

The Socio-economic and Ecological Impacts of Small-scale Irrigation Schemes on Pastoralists and Drylands in Northern Kenya

K.O. Farah,¹ D.M. Nyariki,^{1*} A.A. Noor,² R.K. Ngugi¹ and N.K. Musimba¹

1. Department of Range Management, University of Nairobi, PO Box 29053, Nairobi, Kenya

2. Ministry of Agriculture and Rural Development, Kenya

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ABSTRACT Northern Kenya, as in other sub-Saharan arid and semi-arid regions, has faced challenges related to the prevailing socio-economy, ecology and polity in the last quarter of last century. In some of these areas, pastoralists have been settled on the peri-urban fringes of towns and have been exposed to flood-retreat cultivation; a culture that has been traditionally practised by the riverine Bantu communities. From the late 1960s these pastoralists started irrigation agriculture with assistance from the government and non-governmental organisations. The outcome has been the mushrooming of irrigation schemes along rivers. This paper looks at the development of small-scale irrigation schemes and their sustainability. It also analyses their socio-economic and ecological effects on pastoral households and the drylands, taking Garissa District as a case. Interviews, a questionnaire and existing literature on irrigation schemes were used to collect data. Logistic regressions were carried out to assess the socio-economic effects of irrigation on the pastoral households. The results show that irrigation farming plays a supplementary role in pastoral economies, takes away child labour from pastoralism and reduces pastoral mobility. The implication is that irrigation farming in arid areas does not seem to offer a long-term sustainable economic livelihood.

INTRODUCTION

To feed its population and to provide capital and impetus for other forms of development, Kenya heavily depends on agriculture. Part of this agriculture is practised in the arid and semi-arid lands (ASAL), also referred to as drylands, which form 80% of the country's land area and in which 25% of its population lives. Drylands are areas of meagre or undependable rainfall – ranging between 0mm and 1,500mm – in which the average precipitation is deficient in relation to water requirements. Most of these are found in northern Kenya (NK) and include arid areas where arable crop production is not possible without irrigation, and semi-arid areas where rainfall is sufficient for certain types of crops,

requiring special management techniques (Arnon, 1992).

Since the 1970s the development of ASAL has received increasing attention in recognition of the important contribution these areas can make to national development (GOK, 1994). Despite the efforts made to develop these areas, numerous constraints still exist. The ASAL have harsh and complex environments, with fragile ecosystems quite susceptible to environmental destruction under increased human and livestock utilisation. The threat of drought and its consequences pose particular challenges to development efforts in these areas.

Dryland farming is one way in which resources in the ASAL can be mobilised and utilised for food production, creation of employment and economic growth. Dryland farming refers to the adaptation of crop production or integrated crop and livestock production to conditions of low or uncertain rainfall with or without irrigation; but the main focus of this paper is irrigated agriculture.

The difficulty of developing sustainable dryland farming grows with increasing aridity, the main reason being low response of inputs, such as fertiliser and labour. The high variation of yields due to variable rainfall makes investment in dryland farming costly and risky. It is also difficult to accumulate soil organic matter due to low biomass production and high decomposition rate. Soil erosion and run-off will generally be high under arid or semi-arid conditions because of poor soil cover. Apart from ecological reasons, the socio-economic limitations, such as poor infrastructure, undeveloped markets, high transport costs (due to poor infrastructure and long distances from big towns/market centres), cause low profitability of investments in dryland farming.

Majority of the people in the ASAL are pastoralists, although semi-pastoral and farming communities have increased due to settlement, especially in irrigation schemes. Resources in NK are scarce and the potential of land for rain-fed farming is low under the present technology and limited water availability. Most of the farmers growing crops are not traditionally arable farmers. To increase yields in these areas, an effective means of delivering water to crops is mainly through irrigation. Irrigation is any method or practice apart from natural precipitation that reliably supplies a sufficient quantity of water for plant growth (Carter, 1989; Nelson; 2002; Stern, 1979; Welsh et al., 1996).

Many introduced irrigation schemes in sub-Saharan Africa have failed because of, among others, mismanagement, uneconomic returns, and environmental impacts. This has driven development agencies towards introducing smaller, less expensive, community based irrigation schemes (Cater, 1989). These schemes are of necessity taken to arid and semi-arid areas where precipitation limits crop production. In most cases, these areas are traditionally used for livestock production under extensive systems – pastoralism. However, the sustainability of these schemes, and their effects on the pastoral environment, economy and existing livelihoods have not been adequately analysed. This paper describes the development of irrigation schemes in NK and evaluates the socio-economic and ecological effects of these schemes on the affected pastoralists, taking Garissa District as a case.

STUDY AREA

This study concerns households within the Central Division of Garissa District, Kenya. The district covers about 43,364km². It has an estimated population of less than half a million, giving an average density of about 10 persons a km². The climate is characterised by a low annual average rainfall of 350mm and high temperatures and evapo-transpiration. The predominant ethnic group is Somali, who, due to prevailing conditions, are nomadic pastoralists. Tana River on the western fringes of the district, however, brings with it potential for agricultural production. The landform consists of a flat featureless basement complex with less than

350m variation in altitude. The valley sides are characterised by stretches of late-tertiary sediment outcrops that are strongly saline and alkaline and therefore liable to gully erosion. In most of the district, however, are found sediments smoothly capped by pleistocene sediments of different ages and composition. Tana River basin consists mainly of deep silty clay to heavy clay soils (Sombroek et al., 1992).

Garissa irrigation schemes are situated in Garissa Central Division along Tana River. Because of the severe drought of 1970 and 1971, many pastoralists in Garissa District and the rest of NK became dispossessed as they had lost most of their herds, or had been left with less than the minimum herd size required to meet basic subsistence needs. Most of the dispossessed pastoralists moved to settlement centres to seek survival opportunities. Others ventured into irrigation farming along the eastern side of Tana River within 30km of Garissa Township. As a result, several farms came into existence in the early 1970s. Interventions have been instituted in an attempt to improve the livelihoods and food security of the pastoralists. Irrigation development has been one such strategy. The main thrust of this study was to determine whether irrigation agriculture could be a more permanent adjunct to pastoral activities in Garissa District.

METHODOLOGY

Data Collection

Information on the development of irrigation schemes in Garissa was gathered from existing literature at the Garissa District Information and Documentation Centre as well as through interviews of key informants, which included local leaders and elderly persons involved in irrigation schemes. Socio-economic data related to the consequences of irrigation schemes on the pastoralists was collected from both farming and non-farming pastoral households. The variables of interest were household size, literacy level, household incomes, labour use, movement patterns and investments.

The choice of the households to be interviewed was based on stratified systematic sampling procedure (Prewitt, 1975). In total, 60 households were interviewed. The households

were stratified into two sub-units: “Sedentary” and “Nomadic.” Sedentary households were those owning plots and engaged in farming during the short rains of 1994 (December–January) and the long rains (March–May 1995). Nomadic households, on the other hand, were the pastoral nomads not engaged in any form of crop farming.

The households in each of the sub-units were listed and then systematic selection of the households was carried out. In all, 35 pastoral households engaged in irrigation and 25 purely in pastoralism were interviewed. A random start was used in choosing the first household to be interviewed. Five households were then skipped to get the next household, and so on. In addition, informal discussions were held with persons with considerable knowledge on irrigation schemes.

Data Analysis

Descriptive statistics were used to analyse some of the survey data. Regression models were constructed for binary dependent variables. Binary choice regression models were used to analyse qualitative responses.

Model Specification: Binary choice regression has become the standard method of analysing discrete binary data, in which the dependent variable evokes a yes or no, or present or absent response. The approaches used to estimate models involving dichotomous response variables are the logit, probit and linear probability model (LPM) regressions. Ordinary least squares regression is not appropriate since the residuals do not satisfy the condition $E(m_i)=0$, that is required to derive unbiased estimates (Maddala, 1988). The logit and probit models guarantee that the estimated probabilities lie in the 0–1 range and that they are non-linearly related to the explanatory variables. Of these two, the logit is slightly less involved because by taking the logarithm of the odds ratio what appears to be a highly non-linear model becomes linear (in parameters) and this can now be estimated within the standard ordinary least squares methodology. This means that in the logit model, the dependent variable is the logarithm of the odds that a particular choice will be made. The logit model was chosen primarily because the properties of estimation procedures are more desirable than those associated with the choice of a uniform

distribution, leading to the specification of a LPM, or normal probability distribution, resulting in a probit model (Pindyck and Rubinfeld, 1991). Parameters are obtained through maximum likelihood estimation (MLE).

The form of the regression equation is

$$Y_i = a_i + bX_i + m_i \quad i = 1, 2, \dots, N$$

where Y_i is the dichotomous dependent variable for household i , X_i is the i th observable explanatory variable, a_i captures the household specific unobservable explanatory variables, b is the parameter and m_i is the error term, $m_i \sim (0, d^2)$, of unknown effects on the dependent variable. The logit model to be estimated can then be written as

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = Y_i \\ = \alpha_i + \beta X_i + \mu_i$$

where L_i , the log of the odds ratio, is the logit; P_i is the probability of an event occurring; $1 - P_i$ is the probability of an event not occurring.

Diversification of Pastoral Economy: One of the estimated models is that related to diversification. The variables assumed to influence the diversification of the pastoral economy were sedentarisation, household size, availability of child herding labour, and wealth. The likelihood of diversification of the pastoral economy was defined as the households being involved in one other economic activity besides pastoralism. Sedentarisation was in two categories: 1 for sedentarisation on irrigation scheme and 0 for non-sedentarisation. Household size reflected resident household members; the larger the household the greater the chances of diversifying the economy. The availability of child herding labour was assumed to influence diversification since households with a larger family labour would be more willing to devote labour to another income generating activity in addition to pastoralism. Livestock ownership was used as a proxy for wealth; the more livestock owned by a household the lesser the likelihood of choosing to diversify the economy.

Availability of Child Labour for Herding: Child herding is critical to the pastoral economy since children provide the bulk of the labour force needed for tending the herds. The availability of child herding labour is crucial, therefore, to the

subsistence of pastoral households. Sedentarisation is thought to reduce labour availability for herding. Sedentarisation takes away labour for herding through children going to school and doing farm work, which would not be pronounced in the case of schooling and would not exist at all in the case of farm work without the schemes. The availability of child labour for herding is likely to be related to household size, herd size, school attendance and children doing farm work.

Reduction in Nomadic Pastoralism: Pastoralists have adopted a mobile livestock-based system of land use as the most sustainable way of maximising the human carrying capacity, whilst coping with the spatial and temporal variability of rainfall in the drylands. Sedentarisation may curtail pastoral nomadism by undermining mobility, which is the principal adaptive strategy of pastoralists. The possibility of reduced nomadism is postulated to be related to the duration of settlement in irrigation schemes, wealth, household size, and availability of child herding labour.

Nomadism is represented by the distance moved; the longer the distance the higher the nomadism. The duration of settlement in irrigation scheme is given by the observation that the longer the period of settlement in an irrigation scheme, the shorter the herding distance, a proxy for sedentarisation. The level of wealth (livestock owned) is assumed to influence nomadism in such away that the more the livestock owned the longer the distance. As for household size, the bigger households have more labour for herding and hence longer distances must be covered in order to exploit the patchy forage and water resources. Finally, the availability of child herding labour is expected to influence nomadic pastoralism such that the more labour available for herding the longer the distance moved in search of pastures and water.

RESULTS AND DISCUSSIONS

The Development and Sustainability of Irrigation Schemes

Results show that irrigation schemes evolved due to the dispossession of pastoralists; so that they could access alternative sources of livelihood. Pastoralists in Garissa, as in the entire

NK, were pauperised during the “shifta” war of 1963–1969, which led to their concentration in fixed camps. Literature reveals that drought and movement restrictions, of people and livestock, contributed to pastoral destitution, thereby increasing their dependence on famine relief supplies. The settlement of pastoralists on the outskirts of Garissa Town, precipitated by their displacement from the pastoral economy, brought them into contact with the Pokomo and Malakote riverine Bantu communities who traditionally practise flood-retreat cultivation along the lower parts of the river banks.

The interviewed households reported that they learnt of the existence of irrigation schemes from varying sources. A majority learnt from informal sources. This indicates that the pastoral destitute joined irrigation schemes voluntarily as an alternative source of livelihood. The growing dependence on non-pastoral economic activities suggests a major shift in the Somali pastoral culture from the days of near total economic and nutritional self-sufficiency from pastoralism.

Key informants asserted that irrigation farming started along Tana River in the hope that this would provide an opportunity for them to lead a stable and prosperous life. Records also show that government planners and policy makers recognised sedentary agriculture under irrigation as a major option that would enable destitute pastoralists to uplift their standards of living. With the support of the Kenya Government, Freedom from Hunger Council and church organisations, several irrigation projects were initiated in Garissa District in the early 1970s. Irrigation development efforts were also supported with assistance from the Rural Development Fund (RDF) through North-Eastern Provincial Irrigation Unit. Assistance consisted mainly of bush clearing, canal raising, food for labour and the provision of diesel and pumps.

After the initial aid was withdrawn the schemes hardly survived. The poor performance of the schemes was attributed to lack of technical reliability, which tended to undermine the settlers’ confidence in agriculture, inadequate farmers’ training, and unreliable markets. The government was concerned about the dismal performance of the schemes, and instituted a study on the economic and social aspects of the minor irrigation projects. Cossins (1983), who

carried out the study, detailed the potential of the natural resources of the Tana basin for irrigation agriculture. The recommendations included several aspects attributed to the development of small-scale irrigation projects, which contributed to the success or failure of the schemes. The aspects included farmers' selection and participation, institutional support and project appraisals.

Through government and donor support the rehabilitation of selected small-scale irrigation schemes was given priority. This would be by way of providing adequate and balanced diets, including clean water by making the district self-reliant on basic food items; conserving and upgrading the natural resource status in the area, particularly water, soil and vegetation; providing higher and less risky sources of cash incomes from agriculture and related resources; increasing employment in the rural sector; and integrating the economies of the district more closely with mainstream national economic activities. There were mixed results in respect of performance. The achievements were in the development of organisational and managerial procedures in the schemes, establishment of a revolving fund, awareness creation and acceptance of responsibility for the schemes by their members. Whereas these factors were important for sustainable development, progress towards achieving the objective of increasing agricultural production was limited, and the cropping potential of the existing schemes was far from being fully realised.

According to most of the households interviewed, the following constraints have to be overcome if the schemes have to be sustainable:

- A decline in the rate of payments into the revolving fund established for each scheme.
- Poor transport to markets
- Lack of progress in giving women equal opportunities in schemes
- Conflicts of interest between irrigation agriculture and livestock herding
- Continued under-utilisation of plots
- Few attempts at water management
- Poor monitoring and evaluation procedures

The Impact of Irrigation Schemes on Pastoral Economy

Likelihood of Diversification of Pastoral

Economy: The logit estimates for the model on diversification are presented in Table 1. The influence of household size is positive and significant, implying that not all household members can be sustained by the pastoral economy. This suggests the possibility of surplus labour among nomadic pastoral households. This strongly supports the claim that nomadic pastoral households with excess family labour have a greater likelihood of diversifying their economy.

Table 1: Logit estimation: Factors influencing diversification of pastoral economy

<i>Variable</i>	<i>Coefficient</i>	<i>t-value</i>
Constant	-0.192	-0.443
Household size	0.276	7.516*
Child herding labour	0.174	0.851
Wealth (herd size)	-0.008	-0.949

*Significant at 95% level of confidence; $n = 35$

Wealth influences diversification negatively but insignificantly at 5% level. This may indicate that diversification, especially into irrigation agriculture, does not change the long-enduring lifestyle of pastoralists. Child herding labour shows a positive effect but is insignificant as well; an indication of the existence of labour specialisation in pastoral communities. This may also imply a risk averse measure. Pastoral "drop-outs" (i.e., those not contributing to the pastoral economy) may move to urban areas to seek non-pastoral economic opportunities. It further shows that pastoralists diversify into agriculture or non-land based income generating activities through surplus labour.

Likelihood of Availability of Child Labour for Herding: Table 2 shows the influence of various factors on the availability of boy and girl child labour for herding. Household size is positive but slightly significant (at 10%). While the positive effect is consistent, household size should be expected to be significant, as the larger the size the more likely that child labour would be available. This result implies that there is some degree of 'sharing' or hiring labour for herding among pastoral households to satisfy their basic subsistence needs.

The wealth factor is positive and significant, indicating the importance attached to livestock ownership by pastoral nomads. Pastoralists regard their livestock as banks to use when need arises. The result also implies that sedentary

Table 2: Logit estimation: Factors influencing availability of child labour for herding

Variable	Boys		Girls	
	Coefficient	t-value	Coefficient	t-value
Constant	-0.578	-1.254	-0.263	-0.733
Household size	0.151	1.618*	0.116	1.813*
Wealth (herd size)	0.019	2.647**	0.023	3.925**
Child labour for farm work	0.045	0.282	-0.291	-0.077
School attendance	-0.235	-1.662*	-0.012	-2.348**

**Significant at 95% level of confidence; *Significant at 90% level of confidence; $n = 35$

pastoral households with the ability to hire labour will do so since child labour may be divided between the various production activities such as farm work, schooling and urban employment. In a similar study in Sudan, Sorbo (1977) observed that reallocation of labour between several production activities by the Shukriya Arab settlers, in the Girba Irrigation Scheme on the Nile, undermined the economic viability of irrigated agriculture.

The variable for children doing farm work is insignificant for both boys and girls. This shows that it matters little whether boys or girls do farm work or not; labour for herding must be availed. This again indicates the significance pastoralists attach to their herds as a lifestyle and livelihood. The availability of boys' labour, however, responds negatively and slightly significantly (at 10%), while girls' labour responds negatively and significantly (at 5%) to school attendance. This suggests that boys in both nomadic and sedentary pastoral households have a bigger future role in the family economy and status. Their involvement in household subsistence production is critical. Wealth from the Islamic viewpoint is theirs, and boys therefore have to ensure continuity of the family's prestige. The significance of girl-labour implies that sedentary pastoralists have more girls enrolled in schools, or sedentary pastoral households with the ability to afford hired labour may find it prestigious for their girls not to work on the farm.

Likelihood of Reduction in Nomadic Pastoralism: The results on the likelihood of reduced nomadic pastoralism are shown in Table 3. Child herding labour is positive and significant. This supports the postulation that sedentary pastoral households have shorter herding distances which may be dictated by the number and type of animals owned, and security in terms of livestock management, i.e., fear of

Table 3: Logit estimation: Factors influencing nomadic pastoralism

Variables	Coefficient	t-value
Constant	1.987	3.132**
Wealth (herd size)	0.014	1.169
Duration of settlement in scheme	-0.088	-1.829*
Household size	-0.077	-1.540*
Availability of child herding labour	1.025	3.645**

**Significant at 95% level of confidence; *Significant at 90% level of confidence; $n = 35$

intrusion into other people's lands.

A slightly negative influence (at 10%) of the duration of settlement in irrigation schemes on nomadic pastoralism can be explained as an appreciation of the importance of livestock extension services, which are within reach of the sedentary pastoralists. However, the reduced distance of pastoral migration, resulting from the more settled lifestyle and economy, may initiate a process of structural change. The most serious repercussion is the increased pressure on natural resources. These reduced herding distances, coupled with the heavy concentrations of people and animals around the irrigation schemes may result in ecological damage.

The effect of household size is negative and significant only at 10%, implying that herding distance is more of a factor of pasture and water availability than the size of the available labour. On the other hand, the wealth factor does not seem to have any influence on nomadic pastoralism. This is not obviously explicable. Indeed, it runs counter to what is expected: that households with larger herds are faced with a greater need to move long distances in such of pasture and water. The result may be a reflection of the faith and attitude of pastoral nomads towards sedentarisation, a proxy for irrigation schemes; in turn suggesting that irrigation farming is not considered a full-time economic

pursuit. This may be the reason why some sedentary pastoral households invest part of their income in livestock. Whatever, there is no clear implication.

CONCLUSION

In a nutshell, the overall effects of irrigation schemes on the pastoral economy are that they have increased the probability of a diversified pastoral economy but have at the same time taken away child labour from pastoralism. There is also a great likelihood of reduction in herding distances. The curtailment of nomadism has serious implications on the ecology of the rangeland and on the economy of pastoral households.

A common feature among the irrigation scheme households is the purchase of livestock with the proceeds earned from the sale of crops. Hogg (1987) noted a similar trend among the irrigation scheme dwellers of the Ewaso Nyiro cluster irrigation schemes in Isiolo District, Kenya. The survey also revealed that a majority (62.9%) of the irrigation scheme households had settled to farming in the last five years. This means that most of the original members had opted out of farming.

Again, the question is whether dryland farming through irrigation in NK is sustainable. The poor performance of irrigation schemes due to lack of financial and technical support suggests either failure on the part of pastoralists to adopt managerial and technical skills necessary for sustainable irrigated agriculture in the area, or inadequacy of training provided by the donor agents. The high dropout rate of former pastoral households from irrigation schemes and failure to acquire agronomic skills may suggest low regard for cultivation by pastoralists. Their presence at irrigation schemes may be just a bridging attempt to return to pastoralism. The strategy of developing irrigation schemes as an alternative economy to pastoralism in NK does not appear sustainable, therefore. The irrigation schemes in Garissa District rapidly increased the processes of sedentarisation, which caused the restriction of herders and denied pastoralists access to riverine resources. Mitigation patterns among different rangelands are a major adaptive strategy that must be applied in order to utilise the patchy

vegetation and water. It must be understood that development conundrums like irrigation schemes have to be considered against the felt needs of the region and in relation to other types of land use.

The case from NK and experience from other parts of the country indicate that irrigated farming can be made viable through appropriate practices. Good practices must, however, be supported by improved education and environmental awareness at all levels, a stable micro- and macro-economic situation, and, above all, maintenance of the rule of law (or security).

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