Private –public Partnership and Technological Imperatives for Irrigation Development

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Abstract

In irrigated agriculture, water taken up by crops is partly or totally provided through human intervention. Irrigation water is withdrawn from a water source (river, lake or aquifer) and led to the field through an appropriate conveyance infrastructure.

There is a marked difference in yield response and water requirements between irrigated and non-irrigated agriculture. Irrigated crops produce better yield than rain fed crops because of their higher water consumption even if those rain fed crops get optimal inputs.

Experience shows that rain fed agriculture have been unable to meet the food requirement of the Ethiopian population. The present annual per capita consumption of cereals and pulses in the country is 163kg compared to UNICEF standard of 240kg and that of the average for developing countries of 230kg (2100 Calories). Even though considerable increase in production can be attained through intensification of the rain fed agriculture, it is bound to fall short of the ever increasing population.

The terms "drip", "trickle" and "sprinkler" irrigation, common in many parts of the world in the last 15 years have been emphasized by the term "micro irrigation", "low volume irrigation". Micro irrigation includes all methods of frequent water application, in small flow rates, on or below the soil surface.

This is probably the promising technology choice in terms of water management, fertilizer application, crop protection & increased yield. Considering the need to cop up with growing demands, the choice of appropriate technology is eminent. The technology choice is mainly dictated by the cropping pattern, the level of sophistication & the operational capacity of end users, the optimum combination of efficiency in water use and cost effective operation and maintenance.

The terms "drip", "trickle" and "sprinkler" irrigation, common in many quarters in the last 15 years have been supplanted by the term "micro irrigation", recently adopted by the American Society of Agricultural Engineers. Micro irrigation includes all methods of frequent water application, in small flow rates, on or below the soil surfaces.

Regarding irrigation development areas of cooperation between the private and public sector could be mainly in a)technology choice and adaptation b)financing and resource mobilization c)rural entrepreneurship and private sector development.

Micro irrigation systems have many potential advantages when compared with other irrigation methods. These are mainly: use of smaller flow rate, controlled application of chemicals, use of saline water, improved quality of crop, adaptation to any topography.

1. Irrigation and Current Crop Production System of Ethiopia

1.1. General

In irrigated agriculture, water taken up by crops is partly or totally provided through human intervention. Irrigation water is withdrawn from a water source (river, lake or aquifer) and led to the field through an appropriate conveyance infrastructure. To satisfy their water requirements, irrigated crops benefit both from more or less unreliable natural rainfall and from irrigation water. Irrigation provides a powerful management tool against the vagaries of rainfall, and makes it economically attractive to grow high-yielding seed varieties and to apply adequate plant nutrition as well as pest

control and other inputs, thus giving room for a boost in yields (FAO, 1996). Irrigation is crucial to the country's food supplies.

1.2. Yield Response

There is a marked difference in yield response and water requirements between irrigated and non-irrigated agriculture. Irrigated crops produce better yield than rain fed crops because of their higher water consumption even if those rain fed crops get optimal inputs. The water consumption for rain fed agriculture stops at 5,500 m^3/ha as it is impossible for 'typical' rain fed crops to consume more water. The corresponding yield is estimated to be 5000kg/ha. Whereas the irrigation crops water consumption could go up to 6500m^3 /ha with a corresponding yield of over 7500kg/ha.

1.3. Food Balance

Experience shows that rain fed agriculture have been unable to meet the food requirement of the Ethiopian population (See table 1). The present annual per capita consumption of cereals and pulses in the country is 163kg compared to UNICEF standard of 240kg and that of the average for developing countries of 230kg (2100 Calories). Even though considerable increase in production can be attained through intensification of the rain fed agriculture, it is bound to fall short of the ever increasing population. Table 1 with a five years interval shows the required growth of irrigated agriculture in Ethiopia. It can be seen from the table that although the production from rain fed agriculture is expected to grow still additional production is required to meet the demands, which has to come from the irrigation sub-sector. In order to achieve this nearly 1.5 million hectares and nearly all of the 3.5 million hectares must be developed by 2020 and 2040 respectively.

2. Private-Public Partnership for Irrigation Development

2.1. General

In present day agricultural production system, irrigation is effectively used to compensate for permanent water deficit & to smoothen climate variations mainly caused

Table 1. Required food crop production & irrigation land

Year	1995	2000	2005	2010	2015	2020
Population ('000)	53,277	60,965	70,297	82,689	96,806	113,234
Annual Per Capita Food Consumption(KG)	150	160	170	180	190	200
Total Requirement of Cereals (MT)	7.99	9.7544	11.95	14.88	18.39	22.64
Production from rain fed Cultivation(MT)	7.491	7.99	8.49	8.99	9.99	10.99
Balance Production from irrig. Agriculture(MT)	0.50	1.7644	3.46	5.89	8.40	11.65
Production rate for irrig. Agriculture(t/Ha)	6.5	7	7.25	7.5	7.75	8
Required area under irrig Agriculture (Mha)	0.07	0.25	0.47	0.78	1.08	1.45

Source: - The 1984 population & Housing Census of Ethiopia; Analytical Report at National level, Addis Ababa, Dec.1991

due to precipitation. Irrigated agriculture in Ethiopia from the point of view of technology can be categorized into traditional, modern-community owned, modern- private, and modern-public. The traditional farms are mainly characterized by enormous water loss, uncontrolled water application, backward crop husbandry, etc. However, the modern ones are better in relative terms but still having less than 45 % irrigation efficiency, particularly those that are under surface irrigation. Today there are very few but not exceeding an aggregate of some 3000ha under low volume (drip & sprinkler) modern irrigation systems. This is probably the promising technology choice in terms of water management, fertilizer application, crop protection & increased yield. Considering the need to cop up with growing demands, the choice of appropriate technology is eminent. The technology choice is mainly dictated by the cropping pattern, the level of sophistication & the operational capacity of end users, the optimum combination of efficiency in water use and cost effective operation and maintenance.

2.2. Technological Choice and Research

Apart from the formal higher learning institutions of the country, to date there is no center for irrigation technology choice & adaptation. This has immensely contributed to the stagnation of the backward irrigation technology we are utilizing. Therefore the establishment of a center for technology choice & adaptation is fundamental to the growth of irrigation development in the county. Adaptation of best practices from elsewhere in the country or from abroad could not be conducted using original scientific research, which is time taking & expensive but by employing adoptive research.

The utilization of new technologies & farming practices of irrigation development would greatly benefit from adoptive research. It can also stimulate sustained growth & spread of & improved technologies. As water is becoming more critical for agricultural production, it has also more competing use & therefore efficiency of water use will be of prime concern as irrigation development widens.

2.3. Financing Irrigation Schemes and Resource Mobilization

The issue of financing is critical particularly when irrigation development is considered, since irrigation is finance intensive based on the technology chosen & the scale of intervention.
The shining success in terms of food self sufficiency of India & China, the two mostly populated nations of our world, stems mainly from their use of appropriate planning & implementation together with suitable technology of irrigation including massive mobilization of their people and indigenous resources (both finance & human resource).

2.4. Rural Entrepreneurship and Private Sector

The rural economy needs to be diversified from the mono tuned crop-livestock production system into other economic activities that are either agricultural based or in trade, service & rural industry. The introduction of irrigation yields the opportunity for diversified business activities. As income increases due to surplus production of irrigation, there will be increased demand for non - farm products & services. Hence, the private sector will be involved to handle these business activities. As these activities require financial & institutional support, the role of the government will be to enhance the rural business areas, facilitate or avail capital in a form of credit or incentive & guide in running the businesses and in general develop rural entrepreneurship & private sector participation.

3. Technological Imperatives for Irrigation Development

3.1. General

The terms “drip”, “trickle” and “sprinkler” irrigation, common in many quarters in the last 15 years have been supplanted by the term “low volume irrigation” or “micro irrigation” as recently adopted by the American Society of Agricultural Engineers. Low volume irrigation includes all methods of frequent water application, in small flow rates, on or below the soil surface. Ideally, the volume of water is

applied directly to the root zone in quantities that approach the consumptive use of the plants.

3.2. Components of a micro Irrigation System

In micro or low volume irrigation systems, water is distributed using an extensive hydraulic pipe network that conveys water from its source to the plant. Outflow from the irrigation system occurs through emitters placed along the water delivery (lateral) pipes in the form of droplets, tiny streams or miniature sprays. The emitters can be placed either on or below the soil surface.

Emitters can vary from sophisticated, constant-flow-rate at variable pressure types of devices (pressure compensating emitters) to very small, simple orifices. A large number of different types of emitters have been developed in attempts to find a perfect one. The main objective is to assure uniformity of water distribution. It is essential that the discharge from the emitter be uniform and that it not change significantly with small pressure variations in the system. At the same time the emitter should be constructed in such a way that it does not clog very easily (figure 1).

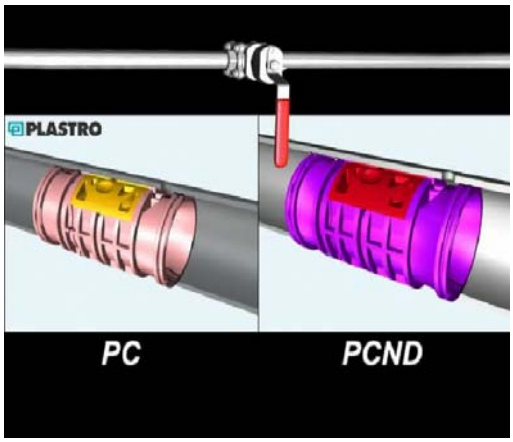

Figure 1. Plastro emitters (PC and PCND types)

3.3. Wetting Patterns under Micro Irrigation

Due to the manner in which water is applied in a micro irrigation system, only a portion of the soil surface and root zone of the total field is wetted. Water flowing from the emitter is distributed in the soil by gravity and capillary forces creating the contour lines. The exact shape of the wetted volume and moisture distribution will depend on the soil texture, initial soil moisture, and to some degree, on the rate of water application (figure 2)

Figure 2. Typical wetting pattern of drip irrigation system

4. Consideration for Selecting the Most Appropriate Irrigation Application

4.1. General

Micro irrigation systems have many potential advantages when compared with other irrigation methods. Most of them are related to the low rates of water application.

Irrigation water requirements can be smaller with micro irrigation when compared with other irrigation methods. This is due to irrigation of a smaller portion of the soil volume, decreased evaporation from the soil surface, and the reduction or elimination of the runoff.

4.2. Smaller Flow Rates

Since the rate of water application in micro irrigation systems is significantly lower than in other systems, smaller sources of water can be used for irrigation of the same acreage. The

delivery pipes, the pump, and other components of the system can be smaller and therefore more economical.

4.3. Application of Chemicals

Micro irrigation system allow for a high level of control of chemical applications. The plants can be supplied with the exact amount of fertilizer required at a given time. Since they are applied directly to the root zone a reduction in the total amount of fertilizer used is possible.

Other chemicals, such as herbicides, insecticides, fungicides, nematicides, growth regulators and carbon dioxide can be efficiently applied through micro irrigation systems to improve crop production.

4.4. Water Sources with High Salt Content

A significant advantage of micro irrigation is that water with relatively high salt content can be used by the system. For optimum plant growth a certain range of total water potential in the root zone must be maintained. The potential defines how difficult it is for a plant to extract water from the soil. Large negative numbers are characteristic of very dry soils with low total water potentials while potentials near zero reflect soils near saturation.

4.5. Improved Quality of the Crop

Micro irrigated plants are supplied very frequently with small amounts of water and the stress due to the moisture fluctuation in the root zone is reduced to the minimum, often resulting in larger and better quality yield. In arid climates, or during dry seasons, the harvest ting can be controlled by proper water management.

4.6. Adaptation to Any Topography

Micro irrigation systems can operate efficiently on hilly terrain if appropriately designed and managed. Well managed micro irrigation system will not create runoff even on hilly terrain.

4.7. Additional Advantages of Micro – Irrigation Systems

During dry seasons or in arid climates disease and insect damage can be reduced in micro irrigation system since the foliage of the plant is not wetted. With a small portion of soil surface being watered, field operations can be continued during irrigation. The water distribution is not affected by the wind for drip irrigation. However, wind can have some effect on jet spray patterns.

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