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Modern Trends in Agriculture: Water use and Irrigation Problems

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Water and nutrients are more often the limiting factors in maintaining or improving crop production. The capacity of soil to hold water, the movement and subsequent release of this water by the soil and its ultimate use by the plant have all been subjects of intensive study by agricultural scientists and irrigation engineers for a long time. Naturally a peep into some of the problems in this soil plant-water relationships will be most proper in a sequence of discussions on Modern Trends in Agriculture.

Irrigation history: The artificial application of water to soils to supplement natural rainfall for crop production is an old art, as old as civilisation itself and has been practised by man from time immemorial in some of the older countries. An examination of the irrigated regions of the world shows that India, Pakistan and China are the oldest countries where irrigation has been extensively pracised from very ancient times and indeed today, these countries have between them, more than half the irrigated areas of the world. Out of over 200 million acres about 110 million acres are situated in these three countries. Every available source of water, both surface and underground, is tapped for use in crop production.

In our own country, we have nearly 30 per cent of the world's irrigated acreage. Our ancient rulers evinced keen interest in irrigation development as witneesed in the great projects like the Cauvery and the innumerable tanks for storing water for crop production.

While this is so, it is surprising that sufficient attention has not been paid all these years to the several problems of irrigation economy, as for instance, the studies on water use of crops, irrigation efficiency and the agronomy of irrigated soils. This last aspect is an important one, as soil crop relationships in an irrigated system is basically different from that of any other. It is well known that the productivity, the nutrient removal, biological activity, the concentration of nutrients, the accumulation of harmful and other salts and the oxidation-reduction phenomena in an irrigated soil system are characteristic of themselves, and therefore a special approach is needed in their study. The reasons for such apathy if any, was possibly because, till recently, irrigation project development and utilisation of water were synonymous with paddy cultivation in a situation of assured and abundant water supply and that these aspects were not considered sufficiently important in that set up.

But this situation has now changed. The expansion of irrigation and the utilisation of water resources of the country to the maximum extent possible is one of the accepted objectives of the plan periods. Such expansion of irrigation facilities are only possible at higher costs as all the cheaper sources have been exploited to the full already. For instance, the relative capital outlay per irrigated acre for the Krishna and Godavery systems constructed during the last century happened to be around Rs. 23 while the Mettur Irrigation System constructed during the recent thirties cost around Rs. 195/- per acre. The capital cost per acre under the recently constructed Lower Bhavani Project was Rs. 458/-, more than double the cost of Mettur.

The New Irrigation Policy: The construction of irrigation projects at such high capital cost is possible because, the national government after independence departed from the old criterion of productivity in the selection and execution of irrigation projects. As a result of the old policy, all the remunerative projects had been executed and they provided a reasonable return on capital, but the more difficult and unremunerative schemes were left out. Adherance to the narrow principle of direct and remunerative return was found to militate against the general economic benefit of the people and national well being. In the newer irrigation policy enunciated by government, the old productivity test of an expected return greater than the rate on the capital borrowed is no longer the overwhelming criterion in sanctioning an irrigation scheme, but only one of the criteria. Projects are now examined primarily to ensure that there is water enough in a normal year to irrigate the area envisaged, that the soil is amenable to irrigated cultivation and the crop production reasonably commensurate with the outlay on the scheme. Naturally this raises important issues like betterment levies and the reassessment of irrigation rates which are beyond the scope of this paper.

Effective and economic utilisation of water: Apart from the high capital cost of the irrigation systems, sources of water supply are also getting short. Even if every possible source of irrigation water were to be developed and strict economy imposed in the use of this water, still the water so exploited may not be able to meet the water requirements of all the cultivated acreage of this State. In Madras, the irrigated area is around six million acres out of a total cultivated area or our 15 million adres. Greater enthusiasm in recent times in irrigation farming coupled with the above fact of shortage of water resources, make effective and economic utilisation of the existing water sources imperative. This involves considerations of the water requirements of crops, the consumptive use of water and irrigation efficiency.

The ultimate objective in water use is the production of maximum yield with minimum amounts of water diverted from storage reservoirs. Irrigation efficiency can be represented as the ratio of the consumptive use of water for a crop to the total water supplied for that crop from an irrigation source. Relatively little in the way of data of application efficiencies are available. In our State, the efficiency of irrigation is low where the source of water supply is a river irrigation system or tank, whereas there is high efficiency when the water is lifted by the farmer for field irrigation. As early as 1928, the Royal Commission on Agriculture stated as follows:

"Judged however by modern scientific standards there is generally a great loss of water due to wasteful and unscientific application and there is room for improvement in the matter of getting the most out of the available supply without deterioration of the fertility of the soil".

The low efficiency is largely due to engineering difficulties in the method of distribution and the system of paying for irrigation water from a river or tank irrigation system based on the acre per season. Naturally therefore, there is no incentive on the part of the consumer to economise in the use the water. This straight per acre rate tends to stimulate use of more water than is needed. In some countries and also under tube well irrigation in North India, there is a system in vogue to charge for the water on the basis of quantity used. Such measured distribution is impractical in the irrigation projects of our State and so there is an urgent need to educate the farmers on economic water use. Yet another reason contributing to inefficiency in water use is the ryot's fear that at some time during the crop period, water supply may be cut off or reduced due to unforeseen seasonal conditions. Naturally therefore, he keeps his fields well supplied with water at all times to meet any situation tha may or may not arise at a future date. There is however, a higl rate of efficiency in water use under well irrigation, because the cos of lifting water is high and also involves considerable effort. Further the conveyance and delivery losses are generally reduced to th minimum in a farm.

Time of Irrigation and Frequency: The general purposes of irrigation is to supplement rainfall by supplying water just when the crop needs the same in the right amount and in the right place, where the roots can absorb the water. This would involve a knowledge of soil moisture conditions, the water holding capacity of the soil and the needs of the crop and eventually balancing this requirement with requisite supply.

In Madras, paddy is the major crop under irrigation from the various irrigation projects and the comsumptive use of water is difficult to assess as the water use is more related to the available supply rather than the actual needs of the crop. There is more or less, a stationary ayacut fixed by past experience and the whole ayacut is cropped and the available water is distributed through the cropped area. In favourable years, more water is consumed and in years when the season is unfavourable, the water supply is shared among the ayacutdars. The utimate crop production is influenced by a plethora or shortage of water supply. A number of irrigation experiments have been carried out in the past to study the consumptive use of water by the paddy crop and the data indicated that the water consumption varies from 80 to 100 acre inches for a medium duration crop under certain standard conditions. Unfortunately our data is incomplete and it has not been possible to predict the influence of varied supplies, because of the difficulties involved in such a study by large scale field experiments. Further, the data obtained in one place is not useful for general application as a number of local factors decide the consumptive use. Even so, a study of the consumptive use of water is necessary as we have yet no answers to many irrigation questions connected with paddy cultivation. Does the paddy crop need to be flooded as is being done now in many places? If so, what is the depth at which water should be maintained in the field, 1 inch, 2 inches or 3 inches or even 6 inches as is being done in many places now? What is the effect of reducing the suppy to field capacity or super field capacity as is being done when paddy is cultivated under gardenland conditions? Should water flow be encouraged all the time? It is possible that the belief in wild flooding is rooted on the theory that waters in irrigation systems carry plenty of silt and other dissolved nutrients which help in increasing yields. There is no chance of this happening now in the reservoir projects where any slit that may be carried is deposited in the reservoir itself and not carried to the cutivator's fields. The study of water-use by the paddy crop is thus a complex problem and has to be tackled in a special manner by co-ordinated large scale experiments in a number of places.

Consumptive use of Water for other Crops: The study of the consumptive use of water by other crops is also equally important as the growing of crops other than paddy under irrigated conditions is extensively practiced in the State. Further, the newer irrigation projects like the Lower Bhavani and some others are planned for crops other than paddy. Studies on the consumptive use of water of sugarcane, cotton, millets etc. have been made. For sugarcane it is found that 70 to 80 acre inches is a satisfactory amount including rainfall; for cotton it is around 30 acre inches including rainfall. For millets like sorghum and ragi, the water requirement has been estimated at 25 acre inches including the rainfall received during the crop period. Though some experiments have been conducted to decide the frequency of the irrigations, it has not been possible to draw positive conclusions though some arbitrary recommendations have been made based on indications from these experiments.

The data from various irrigation experiments show that the consumptive use of water to produce one pound of produce is as follows:

Ragi	—	193	gallons
Cotton kapas	—	653	,,
Cholam grain	—	237	,,
Paddy	—	605	,,
Sugar	—	170	,,

It must at once be said that considerable variations can occur in these figures due to variations in the fertility status of the soil.

Concepts on soil moisture availability: The main problem in the application of water to crops is to decide the optimum level at which moisture has to be maintained in the soil to obtain maximum crop growth. This introduces the availability concept and this availability concept is related to the soil moisture tensions that are allowed to develop. In general it is presumed that all moisture above the wilting percentage in a soil is available for plant growth. There is some controversy among different workers as to whether all this moisture is equally and freely available and there is recent evidence to show that the availability is greater when the moisture is held at lower tensions. The importance of the soil moisture tension measurements to indicate availabilities of moisture for plant growth has now been accepted and this has resulted in the development of several types of equipment for measuring soil moisture tensions. The use of tensiometers and other moisture measuring meters are now in common use for deciding the time of irrigation. These equipment assist in the direct measuring of the moisture status and what the farmer has to do is only to read the meter to decide when he has to irrigate the crop. Such equipment costing under Rs. 300/- can give more or less a picture of moisture status even for a layman. Experiments have been planned on the use of similar equipment in irrigation practise here.

Weather data to predict irrigation need: A recent approach to decide when to irrigate is the use of weather data, particularly evaporation which is related to potential transpiration rate. This is possible because evaporation of water is controlled by the weather conditions. In the United Kingdom, Penman of Rothamstead and later Schofied have proposed the irrigation of grass from weather data and suggested that this procedure might apply to other crops as well. The Meteorological service there issues an estimate for maximum evaporation from crop land as a guide to irrigation based on Penman's method. In the United States, recent studies at the Washington Agricultural Experimental Station have shown that the quantity of water consumed by a crop in the field is directly related to the rate of evaporation from a free water surface. The indications are that it may be entirely feasible for a farmer to use an evaporation tank on his farm to tell when to irrigate using a K coefficient which may vary from crop to crop.

This formula, $U = KE$ was applied to the Ragi and Sorghum crops in the Central Farm raised in an irrigation experiment. The optimum consumptive use of water "U" was 25 acre inches for these two crops including rainfall and the evaporation "E" from an open pan evaporimeter in the Agricultural Observatory was 27·29 inches during the ragi crop period in the South West monsoon period and 33·09 inches during the Sorghum crop period in summer. The 'K' coefficient thus was 0·92 for Ragi and 0·76 for Sorghum respectively.

This is in consonance with the popular view that Sorghum requires less water for maturing than Ragi, which was not reflected in the consumptive use data as both crops required 25 acre inches.

Water scarcity and restriction of consumption: A matter of grave concern connected with irrigation is the frequent need to restrict water use in the irrigation systems as a result of monsoon failures. All the major river irrigation systems and tanks depend on the success of the South West and North East monsoons for their water supply. Indeed, in spite of the development of large irrigation projects, our agriculture still continues to be a gamble with the monsoons only with the risks considerably reduced. Two things emerge out of this situation affecting ultimate crop yields. Firstly, there is a delay in the letting in of water in the canals for agricultural purposes, resulting in delayed or late plantings with consequent fall in yields. Results spread over a number of years have indicated that a fall in yield of 10 to 12 per cent or more may result by late planting of paddy and as much as 30 per cent in the case of irrigated cotton. Secondly, in many small irrigation systems and ayacuts under tank irrigation, the uncertain supplies and increased ayacut areas have resulted in restricted water supplies leading to fall in crop yields. Irrigation authorities can certainly help by considering the agricultural aspects of crop production in supplying water. The possibility of altering the cropping pattern wherever feasible to suit the water supply is an idea worth pursuing in some of these irrigation systems.

The Receding Water Table: The demand for underground water is always heavy and is increasing. Heavy draft on available supplies have come as a result of mechanical pumping which has replaced human and animal lifts. Low rainfall as a result of monsoon failures also has contributed to this recession of deep underground water levels. From the experience of the College Farm wells, the recession in water level has been to the extent of 30 to 40 feet during the last 25 years, that is, over a foot per year. The demand for underground water supply is steadily increasing with electric power availability in rural areas. If the underground water supplies are thus depleted, restriction of crop areas under lift irrigation would result. Already large areas in the Coimbatore region which normally would have been put to irrigated crops are cropped dry. Where power pumping is not so such concentrated the position probably is not so bad.

The issue to ponder over is about the future of these areas. They would very soon become problem areas and so have to be tackled urgently. There are possibly two courses open; one is to adopt a system of water spreading as is adopted in some parts of the U. S. A, and the other is to plan irrigation systems to supplement water supplies from wells. Water spreading on agricultural lands with a view to recharge underground water reservoirs is adopted successfully in some parts of the U. S. A. But the main criterion for success is the easy permeability in these regions. It is well known that the permeability factor and the rate of infiltration are notoriously low in the black soils and the underlying parent material; so much so, one comes across empty wells adjacent to well filled tanks. Such spreading systems may however be feasible in red soil regions. Areas adapted to specially designed systems of water spreading are worth a survey.

Quality of irrigation water: The quality of the water used in irrigation has always been considered important. The approach to the problem of quality has so far been to ascertain the deleterious effects if any, in the use of a particular source of water to a particular type of soil. A new approach has been made to examine the waters for their pH. The opinion is widely held that slightly acid waters influence crop production in soils of high pH and improve their permeability and also productivity. There appears to be considerable reasoning in this theory as witnessed by the high productivity in the Tambraparani valley, where the waters of the Western Ghats having low pH soils are directly used for irrigating the heavy black soils of the Tinnevelly district with their pH ranging between 7·2 and 8·5. Investigation on these lines may probably lead to fruitful results.

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