GROSS MARGIN ANALYSIS OF VARIOUS CROPS CULTIVATED IN THE MARA RIVER BASIN 2004

Incomplete Draft Report

By

Joseph Onjala

This study was commissioned by the World Wide Fund for Nature – East African Regional Office in Nairobi, Kenya

Acknowledgements

This study was commissioned by the World Wide Fund for Nature – East African Regional Office in Nairobi, Kenya. I am grateful to Mr. Mohamed Awer, Ms. Doris Ombara – the Project Manager, and Mr. Koros who coordinated preparation for the work and supervised data collection from the field. All the research assistants worked tirelessly to reach remote parts of the Mara River Basin. Without all of their inputs this exercise would not have been a success.

1.0 BACKGROUND OF THE STUDY

1.1 Introduction

The overall goal of the Mara River Catchment Basin Initiative is the achievement of sustainable natural resources management in the Mara River Catchment Basin. The Mara River is an international river of profound biodiversity interest. The river originates in the forests of the Eastern Mau Escarpment in Kenya and flows along the boundaries between Narok, Bomet and Transmara districts into Masai Mara National Reserve (MMNR) before crossing the border into Serengeti National Park in Tanzania and draining into Lake Victoria. Before debauching from Kenya, Mara River receives water from two important seasonal tributaries, the Talek and Sand River. Both rivers originate from the Loita Hills and drain the Sannia and Loita Plains, a major dry season livestock grazing area and a vitally critical dispersal area for wildlife ungulates in the Mara-Serengeti ecosystem.

The supplementary goals of the present initiative are: Conservation of Mara River Catchment unique biodiversity; Ensuring the maintenance of natural functions by balancing the supply and demand of biodiversity products; and Developing alternative livelihoods of the communities

The objectives of the Initiative are to assess the status, threats and sources of stress of Mara River Catchment Basin and Develop a strategy for developing sustainable use and management of biodiversity of the Mara River Catchment.

The Mara River Basin is a host to diverse human cultures as well as many natural resources. If not utilized in an integrated and sustainable manner, the future of the basin may be in jeopardy. Diverse land uses, various cultures, commercial as well as subsistence enterprises, communally managed as well as private control of land and land – based natural resources occur on both sides of the Tanzania-Kenya border. Increased human activities, rapid growth of population and settlements, high livestock population and deforestation have become great threats to the entire ecosystem vitality.

2.0 Study on Cost Benefit Analysis of Various Crops grown in the Mara River Basin

The Mara River Basin Project would like to facilitate the newly formed Mara River Water User's Association to strengthen its regulatory role on control of water use and abstraction from the Mara River. The association should from this information assist in control and guidance on the types of crops recommended to be grown within the Mara River Basin in respect of the available water in the Mara River.

A number of crops are currently being grown and cotton is proposed as a major one to be grown in the basin future. These include: wheat, irrigated maize, irrigated French beans, cotton and livestock production. For each of these crop enterprises, gross margins needs to be established under both rain-fed and irrigated conditions. Maize for example is currently grown under rain-fed and irrigated conditions. Crop requirement for each enterprise also needs to be established.

Data Collection

Interviews of small scale farmers and pastoralists was undertaken to collect information using structured questionnaires. The information collected covered detailed crop budget for wheat, maize (irrigated and rain-fed), French beans, Tomatoes, Cabbages, Onions and livestock production. About 200 farmers were interviewed during the survey while important information was collected from annual records of Ministry of Agriculture and Livestock in Narok and Bomet Districts. The study took a period of three.

This study of the Gross Margins for various crops in the Mara River Basin was also based on the available studies by other consultants.

3.0 Gross Margin Analysis of Various Crops

Only 28% of available arable land are under agricultural production. Two distinct types of agriculture are experienced; smallholder mixed farming and large-scale commercial farming. Most of the smallholders mixed farms are about 2.0 to 5.0 ha. and the main food crops are maize, wheat, beans, and vegetables. Mixed farming is basically for subsistence. The large commercial farms are found in Mau, Ololunga and Osupuko divisions and they grow barley, pyrethrum, maize, sunflower and wheat. West of Mara River in Trans Mara, the land use types are livestock-sorghum and sunflower-maize zones. Land under maize, wheat and barley production has increased since 1984. The current agriculture trends are:

- Expansion of farming areas;
- Parcelisation of land into small divisions;
- Increased casual laborers from other district, causing population increase; and
- Fencing of such parcels.

Wheat farming in the plains will increase incidences of wildlife-human conflicts. Population densities are highest in high potential areas, especially where sedentary agriculture is practiced.

Irrigation agriculture along river floodplains and in otherwise dry season grazing areas has increased. More than 300 ha in Naroosura are under irrigation as well as planned farms in Seyabei, Mosiro, Lemek, Ngori and parts of Mulot location are suitable for wheat and maize. Kanunka irrigation scheme in Osupuko targets 100,000 ha under horticulture in Kajiado district. The total potential for irrigation in the Catchment has been estimated as 32,000 ha. for upland crop.

There are 7 smallholder irrigation schemes covering an area of 165 ha and 4 individual and 8 private farms in the district. The current water demand for irrigation on the Mara River is 0.019 m^3/sec and 0.059 m^3/sec per month. This is expected to increase as additional marginal areas are brought under cultivation.

3.1 Cabbages Production

Table 3.1: Current Gross Margins for Cabbages Production

	Kg/Acre 2004	
	Modal	Average
Land Preparation		
Ploughing	3000	3500
Harrowing	1500	1400
Seeds	800	800
DAP	1700	930
Chemicals	400	800
Labour Requirements		
Planting	600	700
Spraying	750	700
Weeding	1500	1100
Harvesting	1200	1000
Irrigation		
Fuel	0	0
Labour	600	600
Water		
Packaging	-	-
Transport		
To storage	-	-
Market	500	300
Inputs	-	-
Working Capital 20% interest	2510	2566
Total Variable Costs	15060	15396
Yield in Trays	20000	19805
Price Kshs per kilogram	10	8.25
Gross Output	200000	163390
Gross margin	202510	147994

- The average farm size is 0.80 acres per farmer.
- On average each farmer earns Kshs. 147994 per acre.
- The most common margin is Kshs 202510 per acre.

Figure 3.1: Mara River Basin: The Distribution of Farm sizes for Cultivation of Cabbages, 2005.

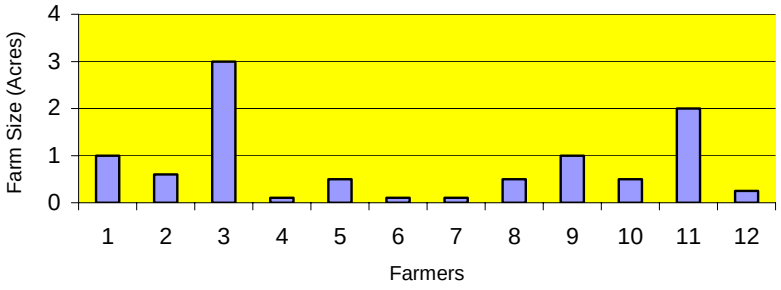


Figure 3.2: Mara River Basin: Price of Cabagges

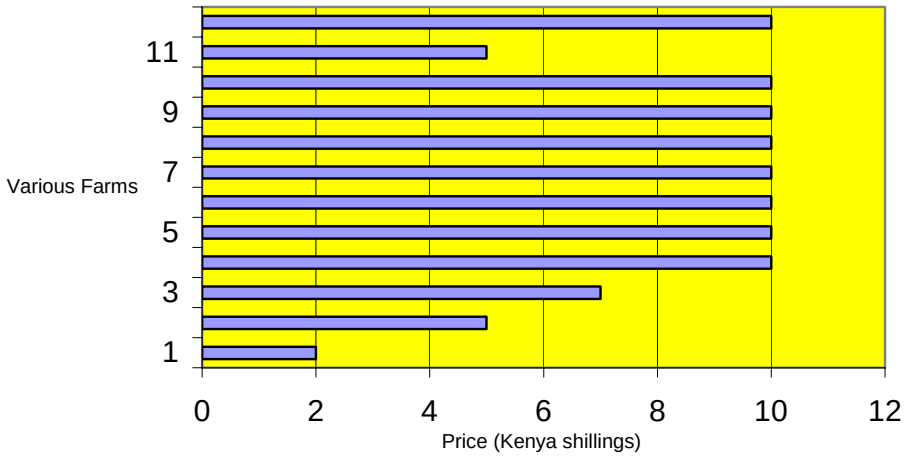
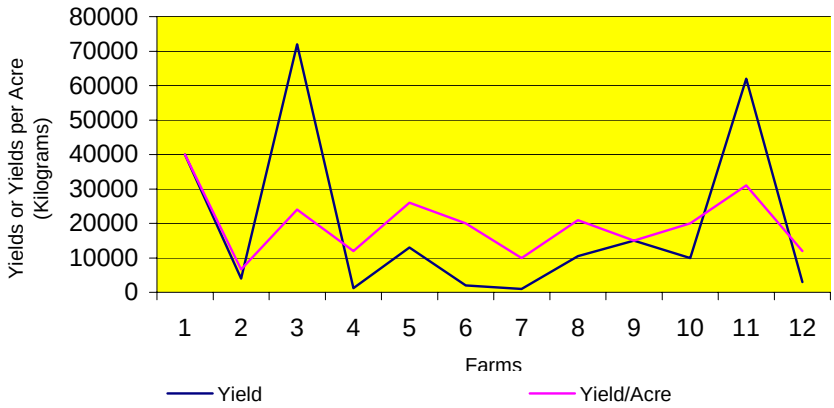


Figure 3.3: Mara River Basin: Yields of Cabbages, 2005



3.2 Onions Production

Table 3.2: Current and Simulated Gross Margins for Onions Production

	Kg/Acre 2004	
	Modal	Average
Land Preparation		
Ploughing	2500	3005
Harrowing	1500	1300
Seeds	900	900
Fertilisers		
DAP	900	1000
Chemicals	500	300
Labour Requirements		
Planting	3000	1800
Weeding	3000	2800
Spraying	200	200
Harvesting	2000	2100
Working Capital 20% interest	2900	2681
Total Variable Costs	17400	16086
Yield in kilograms	800	745
Price Kshs per bag	20	15.50
Gross Output	16000	11547.5
Gross margin	**-1400**	**-4538.5**

- The average farm size is 0.43 acres per farmer.
- When the opportunity cost of capital is included in the gross margin estimates, onion production is unprofitable.
- On average the losses incurred in onions production are much higher, unless higher prices are obtained in the market.

Figure 3.4: Mara River Basin: Cultivation of Onions, 2005

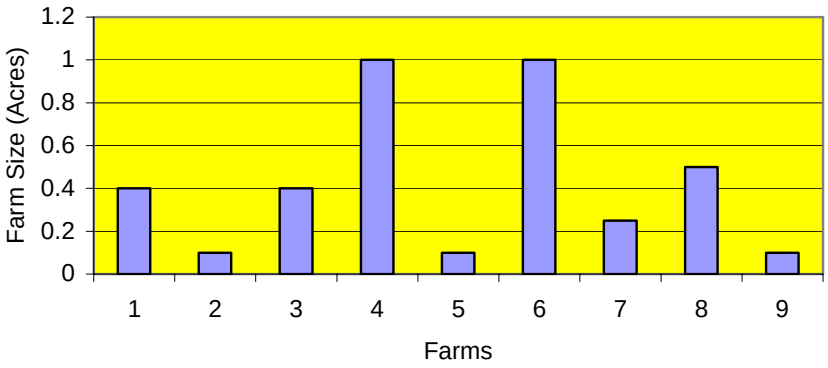


Figure 3.5: Mara River Basin: Onions Production, 2005

3.3 Tomatoes Production

Table 3.3: Current Gross Margins for Tomatoes Production

	Trays/Acre 2004	
	Modal	Average
Land Preparation		
Ploughing	3000	2500
Harrowing	1200	160
Seeds	500	300
DAP	1500	800
Chemicals	800	2000
Labour Requirements		
Planting	1200	1170
Spraying	1200	1600
Weeding	1500	700
Harvesting	2000	1300
Irrigation		
Fuel	3000	1600
Labour	1800	600
Water		
Packaging	800	800
Transport		
To storage	100	100
Market	2500	2500
Inputs	100	100
Working Capital 20% interest	4240	3246
Total Variable Costs	25440	19476
Yield in Trays	170	118
Price Kshs per Tray	600	587
Gross Output	102000	69266
Gross margin	76560	49790

- The average farm size is 0.43 acres per farmer.
- Tomatoes appear to be a very profitable crop for the farmer with gross margin averaging Kshs. 49790 per acre.
- The typical farmer has a gross margin of Kshs. 76560 per acre.

Figure 3.6: Mara River Basin: Cultivation of Tomatoes, 2005

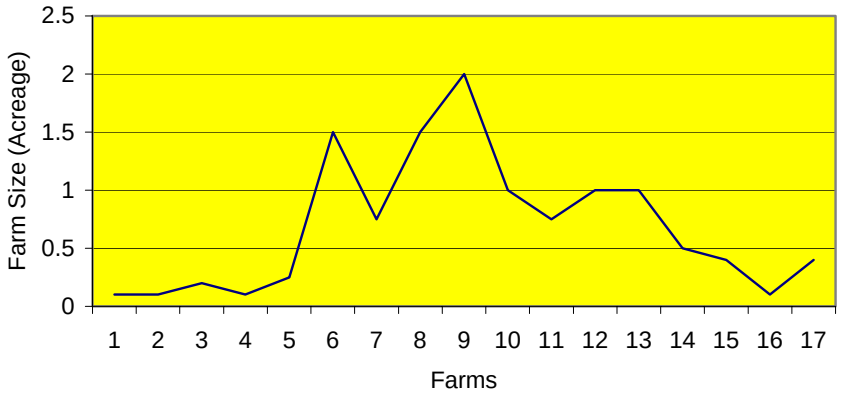
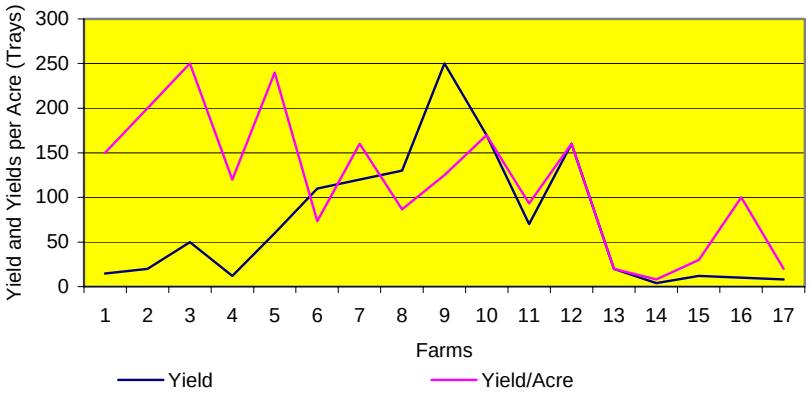


Figure 3.7: Mara River Basin: Tomatoes Production, 2005



3.4 Maize Production

Table 3.4: Current Gross Margins for Maize Production (90kg) Bags/Acre

	2004	
	Modal	Average
Land Preparation		
Ploughing	3000	2500
Harrowing	900	300
Seeds	1250	1200
DAP	1700	1000
Chemicals	100	100
Labour Requirements		
Planting	1200	800
Weeding	2000	2000
Harvesting	1000	800
Shelling	900	600
Drying	500	500
Transport		
Input	300	300
Store	900	400
Market	500	600
Working Capital 20% interest	2850	2220
Total Variable Costs	17100	11100
Yield in bags (90kg)	20	14
Price Kshs per bag	1400	1300
Gross Output	28000	18200
Gross margin	10900	4880

- The average size of maize farms is 3.70 acres per farmer.
- The average gross margin for maize is a mere kshs 4880 per acre.
- For most of the farmers the gross margin is Kshs 10900 per acre.

Figure 3.8: Mara River Basin: The Distrubtion of Maize Acreage

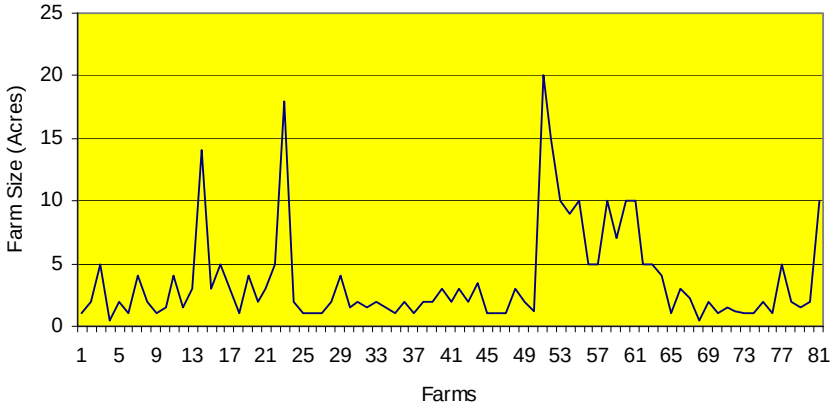
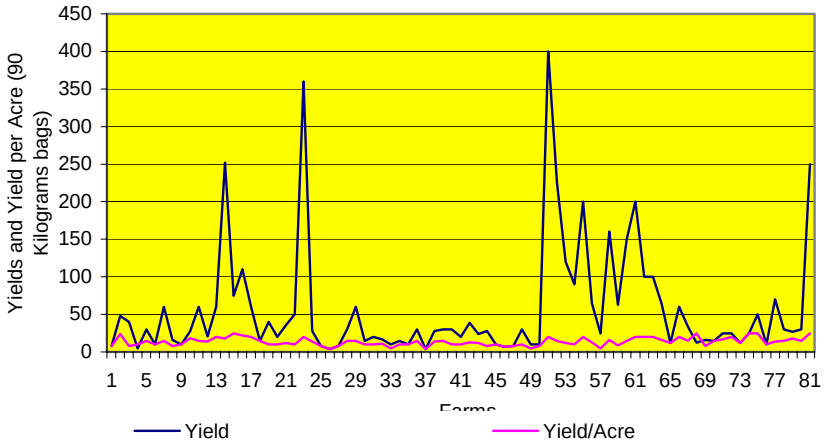


Figure 3.9: Mara River Basin: Maize Yields, 2005



3.5 Wheat Production

Table 3.5: Current Gross Margins for Wheat Production

	2004	
	Modal	Average
Land Preparation		
Ploughing	2500	2300
Harrowing	2000	1600
Seeds	2100	1800
Fertilizers		
DAP	1700	700
MAP	1700	800
Agro-Chemicals		
Tilt	1500	400
Folcur	700	100
2,4,D	350	50
Foliar Feed	200	50
Labour Requirements		
Planting	1300	1200
Spraying	400	500
Harvesting	1200	1250
Drying	300	50
Transport		
Inputs	900	900
Store	1000	400
Market	1000	400
Working Capital 20% interest	3770	2500
Total Variable Costs	17380	15000
Yield in bags (90kg)	20	16
Price Kshs per bag	2000	1900
Gross Output	40000	30400
Gross margin	17380	15400

- The average farm size is 9000 and 20 for large scale and small scale farmers respectively.

- The average gross margin for wheat production in the Mara basin is Kshs 15400 per acre.
- Most farmers have a margin of Kshs 17380 per acre.

Figure 3.10: The Distribution of Wheat Farms in the Mara River Basin (Acres)

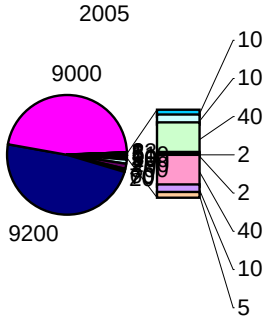
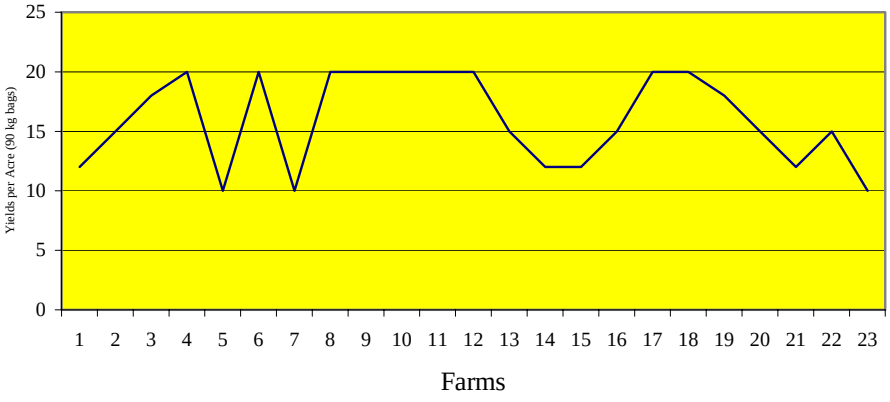


Figure 3.11: Patterns of Wheat Yields per Acre in the Mara River Basin, 2005



3.6 Livestock Dairy Activities

Livestock farming is an important economic activity amongst the Masai. The main livestock reared is the zebu cattle, small East African goats and red Maasai hair sheep. Dairy farming is limited to high potential areas where the mean annual rainfall is 1000mm. In 1992, it was estimated that there were 853,000 cattle and 1,676,000 goats/sheep in the district (JICA, 1992). Narok District has a potential capacity of 387,726 stock units, which during normal years is exceeded three times. Estimates put the number of livestock units to be 511,000 in 1990 and 613,000 in 2000. These estimates were affected by the 1999/2000 drought in which an estimated 40% of the livestock ought to have died due to drought. Most cattle that survived were drawn to the highlands and some sent south into Tanzania. The livestock water demand in Mara River catchment has been estimated as 159.11 m^3/year in 1990, 190.31m^3/year in 2000 and rising to 227.68m^3/year in 2010 (JICA, 1992, p. T84). Over-stocking causes acute wildlife-human conflicts and soil degradation (Krhoda, undated).

Table 3.6: Livestock production and land carrying capacity

Division	Area km2	Land carrying capacity
Osupuko	5,469	7.8
Ololunga	3,966	8.75
Ilmotiok	952	52.56
Central	538	8.5
Olokurto	1,365	45.4
Mau	2,838	24.7

Source: Narok District Development Plan,. Ministry of Planning, Nairobi

Table 3.6 shows land carrying capacities of divisions in Narok. Land carrying capacities in Lolgorian and Kirindoni is 58 and 123 respectively. More than two-thirds of the catchment is rangeland. There are nearly 200 registered group ranches in Narok district. The Group Ranches vary in size from 1,500 to 16,000 ha. and they are not properly managed.

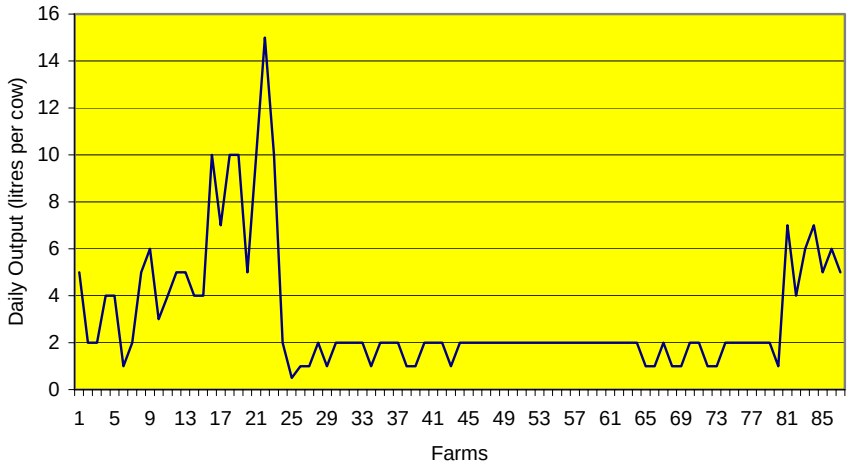
A certain amount of cultivation is carried out in Group Ranches especially along the water courses and swamps. Individual ranches average about 900 ha. In addition there are individual small scale mixed farm holdings.

Table 3.7: Current Gross Margins for Dairy Production

	Litres/cow/year 2004	
	Modal	Average
Labour Requirements		
Grazing	1200	600
Spraying	1900	300
Milking	100	100
Chemicals Drugs per	500	400
Veterinary Services	1000	1400
Milk Containers	200	50
Transport to Market	100	80
Working Capital 20% interest		
Total Variable Costs		
Yield in litres per cow/year	2000	1200
Price Kshs per litre	20	19
Gross Output	40000	22800
Gross margin	34000	19284

- The average milk yields per cow per day is 3.12 litres.
- On average, the gross margin per cow in a year is Kshs. 19284.
- Most farmers are able earn a margin of Kshs 34000 per cow per year.

Figure 3.12: Daily Milk output per Cow in the Mara River Basin, 2005



4.0 Implications of Gross Margins on Water Resources Management in the Mara River Basin.

In a recent study of the hydrology of the Mara River Basin Catchment (Krhoda), a description is undertaken of the river basin and river channel characteristics elucidating water quality characteristics with the aim of making recommendations for project development. The study established relationships between the various land use activities and the hydrology of the River Mara. Our analysis of the crops recommended to the Mara River Water User's Association takes the findings of this study into account.

4.1 Profitability of Various Crops

Table 4.1 Ranking Profitability of Various Activities

Activity	Modal Gross Margin	Average Gross Margin	Rank
Cabbages per acre	202510	147994	**1**
Onions per acre	-1400	-4539	**6**
Tomatoes per acre	76560	49790	**2**
Maize per acre	10900	4880	**6**
Wheat per acre	17380	15400	**4**
Dairy Production per cow/year	34000	19284	**3**

On the basis of the above findings, it would appear that currently:

- Production of cabbages is the most viable activity, followed by Tomatoes, and Dairy production.
- Onions production is not profitable and could be discouraged since farmers are loosing money by engaging the activity.
- As graphical illustrations show (figure 3.11), wheat production has varying profitability with larger farms tending to perform better.

4.2 The Water Resource Base

4.2.1 Drainage network

The drainage network is a reflection of type and arrangements of the bedrock units in the basin. Mara River is composed of five tributaries of which Rivers Nyangores and Amala are its main tributaries. These tributaries originate in the upper part of the basin at an altitude of about 3,000m. above mean sea level. In this upper part of the basin the stream network are parallel pinnate, linear with numerous first order streams, reflecting long parallel ridges. The streams trend in a northeast to southwest direction following the general slope of lava flow and reflect the youthful nature of the landscape. Parallel pinnate river networks are found mainly on recently formed volcanic areas. The short tributaries drain the flanks of the ridges while the long segments drain the troughs between (Krhoda, undated).

Further south, Engare Engito River originating from the Ilmotyoo-Koit Ap Soyet ridges on the east joins the Amala River along fairly settled portion of the Mara Catchment Basin. The ridges here are at 1348m. above mean sea level and divides River Ewaso Ngiro South from Mara River Basin. The Mara River basin is widest at the plains and narrowest at Mara Camp. River Talek, probably the original Mara drainage system on an old geological formation, runs in an east-west direction and joins the Mara within the Mara Game Reserve. Several tributaries of Talek River drain the extension of Loita Hills. Sand River, the last of the major tributaries, joins the Mara at the Kenya-Tanzania border (Krhoda, undated)..

Table 4.2: Characteristics of the Tributaries of Mara River

River tributary	Long profile(km)	Stream gradient
Nyangores	97	0.0136
Amala	94	0.014
Talek	38	0.012
Engare Engobit	27	0.014
Sand River		

Unlike Nyangores and Amala, River Talek and Sand River have dendritic drainage patterns; they demonstrate a drainage network on flat-lying eroded massive crystalline rock of uniform resistance, which has been deeply weathered. The rivers meander in their wide valleys.

Table 1 shows the average stream gradients of the major tributaries of the Mara River Basin. Their gradient range from 0.012 and 0.14, reflecting the potential velocity during the average flows. The lower part of Mara River, Talek and Sand rivers flow over mature and eroded landscapes. Unlike most rivers draining into Lake Victoria, the Mara River and its tributaries do not have any falls or rapids along their courses.

Strahler's method of stream ordering provides quantitative method for analyzing drainage network. The outermost streams constitute stream order ones. Where a stream order one joins another of the same order stream order two is designated. Whenever stream order number two joins another of the same stream order, a stream order three is designated. Table 4.2 shows the stream order and the number of streams for each tributary of the Mara River (Krhoda, undated)..

Table 4.3: Stream orders for various tributaries of Mara River Basin

Stream Order	**Number of streams**				
	Nyangores	Amala	Talek	Engare Engobit	Sand River
1	106	102	176	15	140
2	40	55	71	7	41
3	20	11	41	1	10
4	1	18	6		1
5		1	1		
6			1		

Streams of order one, through headward erosion, cut extend the long profile of the river into the watershed. These are mainly rivulets that collect water rapidly from the drainage divide and route the discharge downstream. As streams of order one join another the volume of water in the channel increases and the channel width increases also.

The ratio of stream order one to stream order two are 1:2. For Rivers Nyangores and Amala the ratio of the highest stream order to the next highest, respectively, are 1:20 and 1:18 as compared to Rivers Talek and Engare Engobit's 1:6 and 1:7. Rivers Talek

and Engare Engobit and Sand River flow over mature landscapes as compared to Rivers Amala and Nyangores.

Table4.4: Water balance for Mara River Basin

	mm (p.a)	Percent
Rainfall	1800 -500	100
Actual evapotranspiration	1400-1800	78-100
Change in groundwater storage	negligible	negligible
Change in soil moisture storage	negligible	negligible
Surface runoff	36.97	3.64

4.3 Water use

There are 10 water supply schemes, extracting water from rivers, operated by the Water Department, 17 boreholes, 9 dams and ponds (1992), which serve the population and livestock. Table 14 shows types of management of water supply in Narok district.

Table 4.5: Water supply by managing authority in Narok District

Community	18
NGOS	1
Local Authority	1
Donors	1
TOTAL	29

Source: JICA, 1992, p.DT.7

Narok town suffers from water deficit at present and the volume of deficit is expected to increase in future. Upper Narok Dam supplies Narok town with the water for meeting the deficit.

The average projected domestic and industrial water demand for Narok district range from 107l/c/d to 109l/c/d (JICA, 1992, p. DT.22-DT.24). From these calculations, the water demand by the year 2010 will be 31,929m^3 per year while the water available will be 21,750m^3/day from surface and 10,179 m^3/day from groundwater sources (JICA, 1992, DT.37).

Table 4.6: Estimated of Water Demand (M3/day)

Year	Population	Rural	Urban	Stock	Industrial	Total
1990	407,099	10,715	2,530	32,127	228	45,600
2000	644,338	19,472	8,559	44,700	422	73,153
2010	840,605	31,929	16,903	54,809	606	104,247

Source: JICA, 1992, (p. D.2.30, D.2.72 and D.2.144).

Settlements have occurred along wildlife corridor and dispersal areas. The great migratory patters of the wildebeest, buffaloes, elephants, lion, etc. have been disrupted by settlements. After the long rains the animals migrate towards the north into group ranches and southwards into Serengeti National Park in Tanzania. The animals return to the reserve during the dry season.

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