Review Of Literature On Study On Irrigation In Various Districts Of State Haryana (India)

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Abstract: One of the basic and important objectives of the canal irrigation system is the delivery and distribution of water for irrigation among the water users. Due to the shortage of water in the system, the water is delivered to different parts of the canal system in rotation, i.e., using the 'Rotational Programme of Channels' (Gustafson and Reidinger, 1971). Supplies of irrigation water to the farmers have been awarded in the past by the system of 'warabandi' based on equitable and proportionate water allowance. Warabandi is a rotational and proportional method for equitable allocation of the available water in an irrigation system. The twin objectives of warabandi have 8 been high efficiency and equity in water use and both objectives are to be achieved and guaranteed by self-policing rotation system (Bandaragoda, 1998). Further, warabandi is agreed upon by concerned farmers/users and appropriate canal authority. Though this system of distribution is intended to be fair but the unpredictability of water supply is being faced by the users. The problem of water supply unpredictability arises due to little or no institutional control mechanism over the rotation and rationing of water based on non-market mechanism. It is also clearly evident that trade-off between hydro power generation and irrigation, reservoir factors and capacity factors contribute to the uncertain water supply (Gustafson and Reidinger, 1971). Presently, in Punjab warabandi system of canal water distribution and allocation among the water users is in operation. Further, mainly three types of warabandi are being used, namely: khuli–wari (open turn), panchayati-wari, and weekly-wari. Field staff of the Irrigation wing fixes the turn, duration and quantity of water for farmers. The basis for the distribution and allocation of water depends upon the size of the land holding, distance from the outlet (mogga), and certain other factors. That is the canal water distribution and allocation in Punjab has been carried out with little modifications in the warabandi system. Now attempt is being made to allocate and distribute water more scientifically through computerization of the distribution and allocation process.

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Source of irrigation

World over the irrigation has acquired an increasing importance in agriculture. From just 8 million hectares (M Ha) in 1800, irrigated area across the world increased fivefold to 40 M Ha (13.4 M Ha in India) in 1900, to 100 M Ha in 1950 and to just over 255 M Ha in 1995; with almost one fifth of that area (50.1 M Ha net irrigated area), India has the highest irrigated land in the world today (Postel, 1999). India's irrigation development in this century, and particularly after independence, has seen number of large storage based systems, all designed and maintained by the government effort and money. In the British period, a few storage structures were built only in the beginning of this century and the post independence India, however, has seen more than 60 percent of irrigation budgets going for major and medium projects (Thakkar, 1999). Large scale irrigation is synonymous with canal irrigation in India and canal irrigation is a costly proposition, more so when provided under the aegis of grave inefficiencies in project implementation and canal operation (Dhawan, 1997). Punjab is a granary state of India and its input-output system is heavily biased in favor of agriculture (Singh and Singh, 2011). Punjab model of irrigation is characterized by excess demand for water for irrigation coupled with unconstrained mining of groundwater for meeting the food bowl requirements of the country. The paper, covering the evolution of the system, evaluates the performance and delineates the policy options for the future.

Indian irrigation infrastructure includes a network of major, medium and minor canals from Indian rivers, groundwater well based systems, tanks, and other rainwater harvesting projects for agricultural activities of these groundwater system is the largest.1 Of the 160 million hectares of cultivated land in India, about 39 million hectare can be irrigated by groundwater wells, and an additional 22 million hectares by irrigation canals.2 In 2010, only about 35% of total agricultural land in India was reliably irrigated.3 About 2/3rd cultivated land in India is dependent on monsoons.4 The improvements in irrigation infrastructure in last 50 years have helped

India improve food security, reduce dependence on monsoons, improve agricultural productivity and create rural job opportunities. Dams used for irrigation projects have also helped provide drinking water supplies to a growing rural population, control flood and prevent drought-related damage to agriculture.5.

Ministry of Water Resources (Govt. of India), on its web site briefly explains the history of irrigation development in India which can be traced back to prehistoric times. Vedas, Ancient Indian writers and ancient Indian scriptures have made references to wells, canals, tanks and dams. These irrigation technologies were in the form of small and minor works, which could be operated by small households to irrigate small patches of land. In the south, perennial irrigation may have begun with construction of the Grand Anicut by the Cholas as early as second century to provide irrigation from the Cauvery River. The entire landscape in the central and southern India is studded with numerous irrigation tanks which have been traced back to many centuries before the beginning of the Christian era. In northern India also there are a number of small canals in the upper valleys of rivers which are very old.

In the First Five Year Plan (1951‐56), the country embarked on a major irrigation programme. A number of multipurpose and major projects were taken up, such as Bhakra Nangal, Nagarjunasagar, Kosi, Chambal, Hirakud, Kakrapar and Tungabhadra. Concurrently minor irrigation schemes including ground water were given emphasis under the Agricultural Sector, along with financial assistance from the Centre. During the periods of the Second Five Year Plan (1956‐61), the Third Five Year Plan (1961‐66) and the three annual plans (1966‐69), new irrigation programmes were implemented. During the Fourth Five Year Plan (1969‐74), the stress was shifted to the completion of ongoing projects, integrated use of surface and ground water, adoption of efficient management techniques and modernization of existing schemes. The new starts, however, continued. During the Fifth Plan (1974‐78), Command Area Development Programme (CADP) was launched as a Centrally Sponsored Scheme with the objective of reducing the gap between the irrigation potential created and the optimum utilization of available land and water.

The programme was conceived as a means of coordinating all related activities to meet these objectives under one umbrella. Initially, 60 Major and Medium projects were covered with a CCA of 15 Mha. During the annual plans of 1978‐80 and the Sixth Five Year Plan (1980‐85), 'new starts' continued and at the end of the Seventh Plan, there were as many as 182 major and 312 medium ongoing projects requiring an estimated amount of Rs. 39,044 crores at the 1990‐91 price level for their completion. 'New starts' were, therefore, restricted considerably and greater emphasis was laid on the completion of projects, which were in advanced stages of completion. This was continued during 80 1990‐91 & 1991‐92 annual plans, the VIII Plan (1992‐97) and the IX Plan (1997‐2002). For the speedy completion of the ongoing projects in advanced stage of construction Accelerated Irrigation Benefit Programme (AIBP) was launched in 1996‐1997. During the VIII Plan period irrigation potential of 2.22 Mha was created under major and medium sector at an annual rate of 0.44 Mha per annum. During the IX Plan period this increased to 4.12 Mha out of which 1.65 Mha (nearly 40%) was through AIBP. Users' participation in the major and medium irrigation schemes received greater attention.

One of the basic and important objectives of the canal irrigation system is the delivery and distribution of water for irrigation among the water users. Due to the shortage of water in the system, the water is delivered to different parts of the canal system in rotation, i.e., using the 'Rotational Programme of Channels' (Gustafson and Reidinger, 1971). Supplies of irrigation water to the farmers have been awarded in the past by the system of 'warabandi' based on equitable and proportionate water allowance. Warabandi is a rotational and proportional method for equitable allocation of the available water in an irrigation system. The twin objectives of warabandi have 8 been high efficiency and equity in water use and both objectives are to be achieved and guaranteed by self-policing rotation system (Bandaragoda, 1998). Further, warabandi is agreed upon by concerned farmers/users and appropriate canal authority. Though this system of distribution is intended to be fair but the unpredictability of water supply is being faced by the users. The problem of water supply unpredictability arises due to little or no institutional control mechanism over the rotation and rationing of water based on non-market mechanism. It is also clearly evident that trade-off between hydro power generation and irrigation, reservoir factors and capacity factors contribute to the uncertain water supply (Gustafson and Reidinger, 1971). Presently, in Punjab warabandi system of canal water distribution and allocation among the water users is in operation. Further, mainly three types of warabandi are being used, namely: khuli–wari (open turn), panchayati-wari, and weekly-wari. Field staff of the Irrigation wing fixes the turn, duration and quantity of water for farmers. The basis for the distribution and allocation of water depends upon the size of the land holding, distance from the outlet (mogga), and certain other factors. That is the canal water distribution and allocation in Punjab has been carried out with little modifications in the warabandi system. Now attempt is being made to allocate and distribute water more scientifically through computerization of the distribution and allocation process.

Compare the level of irrigation (proportion of irrigated area)

Interrelated physical and socio-economic factors are not equally significant in influencing the area variations and temporal development of agricultural phenomena in an area. Agriculture is precarious and production meager where rainfall ranges between 30 cm (300 mm) to 50 cm (500 mm), farming without irrigation is very limited and if the rainfall decreases to less than 30 cm (300 cm), agriculture is impossible without farm irrigation (King, 1953). For efficient utilization of the food resources, the existing rainfall situation in country as well as in state has created an acute need for irrigation.

Irrigation confers indirect benefits through increased agricultural production. Employment potentials of irrigated land increases, increased production helps in developing allied activities, means of water transport are improved, income of government from agriculture increases etc. Availability of regular water supply will increase the income of farmers imparting a sense of security and stability in agriculture (S.K. Misra and V.K. Puri). Gadgil D.R. (1954) in the title on 'The Industrial Evolution of India in Recent Times' studied the economic effects of irrigation and concluded that the total direct and indirect effects of irrigation projects were very favourable to the farmers. With irrigation, farmers received higher levels of income and they were able to make additional investment on cattle, farm implements and on commercial crops like sugarcane and cotton. Further, it generated additional employment opportunities as well. Planning Commission (1964) in the study on 'Criteria for Appraising the Feasibilities of Irrigation Projects' during 1958 to 1961 observed that canal irrigation had helped in promoting greater utilization of land, enlarging the average size of the farm generating demand for additional farm labour, shifting to new and better varieties of crops, increasing additional production investment in farm business and widening the scope for increasing the revenue.

Moorthi T.V. and Mellor W.J. (1972) after a study on 'Cropping Pattern Yields and Income under Different Sources of Irrigation with Special Reference to IADP, Aligarh District, Uttar Pradesh', concluded that farmers with private tube-wells had better control over water supply in terms of timely availability in adequate quantity. This resulted in higher cropping intensity, yield, higher crop income and cultivation of high yielding crops in such farms. This was attributed to the flexibility factors in quantity and timing available in those farms.

Shukla V.P. (1973) in his paper on 'Well Irrigation – Its Costs and Benefits in Jabalpur District in Madhya Pradesh' examined how far irrigation from wells either through electricity or diesel pumps was profitable in Jabalpur district in Madhya Pradesh, especially in the context of advanced technology. Vyas V.S. and Mathai G. (1978) in their paper on 'Farm and Non-farm Employment in Rural Areas: Perspective for Economic Planning' confirmed the direct relationship between irrigation and use of other inputs like fertilizers and chemicals. They also concluded that it resulted in increased labour use. Suryawanshi S.D. and Kapase P.M. (1985) have analysed in their research paper on 'Impact of Chod Irrigation Project on Employment of female Agricultural Labour' that agricultural labour and farm cultivation as the main areas of economic activities for rural women. The National Sample Survey has shown that the percentage contribution of women in agriculture is higher than men, where most of the key operations at farm are done by them. Labour employment depends on many factors such as irrigation potential, cropping pattern, intensity of cropping and such other labour intensive activities. Irrigation has proved beneficial to the country in the context of the above. The findings of their study are i) irrigation facilities gave them better opportunities for providing education to their children, rather than employing them in agriculture. In fact due to irrigation both male and female members got higher employment in agriculture. ii) the cropping pattern was changed and shifted in favour of cash and labour intensive crops which gave more employment. The authors have suggested that women have to be involved in the process of modernization and transfer of new technology. However, this paper does not trace the factors underlying the increase in labour use with irrigation. How is irrigation lead to an increase in cropping intensity, a change in cropping pattern, a more intensive use of HYVs, and fertilizers, etc. These changes in turn would affect labour use. Also a disaggregation by farm size, and farm location (since head-enders usually manage to get a disproportionately large share of canal water relative to the tail-enders) would have been useful. Somashekaraiah N.T. and Mahendra Kumar S. (2008) in their article, an attempt has been made to assess the impact of tube well irrigation on resource use efficiency in agriculture with special reference to paddy cultivation in the study area. To them, tube well irrigation has made a drastic change in the sample villages. There has been upward trend in the number of tube wells and a change in the pattern of tube wells. More and more tube wells have been energized. The cropping pattern has undergone a forcible change. The traditional crop, ragi has been replaced by paddy. There has been remarkable increase in the level of income of the farmers and in the level of employment of the households. The households have also undergone socio-economic changes. The literacy level has gone up and the banking habits increased. In short, the life-style of the sample village folks has under gone drastic changes in recent years due to resource use efficiency. Vairavan K. (2010) said that by adopting the 'Drip Irrigation Technology in Sugarcane', the farmers could save water up to 50 per cent and achieve higher yield of 60 tonnes per acre.

Intensity of irrigation

Sivanappan R.K. and Balasubramanian M. (1976) in their article on 'Water Management Practices in Rice Fields Coimbatore' defined water management as a practice which included the integrated process of intake, conveyance, regulation, measurement, distribution, application and use of irrigation water in farms and removal of excess water from farms with proper amounts and at the right time for the purpose of securing maximum crop production and water economy. The author advocated land levelling, proper irrigation and drainage system and control of water through well laid out control system as measure of water management.

Charan A.S. (1978) in his article on 'Economic Evaluation of an Irrigation Project: A Study of the West Banas Project' revealed that the introduction of irrigation in the region had helped primarily the agricultural sector in fairly estabilizing agricultural production first, and through increased use of inputs in increasing production. The cost-benefit ratio was greater than one. This clearly proved the economic feasibility of the project.

Sadegihi J.M. (1978) in his research work on 'Economic Impacts of Increased Water Supply on Small Farms in Iran' analyzed the changes in the production function of small farms as a result of increased water supply and examined the nature of adjustments in input allocation before and after the increase in water supply. A Cobb-Douglas type model analysis showed the impact of additional water supplied by the Davis dam on rice production function indicating an increase in the productivity coefficients and values of the intercepts.

Sisodia J.S. (1978) applied cost analysis in 'Economic Evaluation of Chambal Irrigation Project in Madhya Pradesh'. Since expert evaluation of the project was attempted in this study, it dealt with a comprehensive study of the economy of the command and non-command area. The level of technology used, yield per hectare and gross farm output in all the farms were seen to be significantly higher in the canal irrigated areas as compared to that in non-command area, and the government investment was justified on these grounds.

Vaidyanathan A. (1980) points out in his book on 'Water Resources Management, Institutions and Irrigation Development in India', that irrigation has several phases (namely control of the water source, the delivery of water, the actual application of water to crops and drainage), each of which involves a number of distinct functions (namely facility construction, operation and maintenance, water allocation and conflict resolution).

Vaidyanathan A. (1980) in the book on 'Water Resources Management, Institutions and Irrigation Development in India' reveals that most countries in Asia attack great importance to rapid development of irrigation and flood control and have spent massive resources for this purpose. Experience shows however that there is great deal more to this than the construction of reservoirs and canals.

Shepperdson M.L. (1981) in his article on 'The Development of Irrigation in Indus River Basin, Pakistan' studied Social and Environmental Impact of Irrigation. He pointed out that a comprehensive account of irrigation development in Indus River Basin, Pakistan and its impact on social, economic and environmental conditions in the region. Macro data-area used to analyse the problems and prospects of irrigation. He opines that adverse effect of irrigation like water logging and salinity are essentially due to cultivation of paddy and other water-intensive crops and adoption of traditional farming methods. This shows that farmer's awareness and understanding of modern technology is essential to implement irrigated farm technology. This aspect remains still unexplored.

Emery N. Castle (1982) in his research article on 'Agriculture and Natural Resource Adequacy' argued that major problems plague agricultural water management in the United States on both a micro and macro basis. A basic fact that most of the low-cost opportunities for irrigation in the United States already have been exploited. Private development of both surface and ground water to increase agricultural output will occur only with greater economic and environmental costs. Salinity is a problem in many parts of the West, and nonagricultural water uses have been growing in importance for several decades. Under such circumstances one logically looks to ways that might make more effective use of existing water supplies. With regards to water adequacy and agriculture the work of Frederick leads to believe that increased irrigation can not be expected to contribute to greater agricultural output in the future to the extent that it has in the past. On balance, irrigated acreage will increase, but at a slower rate, and the increases will occur in less hospitable environments, for example, the Sand Hills of Nebraska, and costs correspondingly will be higher. The author does expect greater economic incentives for the better utilization of water both in irrigated and rain-fed areas; but this would be much greater, of course, if water markets are reformed. The consumptive nonagricultural water uses now on the horizon are not large enough to affect aggregate agricultural output significantly if water were put to more efficient use in agriculture. Higher energy prices are affecting water for irrigation in many areas. This is especially true for groundwater, where pumping lifts are increasing as water tables are dropping. Thus, even though it is hard to visualize a natural water shortage, water allocation and management will be major resource problems for many areas, and agriculture will be at the centre of the conflicts that will occur. However, only agriculture will be forced to adjust if more realistic pricing and allocation policies are adopted.

Rajan Mishra (1984) in his article on 'Impact of Production and Factor Use - A Case Study of Mayrakshi Canal in West Bengal' used production function to examine the effect of irrigation technique on rice and concluded that there was an upward shift in production function in the neutral way by introducing irrigation.

Ramakrishnan, C. (1985) in his study on 'Water Use Pattern and Resource Use Efficiency in Tambaraparani Irrigation System' used a linear production function and among the inputs used in rice cultivation, irrigation water was found to be highly significant indicating the scope for increasing rice yield through water management.

Chikara I.J. and Singh (1986) in their research work on 'Optimisation of Land and Water Resources in Semi and Tropics of Hisar District in Haryana' had revealed that there existed the possibility of increasing net returns at farm level through optimization of land and water resources at both existing level and improved levels of technology.

Dhawan B.D. (1989) in the article on 'Water Resource Management in India: Issues and Dimensions' has suggested from the field-based study in the Sriramsagar (formerly Pochampad) project, that spatial unevenness in our water bounty is inevitable for a country of continental dimensions. What is truly striking are the temporal variations in our water availability, both within the agricultural year and from one year to the next. Whereas spatial unevenness necessitates heavy investment in long distance transfer of water from the more endowed to the less endowed tracts, temporal unevenness makes sizable investments in water storage works imperative.

Lodha N.R.S. et al. (1989) had discussed on 'Canal Administration and Main System Versus Farm Systems Linkages in a Newly Commenced Irrigation Project in a Tribal Belt of Rajasthan'. This study pointed out that the majority of the farmers have knowledge about the hazards of excess use of water. The farmers, by and large, welcome services designed to impart better knowledge of water use technology in relation to other technological inputs. Generally no conflict arises and if at all any conflict occurs the same is resolved by farmers themselves. Farmers are aware of technological gap and the need to bridge it. The extension services need adequate strengthening in the project area. The high degree of recognition between Main system Managers and farmers followed by effective but informal farm level cooperation and the right rationale of tribal farmers on proper water use and technology adoption widen the scope for development of tribal areas through irrigation projects.

Desai S.N. Birari K.S. and Patil P.D. (1989) attempted to study in the paper on 'Role of Irrigation Layout to Check Over-Irrigation' and the study revealed that absence of appropriate land shaping and grading, improper maintenance of field channels, water availability time, uneven flow of water, lack of training in water management, absence of improved crop production technology and knowledge of water measuring devices were the major causes of over-irrigation.

Singh A.J. and Joshi A.S. (1989) examine in their article on 'Important Aspects of Economics of Irrigation in India with Special Reference to Punjab State'. The study has shown that the progress of irrigation development has been rather sluggish due to inter-state disputes and lack of adequate resources. It has been suggested that irrigation should be converted in to a central subject or the riparian principles should be followed to avoid inter-state disputes. Further, the study shows that the potential created should be fully utilized.

Hirashima S. and Gooneratne W. (1990) in their book on 'Irrigation and Water Management in Asia' pointed out that the existing irrigation facilities operate far below their actual potential is well recognized in many countries. While continuing under-performance contributes to a significant loss of production and employment, prevailing management deficiencies have also resulted in widening inequality in access to irrigation water and in income disparities. It has been noted that an increase of as much 20 per cent in total production can be achieved merely by improving the performance of irrigation systems through 'management reform'. The two case studies from Indonesia and the Philippines clearly demonstrate the ability of community management systems to efficiently operate and manage small irrigation facilities by mobilization of local resources (which include not only labour but also financial and material resources), maximizing production and employment through effective and regular system maintenance and efficient management of resources by strict allocation of water and judicious crop planning and ensuring equitable distribution of obligations and benefits. This is successfully achieved by assessing obligations in proportion to the share of water received by each user and by strict enforcement of established rules and regulations.

Kay, M.G. (1990) made a review on 'Recent Developments for Improving Water Management in Surface and Overhead Irrigation' that for surface irrigation, by far the most common method of applying water, there are two important technology related factors which have contributed to this situation. Firstly, there is a lack of good water management at farm level, primarily because of a poor understanding of the principles and practices of water application methods and scheduling techniques. Secondly, irrigation has largely been considered as a separate and distinct activity from other aspects of production. On the farm conflicts have arisen between the layout and management of irrigation and the requirements of cultivation and mechanisation. On larger irrigation schemes, using canal systems to deliver water to several farms, it has led to inflexible supply oriented systems which are unable to respond easily and rapidly to changing farm water requirements. This has resulted, all too often, in poor water distribution and unreliable and/or inadequate water supplies. However, the efficient use of irrigation water relies as much on the skills of the farmer as it does on the physical layout of the system.

Niranjan Pant (1990) has focused in his article on 'The Administrative Aspects of Canal Irrigation of Kosi Project in Bihar'. According to him, 'it is not sufficient to set up an irrigation system. The most important task is to evolve an organizational system which can operate it successfully'. Hence he attributes the gap in utilization mainly to inefficient management of water supplies at the system level. The main constraints affecting the efficiency in utilization of water are noted to be lack of cooperation among the bureaucracy and the beneficiaries, non-completion of residual work, faulty design of canals and outlets and non-implementation of warabandi. With regard to the issue of productivity and equity in irrigation systems, he attributes the gap to faulty statistics and inequality in distribution of water between the head reach and tail-end farmers. Inequality in distribution of water lowers the productivity. He observes that the upper reach farmers resort to multiple wet crops whereas the tail-end farmers realise only one third of the benefits corresponding to the more privileged groups. Hence he suggested that inequalities should be removed by improving the system management.

Maria Saleth R. (1995) reviewed the book of Clarence Maloney and K.V. Raju, 'Managing Irrigation Together: Practice and Policy in India', that unless a radical reform is urgently undertaken to change our present water institution (i.e., water policy, water law and water administration), it will be almost impossible to salvage and sustain our water economy. The emphasis first was given a people centered approach to water management - not on any romantic or idealistic grounds but on practical counts.

The second was the crucial role of social engineering aspects in irrigation management. Since irrigation is not merely a physical or hydro-geological system but equally also an economic and social system, a mere engineering perspective could miss other important aspects like agronomy, economics, sociology, etc., so essential for improving the performance of the system as a whole.

Thirdly, as the title speaks better, not only the farmers, irrigation officials, training and technical institutions, and private development agencies need to come together in managing irrigation but also different segments of the system ranging from catchments to drainage systems need to be managed together.

Fourthly, the authors highlight a serious legal deficiency, i.e., the unsuitability of the prevailing Acts for legally registering Water Management Associations (WMAs). While the involvement of profit precludes their registration under the Societies and Trust Acts, cumbersome procedures, bureaucratic hurdles, and income tax problems discourage their registration under the Co-operatives and Trust Acts.

Fifthly, the authors also deal with one of the most crucial technical snags in ensuring equitable allocation of water and cost by WMAs, i.e., the issue of measuring water cost effectively at the farm-gate level.

Sixthly, while the need for WMAs is clear and the policy environment becomes increasingly favourable for their formation, WMAs are not always spontaneous except in cases where they face an immediate common threat like severe water shortage or share a common social bond.

Dewan J.M., Sundarshan K.N. (1996) in their book on 'Irrigation Management' pointed out that new development in irrigation technology plus complementary advances in plant breeding, crop protection, and agronomy packages have increased productivity and profitability of irrigation agriculture. They stress that proper irrigation can increase area cropped, promote intercropping and multiple cropping, ease changes in cropping pattern to more profitable crops, increase yields by avoiding moisture stress which facilitate profitable use of other inputs and reduce risks and encourage on - farm investment would facilitate food security.

Rao S.V.N. et al. (2004) observed in their article on 'Water Use of Surface and Groundwater for

Coastal and Deltaic Systems' (2004) that management of water resources in coastal and deltaic regions irrigated by run-of-the-river schemes involves two issues: First, availability of water resources in space and time, and Second, seawater intrusion. Improper management arising out of successive irrigation or increased groundwater exploitation often leads to water logging or seawater intrusion problems respectively. Any conjunctive use model must address these two issues for application to coastal and deltaic regions.

Sivanappan, R.K. (2005) has elucidated in the article on "Ensuring Water for All" that water has emerged as the most crucial factor for sustaining the agricultural sector in the coming years. India accounts for 16 percent of the world's human population and nearly 30 per cent of the cattle with only 2.4 per cent of the land area and 4 per cent of water resources. Even if the full irrigation potential is exploited, about 50 per cent of the country's cultivated area will remain unirrigated, particularly with current level of irrigation efficiency. The availability of water per person per year is about 2200 M3 for India and about 800 M3 for Southern States. The share of water for agriculture would reduce further with increasing demand from the other sectors. According to him inappropriate policies leading to indiscriminate use of water, lack of appropriate technologies, poor technology transfer and inadequate and defective institutional support systems have led to serious agro-ecological and sustainability problems in irrigated areas. The Water Use Efficiency (WUE) in Indian agriculture, at about 30-40 per cent, is one of the lowest in the world, against 55 per cent in China. The International water Management Institute forecasts that by 2025, 33 per cent of India's population will live under absolute water scarcity condition. The per capita water availability, in terms of average utilizable water resources in the country, has dropped drastically from 6008 M3 in 1947 to 2200 M3 in 2005 and is expected to dwindle to 1450 M3 by 2025. The National Commission on integrated water resources development has assessed that about 450 million tonnes of food grains will required by the year 2050. In 2050, the cropping intensity should be about 150 per cent and the percentage of irrigation to gross cropped area about 50 per cent. This scenario can be changed by adopting water management practices in surface irrigation and introducing drip and sprinkler irrigation as recommended by the Task Force on micro irrigation (2004). He further pointed out that the methods of irrigation and cropping pattern are the same old ones in spite of various technologies / crops are available and hence the wastage of water with less productivity.

Koli P.A. and Bodhale A.C. (2006) argued in their book on 'Irrigation Development in India' that successful cultivation is not possible in large part of our country; due to a lack of irrigation facilities. In the absence of such facilities, there are large areas in the country which often produce one crop.

John Briscoe and Malik R.P.S. (2007) have discussed in the article on 'India's Water Economy An Overview'. According to them irrigation is the predominant user more than 80 per cent) of water resources in India. The performance of irrigated agriculture, which contributes more than 55 per cent of agricultural output, will be the most important influence on the objectives of growth, employment generation, food security, and poverty reduction. Although India has one of the largest irrigation systems in the world, irrigation development has not been impressive over time. India has a highly seasonal pattern of rainfall. With 50 per cent of precipitation falling in just fifteen days and over 90 per cent of river flows in just four months. India can still store only relatively small quantities of its fickle rainfall. Whereas aridrich countries (such as the United States and Australia) have built over 5000 cubic metres of water storage per capita, and middle-income countries like South Africa, Mexico, and China can store about 1000 cubic metres per capita, India's dams can store only 200 cubic metres per person. India can store only about 30 days of rainfall, compared to 900 days in major river basins in arid areas of developed countries. Water can be transformed from a curse to a blessing only if major investments are made in water infrastructure (in conjunction with soft adaptive measures for living more intelligently with floods). Recognizing this, the Prime Minister has recently called for the establishment of a Tennessee Valley Authority (TVA) for the Brahmaputra which would combine major water infrastructure with modern management approaches to make water a stimulus for growth. A World Bank study of Tamil Nadu, for example, shows that if a flexible water allocation system were adopted, the state economy in 2020 would be 20 per cent larger than under the current, rigid, allocation procedures. A central element of a new approach must be that users have well-defined entitlements to water. The broader messages are that the ideas of the 1991 economic reforms must be drilled down from the regulatory and financial sectors into the real sectors (including water sector) if India is to have sustainable economic growth, and that the role of the Indian water state must change from that of builder and controller to creator of an enabling environment, and facilitator of the actions of water users large and small.

John Briscoe and Malik R.P.S. (2007) mentioned in the book on 'Hand Book of Water Resources in India Development, Management, and Strategies' with regard to water stress and scarcity, the temporal and special variability of rainfall in India is a well-recognized fact. The average annual precipitation is 1170 mm but varies from 11,000 mm in the north eastern region to 100 mm in the western desert. Fifty per cent of the precipitation takes place in 15 days or so and less that 100 hours altogether in a year. In a monsoon dependent rainfall environment, 90 to 95 per cent of the flows in rivers occur in the four months of June to September.

The per capita availability of water has been steadily declining since independence from 6008 m3 to 1829 m3 as of now. A water availability of less than 1700 m3 per capita is termed as a water stress condition while less than 1000 m3 is water scarce. Broadly, the breakdown of 1000 m3 is 600 m3 for food security, many basins like Pennar and Sabarmati are already water scarce. One of the main reasons for water problems in the country is the low per capita storage (only about 200 m3) as compared to Russia (6103), Australia (4733), Brazil (3145), Turkey (1739), Mexico (1245), Spain (1410), China (1111), and South Africa (753). For water stress to be avoided, a minimum per capita storage of 750 to 1000 m3 needs to be achieved. India has no option but to go ahead with its dam construction programme. So far 177 BCM storage has been created and another 77 BCM is from projects under construction.

Lakshmi Narasaiah M. (2007) in his book on ‘Irrigation and Economic Growth’ said that a sharp inequality in water supplies between farmers in the head reaches of irrigation systems and those located downstream is another manifestation of poor performance. Investigations in the Tungabhadra Irrigation scheme reveal that the tail-end of a major distributory commanding 25 per cent of the total area, received approximately 20-40 per cent of the targeted discharge while the upper reaches got more than their share. To him lack of maintenance has caused many systems to fall into disrepair,

further inhibiting performance. Over time, distribution canals have become silted up, increasing the likelihood of breaching, damage to out lets and leading to salt build-up in the soil.

Andharia J.A. (2008) in his article on ‘Agricultural Production and Problems of Agriculture in India’ pointed out that food and water are considered as the most essential for maintaining our lives. To him India’s major food problem is irrigation. He observed that irrigation in India has yet remained dependent upon rainwater and a seasonal one. A huge amount of plan outlay has spent on small, medium and large irrigation schemes in India during Five Year Plans. Yet, irrigated land has not been covered fully.

Ayan Hazra (2008) studied on ‘Socio-Economic Evaluation of Water Management Activities in Chhattisgarh’ and he found out that in the traditional mind set of top down communication processes and farmers are regarded as passive receptor, ignorant, conservative and unwilling to change up with new paradigms. They have well tested and proven traditional technologies for their own specific local situations. Therefore, farmers should be allowed to play significant role in the decision making process. In such situation, instead of an insensitive or inflexible top down approach, there should be shift to faster mutual understanding and cooperation through bottom up approach of consultations. For them the IWDP watershed projects have checked soil erosion, arrested runoff, improved in-situ moisture conservation, increased productivity, increased water availability and improvement in local ecology and hydrology in Durg, Raigarh, Raipur Rajnandgaon and Sarguja districts.

Pandey M.P. and Ghosh A. (2008) in the article on ‘Challenges to the Future of Agriculture-Global Perspective’ pointed out that water is becoming a looming crisis. By 2025 scarcity of water world threaten 30 per cent of the human population as 70 per cent of water withdrawals are used in irrigated agriculture globally. Africa and Asia have experienced an increasing shortage in percaput water availability. Irrigation demand is expected to increase keeping pace with the need to increase agriculture production. Irrigated agriculture needs to be increased by 23 million hectares, i.e. 19 per cent over and above the area lost under water logging and salinization. The majority of the areas would fall in South Asia. About 35 per cent of the land under assured irrigation is at risk due to poor management. They suggested that farmers ensuring proper drainage and irrigation design can promote efficient use of water. Small-scale schemes executed by local government could reduce many problems while backed by national policies that effectively support appropriate technologies, credit, marketing, energy supplies and maintenance of equipment suitable ecology based cropping program therein.

Jat M.L. et al. (2009) in their research article titled on ‘Water Resources Management in a Water Deficit State’ that there is a big gap between water resources available and which is used in Rajasthan. The water resources availability, therefore, needs to be increased by adopting appropriate strategy in the state. The strategies are

1. Rainwater harvesting through farm ponds.
2. Recharging the ground water e.g. recharge through dead wells, nala bunding and anicuts are found to be very suitable for recharging ground water.
3. Conservation of stored water in reservoirs and also in small water harvesting structures.
4. Technique for compartmentation is an effective tool for water saving.

5. Increasing water use efficiency through micro irrigation systems saving in water is possible if techniques like sprinkler and drip are adopted. By drip saving in water use can be of the order of 40-50 per cent and by sprinkler 8.3-34.7 per cent and gave higher yields.

6. Legislative measures for management of ground water: Unchecked and unplanned exploitation of ground water, in some parts of the country, has resulted into problems of salinity intrusion on the sea coast and high salinity in other areas.

Gargi Parsai (2010) reported in the title on 'Double Farm Growth Rate to Ensure Food Security Sustainable Technologies that can Produce More Need'. He pointed out that India commands about 2.3 per cent of the world's land area and about 4 per cent of the earth's fresh water resources, but feeds 17 per cent of the world population. This puts tremendous pressure on our resources and makes the need for newer and better technologies even more critical and which could produce more from less. He stressed the three fundamental principles of sustainable agriculture, viz., i. a live soil ii. Protection of biodiversity and iii. Precision farming and nutrient cycle.

Proportion of Net Sown Agricultural areas

Ashturkar B.W. (1986) made a study on 'Progress and Prospects of Irrigation Water Management in Maharashtra' and reported that jowar, bajra, paddy and cotton based cropping systems were equally profitable compared to sugarcane. The water requirement of these crops were much less when compared to sugarcane and hence if the area under sugarcane was restricted, large areas could be brought under irrigation, which ultimately would increase and stabilize the production and productivity of major cereals, pulses and oil seed crops in the state.

Verma R.C and Banga H.K (1989) focused on "Impact of Rescheduling of Irrigation Water on Farm Incomes and Cropping Pattern - A Case study of Jaisamand Dam in Alwar District of Rajasthan". In this study Linear programming technique was used to develop optimal cropping pattern for the command area. The optimal cropping pattern in turn resulted in optimal distribution of irrigation water of the reservoir. The results of the study showed that the existing pattern of distribution of Water is not proper. Water is released only during the months of October, November And December mainly for the sowing of Rabi crops. For the rest of the year, water is not released even at critical stages of crop growth. Moreover, all the water available in The reservoir is not utilized for irrigation.

Krishnakumari and Swaminathan (1992) studied the changes in cropping pattern, crop combination, crop area and diversification of crop enterprises in Tamil Nadu The results revealed that the changes were mainly due to change in agricultural inputs-high yielding varieties, fertilizers, pesticides, irrigation intensity and tractor use. The analysis indicated that in the Western and North Western regions modernization was low because of low rainfall poor soils and poor irrigation facilities.

Olekar (1996) evaluated about sunflower based cropping in this study small formers net profit was highest in the groundnut sunflower cropping sequence Rs.15356.27 hector and least sunflower follow sequence Rs.6684.59 hector on large formers also the net returns were highest in groundnut sunflower system for the overall of formers the net returns were highest in groundnut sunflower sequences and least in sunflower like this type author explains.

Govardhan Rao (1998) study focused on economic evaluation of the cropping systems in different locations of the TBP canal area. The multistage random sampling technique was employed to get the field level date for the agricultural year 1996-97 through survey of small and large size groups across the locations paddy and cotton cropping systems occupied area of the sample formers. In head reach 86 percent of the sample in paddy-paddy system while 23.34 percent of the sample formers participated in cotton cropping system. In middle reach cotton cropping dominated cropping systems more diversification of crop systems was noticed in tail reach.

Nathan K.K (2002) study revealed that different climatic conditions and well considered irrigation extent a major influence on the growth and quality of citrus fruits lime, mandarin, grapes and lemons while citrus flourish in mild winter and can susceptible height frost conditions, warm summers reflect well on their quality profile variations in the day and night temperature helps in better color development in citrus. This enhances the sugar formation and accumulation as well as acid formation and night are important for its color development as in warm nights, fruits remain green even during the ripe state.

Mahindra Singh (2002) studied the copping intensity scenario of the state is showing the same situation for last ten years the reasons is due to lack of assured irrigation is summer area expansion in crops in restricted which is adversely affecting the cropping intensity and due to lack of regular supply of electricity for operation of state and private electricity operate tube wells irrigations to the crops in any of the season, particularly in cannot be assured hence area are expansion of crops is reduced which also adversely affects the cropping intensity. Under the circumstances of the stagnation of cropping intensity of has necessary to develop new technology for agricultural development along with development of low duration varieties of crops and assured availability of seeds. So that the area in all the seasons may increase and cropping intensity may also increase consequently.

Rajesh Sengar et al., (2004) analyses about impact on crop production water is one of crucial inputs for agricultural production and plays pivotal role in agricultural water is especially valuable fertilizers which are highly dependent in energy input are not only costly but also in short supply, effluents contain plant nutrients like nitrogen, phosphorus, potassium and several micronutrients along with some heavy metals depending on the source of effluents and type of industry use of industrial effluents holds promise as a low cast course for moisture and to some extent the nutrients required by crops.

Yaser Arafat (2004) made a study entitled an economic analysis of cropping pattern in U.K.P. command area he maintains that the recommended cropping pattern was expected to raise the level of profit and improve the conditions of the soil in the command area. But there was a violation of the same by the formers in the command area growing water intensive crop like paddy especially in the upper reaches of the canal system. Thereby the water of the tail reaches of the canal system was not available in sufficient quantity. Hence he argues that the violation of cropping pattern needs to be strongly discouraged.

Mohan L. (2005) explains in their study with respect to gross and net irrigated area by different sources of irrigation in Karnataka Growth rate with respect to gross irrigated area by canals was found to be positive and significant with 2.58 percent annually but no significant and positive in case of net irrigated area with 3.40 percent water availability has brought about changes in the cropping pattern and pattern of inputs utilization yield and returns of a number of crops. These changes have however, not been uniform under different sources of irrigation which are in vague in the command area. Economic evaluation of performance under various sources of irrigation which helps gain insight into policy measures to be taken up has not received adequate.

Anita B. Hanji (2006) an investigation was undertaken to assess the impact of Ghataprabha Malaprabha irrigation project cropping pattern Food consumption basket, life quality Socio-economic states and nutrition security. The production of total cereals decreased from 1, 99,485 to 1, 32,304 mt in Malaprabha and increased from 1, 94,450 to 2, 51,745 mt in Ghataprabha command area during 1981-82 to 2000-01. The production of pulses reduced in both. Tremendous increase in the production of sugarcane and oilseeds was observed in Ghataprabha (433000-1555840 and 18346-36320 mt, respectively) and Malaprapha (360420-1915624 mt 1423-29729 mt respectively command area. The availability of all the major nutrients vitamins, minerals and essential amino acids was highest during 1990-91 and lowers during 2000-01 in Malaprabha command area.

Girish N. Kulkarni (2007) study found that the cropping pattern adopted by formers was more diversified and normal soils allocated more area under water intensive crop like paddy ignoring the suggested cropping pattern. The production activities were highly limited on different degraded soils were a large (55 to 83%) proportion of the total area was abandoned from production and thereby reducing cropping intensity in the soils.

Dharmalingam S and Periasamy, G. (2010) in their article on 'Erratic Monsoon and Indian Economy' pointed out that erratic monsoon has impacted in Indian Economy in the form of distress to farmers and their families, commodity trading and price movement and food inflation. The important suggestion advocated by them is promote through Gram Sabah's community food and water security systems. They should involve establishing at the village level seed, grain and water banks. Seed banks will help to introduce alternative cropping strategies and contingency plans to suit different rainfall patterns. Also they have hoped that the recommendations of the Punchy Commission would enable the central government to take proactive decisions on the issue facing the water sector.

Hangaragi, S.S. (2011) concluded that cropping pattern of the district has not changed significantly in spite of population growth. In the present scenario needs to strengthen the irrigation facilities, soil and moisture conservation, adoption of biotechnology, forestation, changing in the cropping pattern, agronomic practices, livestock development, rural communications, development of medium, small and marginal farmers and agricultural laborers and setting up agro-based industries. The dry land development program, sericulture and small scale industries at village level should be setup through the various programs of agricultural development.

Patil R.B et al., (2012) presented the impact of water percolation tank on changing cropping pattern a case study of Rampur village of Jath Taluk, in this article water percolation tank is one of the best alternatives to solve scarcity problem and thereby increasing the possibilities of sustainable agriculture and it has became boon to rain shadow area of Maharashtra, during the last three decades the efforts have been made towards this direction. The concept of water tank is not a new to the region but, utilizing the natural sites as reservoirs the impound water available from rainfall. The store water has been utilized through the canals to the fields or somewhere the storage tanks are constructed so as to recharge the water table. Moreover, the increasing the water table further leads to the development of well irrigation and changes in cropping pattern of the region.

Ahmad Fahim Rahimi et al., (2014) summaries in their study the pattern of cropping is a major feature of the agricultural land use in an area. Systematic understanding of cropping pattern changes over the years is very important, for the farmers to get better returns, for the entrepreneurs to decide the government and lawmakers to check over or under production of farm products, thus ensuring the required overall balance. The present study was undertaken with an objective to study the temporal changes in cropping pattern, cropping intensity and factors determining these changes over the years in Karnataka. The study used 30 years time series data on area under different crop categories and crops collected from Bureau of Economic and Statistics Bangalore. There was a shift in area under different crops mainly from cereals and commercial crops to pulses, fruits and vegetables during the study period. The concordance coefficient indicated that there were considerable changes in crop area shares over a period of time. There was a considerable increase in cropping intensity over the years.

Deccan Herald (2014) observed that India is among the world's top five nations in cultivating genetically modified (GM) crops according to a new survey by international service for the acquisition of agri. biotech applications, an industry lobby group. This is almost three times more than what china sows. The US tops the list with 70 million hectares under genetically hectares genetically modified maize, soya bean, cotton, canola, sugar bet, alfalfa, papaya and squash. The next two are Brazil and Argentina followed by India, which is the leader in Asia. Canada grows marginally lesser than India. Indian formers cultivated genetically engineered Bt cotton in 11 million hectares (ha) of land with an adoption rate of 95 percent as of 2013. Globally biotech crop acreage increased from 1.7 million ha in 1996 to over 175 million ha in 2013. This means a 100 fold increase over a 18 year period according to the survey.

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