EWASO NG'IRO NORTH BASIN

Draft Report

AGRICULTURE:
CROP AND IRRIGATION SUB-SECTOR STUDY

November 2001

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1. INTRODUCTION

1.1 *BACKGROUND*

The basin mainly consists of drylands (areas where water scarcity is the main constraint to development). However, it is not simply the low levels of rainfall that make rain-fed agriculture largely unviable in these areas, it is also the extreme variability of rainfall, which often results in a cycle of drought years followed by years of excessive rain. They can best be described as *non-equilibrium* environments, prone to temporal variations in available water and biomass for grazing.

1.2 *SCOPE OF THE STUDY*

On the basis of the original terms of reference and the issues raised by the inception report, the components of the irrigation study are summarized as:

1. Documentation of the biophysical and socio-economic factors influencing rainfed and irrigated agricultural development in the basin.
2. Documentation of the status of rainfed and irrigated agriculture, its role in food security and poverty alleviation and the potential for improvements
3. Documentation of the potential for rainfed and irrigated agriculture using marginal water and soil resources, particularly, salt tolerant crops that can be grown with brackish water or grown in salt affected soils
4. Assessment of irrigation requirements under different cropping systems.
5. Identification of strategies for putting in place mechanisms for incentives and disincentives for farmers employing efficient and inefficient irrigation systems respectively.
6. Identify feasible project that could be undertaken to promote irrigated agriculture in the study areas.

1.3 *ORGANIZATION OF THE REPORT*

The report is broken down into three major parts, crop production, irrigation and cross-cutting issues. The appendices cover methodology, crop production results, irrigation results and additional information.

2. CROP PRODUCTION

2.1 *LAND SUITABILITY*

2.1.1 The issues

Land is an indispensable resource for the most essential human activities: it provides the basis for agriculture and forest production, water catchment, recreation, and settlement. The range of uses that can be made of land for human needs, is limited by environmental factors including climate, topography and soil characteristics, and is to a large extent determined by demographic, socioeconomic, cultural, and political factors, such as population density, land tenure, markets, institutions, and agricultural policies.

This section examines land suitability in terms of climatic, terrain (topographic) and soil conditions. Socioeconomic needs of rapidly increasing and wealthier populations are the main driving force in the allocation of land resources to various kinds of uses, with food production as the primary land use. Heavy population pressure and the related increased competition by different types of land users have emphasized the need for more effective land-use planning and policies. Rational and sustainable land use is an issue of great concern for preserving the land resources for the benefit of present and future populations.

Land use is largely conditioned by environmental factors such as climate, topography, bio-diversity and soil characteristics, and determined by demographic, socioeconomic, institutional and political factors, such as education, poverty, land tenure systems, markets, and agricultural policies.

2.1.2 Agro-ecological conditions

Agro-ecological conditions in the basin are highly variable in space and time making it extremely challenging to manage rainfed agriculture. Areas of high agricultural potential is limited and confined to the mountain footslope and highland areas. Agro-ecological zones I, II and III suitable for rainfed agriculture (tea, coffee, wheat, barley, pyrethrum) is limited to 0.32, 0.56 and 1.28% of the basin area respectively. Agro-ecological zones IV and V suitable for marginal crop production and a high livestock production potential covers 1.57 and 6.54% of the basin area respectively. Agro-ecological zones VI and VII, suitable for marginal livestock production cover 12 and 78% of the basin area respectively.

2.1.3 Soil suitability and implication for irrigation development

The edaphic environment is highly variable in terms of soil water holding capacity, soil organic matter and soil nutrients, which determine the soil suitability. The main soils types of the basin are presented in the soils report.

The main soil constraints to irrigation development can be summarized as:

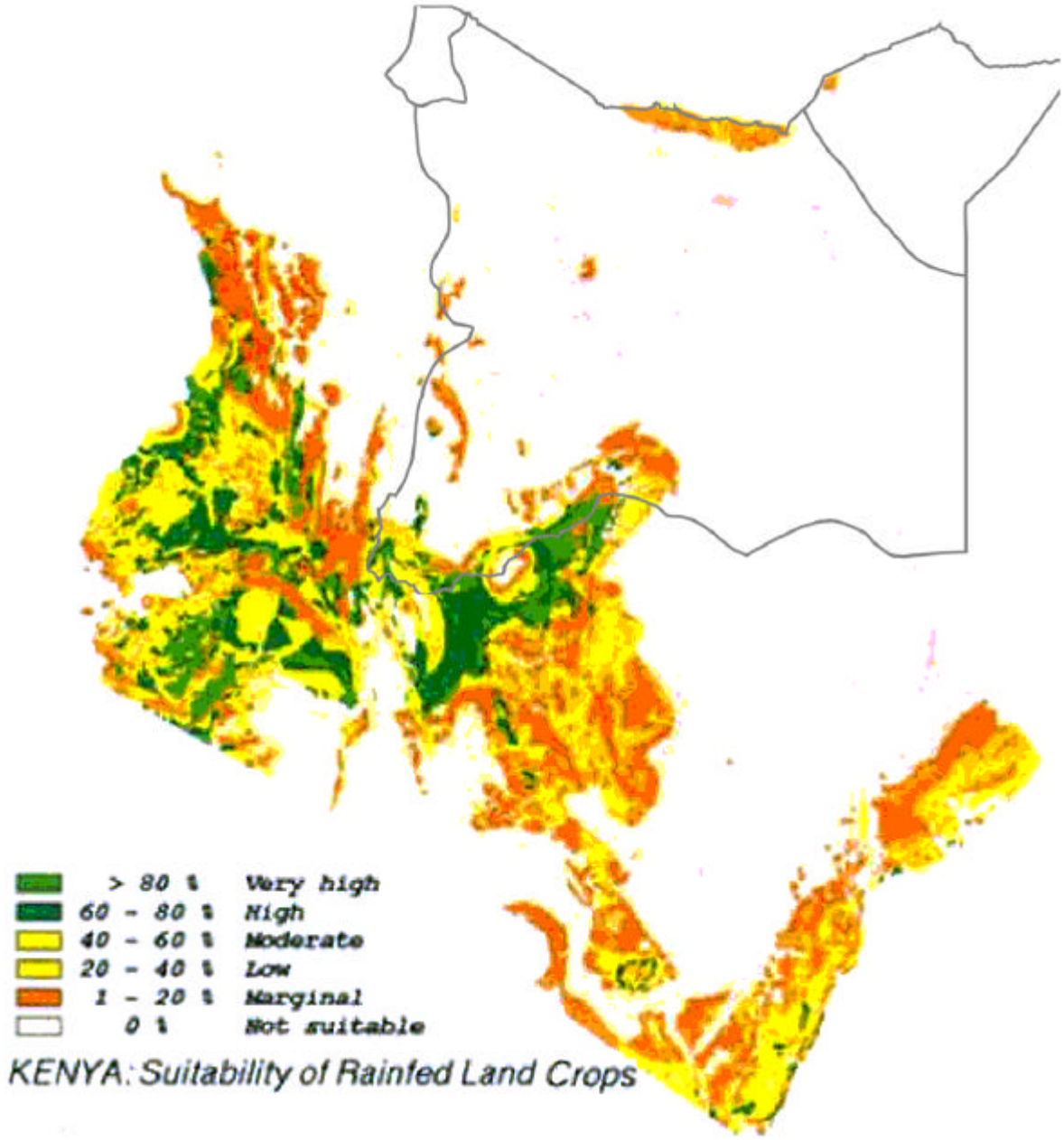
1. Areas with a good water supply in the lowlands does not always coincide with good soils, hence the need to transport water where soils are suitable or to ameliorate soil conditions where water conveyance to suitable soils is not feasible.

2. Poorly drained soils require additional investments to make them suitable for irrigation.
3. Sodic/saline soils
4. Sandy soils with low water holding capacity necessitating more frequent irrigation.
5. Low inherent soil fertility and low organic matter and hence low agricultural productivity under natural conditions.

The implications of these constraints to irrigation development is the fact that additional investments in alleviating soil fertility, excess water and sodic/saline constraints to crop production. This translates to lower net returns to irrigated agriculture. Despite this limitations, utilization of marginal soils is justified in some cases on the basis of:

1. need to promote equitable rural development
2. high cost of moving water to areas with more suitable soils.
3. need for local food security and high cost of transporting food grown elsewhere.
4. low opportunity cost for labour.

It is however important to note that irrigation is constrained more by water availability than by soil suitability.



KENYA: Suitability of Rainfed Land Crops

2.1.4 Agricultural Land Potential

Appendixies B1, B2 and B3 present results of potential production analysis in the basin.

Table 2.1 gives estimates of arable land by productivity class for different districts.

Table 2.1: Arable land suitability for different districts and land class

	Total (ha)	Total arable land suitability for different land classes (ha)						Suitable	Unsuitable
District		C1	C2	C3	C4	C5	C6	(%)	(%)
Nyahururu	330,400	10,800	25,300	39,500	48,900	30,600	175,300	46.9	53.1
Nyeri	335,600	24,800	95,200	24,400	13,100	14,400	163,700	51.2	48.8
Laikipia	922,900	25,700	43,100	27,400	28,000	42,100	756,600	18.0	82.0
Isiolo	2,569,800	6,500	10,300	40,000	74,700	143,900	2,294,400	10.7	89.3
Meru Central	394,200	35,610	36,450	28,770	18,990	19,140	255,240	35.3	64.7
Meru North	298,200	35,090	55,250	66,530	44,310	44,660	52,360	82.4	17.6
Samburu	2,112,700	1,900	1,500	700	1,900	92,300	2,014,400	4.7	95.3
Garissa	2,126,800	4,200	6,200	22,400	77,100	194,500	1,822,400	14.3	85.7
Masarbit	6,129,600	0	0	29,900	33,200	112,000	5,954,500	2.9	97.1
Wajir	5,669,800	0	0	1,400	7,900	17,600	5,642,900	0.5	99.5
Mandera	2,587,100	0	0	0	1,300	11,500	2,574,300	0.5	99.5
Total	23,477,100	144,600	273,300	281,000	349,400	722,700	21,706,100	7.5	92.5

Source:

FAO/IIASA, Agro-ecological land resources assessment for agricultural development planning, a case study of Kenya World Soil Resources Reports and Technical Annex 71/1-8

1. The AEZ results has identified land, climate and biological resources suitable to provide the needs of food and fiber of future generations.
2. Despite this affirmative aggregate picture, there are also reasons for profound concerns. Several regions exist, where the rain-fed cultivation potential has already been exhausted, as for example is the case in Laikipia district. Land degradation, if continuing unchecked, may exacerbate regional land scarcities. Concerns for the environment may prevent some resources from being developed for agriculture.
3. Extend of suitability land varies across the basin by values of between l% and 82 %. Generally land suitability is higher in the upper breached of the basin and decreases as one moves to the lower reaches of the basin. On the basis of currently available soil, terrain and climate data, the AEZ approach estimates that 21 million hectares of land, i.e., more than 90 percent of the land surface suffer rather severe constraints for rain-fed crop cultivation.
4. Various ways are available for estimating the extent of land with rain-fed cultivation potential for rain-fed crops. Any quantification depends on a variety of assumptions: the range of crop types considered, the definition of what level of output qualifies as

acceptable, the social acceptance of land-cover conversions (in particular of forests), and the assumptions on what land constraints may be alleviated with modern inputs and investment. Hence, our estimates range at 144,600 ha for land very suitable and suitable for major cereal crops, under high inputs and mechanization, outside current forest areas. Despite recognizing that statistics of land in cultivation are likely to be underestimating actual use in some districts, AEZ results indicate that there is still a significant potential for conversion to arable use in Wajir and Marsabit (202, 000 ha). This can only be achieved through the provision of water.

2.2 *CROP PRODUCTION*

2.2.1 The issues

In evaluating the past and current status of crop production in the basin, the following issues are raised:

1. Type of crops that have been introduced and grow in the basin
2. Extend and distribution of crop production in the basin.
3. Ecological suitability of different crops within the basin
4. To evaluate actual and potential crop yields in the basin, the following issues are raised: actual current crop production situation; crop yield variability in time and over space; potential crop production situation and potential for increasing crop yield levels.

2.2.2 Biophysical requirements of different crops

Appendix B4 presents the biophysical requirement of different crops grown in the basin. Expect for banana which has a very long growing duration exceeding 300 days, the other crops have a growing duration of between 80 and 180 days. The crops growing duration describes the required humid growing phase from the beginning of the rain season when rainfall exceeds crop water requirement. Under soils with good water storage capacity, the potential growing duration can be extended behold the rain season since soil water storage continue supplying crop water demand after the rain season. Despite the moderate growing duration for most of the crops, in most of the years, this duration is only meet within the upper reaches of the basin due to the low poorly distributed rainfall. The temperature requirement of most of the crops varies between 10 and 35 oC and matches temperature regimes in the basin. Other than for onions and cabbages, the other crop are sensitive or moderately sensitive to frost. Frost occurrence however is limited to low lying areas in the cool months of the year such as July. Most of the crop require well drained soil with lightly acidic to neutral PH. Within the basin, soil characteristic vary widely and specific crop-soil test is necessary on site. Cotton is tolerant to soil salinity while most of the other crop are moderately sensitive to salinity. On the other hand, pulses (beans), onion and banana are sensitive to soil salinity. The different crops have different fertilizer and water requirements. Season water requirement varies between 300 and 600 mm. The water requirement is hardly meet in much of the mid and lower reaches of the basin. Most of the crops have medium to high yield sensitivity to water stress. These include wheat, beans, potatoes, onion, tomatoes and banana. Other crops have medium to low yield sensitivity to water stress. These include cotton, sorghum, sunflower, soybeans and cabbage. Maize has high yield sensitivity to water stress while groundnuts have low yield sensitivity to water stress. Water use efficiency is higher for vegetables and root crops and lower for the cereals and pulses.

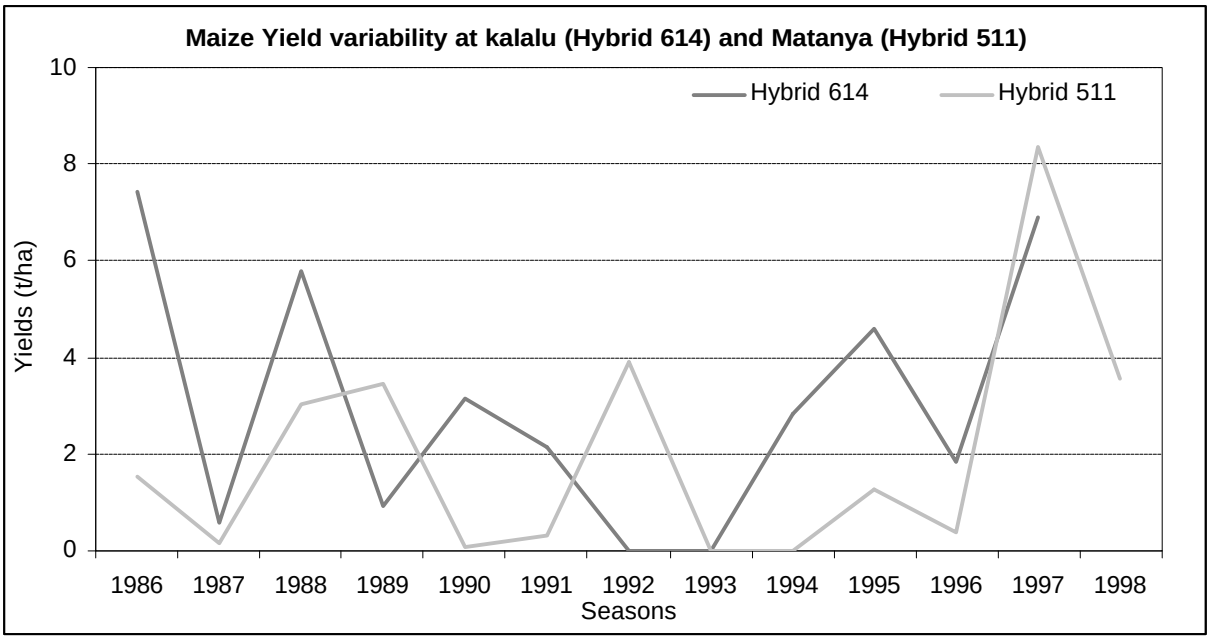
2.2.3 Characteristics of different production systems

Three types of production systems are identified. Appendix B5 shows the characteristics of the difference production systems in the basin. The main factors in differentiating the production system include land size, capital and labour investments, technology adoption, extension and advisory services.

2.2.4 Crop yield levels

Appendix B6 presents crop yields and production for a number of crops in the basin. Crop yield vary widely from year to year and district to district. Maize yields vary between 0.1 to 8.5t/ha while sorghum yields vary between 0.1 and 6.3t/ha. Wheat yield vary between 0.2 to 1.8 t/ha. For the dry arid district such as Wajir, the high yields levels of 8.5t/ta for maize and 6.3t/ha for sorghum are not possible unless with irrigation water. Pulses yields vary between 0 (failure) and 2t/ha. As with yield variation, the total cropped area also vary from year to year. This could be attributed to high variability in seasonal yield and frequent crop failures that lead to unpredictable planting decisions from year to year. As a result of variability in both hectare and yields, the overall total production volumes in the basin show the same high variability.

Figure 1 shows long term maize yields variability for two maize varieties over a period of 13 seasons.



2.2.5 Cropped areas, and production

Table 2.2 shows the current cropped area in the basin.

Table 2.2: Cropped area in the basin

Districts	Total Area (ha)	Area in Basin (ha)	Cropped Area (ha)	Cropped Area (% of Total Area)
Nyandarua	330400	131800	182000	55.08
Meru Central	394200	174100	262000	66.46
Meru North	298200	122400	131000	43.93
Isiolo	2569800	2261800	1200	0.05
Marsabit	6129600	5207900	4700	0.08
Samburu	2112700	1562500	5000	0.24
Laikipia	922900	815300	44600	4.83
Garissa	2126800	1447600	1200	0.06
Nyeri	335600	103500	36800	10.97
Wajir	5669800	5669800	1500	0.03
Mandera	2587100	2587100	5500	0.21
Moyale	939000	939000	4000	0.43

From the percentage cropped area, it is evident that the extent of crop production is wider in the more humid and sub humid districts of Nyandarua, Meru North, Meru central and Nyeri where the area cropped range between 11 and 66 percent of the total district area. In the semi arid and arid district, the extent of crop production is very narrow and range between 0.03 percent in Wajir to 4.8 percent in Laikipia. As variously mentioned, this is mainly attributed to low and poor rainfall distribution in the lower reaches of the basin.

2.2.6 Low productivity of rainfed systems

Livestock and crops are the main sources of food and economic survival in the ENNDA region. Self-sufficiency in food production is desirable in order to reduce the impact of the persistent famines occasioned by adverse and unfavourable weather conditions. Crop production analyses as noted from available reports at Ministry Agriculture have indicated that the spatial distribution of crops in the basin is highly coincidental with agro-climate, and in particular rainfall distribution within the basin.

In the high altitude areas, intensive crop production (i.e. high value horticultural and cash crops) is found while the lower areas which suffer from long periods of dry spells are sparsely utilized for crop production. Where perennial rivers are found, sporadic cluster irrigation schemes do exist. In the arid areas, the irrigation schemes support only subsistence production.

According to the data available from MARD reports LRP, ENNDA, Agriculture Information Centre (AIC), KARI, NWMP reports, and DRSRS, only 3.8% of the Study area is arable. Intensive crop farming is only practiced in the high potential areas of Nyandarua, Nyeri and Meru Central districts. Small pockets of isolated farming take place in ASAL districts of Samburu, Mandera, Garissa, Wajir Meru North and Isiolo. Rainfed agricultural production is low, particularly in the more arid districts of Wajir, Mandera, Marsarbit, Isiolo, Moyale and

Samburu. Marsabit district has an average yield of 1.1, 0.6, 0.5 and 1.3 tons/ha for maize, sorghum, millet and wheat respectively. The pulses grown in this district include beans, cowpeas and green grams. Wajir District has average yield of 0.6 and 0.5 tons/ha of maize and sorghum respectively. The pulses grown include cowpeas, beans and green grams. Garissa District has average yield of 2 and 0.8 tons/ha of maize and sorghum respectively. Generally only 2.72% of the region was under crop farming in 1999.

2.2.7 Crops and family food strategies

Crop yield trends reflect the huge variability from year to year, mainly due to the variable rainfall. Recorded maize production has varied from 20,000 to 80,000 tons per year and farmers are sometimes substantial buyers and sometimes sellers. Trends are difficult to analyse, as the annual statistics amalgamate the results of two distinct rainy periods.

From the statistics farmers appear to get higher yields in both good and bad years from maize than from millet or sorghum, which are the recommended crops for the dry areas. Maize is the preferred as grain staple and farmers seem to regard sorghum more as a market crop than as a foodstuff.

Maize and pulses have always been the principle crops, providing both food and income.

2.2.8 Potential production levels

Appendix B7 shows the total potential crop yield and production for various crops within the basin following FAO/IISA estimated land potentials. Appendix B8 shows a summary of the computed potential crop production in the basin. These results reflect the production potential for individual crops in the basin and assume that the total potential area where the crop is suitable is put under production. The basin has a high production potential for potato, cassava and sugarcane. Due to the processing need for sugarcane, exploitation of this potential would require an evaluation of cost implication to install processing facilities. Likewise, the basin has a good potential for maize, sorghum, wheat, oats, barley, beans, millet, pigeon peas, soybean, and bananas. The basin has a lower potential for oil palm, rice, cowpea, green grams and groundnuts. Much of the production potentials is within the upper and middle reaches of the basin. The lower reaches districts of Mandera, Moyale, Wajir and Marsabit have very low crop production potentials.

2.2.9 Potential production versus food demand

Table 2.3 shows the comparison the current and future food demand to the potential crop production in the basin.

Table 2.3: Food demand and Production potential for a number of crops

	Food Demand (tons)		Crop Production (tons)	
	Current (2000)	Future (2025)	Current(2000)	Future Potential
Maize	215,056	398,702	103,407	750,006
Wheat	54,705	101,421	9,376	496,709
Millet/Sorghum	17,054	31,617	7,033	744,995
Rice	29,014	53,790	0	39,306
Potato	32,779	60,770	156,929	3,480,593
Cassava/Sweet Potato	6,644	12,318	22120	1,930,558
Pulses	30,564	56,664	90,498	702,598
Vegetables	81,504	151,104	99,284	297,852

Source: ***Summary basin potential crop production sheet (Adjacent)***

Table 3 show that the current and future food demand can be meet if the full potential arable area was exploited. As already pointed out, the potential production assumes that each crop is put under all the suitable land area for that crop. Selection of crops should therefore be made in relation to laid down criteria that should take into account population food preference and requirements, crop gross margin, effective use of limited water resources and the social economic status of the population.

2.3 *FOOD NEEDS AND FOOD SECURITY*

2.3.1 The issues

In relation to food needs and security in the basin, the following issues are raised

1. The population of the basin has been growing steadily at a growth rate of 2.9 (CBS Population Census Data, 2000) while as pointed out in the inception report, current crop production remain low.
2. Food supply in the basin is mainly from agricultural production which is mainly rain fed and whose production levels therefore varies widely from district to district and year to year.
3. Food needs and security can be achieved either by increasing production of food crops to meet the food needs of this growing population or by growing high value crops with high economic returns that can be subsequently used to purchase food crops. Additionally, improvement in income from off farm activities can play an important role in meeting the food demand and security by supplementing food supply from farm production.
4. Due to the high spatial and temporal variability in production levels, which is mainly attributed to the dependence of crop production on rainfall, the issue of meet the

growing food needs and subsequent food security for the increasing population in the basin is of major concern.

2.3.2 Food requirements

Per capita food requirement for different food crops varies between urban and rural population. The bulk of the food requirement is meet from maize. There is a high usage of rice the diets of urban population while the opposite is true for sorghum and millet. The usage of animal food sources is higher within the urban population.

Appendix 1 presents the estimated current and future food demand for each of the districts in the basin. Estimated food demands within the different districts vary depending mainly on population differences and urban-rural population proportions. In total, maize demand is highest and currently stands at values above 215,000 tons for the whole basin. This is about four times the demand of the other cereals crops. Wheat, potato and pulses are next to maize in terms of demand. In addition to these crops, milk demand is significant. The other crops and animal produces show moderate demands across the different districts.

2.3.3 Food self-sufficiency and food security

Erratic production and variable yields are primarily due to erratic rainfall, and farmers in the Basin experience frequent crop failures. Due to this, most areas of the Basin are prone to frequent and often severe food shortages which invariably necessitate food aid. For example, the failure of the 1995 short rains, followed by the failure of the 1996 long rains led to a severe food shortage and unusually high food prices in the district.

It follows that farmers are not able to produce as much food for their households as they plan. However, it is also the case that not all households aim at self-sufficiency since they may be short of the necessary labour or land, or they may feel that they can meet their objectives better by devoting some of their resources to livestock production, non-farm business or to a marketable crop and buying part of their food needs. Farmers adopt strategies of supplying food from their farms for durations varying from one month to 1 year depending on the location and seasonal rainfall. Most farmers plan their budgets for their other expenditures, including what they can afford to invest, on the basis of their expected food expenditures, and that, if the rains are bad, food expenses are increased, and other types of expenditure have to be reduced. High food expenses are shown in the Welfare Monitoring Survey Basic Report II after two below average rainfall seasons. Hence there are times when farmers in semi-arid and arid areas have to buy much food, obtaining a comparatively small proportion from their own crops.

Most of the people experience a higher degree of food insecurity. The average number of years with unexpectedly high food purchase varies from 1-4. In food deficit periods, farmers use their own non-farm income to purchase food, or rely on other family members' non-farm jobs or sold livestock. They also cut expenditure on clothes, food and smoking or drinking, improvements to their house or non-farm business and education. Severe food shortages were experienced through the basin in 1960, 1985, 1993,1995,1996, 1997, and 1998 (District informant).

2.3.4 Government policy on food aid

The dependency on food aid increases with an increase in aridity of the area. Hence, there is a fairly widespread reliance on food aid in case of severe and prolonged droughts, which may encourage farmers to stay in farming in these drought-prone areas. However, they also rely on storage and off-farm employment.

The Government of Kenya has had a long-standing policy on the provision of emergency food aid. It operates a Famine Relief and Rehabilitation Programme (FRRP) under the Office of the President (OP) which assists victims of drought and other hazards who may need food relief and other rehabilitation measures. The FRRP has a co-ordinating committee at every administrative level - from the sublocation level to the location, division, district, province and national levels. At the district level, the co-ordinating committee monitors the drought situation (and other hazards) and reports to the District Development Committee (DDC). The DDC compiles a report on sublocation basis and reports to the OP's National Co-ordination Group about the worst hit areas and their food requirements. The OP's National Co-ordination Group then makes allocations of food and other related inputs to the district. Once the district receives its allocations, the District FRRP Committee sits and allocates food and related inputs for distribution to the 'needy' areas. Each FRRP Committee consists of government officers (administration and technical people) and politicians. Minutes and records of meetings of discussion at every level (from sublocation to national level) are kept to ensure transparency and accountability.

Relief activities are generally in the form of food aid, while rehabilitation involved provision of seed, fertilisers and sometimes farm (hand) tools in desperate cases. The Kenyan Government got material support from the World Food Programme (WFP) and the Food and Agriculture Organisation (FAO) of the United Nations (UN) during the 1997 Drought Food Relief and Rehabilitation activities. The WFP donated food while the FAO donated hand tools, seed and fertilisers. Various programmes and donor organisations have assisted farmers in the Basin with different types of inputs in order to enhance crop production recovery since 1992.

2.4 *RETURNS ON CROP INVESTMENTS*

2.4.1 The issues

To evaluate return on crop investments, the following issues are raised:

1. Level of investment made into the production system.
2. Gross margin realized from the investment made.

2.4.2 Net revenue

Appendix B1 shows the characteristics of the different production systems in the basin. Three types of production systems are identified, i.e. low, intermediate and high input systems. The three production systems are differentiated mainly in relation to capital and labour investments, land size, technology adoption, extension and advisory services and consequently, the level of yields possible. Much of the crop production carried out in the upper and middle reaches of the basin fall within the low and intermediate level of input. High input production systems are fewer and are mainly found within the upper reaches of the basin where a number of horticultural farms have been established. Crop production studies carried out by NRM3 over the last decade indicate a shift towards intermediate input level of production. It has been

observed that most farmers' user hybrid maize seeds and apply manure and fertilizer while carrying out at least some limited level of soil and water conservation.

Appendix 6a show revenue return analysis for rain-fed production system with limited fertilizer and crop protection while appendix 6b shows revenue return for an irrigated system with good fertilization and crop protection. Under production level 1 (rain-fed and moderate fertility and crop protection), net revenue returns are higher for vegetables and tree and cash crops followed by cereals and pulses. This attributed to the low yield levels for cereals and pulses under rain-fed condition. It should however be realized that these returns are only possible within the upper and middle reaches of the basin. In the lower reaches of the basin, net returns will remain well below values shown, as yield levels remain well below those used in this evaluation. Under production level 2 (irrigated and good fertility and crop protection), net returns are high but follow the same patterns shown under production level 1. As yield are increased and stabilized by irrigation, these returns are possible within a wider extent of the basin.

Table 4: Net revenue comparison between rain-fed and irrigated production

Crop	Net Revenue		Production
	Rain-fed	Irrigated	Improvement factor
Cotton	1,061	28,104	26.5
Millet	1,078	15,655	14.5
Sunflower	10,257	79,396	7.7
Cow pea	3,019	21,237	7.0
Bean	24,567	79,655	3.2
Maize	15,932	51,434	3.2
Wheat	34,088	102,590	3.0
Sweet Potato	39,203	116,918	3.0
Pyrethrum	19,950	57,215	2.9
Irish Potato	155,095	429,413	2.8
Banana	75,918	206,577	2.7
Simsim	12,114	30,628	2.5
Pigeon pea	22,682	56,860	2.5
Cabbage	198,281	455,183	2.3
Sorghum	14,527	32,704	2.3
Coffee	62,106	124,024	2.0
Onions	140,114	277,016	2.0
Tea	205,143	340,311	1.7
Tomatoes	246,194	377,321	1.5
Cassava	37,370	52,319	1.4
Kale	215,281	284,683	1.3
Tobaco	76,881	94,758	1.2

Table 4 shows a comparison between net revenue for rain-fed and irrigated production. A production improvement factor is calculated. Net revenue increases by between 1.2 and 26 times after increasing yields through irrigation and good amounts of fertilizer and chemical protection.

2.4.3 Constraints on investments

A study on the constraints on investments to improve crop production identified the wide range of factors influencing investments for different crops (see Table 1).

Table 1: Major factors hindering desired investment

	Barrier								
Desired Investment	Labour shortage	Capital shortage	Price unattractive	Input costs	Rain-fall	Other	blank	Grand total	%
Oranges		5			10	1		16	19.3
Cabbages				1	8			9	10.8
Cotton	1	1				6		8	9.6
Maize		4		1	1	1		7	8.4
Mangoes		3			2			5	6.0
Beans	1	1			2			4	4.8
Millet		2				1		3	3.6
Tomatoes					2	1		3	3.6
Sorghum		2						2	2.4
Sweet potatoes	1	1						2	2.4
Green gram						1	1	2	2.4
Pigeon peas					1			1	1.2
Castor oil						1		1	1.2
Cassava	1							1	1.2
Soya beans						1		1	1.2
Onions					1			1	1.2
Total	4	31	1	2	27	17	1	83	
Percentage	4.8	37.3	1.2	2.4	32.5	20.5	1.2	100.0	

Source: Field interviews, 1998**.**

3. IRRIGATION

3.1 *IRRIGATION AND DRAINAGE INVENTORY AND POTENTIAL*

3.1.1 Distribution of irrigation and drainage projects

Figures below presents the irrigation and drainage distribution by district and sub-basin. It is noted that Nyandarua District has the highest hectarage, this is mainly due to the high number of drainage projects in the area and the difficult is assessing the actual hectarages because even partially reclaimed swamp land was considered to be part of the scheme areas.

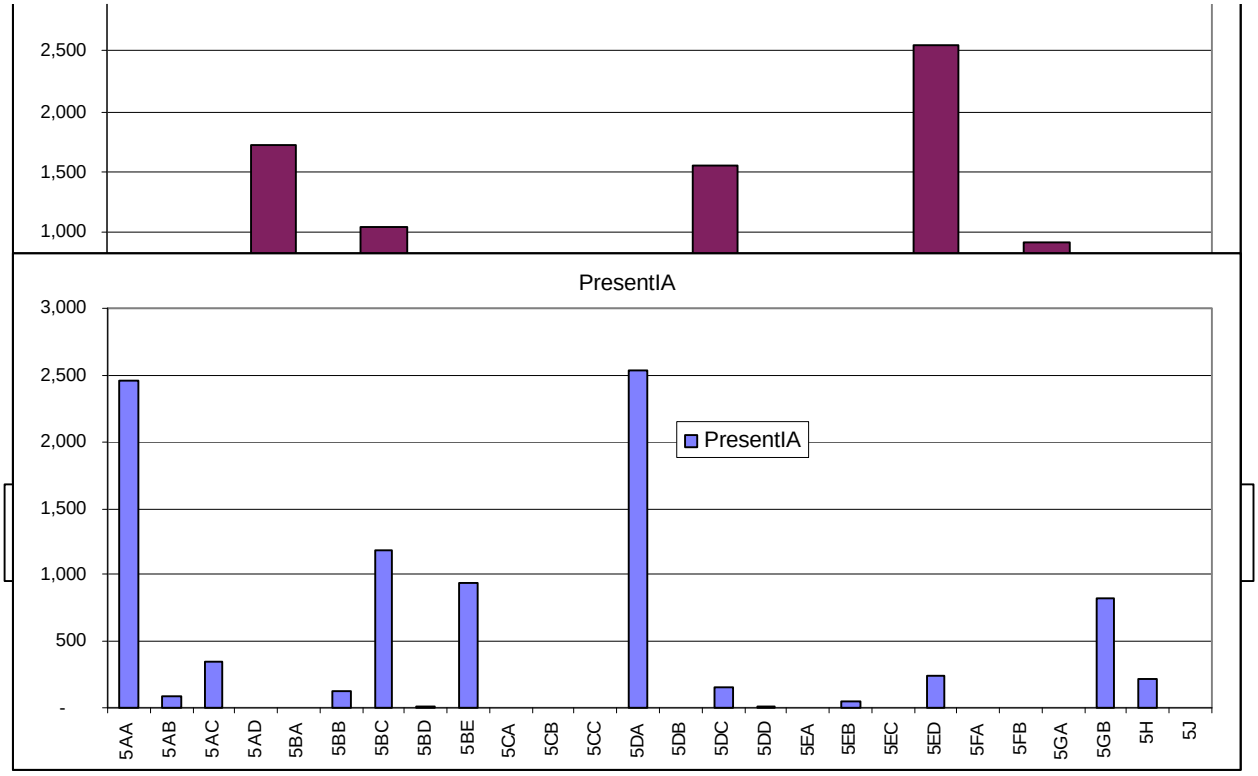


Figure 0: Distribution of irrigation and drainage projects by sub-basin

3.1.2 Irrigation and drainage potential

Irrigation potential figure presented in this reports are based on Ministry of Agricultures assessment of irrigation and drainage potential taking into consideration, land suitability only. These figures therefore need to be adjusted to take into consideration the water requirements. Table 2 and 3 herebelow presents the irrigation and drainage potential by district and by sub-basin.

Table 2: Estimated District irrigation and drainage potential

District	PotentialIA
Isiolo	2,236
Laikipia	4,928
Mandera	2,703
Marsabit	92
Moyale	-
Meru North	4,610
Meru Central	1,887
Nyandarua	5,248
Nyeri	3,226
Samburu	283
Total	25,212

Source: District Agricultural Offices

Table 3: Estimated sub-basin irrigation and drainage potential

Subbasin	PotentialIA
5AA	4,841
5AB	407
5AC	768
5AD	-
5BA	-
5BB	602
5BC	3,579
5BD	50
5BE	2,966
5CA	3
5CB	-
5CC	-
5DA	7,442
5DB	-
5DC	449
5DD	20
5EA	-
5EB	92
5EC	-
5ED	1,291
5FA	-
5FB	-
5GA	-
5GB	1,871
5H	832
5J	-
Basin Total	25,212

Source: District Agricultural offices

3.1.3 Utilization of poorly drained areas

The major swamps in the basin are presented in Table 4. Utilization of poorly drained areas for agricultural production started in the 1950's and has been increasing as a result of the increasing population pressure. Pesi, Ewaso Narok and Ol Bolosat swamps in the semi-arid areas of Laikipia district were cleared and drainage infrastructure provided to facilitate crop production in 1958 (MoW, 1961) as part of an investigation on the agricultural potential of the Ewaso Ngiro North River basin. This study also reported that Lorian swamp was being used by number of Somali tribesmen to grow maize. The estimated area under maize production was 80 hectares. The maize was reported to be doing well despite the poor quality of seed and crop husbandry. The concern then was more of how to improve agricultural production and there was no concern over loss of biodiversity. A 1997 study of Ewaso Narok and Lorian swamps reported that between 1961 and 1997 the Ewaso Narok swamp area had decreased from 22 to 14 km^2 following successful drainage intervention. This has come at a substantial habitat loss and major influence on the flow regime of the Ewaso Narok and Ewaso Ngiro rivers. Cultivation activities at the Lorian swamp, which marks the end of the Ewaso Ngiro river, ceased due to the decreasing inflow and swamp area and the importance of livestock to the Somali community.

Table 4: Major swamps in the basin

Swamps	Area in hectares
Olbolosat	4,251
Narok	1,943
Pesi	891
Moyo	931
Burguret/Rongai Lorian swamp	891

Source: NRM3 Database, 2001

3.1.4 Different perceptions of the problem

Commercial irrigators have to maintain irrigation thought the growing cycle irrespective of the river flow conditions and hence for them provision of storage and in some cases exploitation of groundwater is both a statutory obligation and an economic necessity. Commercial irrigators view smallholder irrigators as inefficient irrigators. They use inefficient water delivery, distribution and application methods, use poor agronomic practices and consequently get a very low return per unit volume of water abstracted. They argue that substantial savings of water can be made if smallholder irrigators were to improve water use efficiencies substantially.

During periods of water scarcity water an accusing finger is pointed at the large scale irrigators even when they have met their statutory obligations with respect to storage. They view this as selective application of the law which will discourage investments in commercial irrigated agriculture and reduce the extent to which the benefits of water resources can be enjoyed by most Kenyans (not just subsistence farmers).

ptimized without adequate infrastructural support (markets, roads, inputs, etc).

5. With the right conditions, irrigation is profitable and can create more jobs.
6. Water harvesting for crop production has been introduced, but is not catching up as fast as in the sub-humid areas, due to the large sized of farms and extensive farming.

Table 6: Distribution of irrigation plot sizes

Area (ha)	%
0.2	20
0.4	22
0.8	25
1	15
2	10
5	5
20	2
50	1
	100
Source: NRM3 database	

3.1.7 Under-utilized irrigation potential

Most of the irrigation potential remains relatively untapped. Constraints on the success of irrigated agriculture include: (a) market factors such as poor market access, low and fluctuating prices, exploitation by middlemen and competition; (b) low level of capital investment due to poor access to credit, low level on income, high transaction cost of lending institutions, and low rates of loan recovery; (c) water scarcity factors such as inefficient irrigation practices and underdeveloped water storage. These constraints lower the profitability of smallholder irrigated agriculture leading to vicious circle of lower profitability-lower investment.

3.1.8 Irrigation technology

The available and actual water resources of the Basin, like most of the cases in other parts of the country are limited. Most of the irrigation methods deployed or used in the basin for small scale irrigation have an overall efficiency of 48%, meaning that 52% of all the water abstracted for irrigation purposes goes to waste. A survey of the main irrigation projects in the upper Ewaso Ngiro North basin (Nanyuki, Timau and Naro Moru rivers) shows that most of abstraction is done using furrows.

Table 7:Conveyance system

Category	%
Bucket	0.5
Furrow	80
Pipe	19.5
	100

Source: NRM3 database, 2001

3.1.9 Water allocation to irrigation sub-sector

Table 8 presents summary of the permitted irrigation water abstraction per sub-basin. The data shows that 5BC has the highest level of both normal and flood flow water permits.

Water resources for irrigated agriculture are poorly distributed throughout the basin. The areas with favourable surface water conditions are the high potential mountain slopes and

surrounding highlands where there is a perennial water resources. Groundwater availability is available but in most cases at depths and quantities that would make water too expensive for irrigated agriculture. In Wajir, there are some shallow wells that are used for supplemental irrigation. Limited water availability is further constrained by the increasing water demand for domestic, wildlife and nature and by water quality deterioration. A more detailed status of water availability is contained in the water study report.

Table 8: Permitted irrigation water abstraction per sub-basin

Sub-basin summary	NF(M3/day)	FF(m3/day)	NF(l/s)	FF(l/s)
5AA	1,359.4	6,172.1	15.7	71.4
5AB	3,987.9	18,515.8	46.2	214.3
5AC	1,680.4	1,105.4	19.4	12.8
5AD	157.9	3,213.0	1.8	37.2
5AH	31.5	315.4	0.4	3.7
5BA	2,875.7	22,512.9	33.3	260.6
5BB	2,056.1	54,974.0	23.8	636.3
5BC	9,159.1	88,829.6	106.0	1,028.1
5BD	887.9	1,714.2	10.3	19.8
5BE	1,774.9	14,572.6	20.5	168.7
5C	10.2	3.6	0.1	0.0
5D	61.6	-	0.7	-
5D6	484.1	-	5.6	-
5DA	65.7	814.2	0.8	9.4
5DC	2.4	-	0.0	-
5DD	22.6	-	0.3	-
5DE	180.9	9.1	2.1	0.1
5E	75.1	29.2	0.9	0.3
	24,873.5	212,781.3	287.9	2,462.7

Legend: NF – Normal flow, FF – Flood flow Source: NRM3, Database, 2001

3.1.10 Transport and telecommunication infrastructure

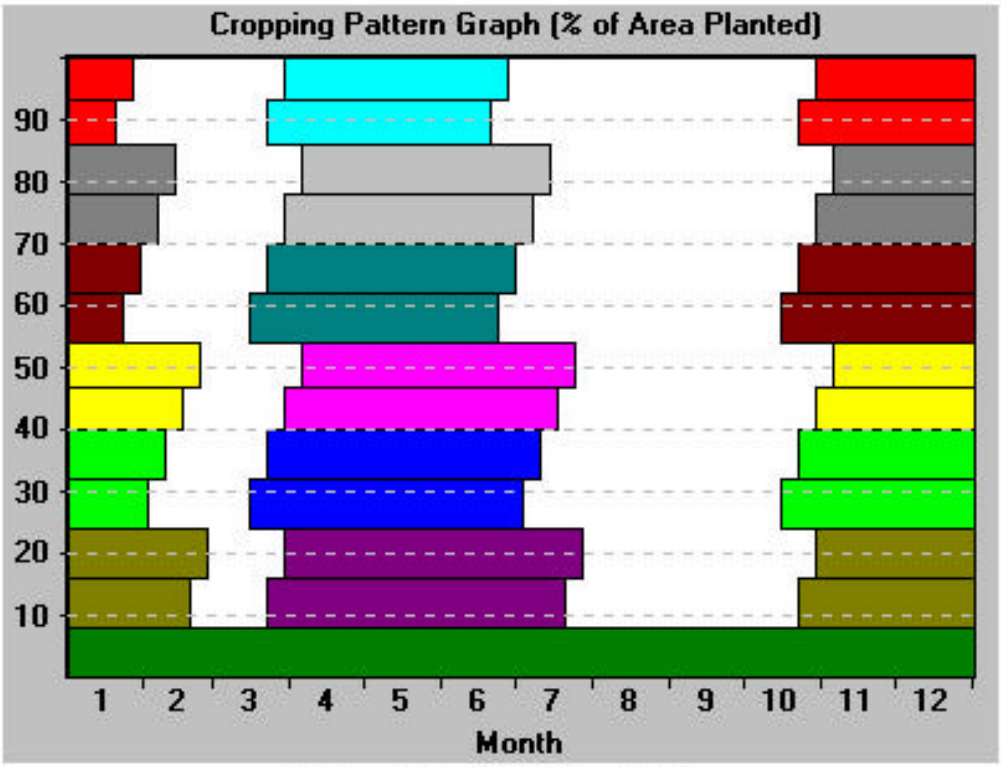
Transport and telecommunication infrastructure is poorly developed in the basin. The total road length is 23,673 km for an area of 210,226 km2 given an average of 1 km of road for every 9 km2 of land. The road network is unevenly developed with the high potential highland areas having reasonably good road network. The situation is worsened by the fact that areas with good irrigation potential such as Oldonyiro, Ngare Ndare, Malka Darkar, etc. have an even more limited road infrastructure.

The implications for irrigation development is that potential investors have no incentives to exploit irrigation potential and the low farm gate prices that farmers obtain for their irrigated agriculture produce.

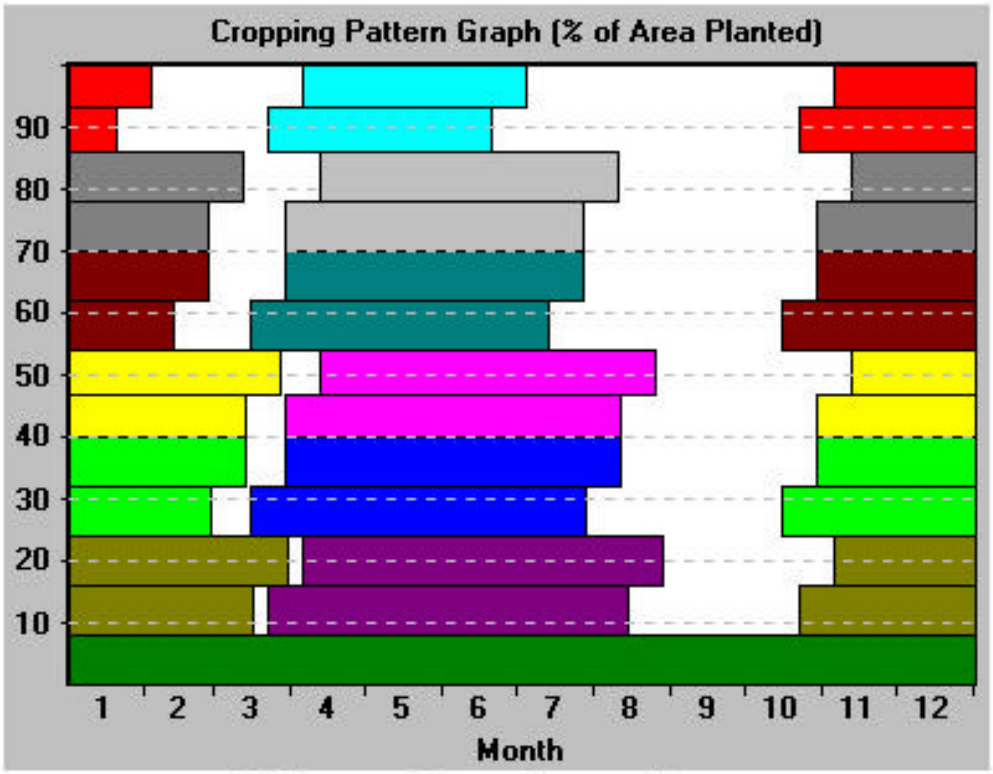
3.2 *IRRIGATION WATER REQUIREMENTS*

3.2.1 Cropping pattern

The cropping systems and patterns adopted by farmers is very complex. For the purposes of computing irrigation water requirements, the cropping pattern adopted is shown on Figure 1.



Isiolo cropping pattern



Matanya Cropping pattern

Figure 1: Cropping pattern

3.2.2 Irrigation requirements

3.2.2.1 *By District*

Table 9 present the irrigation water requirements per district for different months based on the current irrigated areas assuming an irrigation efficiency of 60%.

Table 9: Irrigation water requirement (l/s) by district

District	PresentIA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Isiolo	553	669	228	51	115	630	758	277	72	72	58	36	497
Laikipia	1,720	1,707	1,268	370	255	1,000	1,529	1,202	443	160	176	357	1,143
Mandera	1,041	1,510	521	177	354	1,291	1,500	531	135	135	156	469	1,372
Marsabit	52	71	24	8	18	59	71	25	7	7	8	21	59
Moyale	-	-	-	-	-	-	-	-	-	-	-	-	-
Meru North	1,555	1,774	607	94	235	1,773	2,130	778	202	202	140	1	1,275
Meru Central	775	870	369	66	100	785	978	409	118	95	71	28	613
Nyandarua	2,546	2,368	1,731	535	204	967	1,528	1,222	433	178	229	586	1,666
Nyeri	924	809	606	194	163	585	891	737	264	83	84	122	497
Samburu	34	45	15	5	11	39	47	17	4	4	4	6	35
Total	**9,200**	**9,823**	**5,370**	**1,501**	**1,455**	**7,130**	**9,431**	**5,198**	**1,678**	**937**	**928**	**1,627**	**7,157**

3.2.2.2 *By Sub-Basin*

Table 10 present the irrigation water requirements for different sub-basin. Sub-basin 5AA, 5DA, 5BC have the high irrigation water requirements due to the high intensity of crop production.

Table 10: Irrigation water requirement (l/s) by sub-basin

Subbasin	PresentIA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5AA	2,458	2,286	1,671	516	197	934	1,475	1,180	418	172	221	565	1,608
5AB	88	82	60	18	7	33	53	42	15	6	8	20	58
5AC	342	359	263	92	72	212	311	250	92	31	38	96	253
5AD	-	-	-	-	-	-	-	-	-	-	-	-	-
5BA	-	-	-	-	-	-	-	-	-	-	-	-	-
5BB	129	110	80	27	26	86	129	106	37	12	12	15	67
5BC	1,191	1,012	738	250	238	798	1,191	976	345	107	107	143	617
5BD	17	14	11	4	3	11	17	14	5	2	2	2	9
5BE	939	977	836	197	28	376	695	620	244	85	94	197	618
5CA	2	2	1	0	0	1	2	1	0	0	0	1	2
5CB	-	-	-	-	-	-	-	-	-	-	-	-	-
5CC	-	-	-	-	-	-	-	-	-	-	-	-	-
5DA	2,541	2,897	991	152	381	2,897	3,481	1,271	330	330	229	-	2,080
5DB	-	-	-	-	-	-	-	-	-	-	-	-	-
5DC	149	171	61	21	52	146	165	58	16	18	21	51	153
5DD	8	9	3	1	3	8	9	3	1	1	1	3	8
5EA	-	-	-	-	-	-	-	-	-	-	-	-	-
5EB	52	71	24	8	18	59	71	25	7	7	8	21	59
5EC	-	-	-	-	-	-	-	-	-	-	-	-	-
5ED	243	323	109	36	75	277	333	122	32	32	32	44	252
5FA	-	-	-	-	-	-	-	-	-	-	-	-	-
5FB	-	-	-	-	-	-	-	-	-	-	-	-	-
5GA	-	-	-	-	-	-	-	-	-	-	-	-	-
5GB	820	1,190	410	139	279	1,017	1,181	418	107	107	123	369	1,081
5H	221	320	111	38	75	274	318	113	29	29	33	99	291
5J	-	-	-	-	-	-	-	-	-	-	-	-	-
Basin Total	**9,200**	**9,823**	**5,370**	**1,501**	**1,455**	**7,130**	**9,431**	**5,198**	**1,678**	**937**	**928**	**1,627**	**7,157**

3.3 *RETURNS ON IRRIGATION AND DRAINAGE INVESTMENTS*

3.3.1 Criticism of irrigated agriculture

Irrigated agriculture has to face the criticisms, that the investments are high and the returns on investment on irrigation are low. The reality is that the benefits to irrigated agriculture are great and justify the heavy investment. Some of the criticisms levelled are misplaced because often too much is expected of irrigated agriculture. The economic rate of return varies from 6-15%. This is a satisfactory figure when compared with the opportunity cost of investment that is usually used by the Bank of 6-10%. Even though the rates of return are good, the fact that they are lower than appraisal estimates has evidently caused disappointment with irrigation projects. The criticisms are also one-sided because they fail to consider the “without irrigation” scenario. A proper assessment of the benefits of irrigation development can only come from an appreciation of the difference between the “with” and “without” irrigation scenario.

3.3.2 Incremental benefits of irrigate agriculture

The gross margin of rainfed and irrigated crop production is presented in Table 11.

Table 11: Gross margins of rainfed and irrigated crops production

	Kshs/ha		
	Rainfed	**Irrigated**	**Incremental benefits**
Maize	10,621	34,289	23,668
Wheat	22,725	68,393	45,668
Sorghum	9,684	21,802	12,118
Millet	718	10,436	9,718
W. Potato	77,548	214,707	137,159
S. Potato	26,135	77,945	51,810
Cassava	24,913	34,879	9,966
Bean	12,283	39,827	27,544
Ppea	11,341	28,430	17,089
Cpea	1,509	10,618	9,109
Cabbage	132,187	303,455	171,268
Kale	143,520	189,788	46,268
Onions	93,409	184,677	91,268
Tomatoes	164,129	251,547	87,418
Banana	50,612	137,718	87,106
Cotton	1,061	28,104	27,043
Sunflower	6,838	52,931	46,093
Simsim	8,076	20,419	12,343
Pyrethrum	13,300	38,143	24,843
Tea	205,143	340,311	135,168
Coffee	62,106	124,024	61,918
Tobaco	51,254	63,172	11,918

3.3.3 Risk and uncertainity

There is a growing perception that irrigated horticultural enterprises are abstracting too much water and consequently having an adverse impact on smallholder irrigators and downstream pastoralists. Commercial irrigators operate under conditions of uncertainty of weather, water availability and market conditions. They also have to take into consideration that the Water Bailiff may arrive on any day and ban irrigation all together at a short notice which could result in huge financial losses arising from non-production of irrigated crops and consequently failure to honor delivery contracts. This discourages long term investments in irrigated commercial agriculture.

3.3.4 Demand-led approach

Demand for irrigation in general, across the country, is clearly high. Private small-holder irrigation has shown the greatest increase in acreage over recent years compared to state-run schemes and large-scale farms. Small-holder acreage increased by almost 100% between 1985 and 1995. These farmers are being supported by Ministry of Agriculture extension staff (who, unfortunately, lack sufficient transport funding to visit many schemes) as well as by NGOs. One of the most promising 'demand-driven' interventions is the marketing of irrigation technology – particularly water-saving technology.

3.3.5 Cost sharing in irrigation development

Communities in the drylands are sometimes given special incentives to invest in irrigation. For example, Community Development Trust Fund, a programme funded by the European Commission and Government of Kenya, requires that farmers in high potential areas contribute 30% of the total cost of any CDTF-funded irrigation development. Beneficiaries in the ASAL areas, on the other hand, are required to contribute just 10%. The reason for this policy is, of course, the prevalence of poverty in dryland areas.

3.3.6 Reduced investment in irrigated agriculture

Given the regions demographic features, (high population growth rates in excess of 4% and more than 83.7% of the area being rural) (UNCRD, 1999), the emphasis of the current Development Plan 1997-2001 is very much on investment in Agriculture sector and has to be accorded priority. Despite the noble pronouncements, there has been a marked reduction in public sector investment in irrigation in the basin. A number of reasons are cited for this reduction in irrigation investment:

1. The increasing cost of system construction.
2. The fall in the price of world food prices and the resultant complacency about world food supply.
3. The perceived un-sustainability of the irrigation environment evidenced by soil salinisation, waterlogging, and unsatisfactory resettlement programmes
4. Economic returns below expectations.

4. CROSS CUTTING ISSUES

4.1 *HUMAN RESOURCE IN RELATIONSHIP TO AGRICULTURAL ENTERPRISES*

4.1.1 The people

The basin has a total human population of xxx people with an annual growth rate of xx. There is a high social and economic disparity arising from population densities, ethnic background, sources of livelihood, level of education, access and control over natural resources etc. The people of the basin can be divided into the following actor groups in respect to their influence on irrigation development:

1. Normadic pastoralists communities with limited interest in irrigation development and in some cases viewing irrigation development as a threat to their livelihood in terms of reduced water for their livestock and encroachment of wetlands that have been their dry season grazing areas.
2. Small scale mixed farming communities how are in most cases experiencing limitations of rainfed agriculture and are developing irrigated agriculture even in areas with over-exploited water resources.
3. Large scale/commercial irrigators who are viewing irrigation as a commercial investment with high spin-off benefits for the other communities.

4. Traders and urban communities who depend on irrigated agriculture for their sources of food and business and hence would like to see it expand.

4.1.2 Level of education

The decision maker in relation to agricultural and irrigation decisions is either the husband, the wife or joint decisions. Joint decision making appears to be increasing with the increase in the female level of education. Most of the farm level decision makers have no formal training.

4.1.3 Education and skills in irrigated agriculture

Because of the colonial history, culture, traditions, access to education and other livelihood resources, there is a high disparity in the level of education and as a consequence the skills in modern irrigation technology and management. Communities farming the highland areas (footslopes of Mt. Kenya, Aberdare, Nyambene, Marmanet, etc) and those with a long tradition of irrigated agriculture in Mandera have acquired some irrigation skills. It is however not clear whether the poor irrigation practices observed in many smallholder irrigation schemes is a reflection of their irrigation skills or as a result of lack of incentives for adopting modern and more efficient irrigation practices.

4.2 *AVAILABILITY OF MARKETS*

4.2.1 Availability of markets

The market for irrigated agriculture produce has a high spatial and temporal variability. In areas with good road infrastructure and local demand (including an ability to pay reasonable prices) marketing is not a problem. However in remote areas, where most people are poor and sparcely distributed there are no favourable markets. In the footslopes of Mount Kenya and Aberdare, farmers have a ready market both local and international mainly due to the favourable transport infrastructure and the volume and reliability of irrigated produce.

4.2.2 Exporting horticulture and importing grains

Food imports are essential where countries or regions cannot grow enough food because of water or other constraints. International trade can help alleviate water scarcity and increase water productivity. Countries/regions with plentiful water should export water-intensive crops, such as rice, to water-scarce countries/regions. This is a natural application of the principle of comparative advantage in trade.

Export of horticultural produce provides an interesting example of trade with a shift to higher valued crops. Over the past 10 years both flowers and vegetable exports and cereal grain imports have been increasing at a rapid rate. This is a good strategy so long as the domestic production of the imported cereal grain would have taken much more water. The numbers clearly show a gain in monetary terms and an increase in water productivity.

4.2.3 Marketing crops

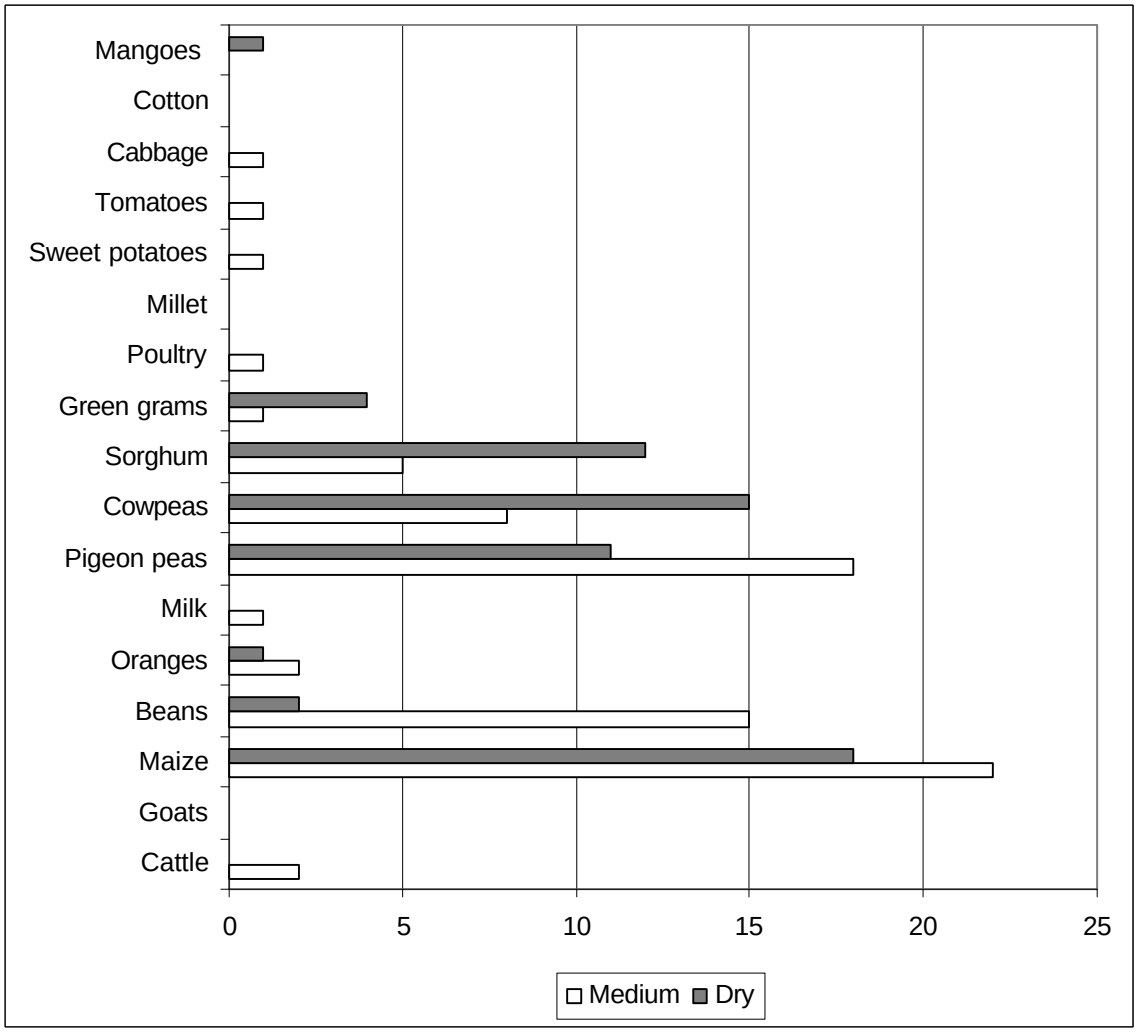
Our thesis is that access to markets is one of the necessary conditions for intensification. Marketing is naturally hampered in districts with low population density and poor roads, and governments have frequently felt they should intervene, either to set up new types of

marketing institution, such as co-operatives and Marketing Boards, or to control the activities of traders who might take advantage of shortages, particularly in basic foodstuffs.

Maize, cowpeas, beans and sorghum have been the principal crops marketed since the 1930s. Cotton was important in the 1980s and export horticultural produce is the principal crops in the footslope of mount Kenya and Aberdare. Farmers see climate as the main constraint preventing them from marketing fruits and vegetables, which are recognised as more profitable, but which demand the concentration of water.

District price data shows that grain and pulse prices vary considerably from month to month, according to the nature of the last harvest. They also respond to general inflation. There were considerable fluctuations in rural prices before the liberalisation of the grain trade, for government prices seem only to have been operational for sales to and from the NCPP depots. There is no evidence the abolition of marketing controls made a difference.

Figure 6: Main products marketed in medium potential and more arid



Source: Field interviews, 1998.

The implication is that even with its bad roads, private traders compete to offer farmers reasonable services in the marketing of crops, though they find it uneconomic to travel remote districts like Wajir and Mandera.

4.2.4 Policy changes since 1989 have changed the marketing environment

1. The creation of new districts and subdivisions have affected demand near new headquarters towns. Improvement in road infrastructure, telephone service has resulted in improved access of market information.
2. Markets have been liberalized. Grain movements no longer need permits. The NCPB cannot compete with private traders but leases space to them. The Kenya Seed Company has lost its monopoly and seed is now supplied from a variety of commercial sources, giving farmers new choices. Fertiliser is more expensive, but more available, but not much used in the dry parts of the District.

4.2.5 Commodity price fluctuations

The prices of the major types of crop produce vary according to the month of the year and between years, depending on the prevailing rainfall situation. Table 6 gives a summary of the price trends for the major commodities between 1992 and 1999 on a quarterly basis and in Kenya shillings per kilogram. Price levels reflect the food supply situation, particularly in the face of more or less steady or increasing demand, and the above data show 1996/97 to have been a relatively difficult period in terms of food shortage. The most notable feature of the Table 6 data is the variability. The dramatic 1997 price rises reflect scarcity. The variability of prices and their rise are sometimes blamed on the freeing of the maize trade and the discontinuance of the stabilising function of the NCPB.

The problem of high variability in both crop yields and produce prices in the drier areas generally reflects food insecurity. Hence there is a need to promote production of drought-tolerant crops in such areas.

Intra-annual prices for beans are very volatile, which may be because they are less often distributed in food relief programmes. Farmers at the workshop said that relief food amounts were generally small, and it does not seem that relief food is being internalised as a survival strategy in Laikipia District.

Table 6: Average crops commodity prices by quarter, 1992-1999 in Ksh/kg

Year and quarter	Maize	Sorghum	Millets	Beans	Cow- peas	Green grams
1992						
Q1	3-5	N/A	N/A	N/A	N/A	N/A
Q2	5-7	5-7	N/A	N/A	N/A	N/A
Q3	7-13	4-8	7-15	7-15	8-10	8-20
Q4	7-10	N/A	N/A	N/A	N/A	N/A
1993:						
Q1	8-12	4-10	5-15	15-20	12-20	12-15
Q2	5-8	8-12	12-16	23-025	10-15	12-15
Q3	7-9	6-13	12-18	24-30	20-30	24-30
Q4	10-15	6-15	12-20	25-35	20-35	18-35
1994:						
Q1	15-18	10-18	14-30	25-40	20-40	18-40
Q2	12-16	10-18	20-25	25-45	25-35	20-50
Q3	10-18	10-25	15-30	25-45	10-20	30-55
Q4	12-18	15-18	16-25	25-45	10-20	30-60
1995:						
Q1	5-8	5-8	10-15	10-18	15-20	20-30
Q2	6-10	6-8	15-20	20-30	15-20	20-30
Q3	8-10	6-8	15-20	20-35	15-20	25-35
Q4	7-12	8-15	10-20	15-35	20-30	25-40
1996:						
Q1	8-10	7-12	15-25	10-25	20-30	20-30
Q2	8-12	10-15	15-25	25-35	25-35	30-40
Q3	11-14	10-18	25-40	35-45	25-35	35-50
Q4	10-16	20-35	30-50	35-50	30-45	40-70
1997:						
Q1	10-15	30-40	35-40	40-60	30-50	40-70
Q2	12-17	10-12	25-40	80-100	60-80	80-120
Q3	12-20	10-15	25-40	30-45	40-60	40-50
Q4	15-20	10-17	15-30	50-60	35-50	50-60
1998:						
Q1	5-8	10-15	12-18	40-50	35-50	40-55
Q2	5-10	5-15	10-30	25-35	30-45	30-45
Q3	8-12	7-15	15-25	25-35	11-15	25-30
Q4	10-15	7-15	35-40	30-40	18-20	30-40
1999:						
Q1	10-7	7-15	25-40	30-40	18-30	30-40
Q2	12-20	7-15	25-40	30-40	25-40	30-45

Source: Meru, Nyeri and Laikipia District Agricultural Offices.

4.2.6 Choice of market outlets

The available market outlets include farm gate, nearest market, nearest big market (major towns such as Isiolo, Nanyuki, Marsabit), Nairobi market or Export market. The choice of market outlet depends on the produce, production level, farm gate prices, transport infrastructure, middle men and availability of transport.

4.3 *POLICY AND LEGISLATION ASPECTS*

4.3.1 Issues

Government policies which influence land conversion are those that influence land tenure and production systems and those that regulated the way land and water resources are allocated, used and managed. They include land, water, agriculture, settlement, education, decentralization, poverty alleviation policies.

In this section we document the following policy, legislation and institutional aspects affecting agriculture and agricultural water management (irrigation and drainage).

1. What policy changes have taken place and how are they influencing agriculture and agricultural water management?
2. What legislation changes have taken place and how are they influencing agriculture and agricultural water management?

The assessment of policy and legislation changes and their influence on agricultural production and agricultural water use (irrigation and drainage) was done using literature review and discussions with district and ENNDA staff.

4.3.2 Environmental policies

The Kenyan policy and legal approach to environmental protection can be described as "corrective management", stemming from a philosophy of "command and control". This is in contrast to a preventative approach to environmental threats. The preventative approach ensures that key natural resources are protected, regardless of whether any threats to such resources exist. The process of ensuring that key resources are protected includes a mechanism for prioritising the importance of the resources, which will inevitably require research and debate on the benefits to local communities, the 'inherent' value of resources as well as any financial value, and baseline levels of biodiversity and other key indicators. Thus environmental management under the 'preventative' philosophy "starts with the problem definition stage". Development strategies are formulated with environmental protection as a key element, so that as long as the strategies are implemented correctly, there will be little need for additional activities.

Generally, Environmental Impact Assessments have been performed due to donor conditionalities, rather than because of Kenyan legislative requirements. However, despite the high priority given by donors to environmental and social issues arising from development projects, (not least in the public relations department), many planning, monitoring, and evaluation exercises fall short of expectations.

Kenya's national environmental strategies have few specific provisions for protection of dryland ecosystems, and those that exist are rarely integrated with other sectoral programmes:

- The ecological fragility of Kenya's dryland areas has been noted in Government policy documents such as Sessional Paper No. 1 of 1986 which asserts that, "environmental protection will be essential to maintain a viable economy in ASAL regions. Reafforestation will serve the three purposes of protecting watersheds, preventing soil erosion and providing firewood."
- The national water policy states that every water development project should incorporate "a comprehensive environmental impact assessment", while EIA reports will be made mandatory for all major water developmental activities. However, it has proved difficult in the past to enforce implementation of recommended mitigation measures (e.g. development of hydro-power in the Tana River basin) and a capacity-building programme would be necessary to ensure that relevant Ministries had a sufficient grounding in EIA skills.
- Kenya's agricultural policy is almost totally silent regarding environmental considerations.

4.3.3 Water policy and legislation

The revised water policy and water act has established the rights and obligations of all stakeholders in water management, the powers and functions of regulatory bodies and the penalties for infractions of the law. What are lacking are detailed guidelines and provisions for enforcement and implementation taking into consideration the local conditions. For example general guidelines work all right where there is water surplus but fails under conditions of water scarcity. There is therefore need for adapting the more dynamic parts of the legislative system (framework of regulations and by-laws) to changes in the hydrologic regimes existing in different parts of the basin. Land use and management regulations are also used to protect water resources[1] but they face the same problem of enforcement as the pressure on land resources intensifies.

Legislation provides the context, basis and framework for government and private intervention and action and hence must be enforceable, particularly under conditions of resource scarcity and associated conflicts. There is general perception that the biggest problem is not lack of adequate legislation but lack of the political will, resources and means to enforce the existing legislation. Many offenders go unpunished and those taken to court are given the low fines that do not serve as deterrents. The existing water legislation and its enforcement has failed to: (a) secure water (use) rights to downstream water users particularly during the dry seasons (eg. fish farmers experience); (b) facilitate flood water storage; (c) protect water catchment and riverine areas thereby reducing soil loss and making construction of large reservoirs feasible (reservoirs construction is seriously constrained by the high rate of sedimentation); and (d) ensure that water developmental decisions are based on sound economic, environmental, and social assessment. Legislation has had little impact in dealing with water offences such as unauthorized water abstraction and water pollution. The main factors inhibiting enforcement of water legislation are (District Water Office informant, 2001):

[1] For example, land uses may be regulated in upstream recharge areas and around reservoirs to prevent pollution, siltation and changed run-off regimes.

1. Lack of awareness of the negative impact on the downstream water users who may be several kilometres away.
2. User-biased interpretation of the water allocation (volume and flow rate), particularly during low flows.
3. Inadequate policing and in some cases lack of a complainant.
4. Low fines for the offenders.
5. Lack of incentives to minimize water pollution and facilitate efficient use of water resources.

4.3.4 Irrigation policy and legislation

The Ministry of Agriculture and Rural Development is currently developing an irrigation policy. Statements from staff indicate that "food security schemes" operating in dryland areas, which make little attempt at cost recovery even for operation and maintenance costs, will be deemed as unsustainable and will not be developed in future. Draft policy documents also suggest that the government will in future give priority to:

- Commercial small-scale irrigation, with farmers providing capital costs as well as operations and maintenance costs.
- Developing irrigation in areas which are already settled, with basic social infrastructure in place. This rules out many dryland areas.
- Developing large irrigation farms in sparsely populated dryland areas, in order to increase national food production and economic growth.

There is likely to be heated debate over the introduction of large schemes in the ASAL, in the context of the repeated failure of such schemes in the past.

The Irrigation Act (1967), Chapter 347 of the Laws of Kenya, is the main piece of relevant legislation. It gives the Minister for Agriculture sweeping powers to expropriate land for the purposes of irrigation:

> "14. (1) The Minister may, by notice in the Gazette, designate any area of land to be a national irrigation scheme.
>
> (2) In respect of land, other than Trust land, in a national irrigation scheme, the Minister shall, in accordance with the law for the time being relating to the compulsory acquisition of land, take such steps as may be necessary to acquire the right, title or interest in such land and to vest it in the Board for the purposes of this Act.
>
> (3) In the case of Trust land-forming part of a national irrigation scheme, the Minister, on behalf of the Board, may take the land on lease, on terms to be agreed between the Minister and the county council concerned."

These powers have been used to gazette large tracts of land for irrigation projects, generally without any compensation for the communities that previously used the land.

The Act was formulated specifically for tenant-based settlement schemes, rather than for guiding and regulating commercial or small-holder subsistence irrigation. Furthermore, it does not provide a framework for the planning or co-ordinating of irrigation activities.

Small holder irrigation policy: Most irrigation activities in the Basin fall under the small-holder irrigation categories. The main goal of smallholder irrigation policy is to contribute in alleviating poverty by increasing agricultural production, creating jobs and earning foreign exchange through the export of irrigated horticultural produce. Changes that have taken place in smallholder irrigation guidelines, strategies and policies are summarised in **Table 12**.

Table 12: Irrigation guidelines, strategies and policy changes

Period	Issue
Pre1970	Development of new irrigation projects to assist nomad /semi-nomadic pastoralists to settle.
1970s	Irrigation and Drainage Branch established in 1978 to facilitate the development of smallholder irrigation projects
1980s	Capacity building and rehabilitation of group based irrigation projects with grants provided by donors. Cost sharing approach promoted.
1991	Smallholder group-based drainage development project incorporated.
1993	Introduction of cost recovery in irrigation development and provision of season input credit.
1994	Move toward loan programme. Funding smallholder irrigations project on a grant basis was phased out and replaced with a cost recovery system. Grants are only applicable for irrigation projects with poor access to horticultural markets, and hence mainly producing food crops or for very poor communities.

Source: IDB, 1991; District Informant, 2001

Introduction of a cost recovery strategy and the move from grant financing to loan financing of irrigation infrastructure development was perceived as a donor-driven change. The change took place in a very short time and therefore did not give people and opportunity to full assess the positive and negative impacts. Consequently, irrigation farmers who had been anticipating grant financing for the rehabilitation of their schemes resisted loan programme strategy.

4.3.5 Fiscal and monetary policy

Inflation was not seen as a policy problem in the 1960s, which was a period of monetary stability, non-alarming budget deficit, and a stable balance of payments. It became a problem in the 1970s, when the growing balance of payments problem which was attributed to oil crisis (increasing oil import prices), led to monetary and fiscal expansionary policy actions and the adoption of administrative controls that served to fuel inflationary pressure. Inflation persisted in the 1980s and 1990s. However, the first half of the 1990s saw inflation peak at 46% in 1993. The period 1990 – 1996 marked a substantial implementation of financial sector reforms in Kenya, towards the use of indirect monetary policy tools, but a reduction in inflation was not immediately achieved due to conflicts in policy actions (partly due to election considerations).

Inflation has two bad consequences for farmers. Firstly, it confuses market signals on prices. Secondly, and more importantly, it devalues their savings if they keep them in cash or put them in a bank. Farmers tend to overcome this by investing immediately they have a surplus after a good harvest. However, for some things they need to accumulate savings.

Kenya liberalised the foreign exchange rate in October 1993. As this coincided with the inflationary peak, it was followed by the depreciation of the exchange rate in the 1st half of 1994. While this resulted in improved balance of payments from the inflow of capital, it increased the cost of imported inputs, especially fertilizer.

Kenya has now adopted a fiscal policy that emphasises the tightening of fiscal deficit to reduce government domestic borrowing while at the same time servicing external debts; releasing of domestic savings to private sector investments; restriction of government expenditure to about 25% of the GDP; and debt management procedures that are consistent with and serviceable within government fiscal policies. The monetary policy emphasises the maintenance of stable and competitive free market determined exchange rates; liberalised interest rates and a liquidity expansion that is tied to GDP growth rates. The question remains whether it will be consistently implemented.

4.3.6 Parastatal marketing and production

In the 1960s the government, like many others, identified government investment through parastatals as a major development alternative to an inexperienced and small private sector. Parastatals were expected to complement government services by providing goods and services in a cost effective manner. Time has revealed inefficiencies and corruption in some of these, finally leading to the collapse or abolition of some in the 1990s despite strong vested interest in their continuation.

4.3.7 Promoting ASAL Development

Kenya has veered at different times between concentrating its public investments on semi-arid areas with a view to reducing poverty, and its high potential areas where large numbers live and a higher return to investment can be expected.

Immediately after independence, the Government focussed attention on its high potential areas, but development plans for 1974/78 and 1979/83 re-emphasised the development of the semi-arid areas, through the development of drought resistant crop varieties, improved cropping systems, land rehabilitation and infrastructural development (Akonga et al. 1987). Institutional development included expansion of research facilities, establishment of regional development authorities and implementation of systematic surveys and pre-investment studies. Aid assistance was sought for Integrated Development Programme to promote integrated development and agricultural intensification and diversification in the semi-arid area. The notable ones in the Basin were Laikipia Rural Development Programme (LRDP) and Embu-Meru-Isiolo (EMI) programme.

4.3.8 Agricultural research and extension

Before 1980 research was regarded as a source for knowledge to be conveyed to ignorant land users. A top-down approach for transfer-of-technology generated by the researchers was therefore adopted, largely ignoring farmers' knowledge. Around 1980 the introduction of Farming Systems Research began the incorporation of the farmers' knowledge, skills and perceptions in the search of feasible options for improving agricultural production. However, the main extension tool became the Training and Visit system (T&V) which demanded heavy inputs of staff. Staff levels were increased in the 1980s, helped by such programmes as LRDP and EMI. With dwindling staff and government resources in the 1990s, the planned 2-weekly visits to farmers under the T&V System has been changed to 4-weekly and now 8-weekly

visits, which has seriously eroded efficacy. In any case, most farmers dislike the idea of assembling for training only at the farms of few "select" farmers. It is now proposed to introduce a "demand driven" extension approach under which the farmers would be provided extension advice upon their request, but it is not clear how the reduced staff now in place will get the needed mobility in areas with scattered population.

4.3.9 District focus for rural development

In 1983 the Government of Kenya inaugurated a District Focus policy under which an elaborate set of planning committees was supposed to adjust national policies to local needs and to solicit government and donor support for the implementation. The committees at District level are dominated by government officers, and elected bodies like the County and Municipal Councils have very small roles. Financial resources remain in the control of central ministries. District Planning has therefore only been a reality when there is also external finance for District projects, as under LRDP, EMI, etc. Despite lip service to community consultation, aid projects tend to be driven by the plans and allocations made during the project proposal stage, and the priorities as perceived by the donor and the government rather than the district and the farmers. Local development committees at location level can include a higher proportion of locally respected persons who are not salaried officials, and some of the more active ones can identify interested NGOs, government officers, special projects and other sources of help.

The government took a different approach to bringing government closer to the people place in the early 1990s with the sub-division of administrative areas. Moyale, Meru North, Meru Central Districts have been created. This has resulted in improvement in the quality and availability of technical advice, in so far as the officers have means to travel. The improved access to administrative officers (sub-chief and chiefs) has contributed to more expeditious solution of local problems, particularly the distribution of famine relief.

It is difficult to isolate and quantify the impact of policy changes on agricultural and irrigation investments. The negative impact of the policy over the last 10 years has been an overall reduction of government staff and services, insecurity and reduced donor investment.

4.3.10 Market liberalization

4.3.10.1 *Grains*

Due to the large proportion of the arid and semi-arid parts in the basin, frequent droughts result in localised food shortages with concomitant huge food prices fluctuations within and between regions. This was seen as the main justification for the establishment of agricultural produce price stabilisation and marketing boards, e.g. the National Cereals and Produce Board (NCPB) in Kenya. Before the final phase of the liberalisation of grain marketing in 1993, the NCPB was important for the marketing of grains and food crops in Kenya. However, market controls, and the imparting of monopoly power to the NCPB over inter-district grain marketing in Kenya prior to 1993, did not deter the proliferation and growth of private trade, especially in the rural market centres. The growth of the informal marketing channel (i.e. private trade channel) in an otherwise controlled marketing environment must be an indicator of some problems in the operations of the formal (i.e. official) marketing channel. And in the case of the NCPB and grain marketing in the basin, it is well documented that inefficiencies in official channels led to situations where the differences between the producer (farm-gate)

prices and the prices that the consumers paid when getting the same produce through official channels could be as high as 146 percent, even only a few months following the harvesting time (Mbogoh, 1991). Clearly, this kind of marketing margin encouraged the growth of parallel (or informal) channels, thus bypassing the state marketing controls. These informal marketing channels were an important food-marketing outlet for the farmers, even during the marketing controls era.

The maize marketing reforms constitute a milestone in the marketing of grain because they spelt the end of over 40 years of maize movement controls in Kenya. Even though farmers, traders and consumers had been allowed to move up to two bags of maize (90 kg each) out of the district of origin without a movement permit from the District Commissioner since the 1940s, this amount was just too small to permit any meaningful free and competitive trade. Hence the initial maize market decontrols were significant in that they raised the number of bags of maize that could be moved without a permit, initially from two to 10 bags in September, 1983. Since the end of 1993, there has not been any marketing policy reversal, and grain marketing is fairly liberalised.

The general impact of grain marketing liberalisation on producers and consumers in the basin has been ambiguous: prices vary considerably, depending on the rainfall situation during the main crop production seasons. When sufficient amounts of rainfall are received, maize producer prices can be as low as Ksh 500 per 90 kg bag, while the prices rise up to Ksh 2,000 per 90 kg bag during a bad year. Nevertheless, liberalisation is said to have led to slightly better producer prices and greater availability of maize in the market throughout the year.

4.3.10.2 *Inputs*

The major farm inputs that may be of concern to farmers include certified seed (mainly maize and beans), pesticides and fertilisers. Prior to the decontrol of the seed industry in 1996, the Government regulated the production and distribution of certified seed maize and beans by granting the Kenya Seed Company (KSC) monopoly status over marketing. With liberalisation, many other players have appeared in the seed industry and price determination is now the responsibility of the seed market/industry. The Government now emphasises the need to intensify extension work on the use of improved seeds in order to boost agricultural development (Kenya, MoALDM, 1996). However, with many more players joining the seed industry, there have been reported cases of fake ‘certified seed’ being sold, and this calls for better supervision of the industry.

The pesticides market in Kenya is fairly large, with a turnover of over Ksh 2 billion annually. This market comprises 45 percent fungicides; 32 percent insecticides; and 20 percent herbicides. The pesticides industry has always enjoyed liberalised marketing, but its main problem is an importation policy which promotes business in already formulated compounds. Imports of technical grade pesticides for local formulation attract much higher duties than the imports of already formulated compounds, such as fungicides and insecticides (Kenya, MoALDM, 1996). Nationally, the largest users of pesticides are horticulture (38 percent), cereals (27 percent), coffee (20 percent), maize (five percent) and other crops (ten percent). In the Basin, the main use of pesticides in farming occurs in cereals production in the form of grains storage dusts, and in coffee and horticultural production.

Prior to 1990, fertiliser marketing was heavily regulated. The process of liberalising fertiliser marketing started in January 1990 with the removal of price controls and was more or less completed with the liberalisation of the foreign exchange requirement in 1993. As a result of

these changes, fertiliser was being imported by about 15-20 companies by 1996 and distributed through commercial firms, parastatal organisations, including marketing boards, co-operatives and stockists. Fertiliser is imported in bulk and packaged in Mombasa port, where there have been reported incidents of fertiliser mixing and adulteration, resulting in questionable quality for indicated fertiliser types. This requires governmental attention to protect farmers from unfair trading by importers. Fertilisers are sold in quantities of 50, 25 and 10 kg packets. However, in a number of cases, stockists are known to sell by the kilogram, thus opening fertiliser to deterioration. This suggests that a market exists for smaller packages of fertiliser to cater for the needs of smallholder producers. With the liberalisation of fertiliser marketing, fertilisers have become more readily available, albeit at higher but more stable prices since 1993. Most fertilisers are used in the upper zones (i.e. zones III and IV), particularly in coffee and horticultural production).

4.3.11 Required interventions

Policy plays an important role in ensuring that people make the investments required to sustainably utilize the available resources to improve their standards of living. While the policy changes have lagged behind they have address major concerns. The constraint has been in translating these policies into joint (synchronized) action plans between farmers and the government. There is need for better targeting policies and programmes so as to create a conducive environment, such as:

1. Introducing a graduate water tariff for irrigators.
2. Providing targeted subsidies for developing agricultural water resources (e.g. for the poor and for investors in high cost water development projects such as dam construction and borehole drilling).
3. With liberalisation and marketing reforms, the scenario has changed. Experiences with implementation of the marketing reforms in Kenya suggest that there is social goodwill to accept reforms that favour profitable private initiatives, the developments in the export-oriented horticultural subsector being a good example. However, there is a general reluctance to accept reforms which appear to hurt the welfare of the majority of people in the society, as in the case of reductions in government spending in some of the agricultural services (e.g. in agricultural advisory) and unchecked liberalisation of international trade in food commodities. Political goodwill is also an important requirement for the success of marketing reforms which may be needed for agricultural development particularly in the more arid environments and where there is poor transport infrastructure.
4. Although, the cost-sharing policies of the Government have been accepted in the higher potential areas, there is need to develop cost-sharing policies that are more region specific so as to cater to the special needs of different agro-ecological zones and socio-economic status. If food security is to be achieved in the basin there is need for the government to provide subsidies for irrigation developments and for the supply of information on agriculture and marketing that is specific to needs which the communities identify.
5. Despite the existence of an elaborate government mechanism for giving and distributing relief food aid in case of natural disasters. Hence, the expectation of relief food during difficult times has in some areas been internalised as a survival strategy. This may work against agricultural development and hence the need for the

Government to put in place policies and strategies that enhance agricultural production and discouraging food relief dependence

4.4 *AGRICULTURAL SERVICES*

4.4.1 Agricultural extension

Government provision of extension services and advice to farmers has substantially diminished over the period due to budgetary constraints, and the Training and Visit (T&V) extension system, originally introduced with World Bank funding, has effectively lapsed. The National Extension Project (NEP Phases I, II and III) was based on the T&V Extension System. For government officers in the Basin, this is an expensive and ineffective extension approach. With dwindling government resources, the planned two-weekly visits to farmers have been changed to four-weekly and now eight-weekly visits, and this has seriously eroded the efficacy of the system. In any case, the system is not popular with most farmers because they do not like the idea of assembling for training at the farms of a few 'select' farmers.

However, with declining funding, there has been a policy change, and it is now proposed to introduce a "demand driven" extension approach under which the farmers would be provided extension advice upon their request. This approach entails the movement of extension subject matter specialists (SMSs) from district headquarters to divisional and, if necessary, to locational headquarters, so that they are more accessible to the farmers.

4.4.2 Irrigation credit scheme

In 1990 the Irrigation and Drainage Branch of the Ministry of Agriculture started exploring options for accelerating the pace of smallholder irrigation development. A cost-recovery strategy was proposed for irrigation infrastructure development and for financing seasonal irrigated agriculture production inputs. In 1991, Smallholder Irrigation Support Development Organisation (SISDO) is a non-profit Non-governmental organization was established[2] to provide loans for the development of infrastructure for group-based gravity-fed irrigation projects, individual pump-fed irrigation projects and seasonal credit for irrigated agriculture production inputs (IDB, 1991).

These services have been utilized by farmers in Nyeri, Laikipia and Meru Central Districts where irrigation is more profitable. The funds are mainly used to purchase seasonal inputs or to rehabilitate the water supply and distribution system to enhance water supply reliability and equity. The credit scheme has however worked successfully in the provision of seasonal credit for inputs (seeds, fertilizer and pesticides) required for intensifying irrigated agriculture (Kamami, 1998, personal communication). For infrastructural improvement loans, repayment has been constrained by the following (IDB, 1995):

1. A lack of a common understanding of the group guarantee concept at scheme, group and household levels.

[2] The credit scheme was set up as a joint venture of the donors (to provide grants to be used as the rotation loan fund), local commercial banks to administer the loan fund lent to a given irrigation group, SISDO to provide technical, financial and management assistance to smallholder irrigation farmers, Irrigation and Drainage Branch staff to complement SISDO in providing technical support in the selection, planning, design of the projects to be implemented and farmers to implement the project.

2. Weak farmers organization leading to inequitable distribution of water and poor marketing strategies.
3. Farmers reluctant to repay the loan in hope that it would be waived.[3]
4. Low profitability attributed to low production levels[4] and low farm-gate prices[5].

4.4.3 Crop production inputs

The farm inputs that farmers sometimes purchase include certified seed (mainly maize and beans), pesticides and fertilisers. In all cases, farmers adopt a low-external input strategy to minimize their risks. Not much fertiliser is used in Zone V of the district due to the risk of rainfall failure.

Prior to decontrol in 1996, the Kenya Seed Company (KSC) had a monopoly on certified maize and bean seeds.

In the drier parts of the basin, the main use of pesticides in the form of grain storage dusts, where there has always been a liberalised market.

4.4.4 Required interventions

The region's natural resources have not been systematically developed in order to generated added value. There is a glaring lack of appropriate research and development institutions with the capacity and expertise required to undertake research and technological adaptation to the development process. The few institutions that exist are not strategically located nor well coordinated to generate the necessary knowledge base from which practitioners can obtain required information and expertise.

4.5 *ENVIRONMENTAL IMPACTS OF AGRICULTURAL DEVELOPMENT*

4.5.1 Overabstraction of river water

A number of large irrigation schemes in the upper reaches of the river have abstracted large amounts of water and have been blamed for "acute water shortages" in the lower reaches. Increasing aridity leads to soil erosion and lowering of the water table, which in turn affects riverine vegetation. The understorey vegetation found in riverine forest areas along the Ewaso Ng'iro river, for example, has partly disappeared as a result of irrigation activities.

High levels of water abstraction in the upper reaches of the Ewaso Ngiro have been blamed for the decreasing water availability in the lower reaches. Overabstraction in the upper reaches of the river has been taking place since the introduction of irrigated agriculture in the area. During the dry season irrigation water demands and economic loss for not irrigating a crop nearing maturity are highest. As much as 60-80% of available water in the upper reaches is abstracted, 40-98% of it being unauthorised (see Table 13). There is a higher level of abstraction in the Mountain slope area mainly due to the hydraulic advantage and the

[3] This problem was exacerbated by the contradiction between SISDO (implementing organization) policy and MISP (funding institution) policy. MISP was keen to provide subsidies since this is a famine relief area.

[4] low productivity low level of inputs and poor crop and water management.

[5] Exploitation by middle men

settlement density. Part of the water abstracted in the Mountain slope area is used in the footslope area for irrigation and urban use. Unauthorised abstractions accounted for 70 and 55% respectively for the Mountain slope and footslopes zones of Mount Kenya. Unauthorised abstractions are mainly attributed to: (a) lack of an effective abstraction monitoring programme; (b) high financial returns from irrigated agriculture and low fines for illegal abstractions; (c) lack of flood water storage facilities; and (d) low water use efficiency as evidenced by low irrigation efficiencies (25-40%).

Table 13: Daily water abstraction from Mount Kenya catchments

	Upper Mountain slope		Lower Mountain slope	
	M^3/day	%	M^3/day	%
Permitted Abstraction	3,774	10	359	2
Authorized to construct abstraction works	7,802	20	10,180	43
Unauthorized abstractions	27,205	70	13,093	55
Total	38,781	100	23,632	100

Source: Gikonyo, 1997. NRM^3 database

4.5.2 Resource degradation

The concentration of people has lead to extensive deforestation for fuelwood. It is noticeable that indigenous systems to control the exploitation of forests (such as individual ownership of tree stands, taboos on cutting certain trees, etc.) are particularly weak around urban centres compared to more remote areas.

Despite the recognition of the need to provide for the inevitable fuel needs of the farming households as early as 1967, a forestry component was not included until 1986. For five years after they had settled on the scheme, the farmers “had no choice but to plunder the riverine forest, the only rich green strip of land in this arid region.” They had removed the equivalent of 10,000 ha of bush in that time, and it was estimated that a similar amount would be removed before the forestry component resulted in full yields.

When irrigation schemes benefit local economies, the money earned from sale of produce may be invested in livestock. The resulting concentration of livestock around the schemes has thus promoted overgrazing in some areas, and this situation has been aggravated by the way in which irrigation schemes have altered land-use rights, “undermining” the traditional systems which often prevented land degradation due to overgrazing.

Irrigation development around wetlands has been shown to result in deforestation of wetland environments, as well as degradation of water sources due to poor siting and design of furrows and fields and cultivation near to springs.

Water pollution is also a factor which can affect downstream users, many of whom use streams for domestic purposes. In many cases, communities in water-scarce drylands are aware of chemical contamination, but continue to drink the water as they have no alternative, as “it is better to have contaminated water than none at all.”

Riparian ecosystems in the drylands of Kenya commonly function as dry-season browse reserves for livestock. Woody plants (*Acacia Tortilis* being the most important tree species in most ASAL areas of Kenya), provide browse such as flowers and seedpods for smallstock. Biomass of herbaceous undergrowth is also increased under tree canopies, providing very

nutritious grazing for animals. Destruction of riparian woodland has been shown to impact negatively on livestock survival rates in pastoral communities.

4.5.3 Loss of biodiversity

Some land uses can have significant environmental degradation effects. For example, drainage brings about direct effects in form of loss of habitat. It can radically impoverish many rich and varied wetland habitats. The most detrimental effect on habitat occurs when a wetland is brought into cultivation either as improved pasture or for arable cropping. This alters and reduces the diversity of wetland habitats. Consequently the plants and animals which require wetland conditions for their survival are destroyed. The effect of drainage could even spread from immediate site to the neighbouring ecosystems. Drainage could also cause other indirect impacts on the habitat. Following drainage, the intensification of agricultural activities will require greater use of fertilizers and pesticides. These agro-chemicals will eventually runoff to aquatic systems such as lakes and rivers where they can cause pollution and eutrophication. This will eventually have deleterious effects to fauna and flora.

4.6 *SOCIAL ECONOMIC IMPACTS OF AGRICULTURAL DEVELOPMENT*

4.6.1 The issues

Assessment of health impacts are subjective due to the fact that few attempts have been made by engineers to fully incorporate ecological and biological knowledge into their design procedures and by public health specialists to quantify the impacts of proposed development in terms of vector habitat creation or increased health risk

4.6.2 Labour

The demands of irrigation may also reduce the amount of labour available for herd-splitting, transhumance, and other common pastoralist mechanisms for maximising production.

Irrigation and drainage improvements increases labour requirements in agriculture and hence enhances employment opportunities. For example, labour input ratio of poorly drained/well drained to vary from 1.5-13 and that of rainfed/irrigated agriculture varies from 2-5.

There is a high positive correlation between the percentage of arable land irrigated and the average income per hectare. The increased income resulting from higher cropping intensity and more intensive cultivation techniques has the effect of expanding rural employment. Data on rural employment illustrates very effectively the difference irrigation can make to employment potential. The “un-irrigated village” has two distinct troughs covering some five months of the year when there is hardly any work for casual workers. The irrigated village on the other hand offers continuous employment. Increased rural employment reduces urban drift and the social problems associated with urban poverty.

4.6.3 Increases in crop production

Wetlands and drylands can be fairly suitable for agricultural production after drainage and irrigation improvements. For example, improved drainage resulted in a maize yield increase from 2500-3500 kg/ha.

Irrigation and drainage improvement also makes it possible to grow higher value crops as evidenced by export-oriented horticultural production.

Natural pasture in poorly drained areas has been reported to have a low livestock carrying capacity of 2 ha/ livestock unit and 0.8-1.2 ha/livestock unit after drainage. Under the natural conditions, the farmers prefer to keep indigenous cattle breeds with low milk production and/or gain in live weight but generally more resistant to diseases. Milk production under such conditions range between 1,200-1,500 kg/cow/year. With improved drainage and pasture, farmers can keep grade cattle and get milk yield of between 2500-3000 kg/cow/year.

4.6.4 Economic impacts

Economic benefits of utilizing wetlands for agricultural production can be assessed by the rate of return on drainage investment. The ratio of rate of return for upland cultivation (dominated mainly by stable grains) and bottomland (dominated mainly by high value crops, vegetables and sugar cane) can be as high as 1:3.

4.6.5 Livelihoods enhancement

Consideration of both production and livelihood is necessary when thinking about rural development such as irrigation. Irrigation development increases non-agricultural as well as agricultural incomes, since the additional wealth created helps to support rural retailing, crafts, industry and services. The rise in living standards as a result of irrigation also enables the development of institutions of education and health, which benefit small and marginal farmers, land-less labourers, women, the seasonally unemployed and poor people generally. These benefits are difficult to quantify and are easy to underestimate. A Ksh 100 increase in irrigated agricultural output stimulates Ksh 105 in additional output in trade and Ksh 114 additional tertiary output, a total non-farm output multiplier of 2.19. The multiplier is even higher in areas with a higher income base because there is already an established economic base with its attendant higher consumption and investment opportunities.

4.6.6 Food security

Global estimates indicate that irrigated agriculture produces 40% of food and agricultural commodities from 17% of agricultural land. This makes food security critically dependent on irrigation. The dependence is most critical in semi-arid and arid areas where some 60% of the food production is from irrigated land. In ENNDA region, the relative contribution from irrigation vary by district and division.

Increased levels of food production in reclaimed wetlands indicates that food self-sufficiency for the communities living near the wetlands can be guaranteed.

4.6.7 Health impacts

Irrigation and wetlands may have negative health impacts to people and livestock living in the vicinity.A large part of the disease burden in the Basin is associated with hunger, malnutrition, inadequate quantities of safe water for domestic use, lack of facilities to dispose of human feces in a sanitary way, and poor hygiene standards. The main diseases associated with irrigation and drainage include malaria, bilharzia, filariasis, arbovirus disease, hookworm and diarrhoeal diseases. Health impacts related to utilization of wetlands for crop production are assessed in terms of vector habitat potential and health risk.

For low-income communities the conventional approach to improve water supply and nutritional standards is to exploit surface and shallow groundwater with low-cost

technologies. Faced with water scarcity, the agricultural and nonagricultural uses of water are increasingly interdependent. In order to translate this into appropriate policy, the use of surface water for domestic purposes should be reevaluated. There is an urgent need to bridge the gap between the irrigation and domestic water supply sectors. Institutional and technical solutions are needed to provide safe drinking water from surface water sources, including irrigation canals and reservoirs. The internationally accepted concept of integrated water resources management could be very useful if elaborated and applied in rural areas and at local levels.

4.6.8 Affordable food prices

Expansion in agricultural output helps to keep food prices down. Such reductions have significant impact on the real incomes of the urban and rural poor who spend a large percentage of their income on basic food supplies. The impact on the poor is also linked to the existing wealth structure of the community. Although large farms benefit the most, smallholders and the land-less do benefit indirectly from increased employment opportunities and lower food prices. In district level comparison one can demonstrate the inverse relationship between the incidence of poverty and the extent of irrigation development. This illustrates the livelihood-enhancing impacts of irrigation, which are however seldom recognised.

4.6.9 Resource use conflicts

Human-wildlife conflicts: Crops grown on irrigation schemes may attract wildlife, leading to damage to crops and farm infrastructure, as well as loss to livestock from predators. Kenya Wildlife Service has failed to develop effective mechanisms for compensating damage to crops by animals from game reserves. Such problems may be minimised with the use of (expensive) electric fencing.

Conflicts among agriculturists: The main sources of conflicts among agriculturalists include:

- disposal of water drained from higher fields and diversion of seepage water for supplemental irrigation during the dry season. This tends to put the farmers at the lower end at a disadvantaged position;
- cultivation of crops requiring different levels of groundwater control whereby farmers with shallow rooted crops would like to keep the groundwater table higher than those with deep rooted crops;
- control of pests and diseases, particularly if some farmers neglect to control them in their fields; and
- competition for markets.

Conflicts between agricultural and pastoral groups: Conflict between agricultural and pastoral groups continues to increase as agricultural activities are introduced in traditional grazing land. When the owners of livestock and cropland represent distinct groups of people conflicts of resource utilization can be complex and intense, particularly if the land is communally owned.

Conflicts over water resources: Utilization of poorly drained areas involves minor or major modifications in the availability of water resources due to alterations in flood flows, base flows

and surface storage. Such alterations could be a major source of conflict between land users in the poorly drained area and downstream water users. Land use changes in the catchment areas may be a source of conflict between upstream land users as they retain or release more water and the poorly drained area users. Fear of water resources degradation as a result of drainage are likely to intensify such conflicts.

Utilization versus preservation conflicts: There is a growing awareness of the need to preserve some of the poorly drained areas for the purposes of water conservation, protection of rare and endangered species, improvements of biodiversity and natural beauty. At the farm level the conflict in land use lies on whether the land should be used for production or should be preserved for environmental considerations. While there is a growing consensus that the emphasis should be on a wise use of the scarce land and water resources, farm level considerations for wise use are very low as farmers continue to emphasize short term benefit rather than long term sustainability.

Box 1: Water conflicts intensify

Smallholder irrigators-smallholder farmers conflicts

On 21st February 2000, residents of Kariminu village led by the Nyeri County Council chairman, barricaded the Nyeri-Nyahururu highway from 8:30 am to 1:00 pm when the police arrived. They were protesting against the diversion of Kariminu river by a group of individuals for irrigation and failure of the local District Officer and District Water Office to take any action to stop the illegal abstractors from draining the river. They claimed that their sub-location had gone without water for several months due to over-abstraction by upstream irrigators resulting in increases in typhoid cases and near closure of a local boarding high school. They demanded audience with the area District Commissioner. As the riot police were restoring law and order a riot erupted and several vehicles were damaged and old men and women who could not flee were injured.

Source: Wachira, 2000

Irrigators-pastoralists conflicts

Mathenge, 2000 reported that Non-Governmental Organisations working with pastoralists were expressing concerns over unbalanced exploitation of water resources which cause serious conflicts. They argued that the benefits accruing from horticultural farming should not be allowed to continue at the expense of denying pastoralists water resources. They blamed large-scale and small-scale irrigators for the drying of Nanyuki river barely 20 km. from Nanyuki Town. They criticized the government for failing to enforce the water act.

Irrigators-Fish farmers conflicts

On March 13th, 2000, a Nation correspondent reported that a Nanyuki fish farmer had lost 30,000 trout fishes (estimated loss of about Ksh 4 million approximately 53,000 US dollars) following diversion of Likii river for irrigation upstream. This is an example of the water availability risks that are borne by downstream water users.

Source: Nation Correspondent, 2000

Human-wildlife conflict

On 23rd march 2000, Mathenge reported that elephants had left the wild to look for water in a village water point in Olborsoit location of Laikipia District. Approximately 4,000 pastoralists and their cattle were experiencing water shortage and forced to move upstream in search for water and grazing resources.

Source: Nation Correspondent, 2000

4.6.10 Displacement

Communities which are displaced by irrigation schemes receive limited compensation, which is calculated by government staff from the Commissioner of Lands. There are no mechanisms for the communities to appeal for more than they are allocated. Further more, this compensation is only offered for lands used for housing, agriculture, and similar 'individual' holdings. "There is no compensation for lost pastures and access to water caused by the enclosure of irrigation schemes."

4.6.11 Loss of riverine resources

Riverine areas and other 'wetland in dryland' areas, have many different economic uses for local pastoralist people. The fruits are eaten, either raw or sundried, for example; the leaves are used for constructing homesteads, the branches are used for building, fencing, and for firewood. Indeed, in the dry season, access to fruit and fodder trees is often the key limitation to movement of herds and people. This resources are lost when riverine ecosystems are destroyed.

4.6.12 Loss of dry season grazing land

Irrigation development may take place on land previously used for pastoralism. In the case of the Lower Tana Village Irrigation Programme, initiated by the Irrigation and Drainage Branch of the Ministry of Agriculture, local Orma and Somali pastoralists lost approximately 10,000 ha of seasonal grazing land.

4.6.13 required interventions

Dry-season grazing rights can be re-negotiated depending on changing relationships between sub-groups, clans, and tribal groups. Normadic pastoralists in the basin use of the riverine forest as a fall-back grazing reserve.

5. PROSPECTIVE PROGRAMMES

5.1 *IMPLICATIONS FOR AGRICULTURE AND IRRIGATION DEVELOPMENT: DIFFERENT SITUATIONS, DIFFERENT NEEDS*

On a per capita basis, the amount of runoff produced annually by precipitation in the basin is high. However, most rainfall comes during two short periods (March-May and October-December). Even though some farmers have invested in storage dams, this is far too short of the required capacity. Groundwater tables are falling in several areas exacerbating the water shortage. Tens of thousands of people in the basin face water shortages. Considering that they are also some of the Kenya's poorest the malnutrition, poverty and insecurity of livelihoods are likely to intensify if nothing is done.

It has been estimated that additional food growth has to be of the order of 4% per annum merely to maintain supplies at current levels. While absolute food shortages at the national level are unlikely, all major estimates point to a growing "food gap" in the arid areas of the basin.

It can therefore be concluded that:

1. without continued irrigation investment, food prices are bound to rise and the poorest segment of the population is likely to suffer most.
2. the implications of neglecting irrigation for food security can be serious, and that investment in water infrastructure, continued reform of supporting institutions, and an enabling environment are necessary to improve food production.
3. in many parts of the basin, security and stability in food supplies is closely linked to success in irrigation, and in the management of river basins, and
4. water scarcity is a critical constraint to food production and is increasingly becoming a major cause of poverty and hunger.

Based on the level of water scarcity there are different needs for different areas. Three useful categorizations help in understanding these differences*: w*ater scarce areas, high potential areas, high need areas.

5.1.1 Water-Scarce Areas

Areas of physical water scarcity are those areas with annual rainfall less than 400 mm, deep groundwater table and ephemeral river that are far apart. A large part of the lower basin falls into this category. These areas do not have additional water that can be tapped for more development. Water-related problems include groundwater overdraft and pollution that threaten long-term productivity of water. Challenges are reallocating water from lower-value, typically agriculture uses, to higher value uses in urban areas for domestic use, livestock and high-value agriculture. This must be done in a manner where poor people can take advantage of the increase in value of water, and where they do not lose out because water is taken away from them. Managing and designing for water savings in agriculture to free up water for domestic, livestock and environment uses are key challenges for many water-stressed areas.

Water scarcity also exists in areas where the communities living there do not have the economic, financial, and skilled human resources to tap this water supply. In these areas, there is a great need for water resource development, but the difficulty in doing so is also quite great. A major difficulty, and a major point of conflict, is that much of the water serves important ecological functions. Legitimate water development concerns must deal with equally legitimate concerns over the environment. Oftentimes, those in favor of water for the environment and those in favor of water for agriculture are at loggerheads over the issue. Meanwhile, we are far from an optimal solution, and people suffer. A major question in this area is how to use water for agricultural and rural development in a way that meets ecological needs.

5.1.2 Non-water scarce areas

Water is not the main limiting resource in areas where rainfall exceeds 900 mm per annum and there is much remaining scope to use water development to help poor people. Where there are adequate water resources but the communities continue to experience water scarcity, the area can be classified as economic water scarce area. Examples of this include the subsistence farmers in the foot slopes mount Kenya, Aberdare, Nyambene hills. In these areas, there is huge scope remaining to increase production. The problem, of course, is that during a few days of the year, there is too much water, while during most of the year, water supplies are insufficient. Many argue for more large dams, while others look to groundwater and

alternative means of storage to help in this area. There is scope for investment in these areas, but these should be made with an understanding of basin-wide impacts of various development alternatives.

5.2 *SUSTAINABLE WETLAND UTILIZATION*

There is a growing concern by the rate of conversion of poorly drained areas into cropland and the potential environmental degradation that may result from uncontrolled and unplanned irrigation development started a smallholder drainage project. This project will be aimed at providing technical and financial assistance in drainage development to:

1. Areas occupied by smallholder farmers that had started drainage interventions;
2. Areas with high potential for agricultural production; and
3. Areas with minimum negative environmental impacts or where mitigation measures could be easily implemented.

5.3 *REDUCING AGRICULTURAL WATER DEMAND*

Drylands agriculture accounts for about 80% of the total consumption of water. In the basin, the scarcity of water is rapidly increasing and the competition for its use is growing more intense. Consequently, water is the factor that limits agricultural production. Most of the conventional sources of fresh water in the region have already been developed and tendency towards overexploitation of natural resources is growing. Therefore, the only option left, in addition to some non-conventional sources, to feed the ever increasing population of the region using the same amount of water, if not less, is by sustainably increasing the efficiency of water use; that is to increase the food production (quantitatively and qualitatively) per unit of water used.

In the past, water management strategies have focused on developing new supplies to satisfy the ever-increasing demands from all sectors and on building infrastructures to convey and distribute these supplies to the different users. Now, almost all the supplies have been developed, and demand and quality management evolved as the complementary solutions to solve the problem. Demand management seeks to optimize the allocation of available water, at any particular time, to the competing water-user sectors. Quality management aims to maintain the usability of the resource by controlling pollution.

This calls for an integrated strategy that looks at the whole set of technical, institutional, managerial, legal, and operational activities required to plan, develop, operate, and manage the water resources system on all scales: farm, project, basin and national while considering all the sectors of economy which depend on water. Sustainability is a major objective of these policies in the sense that the utilization of resources by future generations should not be limited by the use of current generations in any way. This calls for projects aimed at:

1. Development of alternative land use systems and cropping patterns for improved water use in various agro-ecologies and socio-economic situations that are economically competitive and respond to changing markets and demands.
2. Development and transfer of alternative irrigation technologies suitable for irrigation in these alternative land use systems at high efficiency.
3. Developing new guidelines for irrigation scheduling under water scarcity conditions. Conventional guidelines are suitable only under normal water supply.

4. Developing methodologies for the assessment of water use at basin level of representative areas for evaluating consumed and recoverable water and economic returns.
5. Improved crop materials(germplasm) for higher WUE in addition to the conventional target of high yield.
6. Evaluation of the environmental consequences of a conservative management of water under scarcity and ways to overcome these consequences.
7. Maintaining a balance between water allocation for food and for environment under dry conditions.
8. Socioeconomic incentives for improved water management at the farm level with policies required.

5.4 *IMPROVING RAINFED AGRICULTURE*

Research from several semi-arid tropical regions show that the occurrence of dry spells, short periods of 2 – 4 weeks with no rainfall, far exceeds the occurrence of droughts. Hence mitigating intra-seasonal dry-spells is a key to improved water productivity in rainfed agriculture in semi-arid and dry sub-humid tropical environments. There are three major avenues to achieve this:

- Maximize plant water availability (maximize infiltration of rainfall, minimize unproductive water losses (evaporation), increase soil water holding capacity, and maximize root depth).
- Maximize plant water uptake capacity (timeliness of operations, crop management, soil fertility management).
- Bridge crop water deficits during dry-spells through supplemental irrigation.

The achievable yield level in this semi-arid case amounts to 5 t ha^{-1} grain yield. Actual observed yield levels are however disappointingly low. Poor rainfall partitioning reduces the possible yields with 1 – 2.5 t ha^{-1}, and poor plant water uptake capacity reduces yields with 1.5 - 3 t ha^{-1}. The average experienced yield level amounts to 1.5 - 2 t ha^{-1}. The common on-farm reality is yield range of 0.5 - 1 t ha^{-1}. In the on-farm case only some 35 - 55 percent of crop water requirement is available in the root zone (due to high runoff and deep percolation) and productive green water amounts to only 15 - 25 percent of total green water flow (indicating large evaporation losses). There is therefore a large scope for improving yield levels within the available water balance in rainfed farming systems. It seems that there are no agro-hydrological limitations to enable even a large and stable yield increase from, e.g., 0.5 t ha^{-1} to 2 t ha^{-1} (i.e., a quadrupling of yields) in semi-arid environments. The challenge is to maximize infiltration, mitigate dry -spells (increase the amount of available water in relation to CWR over time) and to improve primarily soil fertility management in order to increase the productive green water ratio.

5.5 *DROUGHT TOLERANT CROPS IMPROVEMENT PROJECT*

Yield losses due to drought are highly variable depending on timing, intensity, and duration coupled with other location specific environmental stress factors such as high irradiance and temperature. Drought may cause complete crop failure or varying amount reduction in biomass and grain yield. In addition to the direct effect of drought on the yield loss, the

potential beneficial effects of improved crop management practices such as fertilizer application or intercropping are not fully realized in terms of increased production.

Given the increasing scarcity and competition for water resources, irrigation is generally not a possible option to alleviate drought problems in the Basin. Drought management strategies, whether agronomic or genetic, therefore need to focus on maximum extraction of available soil moisture and its most efficient use in crop establishment, maximum crop growth, and for increasing biomass and seed yield.

In order to plan crop yield improvement programs for a given target drought-prone area the following steps are essential

- Characterize the major patterns of drought stress and their frequency of occurrence in the target environment.
- Evaluate crop response to the major drought patterns (simulation modeling)
- Match crop phenology (growth period, sowing, flowering, seed filling) with most favorable period of soil moisture and climatic regimes
- Develop a strategy for the optimal use of supplementary irrigation, when available
- Increase available soil water to crop through agronomic management practices
- Identify plant traits that would maximize (i) use of available soil moisture in transpiration (ii) production of biomass per unit water transpired, and (iii) partitioning into seed, thereby conferring enhanced crop water productivity.