4. Research Priority of Irrigation Management in Nigeria.

PRACHANDA PRADHAN
Project Leader,
IIMI-Nigeria Programme
Kano

4.1 INTRODUCTION:

Irrigation is gradually taking an important place in the overall agricultural development of Nigeria. It is a strategically important sector of the economy because it does not only help to produce the food required for an increasing population but also helps to ensure food security, maintenance of law, order and peace in the country. It is, therefore, important to pay attention to the better management and improvement of the irrigation sector.

There are several agencies involved in the irrigation sector. These include the policy making agencies at the ministry level, the implementing agencies such as the River Basin Development Authorities (RBDAs) and the Agricultural Development Projects (ADPs), and research and training institutions such as the universities and training centres. These agencies have to sit together to identify the problems afflicting the irrigation sector. With mutual understanding and respect, they are also the group to solve the identified problems so that the irrigation system could perform better.

Since the available resources will not be adequate to solve all the problems at the same time, it is necessary to set priorities on the basis of the order of importance of the problems to irrigation management.

This paper aims at presenting:

a) features of the irrigation sector in Nigeria,

b) problems and issues identified in the sector, and

c) criteria for setting research priority for improving the irrigation management in Nigeria.

4.2 FEATURES OF THE NIGERIAN IRRIGATION SCENE:

Nigeria is a densely populated country in West Africa, with a population of 89 million according to the official census although many people estimate it to be much more. It is also one of the largest countries in West Africa and dominates the region in irrigated agriculture.

About 90 percent of the area under irrigation in Nigeria has traditional irrigation systems while only 10 percent has modern irrigation systems defined as those with large dams or diversion weirs and headworks with water control structures. They have an elaborate network of infrastructure to deliver water and are managed independently by the irrigation agency or jointly by the irrigation agency and beneficiary farmers. Some of the features of irrigated agriculture in Nigeria are given in Table 4.1.

Table 4.1: Features of irrigated agriculture in Nigeria.

1	2	3
i)Total land area	98.3 million ha.	-
ii)Cultivable area	73 million ha.	74% of 1 (i)
iii)Crop coverage	25 million ha.	34% of 1 (ii)
iv)Cereal crop coverage	13 million ha.	52% of 1 (iii)
v)Rice coverage	01 million ha.	08% of 1 (iv)
vi)Irrigated area	01 million ha	08% of 1 (v)
vii)Area under traditional irrigation	900,000 ha.	90% of 1 (vi)
viii)Area under modern irrigation	100,000 ha.	10% of 1 (vi)

Source: IIMI Nigeria. 1992b.

The World bank has projected that rain-fed agriculture will not be adequate to feed the people of Nigeria after the year 2000. According to FAO estimates, even after an imposition of a ban on food imports, Nigeria imported 800,000 MT in 1989. Imports have declined to 540,000MT in 1991 according to the same source. There is, however, a need for irrigation sub sector development in Nigeria to meet short-term and long term food requirements of the country.

4.3 LARGE- AND SMALL-SCALE IRRIGATION SYSTEMS

Nigeria has both small-scale traditional irrigation systems as well as large-scale public sector irrigation systems. The history of the traditional irrigation system dates back to the 9th century although public sector irrigation development commenced

only about two decades ago. The economic implications of the nation's dependence on food imports led to the adoption of new policies by the Government of Nigeria, aimed at attaining self-sufficiency in food. Consequently, substantial investment in irrigation infrastructure development was made by the government during the years 1970-1980. The Government of Nigeria invested about US$ 3 billion in irrigation development over a period of two decades, through River Basin Development Authorities (RBDAs) which are parastatal agencies of the Federal Ministry of Agriculture, Water Resources and Rural Development (this amount does not include the money expended on irrigation development through Agricultural Development projects). Under this programme, dams and major structures of many systems have been constructed although the irrigation distribution network remains to be completed. As of 1991, the total irrigated area under large-scale irrigation was only 70,000 ha. There are public sector irrigation developments by the State Ministry of Agriculture as well. However, the area under public sector irrigation is expected to increase considerably by the end of 1992. The low performance of the large-scale irrigation systems is reflected in the shortfall between the achievement and the target set out in the national Development Plan of Nigeria (Adams, 1991).

4.4 TECHNOLOGIES ADOPTED FOR SMALL-SCALE IRRIGATION DEVELOPMENT

In the later 1980s, a new programme designed to develop small-scale, farmer-based, privatized irrigation systems in fadama lands for wheat and vegetable cultivation, especially during the dry season, was implemented by the government through the Agricultural Development Projects (ADPs). Fadama is low land flood plains or valley bottoms with a high water table. The technologies adopted for irrigation development in these lands included water lifting from streams or rivers with the help of small or large pumps depending on the size of the land to be irrigated. Construction of ponds and wells and small earth dams, and installation of washbores or shallow tubewells (STWs), were undertaken as part of the development programme. Most of these systems are managed by the beneficiary farmers themselves. The Nigeria Government's policy promoted small-scale irrigation for farming of winter crops such as wheat and vegetables, especially in the northern States of Sokoto, Kano, Katsina and Bauchi (Brown and Nooter, 1992.).

Valley bottom irrigation systems for rice cultivation are prevalent in the central zone of the country. These irrigation systems are constructed to divert water from the valley bottom streams to the rice fields. There are different techniques of irrigation used before and after the flood plain and such systems could be found around Bida in Niger State. Many of these systems are managed by the farmers themselves. However, the State Government has provided occasional assistance for improvement of these systems. It has been identified that vast potential exists for improving agricultural production in these areas through appropriate assistance programmes for better water management (Izac.et.al., 1991).

The potentiality of small-scale irrigation development in Nigeria is tremendous. Over one million ha of fadama land can be developed for irrigated agriculture. This needs to be considered from the point of view of appropriate technology, both efficient and economical, to the farmers and developing a suitable institutional base at the farmer level. The important issue to be taken into consideration in small-scale

irrigation is the process developed by the agencies to assist farmers develop their systems.

4.5 AGENCIES RESPONSIBLE FOR IRRIGATION DEVELOPMENT

There are three public sector agencies responsible for irrigation infrastructure development in Nigeria: the State Ministry of Agriculture and Natural Resources; Directorate of Foods, Roads and Rural Infrastructure (DFRRI); and River Basin Development Authorities (RBDAs). The State Ministry of Agriculture and Natural Resources implements irrigation infrastructure development programmes through the provision of credit to small scale-farmers for construction of boreholes, installation of STWs, and purchase of pumps and also through the construction of medium-scale irrigation systems. Small-scale (less than 50ha) and medium-scale (50-2000 ha) irrigation systems come under the jurisdiction of the State Ministry of Agriculture. Parastatal institutions such as the ADPs were established with a view to promoting agriculture and irrigation development in the States. Although DFRRI also has a mandate for small-scale village-based irrigation system development it plays a more active role in potable water schemes. RBDAs are responsible for the construction and management of the large-scale irrigation systems.

Water is a scarce resource in northern Nigeria. Therefore, it needs to be conserved and better utilized. Consequent to the severe drought that prevailed during the period 1972-1974, 11 River Basin Development Authorities were established with responsibilities for developing infrastructure for irrigation, increasing agricultural production and undertaking rural development activities in systems with a command area of above 2,000ha. However, the performance of these irrigation systems under the RBDAs, was marred due to shortfalls in achieving their area targets, operating only at 50 percent efficiency, wastage of water, lack of maintenance of the systems and shortage of spare parts for the maintenance of machinery. It is reported that the main reason for the poor overall performance of the systems is lack of funds. Although RBDAs were initially formed with multiple functions, at present, they are only responsible for water-related activities and are no longer involved in direct agricultural production.

4.6 NEW POLICY THRUST IN PUBLIC SECTOR IRRIGATION

The commercialization and privatization policy adopted by the government in 1987, as a package of the Structural Adjustment Programme (SAP), has made the River Basin Development Authorities (RBDAs) to be partially commercialized. With the implementation of this programme, the cost of services provided by the RBDAs is no longer subsidized but has to be borne by the beneficiaries themselves. Hence, the policy of commercialization and privatization has brought about institutional re-organization in the legal system of irrigation management, in the role of users' organizations, in water charge collection, and in sharing of responsibility jointly by the agency and the farmers for the operation and maintenance of the system. The government is to provide funds for the construction of the infrastructure while the

completed irrigation systems have to mobilize resources internally to meet the recurrent costs of operation and maintenance of the system.

4.7 GLOBAL TREND IN IRRIGATION SECTOR

Over the last thirty years, developing countries outside of Africa have met their food needs in large part by extending their cultivable irrigated areas, in combination with the provision of improved seeds and other inputs and with supportive policies and institutions. The success of those developing nations in increasing agricultural production has hinged mainly on the output from irrigated fields.

But the experience of these last three decades is unlikely to be repeated. Expansion of irrigated areas has already slowed down and will slow down further as the best sites are exploited and the cost of new projects in poorer sites rises disproportionately. In the seventies, the annual rate of expansion of irrigated areas in developing countries was 2.22 percent; in the eighties the figure was 1.19 percent (IIMI. 1992a).

On the other hand, food demand continues to grow rapidly, stimulated by demographic expansion, by urbanization, and in many countries, by rising standards of living. At the same time, in many of the same countries, large numbers of people are living in poverty, without employment and unable to afford the food they need. The problem of food supplies remains acute, but future expansion of irrigated areas will not contribute to a solution on the same scale as in the past. Since there have not been major breakthroughs to enable rain-fed agriculture to play a dynamic role in meeting production targets, where are developing countries to find an engine of growth?

The answer lies in more intensive use of existing irrigated areas, coupled with carefully planned horizontal expansion of irrigation. The productivity of irrigated agriculture will need to rise by as much as three percent per annum, and in some areas by even more, if the basic food needs of developing nations are to be met (IIMI, 1992a).

Much of this increase in productivity can be achieved by improved irrigation management. Perhaps there is no other sub-sector of world agriculture in which the pay off will be higher - although reaching that pay off will not be easy.

Only a few irrigation schemes in the developing world are operating at their full potential because:

a) Areas cultivated are much smaller than areas commanded.

b) Water deliveries rarely correspond in quantity and timing to the requirements of the crops.

c) There are sharp inequities between supplies to farmers in the head reaches of a system and those located downstream.

d) Maintenance is often poor, leading to the silting of distribution channels and the corrosion of machinery and equipment.

e) Flooding, lack of adequate drainage, poor operation and maintenance, and inefficient water application have contributed to the environmental degradation of irrigated lands through waterlogging and salinization.

Improvements in irrigation policies and management are preconditions for meeting future food requirements - although not, of course, sufficient by themselves; they must be accompanied by many forms of technological advance, including improved crop varieties.

4.8 CURRENT ISSUES IN NIGERIA'S IRRIGATION DEVELOPMENT[1]

Within the overall context of irrigation development and management, it has been identified a number of issues or problems affecting the development of Nigerian irrigation, which either have arisen already or seem likely to deserve attention in the near future by the policy makers and research institutions in order to make irrigation a viable and sustainable sector of the national economy. These are:

4.8.1. Issues Concerning the Performance of Irrigation Systems.

(a) *Monitoring of System Performance*

At present it seems that there are not enough data about the performance of the existing irrigation systems, to guide decision-making by managers. Monitoring and evaluation of such parameters as cropping intensity, crop output, water input and various others would probably improve the quality of management decisions and actions.

(b) *Under-Utilization of Irrigation Facilities*

In several cases, formal irrigation facilities which the government has created are not being used by farmers to their full potential capacity. The reasons for this seem to be complex. They include question of farmers' attitudes and motivation, as well as institutional and technical causes such as insufficient performance of maintenance. The reasons for under-utilization, and remedies for it, need to be understood urgently because of their impact on revenue collection by the RBDAs.

[1]This section is adopted from the IIMI - Nigeria Mission Report, 1992, prepared by Mr Charles Abernethy, Dr Derrick Thom and Dr. Prachanda Pradhan.

(c) *Development of usable indicators and methodology by the system managers*

The managers of irrigation system need to have usable indicators and methodology to access the performance of irrigation systems. Hence, it is important to develop feasible methodology and indicators that can be used by the managers.

(d) *Socio-Economic Impact*

It is necessary to understand the impact of irrigation on equity, profitability, poverty alleviation, property relationship on land and gender relations so that irrigation development does not create a big gap between rich and poor and inequitable resource distribution.

4.8.2. Issues Concerning Management of Water

(a) *Integrated Management of Water Resources*

It appears that in the northern states, and perhaps in states in the middle belt as well, the most rapid growth of irrigation is occurring through small-scale pump-based activities by individual farmers, abstracting water from streams or shallow aquifers. It is sometimes claimed that the areas served by these are increasing up to ten times as fast as formal irrigation. There are risks of water- table decline, environmental change, and deprivation of other water users, unless there are regulatory processes to govern use of the total water resources. This question is critically relevant in the three northern-most river basins.

(b) *Productivity of Water*

The three northern river basins (Sokoto-Rima, Hadejia-Jama'are, and Chad) are extremely deficient in surface water. These three basins contain about 35% of the area, and 27% of the people of Nigeria. The available surface water resources of $478m^3$ per person per year are, by international standards, very small (for comparison, Egypt has about twice as much), and the average annual rainfall received is now about 65% of which it was 30 years ago. In these circumstances, it is essential to ensure that policies are adopted which maximize the benefit obtained from each use of this very scarce resource.

(c) *Prevention of "Irrigation Water Loss"*

Irrigation water is a valuable commodity. Irrigation water is lost in several ways; through seepage and percolation from canal and fields, through the release of more than required water, poor maintenance causing wastage of irrigation, delivery of water at wrong time and through leaks and breaches in conveyance system. The issue of water loss is related to understanding the technical aspect of the field situation of water use and institutional arrangement for prevention of "water loss".

4.8.3 Issues concerning management of the irrigated agriculture sector

(a) *Economics of different scales of irrigation development*

Irrigation is being undertaken in various modes, ranging from individual activities based on shallow-well pumps up to formal systems backed by very large dams. To guide policy decisions about the thrust of future irrigation investments, there appears to be need for economic analysis of the cost-benefit performances of different types of irrigation. Such economic analysis would need to take account of the economic perspective of the individual farmer and of farmers' groups or users' associations, as well as that of the managing agency and the national economy,

(b) *Introduction of irrigation to new regions*

There are specific management problems associated with the introduction of formal irrigation systems in areas where irrigation has not previously been practiced much. The agency staff and the farming community may both need to develop new attitudes and skills. Training and information campaigns are needed, and better understanding of the constraints affecting both groups of people is also desirable. This issue is most likely to arise in states of the middle belt where rainfed production is a strong competitor for the available labour resources.

(c) *Farmers' participation in management processes*

Changing the relationship between the managing agencies and the farming community seems to be a necessary step in the solution of some of the other issues. Formation of water users' associations is one element of this, but there are numerous other matters that may need attention if participatory policy is to be put into operation. These include better definition of the legal framework, water rights and land rights; and adoption of planning processes so as to guarantee to farmers some formalized opportunities to understand and influence the evolution of projects that will affect them. The farmers participation is also important for the implementation of privatization and commercialization policy of the government.

4.8.4. Issues concerning the management of public irrigation organizations.

(a) *Cost recovery*

Current policy of the Federal Government requires that operational costs be borne by the users (of formal irrigation) rather than by the federal budget. The present level of cost recovery from users is however low. Means have therefore to be devised, which will enhance cost recovery, yet will not aggravate the other problems by, for example, reducing further the levels of system utilization.

Next >>

(b) *Improving the existing public irrigation organizations*

There is need of improvement of existing public irrigation organizations. These improvements take place by institutionalizing the management training programme and strategic planning exercise. It also can be done through internal structural change and adoption and introduction of new techniques in management. Hence, the improvement and reforms of existing organizations is to be considered from the standpoint of alternative strategies for effective improvement programme in order to achieve the efficiency and productivity of these organizations.

(c) *Management training*

There are already several universities, polytechnics and other types of institutes which provide training in irrigation technology as part of agricultural or civil engineering courses. There seems to be a need to supplement these kinds of technical training, by developing curricula in the organization and management of irrigation.

(d) *Management of maintenance*

Maintaining the irrigation facilities in good functioning condition is a normal duty of management. Its importance increases where the agency is endeavouring to induce farmers to pay fees at a level they are not accustomed to. The agencies are also trying to reduce their own costs, so there must be close attention to developing efficient and cost-effective management of maintenance. Farmers' associations may be persuaded to take on lower-level maintenance tasks. However, if they do so, they are likely to demand that the agencies improve their maintenance of the larger facilities.

(e) *Financial Autonomy*

The question of irrigation organization status is important. It is relevant to look into the effect of financial autonomy of irrigation systems on effectiveness, profitability and sustainability of the system.

4.8.5 Issues Concerning Community Irrigation Organizations

(a) *Formation of irrigators' Associations*

The formation of sustainable organizations of farmers, and the strengthening of these so that they can become valid partners of the government agencies, are generally perceived as desirable. Movement in this direction has however been slow, because there is a lack of replicable organizational models in the country as yet, and because a process for encouraging the creation of such organizations has yet to be developed. Among the issues here is the problem of identifying factors that will motivate the

farmers to want to support such organizations and will bind the organizations together.

(b) *Organizations for Small-Scale Irrigation Development*

Although small-scale irrigation has flourished in recent years, it has not yet been accompanied by much institutional development among the farmers. This seems to be needed if these systems are to remain sustainable in the longer term. Such organizations would not be the same as those in the medium or large formal systems, and should probably be designed on the basis of studies of traditional modes of cooperation in fadama agriculture. Apart from the institutional questions, the rapid spread of small-scale pump-based irrigation may present issues of zoning of development areas, and integration with other users of water and land.

(c) *Intervention Strategy in Fadama Development*

There is fast development of small scale, farmer based, privatized irrigation systems. There is need to understand alternative intervention strategies in order to provide assistance to these systems when they stand for assistance. The important issue to be taken into consideration in small scale irrigation is the process developed by the agencies like the ADPs and departments of irrigation of States to assist farmers develop their systems.

(d) *Strengthening the Local Organization for Irrigation Management*

There has not been deliberate effort to strengthen local organizations for irrigation organization. The government policies announced on different occasions indicate the participation of the farmers and their responsibility to share the cost of maintenance and management of the irrigation systems. Issues relating to strengthening local organizations for irrigation management is to be investigated.

(e) *Legal Basis of Self-Management and Farmer Participation*

Irrigation management is not only technical proposition, it consists of socio-institutional and technical aspects. There is need to investigate the legal framework required for self-management of irrigation systems by the farmers and farmers' participation through the water users association.

4.8.6. Other Issues

(a) *Public Health Impacts of Irrigation*

Schistosomiasis has a definite linkage to irrigation in several formal systems in Nigeria. The association of other diseases such as malaria, onchocerciasis, guinea worm and diarrhoeal diseases with irrigation is possible but less clear. It is not

known whether small-scale irrigation development has more or less impact on schistosomiasis, than formal irrigation has. Reduction of the impact of schistosomiasis requires attention to features of the design of new systems, and also of operation and maintenance of existing systems.

4.9 CRITERIA FOR SETTING RESEARCH PRIORITY IN IMPROVING THE IRRIGATION MANAGEMENT

There are always grumblings that we know the problems and we know the solutions as well. However, there has not been systematic way of resolving the problems. The list of issues as identified in earlier sections need proper attention to seek solution. Often times, one encounters the argument that these problems have come due to unavailability of financial resources. They say that if financial resources are available, such problems can be taken care of easily. The argument is only partly correct. We have to recognize other factors which contribute to improved management of irrigation systems.

A comparative study of rehabilitation and modernization of the irrigation systems in Sri Lanka shows that the benefit/cost ratio and internal rate of return are higher in those rehabilitation schemes where research component was included during the process of implementation of rehabilitation and modernization programme (Brewer. et al., 1992). In countries where there is strong tradition of interaction between research institutions and irrigation systems, performance of irrigation systems are comparatively better. Hence, research input in irrigation system management helps improve the performance of the system.

Morocco is a case in point. Examples from the United States of America and European countries definitely support this argument. Similar example can be found in Philippines, Taiwan, Malaysia, Thailand and Indonesia. Among the south Asian countries, Sri lanka has demonstrated the positive relationships between the research input and better performance of irrigation systems. Gal Oya Irrigation project is a typical example.

As indicated in the previous section, irrigation is strategically very important sector of the economy. It also helps to ensure food security which contributes to law and order and peace in a country. Hence, it is important to look into the question of performance in irrigation sector. All issues enumerated in the earlier section cannot be resolved immediately. some of the issues require long term preparatión and others can be resolved immediately. In doing so, we have to set priority. The priority for irrigation management research is to be reviewed on the following four important considerations;

(a) Overall national policy (agricultural policy)

(b) comparative advantage in undertaking research into a particular component

(c) specific objective to contribute to national policy

(d) expected high rate of return on investment.

The discussion forum of researchers, officials and irrigation managers at the field level would help prioritize the components of irrigation management research. Such forum will establish a communication link among the policy makers, planners, implementors and researchers. In the absence of open and frank interaction through discussion forum of different actors, each one may be suspicious of the other. The credibility of implementation of improvement programme by the managers may be questioned so also may the research results. Hence, efforts and resources may be wasted. Such situation is to be avoided. Priority on irrigation management improvement research is to be decided by the process of collective interaction of different actors involved in the irrigation sector.

One might ask the question: where is the list of research priorities in irrigation management in this paper?

However, the emphasis in this section is to highlight the elements that are to be taken into consideration in prioritizing the research for irrigation improvement. Along with the components to be taken into consideration, the process as to how the prioritization takes place is also equally important. The listing of topics as research priority areas without going through the process of interaction with different concerned actors may not be very useful . As far as the potential issues seeking answers are concerned, the list is prepared in section two of this paper. More issues can be added to the list.

4.10 IIMI - HJRBDA PRIORITIZATION PROCESS

The following section attempts to present the prioritization process adopted by IIMI in interacting with the HJRBDA to spell out the priority area of action research activity to promote joint - management in Kano River Irrigation System.

The Federal Ministry of Water Resources wanted IIMI to help in promoting participatory irrigation management in public sector irrigation systems in Nigeria. The Ministry mandated IIMI to work with HJRBDA.

The Hadejia Jama'are River Basin Development Authority (HJRBDA) is responsible for the construction and management of the Kano River Irrigation Project (KRIP) in Kano, northern Nigeria. The Project is being developed in two phases. Under Phase I, 22,000 ha. of irrigation system will be developed; of this 15,000 ha have already been fully developed. The second stage will concentrate on the development of another 40,000 ha.

Agricultural production and crop coverage in KRIP have increased over time as a result of farmers adopting irrigated agriculture as a viable alternative to rain-fed agriculture. The system has achieved about 120% cropping intensity. There is potentiality for increasing cropping intensity. During the wet season, 50 percent of the area is under rice. Farmers also plant non-rice crops such as sorghum, millet, maize, cowpea and vegetables during this period. KRIP has large areas under wheat during the dry season and a smaller area under maize and other crops.

The privatization and commercialization policy adopted by the Government of Nigeria in 1987 aims at handing over public sector enterprises to private-sector management. This have resulted in a change in the mode of management of irrigation systems from agency-management to joint-management. In the latter, both agency personnel and farmers become partners and share the responsibility of management and resource mobilization. The new policy also calls for the transfer of increased responsibilities for operation and maintenance of irrigation systems to the users.

HJRBDA, in collaboration with IIMI, has undertaken action research to support the turnover of management of irrigation systems to their users. The HJRBDA-IIMI Collaborative Action Research Program in KRIP focuses on four issues (Pradhan. 1992b).

1. **Institutional Aspects.** This action research component is directed at strengthening the institutional support for irrigation management. It addresses such issues as legal provision for the role of the farmers, legal basis for farmer organizations in relation to water management, and procedures to form water users' organizations.

2. **Changes in Mode of Management.** The transition from agency-management to joint-management requires a change in the existing power structure of the agency. In order to help make this transition, re-orientation programmes for the farmers and officials are being organized to discuss ways and means of implementing joint-management.

3. **Operation and Maintenance (O & M) Procedures.** This is an important area which needs an analysis of the work to be done and costs and responsibilities to be shared. The O&M procedure concerns farmer organizations as well as resource mobilization.

4. **Resource Mobilization.** Internal resource mobilization is a prerequisite for better operation and maintenance of irrigation systems. This research component includes an analysis of alternative sources of resources and development of a procedure for the collection of a higher percentage of water fees as these are the major sources of revenue for KRIP.

The expected outputs of the programme are a greater awareness among irrigation managers and users regarding the requirements for successful joint-management of irrigation systems, establishment of procedures for joint-management, recognition of users' organizations, and improvement in the operation and maintenance of the system. The lessons learned will be relevant for other systems in Nigeria.

4.11 REFERENCES

Adams, W. M. 1991. Large scale irrigation in Northern Nigeria: Performance and ideology. Trans. Inst. Br. Georgr. N. S.. 16: 287-300.

Brewer, J., D. R. Saktivadivel and C. M. Wijayaratna. 1992. Achieving cost effective rehabilitation and modernization of irrigation systems: Research results from Sri Lanka. Paper presented in IPR 1992. Colombo: IIMI.

Brown, E. P., and R. Nooter. 1992. Successful small scale irrigation in the Sahel. Washington D., C. World Bank Technical paper No. 171.

IIMI. 1992 a. Medium Term Plan, 1992-1998 (Draft), IIMI; Colombo.

IIMI. 1992b. Report of a mission to Nigeria to develop a medium term plan for collaboration between IIMI and Nigeria organizations. Colombo: IIMI

Izac, A. M. et al. 1991. Strategy for Inland Valley Agroecosystems Research in West and Central Africa, Ibadan: IITA.

Moris, J. and D. J. Thom. 1991. Irrigation Development in Africa: Lessons of Experience, Boulder: Westview Press.

P. Pradhan. 1992a. Irrigation Sector Reforms in Nigeria, IIMI Review. Vol.6. No. 1. Colombo: IIMI

_____. 1992b. IIMI Research program in Nigeria, Paper presented in Water Forum Seminar organized by National Water Resources Institute, Kaduna, May 26-28, 1992.