,86
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	7	147	79	161	35	0,22
INTERMEDIATE INPUT	9	33	355	397	316	0.80
HIGH INPUT	9	53	954	1018	835	0,82

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	12.5	0,6	99,4	20.9	0.3	99.7
INTERMEDIATE INPUT	5,9	1.1	98,9	7,9	0,3	99.7
HIGH INPUT	1,2	3.5	96.5	6.1	0.1	99,9

1975 : Area 33000 Ha, Yield 6,32 MT/Ha

KENYA : SUGAR CANE PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE A15.

CROP : OIL PALM	PRODUCTIVITY CLASS: VERY HIGH AND HIGH '000 Ha	PRODUCTIVITY CLASS: MODERATE '000 Ha	PRODUCTIVITY CLASS: LOW '000 Ha	POTENTIAL: TOTAL AREA '000 Ha	POTENTIAL: TOTAL PRODUCTION '000 MT	POTENTIAL: AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	7	-	433	440	71	0.16
INTERMEDIATE INPUT	7	-	433	440	198	0.45
HIGH INPUT	7	-	418	425	195	0.45
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	7	-	412	419	67	0.16
INTERMEDIATE INPUT	7	-	406	413	185	0.45
HIGH INPUT	7	-	398	405	184	0.45

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	4.9	-	100.0	5.4	-	100.0
INTERMEDIATE INPUT	6.3	-	100.0	6.8	-	100.0
HIGH INPUT	4.7	-	100.0	5.6	-	100.0

1975 : No Production

KENYA : OIL PALM PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

TABLE 16.

CROP : LIVESTOCK	PRODUCTIVITY CLASS VERY HIGH AND HIGH '000 Ha	MODERATE '000 Ha	LOW '000 Ha	POTENTIAL TOTAL AREA '000 Ha	TOTAL PRODUCTION '000 MT	AVERAGE YIELD MT per Ha
MAXIMUM POTENTIAL WITH CONSERVATION MEASURES						
LOW INPUT	7638	10509	15335	33482	9610	0.29
INTERMEDIATE INPUT	7638	10509	15335	33481	19248	0.58
HIGH INPUT	7610	10173	11820	29603	36042	1.22
MAXIMUM POTENTIAL WITHOUT CONSERVATION MEASURES						
LOW INPUT	4003	7626	21275	32904	7532	0.23
INTERMEDIATE INPUT	5433	9153	18420	33008	16805	0.51
HIGH INPUT	6044	8574	14522	29139	32040	1.10

DEGRADATION HAZARD

	% AREA LOSS	% REDUCTION AREA		% PRODUCTION LOSS	% REDUCTION IN PRODUCTION	
		SOIL EROSION	WATER EROSION		SOIL EROSION	WATER EROSION
LOW INPUT	1.7	5.5	94.5	21.6	62.5	37.5
INTERMEDIATE INPUT	1.4	1.3	98.7	12.7	47.6	52.4
HIGH INPUT	1.6	0.8	99.2	11.1	21.5	78.5

KENYA : LIVESTOCK PRODUCTION POTENTIAL AND DEGRADATION HAZARD - LOW INTERMEDIATE AND HIGH INPUT LEVEL

APPENDIX B - RESULTS

ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

ALTERNATIVE 1

PRESENT CROP-MIX CONSTRAINT

TABLES B1-B3 = LOW, INTERMEDIATE and HIGH INPUT WITH CONSERVATION

TABLES B4-B6 = LOW, INTERMEDIATE and HIGH INPUT WITHOUT CONSERVATION

ALTERNATIVE 2

MAXIMIZE CALORIE PRODUCTION WITH PROTEIN CONSTRAINT

TABLES B7-B9 = LOW, INTERMEDIATE and HIGH INPUT WITH CONSERVATION

TABLES B10-12 = LOW, INTERMEDIATE and HIGH INPUT WITHOUT CONSERVATION

TABLE B1 ASSESSMENT OF CROPS PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop mix constraint

LOW input with conservation

SUMMARY FOR COUNTRY 114 IN REGION 6
==================================

YEAR = 1975
MODE = 3
LEVEL = L

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	8118130.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.142
POTENTIAL/TOTAL POPULATION	0.640
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	6874432.
TOTAL PROTEIN PRODUCTION	162079.
CALORIE/PROTEIN RATIO	38.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	5775298.
RAINFED PROTEIN PRODUCTION	152867.
LIVESTOCK CALORIE PRODUCTION	396859.
LIVESTOCK PROTEIN PRODUCTION	19577.
NS-RANGE LAND CAL.PRODUCTION	10475.
NS-RANGE LAND PRT.PRODUCTION	517.
SURPLUS PROTEIN	67110.
TOTAL ALLOCATED LAND	37606.
TOTAL CROP LAND	11137.
TOTAL RANGE LAND	26469.
TOTAL EFFECTIVE LAND	27978.
TOTAL FALLOW LAND	5339.
TOTAL NS-RANGE LAND	348.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	72.7	0.0	23.5	44.0	5.1	33.34	102030.	0.260	2.012
2	242.9	8.7	28.2	84.1	121.8	76.55	236554.	0.868	6.725
3	2010.1	87.8	399.8	349.9	1172.6	1032.43	3376060.	7.184	55.652
5	686.6	22.8	163.2	92.4	408.2	115.12	392553.	2.454	19.009
7	26.6	10.1	0.5	2.4	13.6	35.30	107165.	0.095	0.735
8	49.4	2.7	6.1	4.3	36.3	30.75	95848.	0.176	1.366
9	85.6	0.0	0.0	34.9	50.7	16.05	57839.	0.306	2.370
10	152.5	39.4	38.3	26.2	48.6	116.85	306147.	0.545	4.221
11	255.2	135.8	77.0	14.7	27.7	445.13	1037602.	0.912	7.066
14	0.3	0.0	0.0	0.0	0.3	0.10	344.	0.001	0.008
15	11.6	2.4	2.5	6.0	0.7	5.21	31107.	0.041	0.320
16	5.2	0.0	0.0	0.0	5.2	0.94	3128.	0.019	0.144
17	13.4	0.0	4.8	0.2	8.4	9.64	28922.	0.048	0.370
19	24366.3	21.3	3982.5	6273.9	14988.7	5807.98	396859.	87.090	0.000

TABLE B2. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop-mix Constraint

Intermediate input with conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 3
LEVEL = 1

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	23303794.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.409
POTENTIAL/TOTAL POPULATION	1.836
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	19733652.
TOTAL PROTEIN PRODUCTION	520477.
CALORIE/PROTEIN RATIO	38.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	18123662.
RAINFED PROTEIN PRODUCTION	466065.
LIVESTOCK CALORIE PRODUCTION	795238.
LIVESTOCK PROTEIN PRODUCTION	39229.
NS-RANGE LAND CAL.PRODUCTION	122953.
NS-RANGE LAND PRT.PRODUCTION	6065.
SURPLUS PROTEIN	190449.
TOTAL ALLOCATED LAND	37606.
TOTAL CROP LAND	11130.
TOTAL RANGE LAND	26477.
TOTAL EFFECTIVE LAND	28256.
TOTAL FALLOW LAND	3183.
TOTAL NS-RANGE LAND	2280.

CROP STATISTIC 1

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	67.8	1.7	18.6	47.2	0.3	76.92	235377.	0.240	1.748
2	227.7	7.7	38.5	51.0	130.6	215.16	660837.	0.806	5.867
3	2403.7	174.6	523.2	709.5	996.5	3552.38	11616288.	8.507	61.925
5	526.1	44.2	71.1	61.9	348.9	272.41	928908.	1.862	13.553
7	37.9	9.4	2.3	0.0	26.1	94.01	285420.	0.134	0.975
8	50.3	3.1	7.1	4.2	35.9	95.83	290698.	0.178	1.295
9	83.7	0.0	1.4	34.9	47.4	53.28	192052.	0.296	2.156
10	156.8	42.8	61.9	17.6	34.6	319.27	836497.	0.555	4.041
11	275.3	154.5	78.2	15.5	27.0	1195.66	2787093.	0.974	7.092
15	22.6	4.1	5.9	4.7	7.9	24.30	145216.	0.080	0.583
16	5.2	0.0	0.0	0.0	5.2	1.88	6257.	0.018	0.134
17	24.5	0.0	5.5	0.5	18.5	42.35	127038.	0.087	0.631
19	24373.9	21.3	3090.0	6273.9	14988.7	11638.21	795238.	86.262	0.000

TABLE B3 ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop-mix Constraint

High input with conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 3
LEVEL = H

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	46728160.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.820
POTENTIAL/TOTAL POPULATION	3.681
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	39569416.
TOTAL PROTEIN PRODUCTION	1030334.
CALORIE/PROTEIN RATIO	38.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	37044860.
RAINFED PROTEIN PRODUCTION	930806.
LIVESTOCK CALORIE PRODUCTION	1453696.
LIVESTOCK PROTEIN PRODUCTION	71711.
NS-RANGE LAND CAL.PRODUCTION	379055.
NS-RANGE LAND PRT.PRODUCTION	18699.
SURPLUS PROTEIN	368569.
TOTAL ALLOCATED LAND	33136.
TOTAL CROP LAND	10513.
TOTAL RANGE LAND	22623.
TOTAL EFFECTIVE LAND	25877.
TOTAL FALLOW LAND	1244.
TOTAL NS-RANGE LAND	3238.

CROP STATISTIC I

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	93.8	6.5	45.4	41.9	0.0	203.84	623757.	0.363	1.935
2	289.7	54.6	79.7	79.4	75.9	621.13	1919288.	1.120	5.974
3	3349.0	267.7	745.0	938.3	1398.0	7812.75	25547714.	12.942	69.056
5	458.0	55.3	57.0	97.5	248.2	426.71	1455098.	1.770	9.444
7	44.4	2.2	11.1	1.8	29.3	173.43	526538.	0.172	0.915
8	59.0	18.4	16.5	1.0	23.1	323.20	1007429.	0.228	1.217
9	54.2	0.0	3.3	22.5	28.4	61.91	223118.	0.209	1.117
10	168.5	65.1	70.8	16.8	15.7	570.21	1504431.	0.651	3.474
11	271.7	137.1	73.0	59.6	2.0	1576.51	3674835.	1.050	5.605
15	23.1	7.1	3.6	9.8	2.6	50.76	303318.	0.089	0.476
16	5.2	0.0	0.0	0.0	5.2	2.02	9385.	0.020	0.108
17	33.1	0.0	6.5	0.3	26.3	83.32	249951.	0.128	0.682
19	21027.3	21.3	3080.2	6219.0	11706.8	21274.64	1453696.	81.259	0.000

TABLE B4. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop-mix Constraint

Low input without Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 13
LEVEL = L

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	3917000.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.069
POTENTIAL/TOTAL POPULATION	0.309
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	3316916.
TOTAL PROTEIN PRODUCTION	77389.
CALORIE/PROTEIN RATIO	43.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	2219216.
RAINFED PROTEIN PRODUCTION	48248.
LIVESTOCK CALORIE PRODUCTION	354695.
LIVESTOCK PROTEIN PRODUCTION	17497.
NS-RANGE LAND CAL.PRODUCTION	51204.
NS-RANGE LAND PRT.PRODUCTION	2526.
SURPLUS PROTEIN	21916.
TOTAL ALLOCATED LAND	37460.
TOTAL CROP LAND	7608.
TOTAL RANGE LAND	29852.
TOTAL EFFECTIVE LAND	27989.
TOTAL FALLOW LAND	2480.
TOTAL NS-RANGE LAND	2459.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	10.5	0.0	1.4	1.4	7.7	3.22	9840.	0.037	0.560
2	60.5	0.0	13.2	5.5	41.8	16.37	50572.	0.216	3.235
3	810.3	2.2	60.3	134.7	613.1	281.50	920493.	2.895	43.293
5	121.4	0.0	8.6	70.5	42.3	17.85	60867.	0.434	6.486
7	127.7	2.4	3.5	2.0	119.8	36.23	109989.	0.456	6.821
8	14.2	0.0	1.1	1.2	11.9	6.10	19000.	0.051	0.757
9	142.2	0.0	0.0	50.8	91.4	24.02	86578.	0.508	7.598
10	108.2	18.8	26.3	29.8	33.3	69.65	182478.	0.386	5.778
11	204.8	28.0	65.5	82.4	28.1	192.25	448144.	0.732	10.942
14	56.3	0.0	0.0	0.0	56.3	8.75	31536.	0.201	3.008
15	13.8	1.2	2.1	2.3	8.2	3.37	20129.	0.049	0.735
16	5.2	0.0	0.0	0.0	5.2	0.94	3129.	0.019	0.279
17	22.0	0.0	4.8	0.7	16.5	11.11	33327.	0.079	1.176
18	174.7	0.0	0.0	0.0	174.7	27.50	243134.	0.624	9.333
19	26117.3	26.1	1674.8	4662.1	19754.3	5190.91	354695.	93.313	0.000

TABLE B5. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop-mix Constraint

Intermediate input without conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 13
LEVEL = 1

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	12521597.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.220
POTENTIAL/TOTAL POPULATION	0.986
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	10603290.
TOTAL PROTEIN PRODUCTION	253695.
CALORIE/PROTEIN RATIO	42.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	8989678.
RAINFED PROTEIN PRODUCTION	199105.
LIVESTOCK CALORIE PRODUCTION	794429.
LIVESTOCK PROTEIN PRODUCTION	39189.
NS-RANGE LAND CAL.PRODUCTION	127380.
NS-RANGE LAND PRT.PRODUCTION	6284.
SURPLUS PROTEIN	76365.
TOTAL ALLOCATED LAND	37463.
TOTAL CROP LAND	7694.
TOTAL RANGE LAND	29769.
TOTAL EFFECTIVE LAND	28563.
TOTAL FALLOW LAND	1758.
TOTAL NS-RANGE LAND	2781.

CROP STATISTIC I

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	28.0	0.8	1.6	15.5	10.0	22.05	69913.	0.098	1.163
2	51.4	0.0	10.5	11.5	29.5	40.27	124429.	0.180	2.137
3	1298.4	38.0	168.9	289.0	802.5	1459.80	4773547.	4.546	53.948
4	2.8	0.0	0.0	0.0	2.8	1.02	3924.	0.010	0.116
5	66.8	5.8	15.9	28.4	16.6	44.65	152252.	0.234	2.774
7	87.8	5.1	4.2	0.8	77.8	99.24	381286.	0.308	3.650
8	23.9	0.0	4.0	6.5	13.4	52.31	163046.	0.084	0.992
9	124.1	0.0	1.6	44.1	78.4	73.87	266227.	0.434	5.156
10	153.6	19.3	52.1	40.5	41.8	234.55	614511.	0.538	6.384
11	260.4	35.0	105.6	87.2	32.5	642.92	1498648.	0.912	10.818
14	87.2	0.0	0.0	0.0	87.2	36.28	130746.	0.305	3.624
15	18.3	1.6	3.9	1.7	11.0	15.54	92854.	0.064	0.759
16	5.2	0.0	0.0	0.0	5.2	1.88	6257.	0.018	0.217
17	29.2	0.0	5.8	1.3	22.2	45.96	137866.	0.102	1.212
18	169.7	0.0	0.0	0.0	169.7	74.06	654673.	0.594	7.050
19	26155.9	84.7	2573.9	5878.3	17619.0	11626.35	794429.	91.574	0.000

TABLE B6. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Present Crop-mix Constraint

High input without Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6
****

YEAR = 1975
MODE = 13
LEVEL = H

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	26746572.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.469
POTENTIAL/TOTAL POPULATION	2.107
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	22649000.
TOTAL PROTEIN PRODUCTION	566442.
CALORIE/PROTEIN RATIO	40.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	20246924.
RAINFED PROTEIN PRODUCTION	472956.
LIVESTOCK CALORIE PRODUCTION	1507653.
LIVESTOCK PROTEIN PRODUCTION	74373.
NS-RANGE LAND CAL.PRODUCTION	202622.
NS-RANGE LAND PRT.PRODUCTION	9995.
SURPLUS PROTEIN	187657.
TOTAL ALLOCATED LAND	32997.
TOTAL CROP LAND	7276.
TOTAL RANGE LAND	25722.
TOTAL EFFECTIVE LAND	26402.
TOTAL FALLOW LAND	883.
TOTAL NS-RANGE LAND	2124.

CROP STATISTIC I

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	45.6	2.8	2.8	38.0	1.9	72.48	221794.	0.173	1.232
2	114.3	21.9	46.0	29.2	17.2	261.98	809513.	0.433	3.087
3	2568.0	71.5	235.9	480.1	1780.6	3882.28	12695051.	9.727	69.376
5	214.7	1.9	18.7	58.6	135.4	132.72	452571.	0.813	5.799
7	48.0	0.9	6.2	5.9	35.0	144.68	439240.	0.182	1.297
8	53.7	9.2	17.2	8.0	19.3	251.07	782577.	0.203	1.449
9	108.9	0.0	3.9	40.8	64.1	122.40	441119.	0.412	2.942
10	147.3	30.8	48.5	39.3	28.8	370.43	970522.	0.558	3.979
11	242.0	54.3	86.6	87.4	13.6	995.98	2321629.	0.917	6.537
14	26.5	0.0	0.0	0.0	26.5	17.80	64151.	0.100	0.716
15	21.0	4.1	5.3	2.0	9.6	36.65	218966.	0.080	0.567
16	5.2	0.0	0.0	0.0	5.2	2.82	9386.	0.020	0.141
17	49.8	0.0	6.2	2.0	41.6	92.88	278654.	0.188	1.344
18	56.7	0.0	0.0	0.0	56.7	61.28	541753.	0.215	1.533
19	22700.0	37.7	3319.0	5329.3	14014.0	22864.29	1507653.	85.980	0.000

TABLE B7. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Maximize calories with Protein Constraint
- Low input with Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6
================================

YEAR = 1975
MODE = 3
LEVEL = I

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	10455523.
PRESENT DENSITY	0.225
POTENTIAL DENSITY	0.183
POTENTIAL/TOTAL POPULATION	0.824
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	8853736.
TOTAL PROTEIN PRODUCTION	198684.
CALORIE/PROTEIN RATIO	45.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	7758432.
RAINFED PROTEIN PRODUCTION	169662.
LIVESTOCK CALORIE PRODUCTION	397256.
LIVESTOCK PROTEIN PRODUCTION	19597.
NS-RANGE LAND CAL.PRODUCTION	6249.
NS-RANGE LAND PRT.PRODUCTION	308.
SURPLUS PROTEIN	50613.
TOTAL ALLOCATED LAND	37606.
TOTAL CROP LAND	11128.
TOTAL RANGE-LAND	26478.
TOTAL EFFECTIVE LAND	28472.
TOTAL FALLOW LAND	5033.
TOTAL NS-RANGE LAND	174.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF,LAND	% CROPLAND
1	594.6	0.0	150.2	425.2	19.4	255.36	781410.	2,089	14,523
2	503.7	0.0	0.0	0.0	503.7	80.60	249043.	1,769	12,299
3	1106.0	63.2	263.3	293.7	485.8	720.80	2357032.	3,885	27,005
5	8.1	0.0	0.0	0.0	8.1	0.77	2629.	0,028	0.198
7	205.3	37.0	93.8	45.8	28.7	274.82	834356.	0,721	5.012
8	14.5	2.7	0.0	1.3	10.5	10.75	33516.	0,051	0.354
9	360.5	0.0	24.4	157.6	178.5	84.58	304816.	1,266	8.803
10	198.4	70.5	75.8	21.2	30.8	182.54	478257.	0,697	4,843
11	785.2	168.7	317.4	195.4	103.8	922.82	2151105.	2,758	19.171
14	18.2	0.0	2.0	0.0	16.2	7.00	25244.	0,064	0.445
15	19.6	2.4	17.2	0.0	0.0	9.82	58677.	0,069	0.478
18	281.3	0.0	2.7	0.0	278.6	54.56	482347.	0,988	6,868
19	24375.8	23.3	3099.0	6273.9	14980.7	5813.78	397256.	85,615	0.000

TABLE B8. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Maximize calories with Protein Constraint

Intermediate input with Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 1
LEVEL = I

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	29225818.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.513
POTENTIAL/TOTAL POPULATION	2.302
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	24748426.
TOTAL PROTEIN PRODUCTION	579272.
CALORIE/PROTEIN RATIO	43.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	23148086.
RAINFED PROTEIN PRODUCTION	525336.
LIVESTOCK CALORIE PRODUCTION	795236.
LIVESTOCK PROTEIN PRODUCTION	39229.
NS-RANGE LAND CAL.PRODUCTION	113295.
NS-RANGE LAND PRT.PRODUCTION	5589.
SURPLUS PROTEIN	165376.
TOTAL ALLOCATED LAND	37606.
TOTAL CROP LAND	11130.
TOTAL RANGE LAND	26477.
TOTAL EFFECTIVE LAND	28552.
TOTAL FALLOW LAND	3100.
TOTAL NS-RANGE LAND	2109.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	1503.4	5.0	431.4	802.9	264.0	1546.07	4730986.	5.265	35.983
2	5.8	0.0	2.9	2.9	0.0	9.67	29889.	0.020	0.139
3	857.4	159.2	268.6	206.5	223.0	1779.19	5817958.	3.003	20.521
5	13.1	0.0	0.0	5.1	8.0	4.68	15970.	0.046	0.312
7	387.1	40.8	156.3	18.3	171.7	979.35	2973315.	1.356	9.264
8	9.2	2.2	5.5	1.6	0.0	54.90	171116.	0.032	0.223
9	219.4	0.0	16.3	91.4	111.7	154.42	556517.	0.768	5.251
10	275.6	135.1	104.0	14.8	21.7	687.50	1801239.	0.965	6.596
11	608.1	236.6	232.0	96.9	42.6	2291.11	5340588.	2.130	14.556
14	3.8	0.0	0.4	0.0	3.4	4.34	15652.	0.013	0.090
15	84.3	4.3	29.1	22.8	28.1	86.84	518883.	0.295	2.016
17	3.8	0.0	1.9	0.0	1.9	10.60	31804.	0.013	0.091
18	207.2	0.0	2.7	0.0	204.5	129.43	1144169.	0.726	4.959
19	24373.9	21.3	3090.0	6273.9	14988.7	11638.21	795238.	85.367	0.000

TABLE B9. ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Maximize calories with Protein Constraint

High Input with Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6
===================================

YEAR = 1975
MODE = 1
LEVEL = H

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	57233432.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	1.024
POTENTIAL/TOTAL POPULATION	4.509
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	48465276.
TOTAL PROTEIN PRODUCTION	1133672.
CALORIE/PROTEIN RATIO	43.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	45949836.
RAINFED PROTEIN PRODUCTION	1034594.
LIVESTOCK CALORIE PRODUCTION	1455169.
LIVESTOCK PROTEIN PRODUCTION	71783.
NS-RANGE LAND CAL.PRODUCTION	366474.
NS-RANGE LAND PRT.PRODUCTION	18177.
SURPLUS PROTEIN	323132.
TOTAL ALLOCATED LAND	33136.
TOTAL CROP LAND	10503.
TOTAL RANGE LAND	22633.
TOTAL EFFECTIVE LAND	25968.
TOTAL FALLOW LAND	1228.
TOTAL NS-RANGE LAND	3157.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	1794.2	8.4	643.4	903.9	238.4	3118.59	9542887.	6.909	36.388
2	37.8	4.9	17.7	15.2	0.0	105.05	324610.	0.146	0.767
3	1515.6	230.8	491.6	376.8	408.4	4693.14	15346554.	5.836	30.738
5	22.5	0.0	0.0	14.2	8.3	15.67	53442.	0.087	0.456
7	209.4	1.5	45.8	77.1	84.9	921.81	2798611.	0.806	4.246
8	255.1	76.4	122.7	54.2	1.8	1777.66	5540955.	0.982	5.173
9	82.7	0.0	14.7	37.8	30.3	112.46	405304.	0.319	1.676
10	246.9	149.1	86.2	7.3	4.3	994.90	2626647.	0.951	5.008
11	537.7	201.4	182.7	130.6	23.1	2799.31	6525181.	2.071	10.906
15	108.1	7.6	49.1	50.4	0.9	254.92	1523121.	0.416	2.191
17	12.3	0.0	6.2	0.0	6.2	56.73	170190.	0.047	0.250
18	108.4	0.0	2.7	0.0	105.7	125.63	1112331.	0.418	2.199
19	21037.1	21.3	3090.0	6219.0	11706.6	21296.20	1455169.	81.012	0.000

SUMMARY FOR COUNTRY 114 IN REGION 6
==

YEAR = 1975
HODE = 11
LEVEL = L

Table B10 ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- **Maximize calories with Protein Constraint**
- **Low input with Conservation**

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	4650694.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.082
POTENTIAL/TOTAL POPULATION	0.366
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	3938209.
TOTAL PROTEIN PRODUCTION	81725.
CALORIE/PROTEIN RATIO	48.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	2849073.
RAINFED PROTEIN PRODUCTION	53007.
LIVESTOCK CALORIE PRODUCTION	354748.
LIVESTOCK PROTEIN PRODUCTION	17500.
NS-RANGE LAND CAL.PRODUCTION	42586.
NS-RANGE LAND PRT.PRODUCTION	2101.
SURPLUS PROTEIN	15862.
TOTAL ALLOCATED LAND	37460.
TOTAL CROP LAND	7606.
TOTAL RANGE LAND	29854.
TOTAL EFFECTIVE LAND	28584.
TOTAL FALLOW LAND	2229.
TOTAL NS-RANGE LAND	2158.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	1.0	0.0	0.0	0.0	1.0	0.16	486.	0.003	0.040
2	269.3	0.0	0.0	0.0	269.3	43.08	133132.	0.942	10.927
3	310.9	1.9	29.5	80.1	199.4	141.86	463805.	1.085	12.616
5	16.3	0.0	0.0	0.0	16.3	1.54	5264.	0.057	0.659
7	342.3	2.6	4.4	16.4	318.8	103.63	314632.	1.197	13.888
8	9.1	0.0	0.0	0.0	9.1	3.44	10730.	0.032	0.369
9	614.2	0.0	25.1	218.5	370.7	119.10	429236.	2.149	24.924
10	169.0	35.3	54.3	57.3	22.1	120.83	316569.	0.591	6.858
11	285.9	28.6	76.4	133.3	47.3	236.21	550601.	1.000	11.599
14	112.7	0.0	0.2	0.2	112.4	22.51	81111.	0.394	4.575
15	23.5	1.2	8.1	7.6	6.6	6.54	39049.	0.082	0.952
17	4.6	0.0	1.7	0.0	3.0	3.56	10681.	0.016	0.187
18	305.7	0.0	2.7	0.0	303.1	55.85	493698.	1.070	12.406
19	26119.2	26.1	1675.8	4663.0	19754.3	5191.69	354748.	91.378	0.000

SUMMARY FOR COUNTRY 114 IN REGION 6
==================================

YEAR	=	1975
MODE	=	11
LEVEL	=	I

Table B11 ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Maximize calories with Protein Constraint

Intermediate input without Conservation

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	14991871.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.263
POTENTIAL/TOTAL POPULATION	1.181
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	12695118.
TOTAL PROTEIN PRODUCTION	272346.
CALORIE/PROTEIN RATIO	47.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	11106133.
RAINFED PROTEIN PRODUCTION	218969.
LIVESTOCK CALORIE PRODUCTION	794429.
LIVESTOCK PROTEIN PRODUCTION	39189.
NS-RANGE LAND CAL.PRODUCTION	102758.
NS-RANGE LAND PRT.PRODUCTION	5069.
SURPLUS PROTEIN	63031.
TOTAL ALLOCATED LAND	37463.
TOTAL CROP LAND	7694.
TOTAL RANGE LAND	29769.
TOTAL EFFECTIVE LAND	28938.
TOTAL FALLOW LAND	1803.
TOTAL NS-RANGE LAND	2414.

CROP STATISTIC :

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	18.7	1.4	3.8	10.5	3.1	20.73	63430.	0.265	0.673
3	668.0	29.8	72.7	138.8	426.7	724.67	2369654.	2.308	24.007
4	2.8	0.0	0.0	0.0	2.8	1.02	3424.	0.010	0.101
7	662.4	9.2	40.8	45.9	566.5	777.03	2359070.	2.289	23.804
8	4.1	0.0	0.0	0.0	4.1	3.97	12365.	0.014	0.148
9	294.8	0.0	23.3	105.2	166.3	203.29	732665.	1.019	10.594
10	279.4	67.5	119.5	61.5	30.9	516.70	1353742.	0.966	10.042
11	338.2	50.3	133.6	108.1	46.2	867.31	2021703.	1.169	12.156
14	135.7	0.0	0.4	6.6	128.7	72.46	261145.	0.469	4.877
15	75.1	7.2	35.0	11.7	21.3	94.77	566234.	0.260	2.701
17	7.1	0.0	1.9	0.0	5.2	12.42	37259.	0.025	0.256
18	296.1	0.0	2.7	0.0	293.4	149.94	1325439.	1.023	10.642
19	26155.9	84.7	2573.9	5878.3	17619.0	11626.35	794429.	90.385	0.000

TABLE B12 ASSESSMENT OF CROP PRODUCTION AND POPULATION SUPPORTING CAPACITY

- Maximize calories with Protein Constraint

High Input without Conservation

SUMMARY FOR COUNTRY 114 IN REGION 6

YEAR = 1975
MODE = 3
LEVEL = L

NUMBER OF ZONES INCLUDED	32
NUMBER OF ZONES SKIPPED	0
TOTAL POPULATION	12693752.
POTENTIAL POPULATION	31487486.
PRESENT DENSITY	0.223
POTENTIAL DENSITY	0.552
POTENTIAL/TOTAL POPULATION	2.481
TOTAL AREA	56991.
TOTAL AGRICULTURAL LAND	56315.
TOTAL IRRIGATED LAND	43.
TOTAL CALORIE PRODUCTION	26663606.
TOTAL PROTEIN PRODUCTION	571474.
CALORIE/PROTEIN RATIO	47.
IRRIGATED CALORIE PRODUCTION	691800.
IRRIGATED PROTEIN PRODUCTION	9118.
RAINFED CALORIE PRODUCTION	24272240.
RAINFED PROTEIN PRODUCTION	478517.
LIVESTOCK CALORIE PRODUCTION	1511230.
LIVESTOCK PROTEIN PRODUCTION	74549.
NS-RANGE LAND CAL.PRODUCTION	188336.
NS-RANGE LAND PRT.PRODUCTION	9291.
SURPLUS PROTEIN	125548.
TOTAL ALLOCATED LAND	32997.
TOTAL CROP LAND	7238.
TOTAL RANGE LAND	25759.
TOTAL EFFECTIVE LAND	26550.
TOTAL FALLOW LAND	880.
TOTAL NS-RANGE LAND	1992.

CROP STATISTIC 1

NR	TOTAL	VH	H	M	L	PRODUCTION	CALORIES	% EFF.LAND	% CROPLAND
1	15.7	3.0	4.1	8.6	0.0	34.76	106354.	0.059	0.412
2	0.4	0.0	0.4	0.0	0.0	0.71	2199.	0.001	0.010
3	1851.1	64.9	138.8	328.7	1318.8	2759.44	9023380.	6.972	48.564
5	10.4	0.0	0.0	2.6	7.8	6.04	20587.	0.039	0.274
7	586.4	0.0	7.2	43.4	535.8	1224.18	3716598.	2.209	15.385
8	209.1	26.0	80.4	77.5	25.1	1075.30	3351709.	0.788	5.485
9	192.0	0.0	17.9	69.0	105.1	230.11	829317.	0.723	5.037
10	237.6	70.9	108.0	42.2	16.6	706.10	1849987.	0.895	6.234
11	335.5	54.3	90.3	130.3	60.5	1165.12	2715898.	1.263	8.801
14	64.7	0.0	0.0	6.6	58.0	55.62	200467.	0.244	1.697
15	175.0	4.1	27.9	24.6	118.4	187.50	1120309.	0.659	4.591
17	29.3	0.0	6.2	1.2	21.9	86.75	260240.	0.110	0.769
18	104.5	0.0	2.7	0.0	101.8	121.63	1075193.	0.394	2.742
19	22737.9	37.7	3328.9	5357.3	14014.0	22116.63	1511230.	85.643	0.000

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