Jour. Ind. Soc. Ag. Statistics
Vol. XLII, No. 1 (1990), pp. 19-30

PROBLEMS AND PROSPECTS OF IRRIGATED AGRICULTURE*

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The achievements in the agricultural sector of our economy during successive Plans have been impressive and have attracted appreciation both at the national and international levels. These can be attributed to the commitment of successive governments for improving the quality of rural life, science-based technology back-up provided by our national agricultural research system, committed administration which has ensured timely availability of production inputs and support services, and a dedicated peasantry responsive to modern agricultural technologies.

During the last 40 years, the human population increased from 360 to 820 millions. Foodgrain production also increased from 50.8 M tonnes during 1950-51 to 172.2 M tonnes in 1988-89. Not only has foodgrain production synchronised with the growth rate of population, there has also been an improvement in the net availability of foodgrains from 144 Kg in 1951 to about 175-180 Kg per caput per annum in the eighties. Not-withstanding peaks and troughs, however, with passage of time, these have gradually narrowed and exhibit a tendency towards stabilisation of foodgrain production, It is also recognised that expanding irrigation has played a major role in enhancement and stabilisation of foodgrain production.

Irrigation Development and Foodgrain Production

The Green Revolution, which triggered off with the availability of seeds of high yielding crop varieties in mid-sixties, was sustained with

*"Dr. Rajendra Prasad Memorial Lecture" delivered on 18th December, 1989, at HAU, Hisar, during the 43rd Annual Conference, ISAS.

expanding irrigation potential. Till 1951, when the First Plan was launched, India had an irrigation potential of 22.6 M ha. By the end of Seventh Plan, gross irrigation potential of 76.9 M ha is anticipated and the Eighth Plan target is creation of an additional 15 M ha irrigation potential. The irrigated area under foodgrains which averaged 23 M ha during the quinquennium 1961-65 increased to 26.7, 30.7, 35.6 and 38.7 M ha during the quinquenniums 1966-70, 1971-75, 1976-80 and 1981-85, respectively. Foodgrain production during these periods averaged 83, 87, 103, 120, and 138 M tonnes. A record production of 172.2 M tonnes was achieved in 1988-89.

The coverage of foodgrain area under irrigation averaged 18.8 per cent during 1951-65 which rose to 22.4, 25.0, 28.1 and 30.3 per cent during 1965-70, 1970-75, 1975-80 and 1980-85, respectively. During 1984-85, the coverage of foodgrain crop area under irrigation was 31.5 per cent which in the absolute term comes to 39.9 M ha against the gross irrigated area of 54 M ha (utilized irrigation potential) i.e. 74 per cent of the irrigation potential has been committed to foodgrain production. Amongst various foodgrain crops, the per cent coverage of wheat area under irrigation increased from 34 per cent in 1950-51 to 74 per cent in 1984-85 which is followed by rice (32 to 43%), while for coarse cereals and pulses, it has been static around 8-9 per cent over the years. In absolute terms, the irrigated areas come to 17.7 M ha under rice, 17.4 M ha under wheat, 3.1 M ha under coarse cereals and 1.7 M ha under pulses. By and large, the spurt in production has been related to assured irrigation which provides insulation against recurrent crop failures and generated confidence among farmers for gradual improvement in the level of adoption of improved crop production input packages. Wheat and rice, sharing about 88 per cent of irrigation water diverted to foodgrain crops, have registered the main spurt in production; while coarse cereals and pulses, sharing only 12 per cent of that water, have not shown any spectacular increases in production.

Past Progress and Anomalies in Agricultural Growth

It is indeed satisfying to note the growing resilience in the Indian agriculture. The foodgrain production of 138.4 M tonnes in the drought year of 1987-88 was well above the previous trough production of 109.7 M tonnes in 1979-80. Similarly the production of 172.2 M tonnes in 1988-89 is well above the previous peak production of 152.4 M tonnes in 1983-84. The performance trends showing enhancement and resilience in foodgrain production are attributable to expansion of irrigation. Parallelism in the compound growth rate of foodgrain production

(2.70 per cent during 1949-50 to 1986-87) and gross irrigated area (2.60 per cent) attests this contention.

The gains in production have, however, been confined to select crops and regions. Among foodgrain crops, the increase in production of wheat from about 15 M tonnes in 1965-70 to 47 M tonnes in 1985-89 with a peak of 54 M tonnes in 1988-89 and that of rice from 37 to 63 M tonnes during this period with a peak of 70 M tonnes in 1988-89 has been commendable. The production of coarse cereals increased from 25 M tonnes in 1965-70 to 30 M tonnes in 1980-85, declined thereafter but peaked upto about 33 M tonnes in 1988-89. Stagnation in pulses production around 11-12 M tonnes for the last 35 years has been a worrying feature, but an improvement has been discernible in recent years with production of about 13 and 15 M tonnes in 1987-88 and 1988-89, respectively. Among non-food crops, appreciable gains in production also have been obtained in castor, rapeseed-mustard, sugarcane, cotton and grapes. The production of oilseeds which has been stagnant around 11 M tonnes for the last several years has picked up in recent years and a production of around 18 M tonnes has been achieved in 1988-89 which is a significant achievement.

In an overall view, it would appear that the production trend in wheat and rice is satisfactory. These are the crops which received the greatest stimulus of varietal improvement, shared major proportion of irrigation and fertilizers, and benefitted most from governmental price support and procurement policies. In consequence, these crops registered a marked increase in area, production and productivity. Contrasted to them, pulse and oilseed crops remained rather deprived of these benefits, being relegated to marginal and unirrigated areas. Since early fifties, the area under pulses has been stagnant around 22-23 M ha, the coverage under irrigation around 8 to 10 per cent and production around 11-12 M tonnes. Per capita consumption of pulses has declined from 69 g/day in 1961 to 36.3 g/day in 1987 causing concern for nutritional security. The areas under oilseed crops increased gradually from an average of 12.1 M ha in fifties to 18.5 M ha in eighties and the coverage under irrigation increasing from 2 to 16 per cent but the yield increase from 485 to 637 Kg/ha during this period has not been substantial. The requirement of edible oils has been met by footing heavy import bill which crossed Rs. 1300 crores in 1982-83. While a buoyant trend in oilseed production has been perceptible in recent years ; yet, the production is short of national requirement which has to be pushed up. Fruits, vegetables, tuber crops, plantation crops and spices occupy about 15.0 M ha of the total cropped area. As these are important for human diet, their cultiva-

tion needs to be extended. Fodder crops have been given hardly any attention. Since animal husbandry has to be promoted for increasing milk production to improve nutritional level as also the farm income, fodder production in quantity and quality is essential. This can only be obtained by increasing area under fodder crops from 7.8 to 18.00 ha.

A discerning feature of the agricultural production scene has been the fact that despite physical visibility of food at the national level, its accessibility to a perceptible segment of our population in various regions has not been achieved due to very poor economic base of these communities.

The northern region of the country comprising of Punjab, Haryana and Western Uttar Pradesh is agriculturally advanced. Similar is the situation in coastal Andhra Pradesh and several districts of Tamil Nadu. The key factor contributing to the advancement of these areas is the extensive coverage of these regions under irrigation with dependable water supply through ground and surface water resources. Assured availability of water has caused concentration of other production inputs and adoption of high yield technology. Contrasted to it, the other regions are much behind. The eastern region comprising of eastern Uttar Pradesh, Bihar, West Bengal, Assam, Orissa and eastern Madhya Pradesh is the grey area in agricultural development notwithstanding the richness of the production resource base in terms of soil, water, climate and human population. The major constraint to agricultural development is the poor water resource development and management resulting in low coverage (about 30 per cent) of the cropped area under irrigation which has constrained the usage of other production inputs and adoption of high yield technology. Consumption of fertiliser nutrients per ha of gross cropped area in 1986-87 averaged 38.6 Kg for the entire eastern region and was as low as 4.6 Kg in Assam, 17.3 Kg in Orissa and 22.1 Kg in Madhya Pradesh. Prevalence of poor socio-economic conditions is a great handicap to the investiveness of the farmers towards development of private means of irrigation and adoption of modern agricultural practices. The resource-poor farmers of the eastern region have greatest need for external financial support but they are the people more often deprived of it.

The cooperative support to agriculture in terms of short term loans at All India level has more than doubled from 1526.32 crores in 1980-81 to 3288.69 crores in 1987-88. Yet, none of the states in the eastern region has come anywhere nearer to All India average of Rs. 181 per ha of gross cropped area as for the year 1985-86. It has ranged from Rs. 52 in Bihar to Rs. 57 in Orissa, Rs. 72 in West Bengal and Rs. 101 per ha of gross cropped area in Madhya Pradesh. Contrasted to it, Haryana and Punjab received Rs. 471 and 522 per ha, respectively. Also, crop produc-

tion technology appropriate to physical environment of the eastern region and relevant to marginal and small farming groups which constitute the majority in the region has not been developed largely because investment on agricultural research by the eastern States is very low. As of now, per ha investment on agricultural research in the eastern region comes to about Rs. 3 against Rs. 15 by Haryana and Punjab. In general, farmers face problems arising from inadequacies in the package of technology, services and public policies available to them. There is, however, a great scope for improving agricultural production in the eastern region if proper attention is directed to remedy the aforementioned maladies.

Emerging Problems of Irrigated Agriculture

Development of irrigation potential to the tune of 76.9 M ha has been a notable accomplishment. It has acted as a prime mover in the agricultural development process by way of increasing and stabilising crop production. However, there are a number of issues which are a cause of concern and these are:— the return from major and medium irrigation projects is not commensurate with the investment made on it; a wide gap exists between the created and the utilized irrigation potential; canal irrigation efficiency is very low and on an average less than 40 per cent; overall crop productivity in canal irrigated areas continues to be low, cropping intensity has not improved substantially and environmental concerns arising from creation of large reservoirs and associated problems of water logging and salinity in the irrigation command areas. Moreover, highly intensive agriculture involving largely cereal crops in areas of assured irrigation; the mining of soil nutrients is heavy resulting in multiple nutrient deficiencies and an overall decline in soil productivity with the result that the incremental cost on agricultural output is increasing.

As mentioned earlier, there is a wide spread degradation of basic soil resource in terms of water logging and soil salinization in canal commands. While no systematic efforts have been made to monitor regularly the spread of these problems, some qualitative estimates are available. About 7.31 per cent of the canal command area (CCA) in the Indira Gandhi Nahar Pariyojana has come in the grip of waterlogging and soil salinity and if the water table rise is not arrested, about 24 per cent of the CCA may be waterlogged and salinised. In Hirakud command area, about 14 per cent of the productive lands are severely waterlogged and need to be drained before making them fit for rice cultivation. In Mula and Jayakwadi irrigation command areas, the productivity in 16 per cent of the CCA has been reduced as a result of waterlogging and development of secondary salinity. In Sharda Sahayak Command Area, about

50,000 ha area is reported to be damaged by waterlogging and soil salinity. Likewise in Ramganga Command, out of 12 lakh ha of CCA, nearly 3.5 lakh ha are facing the problem of water logging and salinity. In Ukai Kakrapar irrigation project, about 1.2 lakh ha out of about 4 lakh ha CCA are damaged by waterlogging and secondary salinity. From the above data it is quite evident that the problem of secondary salinisation alongwith waterlogging have fast appeared in most of the irrigation projects located in arid and semi-arid regions of the country, the situation being grim in projects located in Vertisols of central and south India which have potentially saline soils. Secondary salinisation in canal irrigated areas is invaribly associated with water-table rise. The major contributing factor to rise in water table is seepage from canal system. According to the Second Irrigation Commission (1972), the losses in seepage, on an average, amount to 45 per cent of the irrigation water diverted from the source of which 25 per cent is lost from main canal and distributaries 20 per cent from field channels.

Even in absence of quantitative data from irrigation commands, the above mentioned maladies are perceptible enough to be reckoned with. Most of them are incidental to following reasons:

1. Lack of advance action in development of land in the command areas to receive irrigation water.
2. Lack of appropriate crop plans to match the availability of irrigation water. Even when crop plans are available, these are to be supported by ecologically sound and scientifically structured implementation plans. More often, a large proportion of water is diverted to high water demanding crops in the head reaches contrary to the concept of equity in water distribution or it is diverted to high-value cash crops contrary to the concept of food security.
3. The canal irrigation system, instead of being demand-driven, is usually supply-driven particularly in the initial stages of irrigation resource development which impels farmers to garner as much water as they can without any regard to crop water demand and soil health. In many commands, there is no practice of night irrigation with the result that the irrigation water in the channels flows uncontrolled causing wastage of water and problems of excess water. In some commands, *kharif* irrigation is a must, and there is no effort to match it with the rainfall events.
4. Surface, ground and rain water resources are not conjunctively utilized resulting in inefficient utilisation of component resources which lead to soil health hazards.

5. Drainage is usually not conceived or it is not planned concurrently with irrigation in the command areas. Only when the problem emerges, it becomes a subject of concern.
6. While shifting from rainfed to irrigation agriculture, farmers are not properly oriented towards it in terms of soil, crop, water and other inputs management.

Future Outlook

Since independence the country has justifiably made huge investment n development of irrigation potential. Beginning with the expenditure of Rs. 300 crores for major and medium irrigation projects and Rs. 66 crores for minor irrigation projects during First Plan, the outlay during Seventh Plan reached a staggering amount of Rs. 11,556 crores for major and medium projects and Rs. 6305 crores for minor irrigation projects. Cost per ha of irrigation potential under major- and medium projects was Rs. 38,000 during the Seventh Plan and may escalate to around Rs. 45,000 and even more during the Eighth Plan. Under minor irrigation projects also the cost has increased considerably, reaching Rs. 7,300 per ha of irrigation potential during Seventh Plan. Thus, irrigation development is a highly costly venture. Nevertheless the programme has to continue as it provides the major plank of agricultural development, arising from the potential of high responsiveness of irrigated areas to agricultural technology, inputs and services. However, while creation of irrigation potential is an important venture, efficient utilization of the created potential is a necessity in view of the expenditure incurred on it and also because of the detrimental consequences in terms of soil and environmental degradation following from inefficient irrigation. Therefore, the focus needs to be directed towards achieving balanced agricultural growth of different regions by way of water resource development and management, and practising irrigated agriculture such that enhancement in productivity and profitability per unit of area, water expense and cost of other production inputs with continuing sustainability of production base is ensured. The main elements of strategy may be the following :

1. *Creating Irrigation Potential in Lagging Areas*

The progress of irrigation development has been variable among States. Major proportion of surface and ground water resource remains to be developed in some of the eastern states. By the end of Seventh Plan, Bihar, Orissa and Madhya Pradesh have been able to develop only 33 to 43 per cent of its surface water resource through major and medium pro-

jects, and 13 to 43 per cent of its ground water resource. Maharashtra and Gujarat too have been lagging as more than 50 per cent of surface and ground water resources remain to be developed. The southern States have performed well in respect of surface water resource development which is as high as 90 per cent in Tamil Nadu and 62 to 64 per cent in Andhra Pradesh and Karnataka but these States too have more than 50 per cent of the ground water resource remaining to be developed.

The costs on bringing water to the farm gate through the irrigation projects have been increasing tremendously since the plan periods. Therefore, it is time that the Government takes some policy decisions regarding the irrigation projects in hand and priority should be on completion of these projects before any new projects are undertaken. The lagging areas must receive priority in allocation of funds for development of surface and ground water resources keeping in view cost effectiveness and environmental security.

The age-old tradition of tank irrigation which was practised throughout India but more markedly in the southern States has been relegated to the background under the tumult of canal and tube-well irrigation. Of the total net irrigated area, tank irrigation accounts for 6 per cent in the western states, 9 per cent in the eastern states and 3 per cent in the southern states. This important source of irrigation needs to be revitalised not from the point of reviving the tradition but from the point of management of excess runoff leading to flash floods, recycling of ponded water as life saving irrigation and its contribution to ground water recharge.

2. *Ensuring Efficient Utilisation of Irrigation Water*

Efficient utilization of irrigation potential is *sine que non* for agricultural intensifiscation and substainability. The requisites are following :

(i) The gap of about 8 M ha in utilization of the created irrigation potential is wide enough which must be reduced to a minimum.

(ii) Keeping in view the equity principle, allocation of water needs to be so regulated that cropping system all along the distribution line matches with water availability.

(iii) Pricing of canal water for irrigation is done on volumetric rather than area basis with provision for incentive in terms of lower price for low water demanding crops and penalty in terms of higher price for high water demanding crops.

(iv) Canal system is operated to supply water as per crop water demand to the extent permissible under the existing design frame.

(v) To optimally meet the irrigation requirement, ground water is utilized conjuctively with surface water by proper dovetailing of operation of canals with wells keeping in view the replenishability of ground water by recharge.

(vi) Appropriate irrigation schedules and methods are adopted to optimise water application and irrigation water use efficiency.

(vii) Irrigation water use is integrated with crop production packages viz., growing climatically efficient high yielding cultivars, timely delivery of inputs in quality and quantity such as seeds, fertilizers and pesticides, and adoption of scientific farming techniques.

The imperative for efficient management of irrigation water had first been recognised in 1973 when the Government decided to establish the Command Area Development (CAD) programme with the broad-based objective to increase agricultural production on a sustainable basis by reducing the gap in utilization of created irrigation potential, enhancing irrigation efficiency, ameliorating soil degradation, adopting scientific crop planning, and ensuring availability of technologies, inputs, credit and marketing facilities. While the CAD programme is a major institutional innovation, but being a post project programme, its success has been constrained by the fact that the farmers in the head reach being attuned to a particular pattern of cropping and water utilization are reluctant to a belated change which involves devolution of benefits even undeservedly accredited as they may be. To derive maximum benefits from irrigation projects, command area development programme should be undertaken concurrently with the inception of the project so that by the time the project becomes operative, the command area is well prepared to utilize water as planned.

Concluding Remarks

1. Development of data base in respect of ultimate irrigation potential and its spread in the country is currently extremely poor. This has to be done preferably for each of the 15 agro-ecological zones identified by the Planning Commission by a central agency, with a wide network to collect, compile and analyse data covering the whole spectrum of irrigated agriculture. This should be followed by identification of appropriate crops in terms of climatic efficiency, economic competitiveness and economy of water, before they are recommended for cultivation through appropriate policy incentives.

2. Irrigation has to play a crucial role as it is a central input for convergence of other inputs and services. Therefore, continuing expansion

of irrigation programme is essential for agricultural development. What is needed is that surface, ground and rain water resources must be viewed as components of a composite water resource entity on a watershed basis and need to be developed in an integrated manner considering cost-effective options, climatic situations, periodicity of water demands and agrarian structure.

3. At present there is no proper coordination among the major agencies concerned with water use, such as the Department of Water Resources, the Department of Agriculture, and the State Agricultural Universities. The water use efficiency at the field level would demand involvement of multi-disciplinary teams which are existing in SAUs and need to be fully exploited for achieving the desired results. Though the share of consumption of domestic and industrial use of water is less compared to the agricultural use at present, it is likely to increase considerably in the coming years. Therefore, in order to address such management problems in an effective manner it is desirable to create a '*National Mission for Irrigated Agriculture*' which can co-ordinate activities of various agencies connected with water use for a common cause.

4. The earlier policy decision to concentrate production inputs in the highly input responsive areas was a logical response to the grave food crisis that the country was confronted with. Indian agriculture now faces another challenge of accelerating development of lagging areas whose production potentiality has been marked by socio-economic handicaps. The eastern region presents a most glaring scene of backward agriculture on this account, despite being endowed with rich soil and water resource base. The major developmental strategy for this region requires sizeable allocation of funds for drainage, ground water resource development and for provision of rural electrification so as to utilize the created ground water potential coupled with development of infrastructure to ensure availability of inputs, services and technologies.

5. In the coming years maximum concentration should be on the exploitation of untapped ground water potential in the lagging regions along with matching energy to lift this water. Priority investments in these regions, can go a long way in winning the confidence of these disadvantaged populations who are reluctant to accept new technologies.

6. Share of water allocation to lagging crops such as pulses, oilseeds, fruits and vegetables, and fodders needs to be enhanced. A policy prescription must be framed to priortise and subsidise water supply to food crops and low water demanding crops in preference to cash crops and high water demanding crops.

7. Small and marginal farmers need special attention as they have remained deprived of the benefits of modern agricultural technology and

services such as supply of water, energy, seeds, fertilizers etc., because of size limitations of farm holdings, lack of input mobilising and risk taking capacity. These groups must receive benefits of subsidy as well as prioritisation in supply of water and other inputs.

8. Farmers, being beneficiaries of irrigation projects, have a great stake in water management, accordingly there is some effort to involve them but the same needs to be further strengthened for efficient water utilization. Farmers' involvement in irrigation water management has to be sought through 'Farmers Water Use Cooperatives' having representation from all sections of the farming community throughout the distribution network.

9. The pace of agricultural development in irrigated areas will largely depend on how efficiently is the created water resource potential utilised for crop production. An essential requirement for it will be the development of sound water use technologies based on knowledge generated from basic, applied and action researches on use of water as an input for crop production in irrigation commands below outlet. The specificity of water use research seeks involvement of irrigation engineers, water management scientists and crop production technologists so that science-based water use technology for agricultural production is developed. There is a need to specify research dimensions relevant to water resource development and water resource utilization for agricultural production, and strengthen the research base in both fields in terms of scientific capability and physical infrastructure.

10. It is also necessary to intensify research on hydrological balance, checking over-exploitation of natural resources in favourable environment and use of modern tools in irrigation water management for effective utilization of the scarce resources.

11. Development of agriculture in the irrigated area will continue to be the major concern of the country to meet the food requirement of the increasing population. Presently the national average productivity of the irrigated area is about 2 tonnes/ha. It seems plausible to attain a productivity level of 3 tonnes/ha by the turn of the century and ultimately 4 tonnes and even more in irrigated areas with strategic water resource development and management in association with technological back-up and assured availability of other production inputs.

12. Future gains in agricultural production will continue to be determined by proper development and utilization of the country's water resources. This will have to be achieved by added dimensions of regional

parity, social equity, ecological security and cost effectiveness. Hence, irrigation water has to be efficiently utilized to achieve an accelerated agricultural growth rate to ensure economic well-being of our rural population.

Before concluding, I would like to offer my gratitude to the Indian Society of Agricultural Statistics for providing me an opportunity of delivering the Dr. Rajendra Prasad Memorial Lecture.