THE PROSPECTS AND PROBLEMS OF SMALL-SCALE IRRIGATION SCHEMES IN ALLEVIATING POVERTY: THE EXPERIENCE FROM TIGRAY

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Abstract

The objective of this paper is to assess the performance of small-scale irrigation schemes in one of the semi-arid regions of Ethiopia. Have the potential benefits of irrigation started to be realised and hence contributing to alleviate poverty?

The study shows that despite the fact that the sector has been bisected by many problems that have left many irrigation schemes to operate significantly under capacity, some of the potential benefits of irrigated agriculture have started to be realised.

One can draw a number of policy implications from the present study. There is a need for giving priority to ensure efficient utilisation of already committed resources and, hence, work out to raise full capacity operation of the existing schemes instead of rushing to invest on new irrigation projects. To this effect, and for improved performance in the future, it is timely to develop an irrigation policy. Moreover, it is timely to consciously develop institutional capabilities in relevant areas, and ensure the full-fledged participation of stakeholders and especially the beneficiary farmers, at every phase of the process.

1. INTRODUCTION

1.1. Background

The Ethiopian government has accorded priority to the agricultural sector and particularly to the small farmer in its 'Agricultural Development Led Industrialisation Strategy' (ADLI). This includes the promotion of intensive farming through the provision of yield increasing inputs, and construction of small-scale irrigation schemes.

The success of the yield-increasing inputs presupposes the existence of adequate and reliable water supply to ensure sufficient moisture level for full growth of plants

and crops. Rainfall in the country in general, and in particular in semi-arid regions like Tigray, has been showing unpredictable features in volume and in its pattern of coming, stay and stoppage. So it appears that transformation of the agriculture sector with rain-fed agriculture is difficult.

Obviously, the development of small-scale irrigation schemes is expected to bring about a set of benefits to the beneficiary farmers and to the national economy in alleviating poverty and ensuring food security at both the household and country levels. The significance of such schemes in alleviating poverty and mitigating food insecurity is expected to be high in drought prone areas.

Despite the importance accorded to the promotion of small-scale irrigation schemes and the effort being exerted to construct such schemes, there has not been an impact assessment study made so far in the country. At least to the knowledge of this author, there is no systematic study about the performance of the already operational schemes. There are important questions that need to be addressed if, at all, one is to ensure effective and efficient utilisation of the scarce resources being committed to promote irrigation.

The principal objective of the present study is to assess the performance of small-scale irrigation schemes against the anticipated benefits from irrigated agriculture. In particular, the paper addresses the following questions:

1. What are the prospects of small-scale irrigation schemes in alleviating the problems of rain-fed agriculture, and hence poverty?
2. What are the major problems that hinder the promotion of small-scale irrigation schemes?
3. How are the already constructed irrigation schemes operating?
4. Have the anticipated benefits of irrigation started to be realised?
5. What are the bottlenecks that constrain the full realisation of the benefits from irrigated farming?
6. What policy implications can one draw from the experience of a semi-arid region?

The study is primarily based on secondary data collected from the implementing organisations, mainly the commission established to construct irrigation schemes in the study region and the bureau of agriculture. Moreover, the study has also depended on data collected and observations made during 1998/1999 for MSc thesis of the author. These data sources were complemented by ideas and suggestions shared from observations by professionals in the implementing organisations. Considering the nature of the accessible data, the paper is essentially narrative and descriptive.

The present study deals with the assessment of the performance of the strategy to promote small-scale irrigation schemes taking the experience of one of the severely drought-prone areas in the country (the regional State of Tigray). Following the

literature survey, which is treated in the next section, the irrigation experience of the Regional State of Tigray is treated in section 3. The final section presents conclusion and policy implications.

2. A REVIEW OF IRRIGATION TECHNOLOGY

Irrigation can be defined as a technology to ensure a controlled supply of water for crop production. Irrigation technology, as the process of controlled supply of water, has two dimensions. These are the irrigation engineering and the irrigated agriculture and its management aspects. A concise review of irrigation technology will create a context for subsequent discussions.

2.1. Irrigated Agriculture

Irrigation is the controlled supply of water to agricultural crops by artificial means. It is a process of introducing adequate water into the part of the soil profile that serves as the root zone, for the subsequent use of the crop. A well-managed irrigation system is one that optimises the spatial and temporal distribution of water in order to promote crop production (Daniel 1987).

For successful growth every type of plant should attain an economy of water whereby the demand made upon it by the climate is balanced with available supply to it. In a time of water shortage, the crop must rely on whatever level of moisture is temporarily available in the soil. Even short-term deprivation may adequately impair normal physiological functions and reduce output (Daniel 1987).

The water-crop relation is not linear. The crop field constitutes a dynamic interaction of a multitude of factors: soil, plant, water and climate. In principle, the water intake of a crop depends upon (1) the ability of the roots of that crop to absorb water, and (2) the ability of the soil to retain, supply and transmit water towards the roots which is adequate for transpiration and growth requirements. (Daniel 1987).

Thus, irrigation takes into consideration these interacting variables so as to attain optimal growth of crops. The word 'control' implies the supply of just adequate water - no more, no less. Small supply does not bring about the desired outcome of increased yield. Excessive application, on the other hand, entails oversaturation of soil, impeding aeration, leaches, nutrients, increases salinity in the soil surface, thereby decreasing yield and even degrading the land to the extent of becoming barren.

An irrigation strategy and policy should not solely aim at obtaining highest yields per unit area of land or even per unit volume of water in the short-run. There should exist long-run perspective of sustainable use of water and land resources. Specifically, the issue of salinity needs to get due attention from the very outset. Salinity problem is caused by water logging and over-utilisation of water on farmlands.

The supply of, and the demand for irrigation water are complex processes with different characteristics. The success of irrigation projects is dependent upon a host of factors that have a bearing on the supply of, and demand for irrigation water (Spulber and Sabbaghi 1994; Young and Haveman 1985). Basically, crop production is a biological process carried out in uncontrolled and highly variable environments. Yield response to irrigation water application is sensitive to the rate at which water is combined with other inputs. Dissolved salts (salinity) in the irrigation water may inhibit crop response. The productivity of irrigation water varies widely over the year, depending particularly upon soil moisture level and upon stage of growth of the plant. The supply of irrigation water is a location-specific input. It cannot be made available every where, or at least it could be uneconomical to do so. In addition, all types of water are not fit for irrigation.

The process of controlled supply of water and the multitude of factors that need to be taken into account in the decision to supply water to crops indicate the importance of capability building both at the level of the implementing organisations and at the grass root level. The adoption of irrigation technology and ensuring the optimal usage of the technology calls for a continuous and persistent effort at human resource development with special focus to the beneficiary farmers and acquiring institutional capabilities.

2.2. Potential Benefits of Irrigated Agriculture

Irrigation helps to overcome water supply shortages in arid and semi-arid areas. Such areas face inadequate water for farming, hence irrigation has the advantage of increasing cultivable land. In addition to its spatial dimension, irrigation has temporal dimension as well. It extends the periods of cultivation. Availability of irrigation water ensures longer cropping season and enables two or even more cultivation cycles in a given year. Thus, irrigation is a means of introducing intensive agriculture.

Moreover, irrigation reduces the risk of farming by ensuring relatively stable supply of water. Rainfall exhibits high variation in magnitude and irregularities in the coming and stopping periods during the rainy season. In arid and semi-arid areas, early/late coming, interruption, early/late stoppage are all the frequent phenomena that increase risk of farming.

Irrigation solves the shortcomings arising from rain-fed agriculture and enhances the potential growth of crops, which increases land productivity. In addition, an efficient utilisation of irrigation water could enhance the efficient utilisation of the other productive inputs (like fertilisers, improved seeds, etc.) used in farming. Consequently, this could result in an overall increase in agricultural production that is larger than the sum of contributions of individual inputs used. In other words, it creates synergetic increase in agricultural production.

Yet there are other direct and indirect benefits that are generated from backward and

forward linkages of irrigation with other sectors of the economy. Irrigation works require inputs from the construction industry, irrigation engineering, and supply of different manufactured equipment and machinery. Moreover, it creates larger market for non-agricultural products and services in the rural economy. It generates employment and hence reduces rural underemployment and unemployment. It further increases livestock productivity by supplying water for consumption and by increasing fodder production. Increased production of agricultural output ultimately enhances the introduction of processing agro-industries, possibly triggering the whole economy.

2.3. Other Countries' Experience in Irrigated Agriculture

Different studies across countries in the world in general, and in sub-Saharan Africa (SSA) in particular, are presented in this sub-section.

According to Chakravorty (1998), "in spite of the significant contribution of irrigation to agricultural production and food security, the current state of irrigation is not encouraging. Despite major investments in irrigation during the past four decades in the world, irrigation projects around the world are operating under capacity, bringing about less benefits than the potential. In general, ex post project benefits have often been far lower than projected ex ante returns. Hence, there is a need for a change in approach in the direction to a more comprehensive approach that integrates the different elements of irrigation policy which include the economic and environmental effects and the associated inter sectoral linkages".

For the reasons that explain such mal-performance, Chakravorty shares with Seckler (1990) Ostrom (1996), and Barghouti and Moigne (1990) who pay particular attention to post-project management problems. These include problems in the areas of farming and maintenance of structures, training of beneficiaries, extension services, shift in crop-mix, environmental considerations and others.

Similarly, the World Bank's Asia Technical Agriculture Division had a series of sessions to list all the problems experienced in irrigation schemes in the world. Accordingly, 129 problems sorted into 16 problem areas were identified. These problem areas include availability of basic data, problem of planning and initial study, design problem, lack of agricultural support mechanisms, problem in project implementation, problem in management of the irrigation infrastructure and irrigated farming, etc. (Bill and William 1994).

While studies by Frank (1992) and others focus on resource constraints like human, financial and the physical irrigation resources, a study by Barghouti and Moigne (1990) focuses on experiences in project studies and implementation.

On the other hand, Ostrom (1996) pays particular attention to the incentive systems of the different stakeholders. According to this author, we find the success stories not in the modernity of the irrigation structures but rather in the sense of belongingness of

the participating bodies, particularly the beneficiary farmers.

Thus, the different studies show the fact that there are many instances where the performance of irrigation schemes could be far behind from the expected levels. Yet none of the studies has indicated the inappropriateness of promoting irrigation schemes.

3. IRRIGATION EXPERIENCE IN TIGRAY

3.1. Introduction

The Tigray National Regional State is located 36^0 27'20' to $39^0$59'40' east latitudes and $12^0$15'30' to $14^0$51'10' north longitude. It covers 51,560 km^2 of land. The region can be characterised as low potential zone that has been facing persistent food deficit. The mean annual rainfall in the Southern, Eastern, and Central zones ranges from 525 mm to 850 mm whereas in the Western zone, it ranges from 540 to 1000 mm (REST 2000).

The potential land area that could be irrigated through small-scale irrigation schemes is reported to be 165,000 to 300,000 hectares of land. About 6,000 hectares is said to be currently under both traditional and modern irrigation. There are about 458 traditional irrigation schemes in the Regional State of Tigray. The first modern irrigation works were those undertaken by the Bureau of Natural Resource and Environment in the period between 1993 and 1996. These works were limited in number and had problems in project studies, design and construction (REST 2000).

In order to rectify the weaknesses experienced previously, the Commission for Sustainable Agriculture and Environment Rehabilitation for Tigray (SAERT) was established in 1996, with the objectives of alleviating food deficit, conserving natural resources and ensuring full-fledged participation of the beneficiaries. SAERT is currently the principal organisation for construction of irrigation works in the region. The Commission has consecutively pursued two strategies in its years of operation. In the beginning, SAERT had an ambitious plan of constructing about 500 micro-dams of size of 100 to 200 hectares, and cultivate about 50,000 hectares of land in ten years period of time.

In response to a failure to identify adequate number of potential sites of the prescribed size, the commission considered to construct even ponds, which, however, are not cost efficient, merely because of their smallness.

The major change in the strategy by the commission is the shift towards the promotion of an Area-based Development Strategy. This strategy provides for the development of all possible water harvesting methods to irrigate whatever available cultivable land. It is said that the present strategy has an inherent flexibility in using

different sources to develop an area (Co-SAERT 1998). Is this claimed flexibility, peculiar to this area-based strategy? The commission could have developed alternative sources of water – harvesting surface water or underground water. That was not a problem of strategy as such.

Whatever, it appears that the shift in strategy was not made on the basis of an in-depth, participatory and transparent evaluation of the previous performance of the commission. As a result, apart from broad directions, the commission could not come out with an explicit irrigation policy and strategy.

3.2. Magnitude of Work Accomplished

The commission for SAERT has constructed about 50 micro-dams and ponds since its establishment. In 1998, there were 54 completed irrigation schemes in the region, with a designed command area of 2937 hectares. This gives an average of 59 hectares per scheme for the 50 schemes for which there is complete information. There is significant variation in designed command area ranging between 9 hectares to 250 hectares (SAERT 1998).

The same source indicates that out of the 54 completed irrigation schemes, the average capacity utilisation was only 35%. Of the total designed command area of 2937 hectares, only 1037 hectares of land were actually irrigated. Out of 48 schemes that have complete information, 10 schemes (i.e., 21% of them) had failed entirely at least till the reporting period. Moreover, out of the 48 schemes, only 18 of them (38%) had operated above 50% of their designed capacity and only 3 schemes had actually irrigated the whole designed command area.

There is no systematic and comprehensive study that attempts to identify the cause(s) for such divergence so far. Data from secondary sources and observations from experts in the area indicate that the reasons for such divergence in capacity operation boil down to design problems and quality and completeness of construction works.

The number of beneficiaries from 30 schemes constituted about 4,855 households, with an average of 162 peasant households per scheme. Here also the number has wider variation, ranging between 10 and 935.

The size of actually irrigated land per household is mostly in the range of 0.20 to 0.25 hectares. The smallness of the actually irrigated land implies the necessity for intensive cultivation of high value crops, not cultivation of traditional crops. (SAERT 1998).

3.3. Experience in Project Implementation

The experience in project implementation can be captured from two considerations: the completeness and quality of the physical works and the cost aspects.

3.3.1. Completeness and Quality of Works

From the initial ambitious plan and the earlier practice of construction, it appears that there was haste towards constructing many projects instead of restraining oneself to the objectively existing institutional capabilities and the resource bases of the region.

The urge to construct more, the constraints in construction machinery and probably the ignorance to opinions of experts in the field has led to the extent of use manual compaction of dam-works at the expense of the quality of the construction works.

The less significance attached to quality of work was manifested also through the less emphasis given to essential project studies in different disciplines: geology, soil, hydrology, financial, economic as well as environmental analysis.

Design and construction problems experienced are reflected in terms of seepage problems, (e.g. Arato and Mai Serakit are only two) entire failure to store water, (e.g. Eira in Eastern zone) and early failure in the structures.

Incompleteness of works has been one of the problems observed in irrigation schemes. There have been delays in the construction of distribution network, after the completion of head works. Sedimentation protection works have been and still are undertaken through food-for-work programmes without proper design and supervision of the works by SAERT. Moreover, it is reported that there are specific omissions in the structures of a number of schemes. For instance, the author has witnessed in a scheme called Korir that the reservoir area was left with a very big mole of earth, damped during the construction period occupying significant area of the reservoir.

3.3.2. Cost of Construction

Unpublished data source of Co-SAERT indicates that the total cost of 20 projects is about Birr 33 million, with an average project cost of Birr 1.6 million. The designed command area corresponding to these 20 projects is 1,184 hectares or an average of 59.2 hectares per project. This implies that the cost per hectare for these 20 schemes is Birr 27,764. If we take the information on 17 projects for which we have data for both actually irrigated area and the costs of construction, the cost per hectare for actually cultivated area becomes Birr 62,704.5, or US$7,554.76 (at 1US$/Birr 8.3). Similarly, a datum for 6 projects indicates that the cost per hectare is 52,109 Birr, which is US$ 6278.2/ha.

In fact, these cost data are understated, since these costs do not include the costs of catchment treatment areas to protect sedimentation, the free labour offered by community members in the localities of the schemes, and costs of related activities.

How would this compare with the experience in other countries? FAO (1987) indicates that the cost per hectare ranges between US$ 650 in Mali to a highest of

US$15,030/ha in Madagascar. The average in Tigray is lying on the high side compared with a regional average for Africa which is US$6,000/ha. Moreover, this cost is significantly higher than the average range given in the FAO study for Ethiopia, which is in the range of US$1500 to US$ 2500. Weighted average of irrigation cost per hectare in Botswana, Kenya, Zambia and Zimbabwe are 5,900, 5,600, 2000 and 9500 all in US dollars, respectively. On average, these figures give about 8,000 per hectare.

3.4. Management of Operational Irrigation Schemes

3.4.1. Clarity of Responsibility and Accountability

Who is responsible for the follow up of the management and operation of the irrigation schemes? Is there a clear-cut assignment of responsibility and accountability for the smooth operation of the already established irrigation schemes?

There are at least three stakeholders in the region: the Co-SAERT, the Bureau of Agriculture and the beneficiaries. Off hand, the Co-SAERT constructs and then submits to the beneficiary peasants through the media of the Bureau of Agriculture, which, in turn, has to supervise the management of the schemes and provide extension service.

For one thing, there is no inherent mechanism for ensuring accountability within SAERT, despite the observed incompleteness and quality problems of works in many projects. Moreover, there has not been technical audit and formal system of handover of completed works between SAERT and the beneficiary farmers until 2000.

There is one person in formal irrigation unit in the structure of the bureau of agriculture. The current procedure is that the bureau just provides the conventional extension service to the beneficiary peasants through the already existing structure of the bureau. There is no dedicated extension service to irrigation. Yet, the existing extension workers do not have specific training on irrigated farming. Moreover, there is shortage in the number of extension workers. They deal with many things instead of specialisation and focus. They lack the required equipment and facilities to provide technical assistance to the beneficiaries.

3.4.2. Integrated Supply of Inputs and the Change in Crop-Mix

Basically, this is essentially the extension package. Much remains to establish a dedicated irrigation system for irrigated agriculture. There are limited efforts in the supply of chemical fertilisers, credit facility, and the supply of vegetable seeds. But there are both supply and demand constraints in the provision of these packages. The existing market in nearby towns is limited, and there is no institutional measure to promote the demand for vegetables, and hence create the market conditions for the change in crop mix.

3.4.3. Participation of Beneficiary Peasants and Cost Recovery Measures

Full-fledged participation of the beneficiaries is not realised in the region. There is no participation of the beneficiaries from the outset, i.e., the conceptualisation of the project idea. There are no established water users' associations. The basis for the introduction of cost-recovery is not yet laid down.

3.4.4. Maintenance and Repairs Work of Already Operational Schemes

The Bureau of agriculture is not manned to handle maintenance and repair work. The beneficiaries are not organised and trained to at least partially handle these problems. There is neither formal unit nor established mechanism for handling this problem in SAERT. Yet, the problem has already started to manifest itself. For instance, a small diversion work called Genefel, located near Wikro town in the Eastern Zone, has serious leakage problem in the primary distribution lines.

3.4.5. Environmental Damages: Salinity of Soil and Health Hazards

So far there is no explicit recognition of the need to protect salinity in advance from the outset. Malaria and Schistosomiasis (Bilaharzia), the diseases that are expected to proliferate with irrigation are already endemic in Tigray. In fact, in order to assess the impact of these micro dams on the incidence of malaria, there was a recent study conducted on 7000 children under 10 years old in eight risk communities. The result of the study indicates that the incidence of malaria for the villages close to dams was 14.0 episodes/1000 child months while it was 1.9 in control villages, which is a seven fold increase in the ratio (Tedros et al., 1999).

With these shortcomings, have the potential benefits of irrigation began realisation?

3.5. Have Potential Benefits Started to be Realised?

Different potential areas of benefits are considered despite limitation in quantified data.

3.5.1. Extension and/or Smoothing of Cropping Season

Even with limited capacity utilisation of the existing schemes, the highest benefit realised so far has been the extension of the cropping season into the dry season and the supplementary irrigation during the wet season. Whatever the type of crop, be it maize or tomato, there is additional opportunity for cultivation irrespective of land productivity. The benefit obtained from the main irrigation has been significant for schemes located near big towns such as Mekelle, Wikro, Adigrat, and Axum. The benefit from the supplementary irrigation is conditional on the state of rainfall. But when there is shortage or fluctuation in annual precipitation, supplementary irrigation becomes critically important. For instance, in a scheme called Genfel, in the Eastern

Zone, during the 1989/1990's (E.C.) crop season, there was a long interruption in rainfall at mid of the cropping season in the area. While the beneficiaries of the scheme managed to survive this interruption, the non-beneficiaries were victimised by it.

3.5.2. Agro-Forestry and Fodder Production

The extension of the cultivable season has increased the supply of fodder from both the crop residue and by growing fodder crops. The supply of fodder from residues is the most acknowledged benefit by beneficiary peasants. In fact, some argue that they prefer to cultivate the traditional crops, mainly for the residue supply for their livestock. The increase in feed is expected to increase livestock yield. This highlights the benefits of stall-feeding compared to free grazing which will in effect solve the bottleneck of natural resources conservation.

With respect to the cultivation of new fodder crops, perennial crops and other agro-forestry plants, the achievement so far has been quite limited. For example, in Genfel diversion scheme, there are limited trials to cultivate new variety of fodder and perennial crops on idle lands and the border lines in the irrigable field. This shows that the extension works in this area have not been active.

3.5.3. Water Supply for Drinking

In some areas, which are relatively arid and where herding is important, the surrounding peasants value the irrigation schemes as the source of drinking water for their livestock.

3.5.4. Land Productivity

One major area of irrigation benefit that needs to be realised is the potential to raise land productivity. There has not been systematic study in this area. Though there are claims that there is an increase in land productivity, the general understanding is that there is not much change in production in the irrigated farms. Water supply alone could not bring about substantial increment of land productivity. It needs to be complemented with the supply of other inputs and the required level of extension service.

3.5.5. Employment Creation and/or Reduction of Under-Employment

The increase in demand for wage employment could not extend beyond the family supply of labour due to the fact that the households landholding of irrigable land is small. Moreover, the fact that there is small shift in crop mix in favour of labour demanding high-value crops, does not impel households to employ wage employees. Thus, the real contribution is in the reduction of underemployment.

3.5.6. Ground Water Potential Recharge and Downstream Fill

Though there is no systematic study on the subject, practitioners in the area state that there are clear indications about the contribution of micro-dams to recharge underground water and down stream fill. In the case of river diversion schemes, it is known that the flow of the stream is affected by the diversion structure. On the other hand, the micro-dams contribute positively to down stream fill through seepage. Since most of the structures being constructed are micro-dams, this benefit could be taken as an important contribution of irrigation in the region.

4. CONCLUSION AND POLICY IMPLICATIONS

4.1. Conclusion

Though there is significant deviation from the initial plan, the achievements attained so far are commendable. There are a number of irrigation schemes constructed, and there are sufficient indications that the potential benefits of irrigation have started to be realised.

Full realisation of benefits especially of irrigation schemes requires a grace period for learning. Firstly, as an agricultural venture, it is more of a biological process exposed to the influence of many natural factors. Secondly, the whole work involves at least three distinct but inexperienced bodies (in fact the two implementing organisations were newly established), that operate under scarcity in material, financial, human and institutional resources.

Nevertheless, the number of unoperational projects has been significant up to the recent period of time. There has been significant under-capacity utilisation of the operational irrigation schemes. There are a number of problem areas starting from the planning and extending to organising, project studies, project implementation and management of operational schemes which measure the present state of performance.

Most of the problems are related to institutional capacity building, and others are related to the lack of accountability and hence irresponsiveness to rectify problems on time. In fact, most of the problems are the ones that served for the rationalisation for the establishment of the commission. Yet the time elapsed has not been short to establish institutional capabilities to achieve objectives. The scarce resources committed were large enough to get prior attention to establish and fine-tune systems that ensure accountability to one's performance.

The following policy implications can be inferred.

1. Give priority to efficiency of resource utilisation: this implies that priority should be

given to the full capacity operation and efficient utilisation of existing irrigation schemes instead of rushing to build new ones;
2. Timely irrigation policy which should be comprehensive enough to guide the activities of all the concerned parties and to address all relevant issues;
3. The implementing units should be in a position to attract and retain qualified personnel. Moreover, a system should be developed to ensure transparency and participation of professionals in the decision-making process at both the policy making and implementation levels;
4. Developing institutionalised accountability of the government institutions to their respective performance;
5. Institutional capacity building in different areas including project study and implementation and the operational management of the schemes;
6. The beneficiary farmers should be trained in order to ensure the efficient utilisation of the already committed resources. This involves real participation of the beneficiaries in all matters, provision of training and dedicated extension service, ensuring autonomous self management of beneficiaries and developing managerial capability of grass root organisations like water user's associations;
7. From the outset, there is a need for explicit policy considerations of environmental damages (specifically salinity) and health hazards (malaria and bilaharzia) that follow from the expansion of irrigation works;
8. Develop input and output markets, and develop research capability tailored to irrigated agriculture.

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