

Research Article – Agriculture

## Water resource development and management for agricultural sustainability

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### Abstract

Agricultural production can only be sustained on a long term basis if the land, water and forests on which it is based are not degraded further. Improvements in water resources management are essential to raise agricultural productivity and reduce land degradation and water pollution. Salinization, alkalization and water logging should be addressed by a more careful approach to drainage and the regulation of water quantities through efficient use of irrigation water, which require that water be applied to growing crops at appropriate times and in adequate. The integrated management of water resources could only be possible through adoption of efficient and optimum use of irrigation water, which could only be ensured by judicious and economic use of irrigation potential whatsoever created to increase crop production. The integrated water resources management also includes the concept of rainwater management that has got an immense important on the way to develop the rainfed farming system. It has got relevancy particularly in installing small-scale irrigation system based on farmers' participatory approach for sustainable crop production for maintaining sustainable growth and development of agriculture. Modern irrigation techniques like sprinkler and drip should be promoted when water is scarce and the topographic and soil conditions do not permit efficient irrigation by conventional methods. Promotions of such water saving devices should be an objective of the national water policy. Water resource management is a integrated and multidisciplinary activity, managing irrigation water that needs agronomy and crop husbandry, efficient methods and system of irrigation needs soils scientists and engineers. More than 98% of the irrigated lands are under the coverage of surface irrigation where more than 50% of water as considered as wastages wherein effective minimization of wastage of water used for irrigation and application of right quantity of water at right time will be the key to successful management of this crucial resource. So question of judicious management of water is pertinent while prioritizing researchable issues became of national importance.

*Key words:* Water Management; Researchable Issues; Production Sustainability

### Introduction

Despite fact that more than two-third of the earth's surface is covered with water, currently, near about 450 million people in 29 countries are facing severe water shortage and at least 20 percent more water would be required to feed additional 3 billion population by 2025. About 97.5 percent

of ocean-sea water are not available due to its salinity and 2.49 percent is locked up in ice and only 0.01 percent is technologically available and economically accessible water either from surface or ground water sources for human uses. So water saving technologies developed so far is very pertinent to propagate amongst the users. Water is an essential natural resource for sustaining the environment and supporting life where the agriculture is the major user of water resource. Water is an indispensable for sustainable agricultural growth and development. Previously, rainfed agriculture

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was associated primarily with conservational land treatments to check soil erosion and land degradation. But in the areas of medium to heavy rainfall, there is ample scope of tapping excess rain water through suitable water harvesting structures constructed for this purpose for its subsequent uses as irrigation or to apply life saving irrigation to the crops which should also come under the purview of water management for crop production. Although there is a difference in the objectives of water management where there is abundant availability of water from continuous flow connected with perennial sources or lakes and rivers and that of from restricted or limited supply from collection of excess rain through water harvesting structures. The former is associated with to obtain as much as yield of crop per unit area under water application and later is associated with increasing productivity of crop per unit of water application even under rainwater recycling and its effective management for the purpose of irrigation. Hence, both the rainwater and irrigation water are considered to be equally important to context of agricultural development of the country to get higher water use efficiency and proper utilization of water resources.

#### **Available water resources**

The water resources of the country constitute only a tiny fraction of the total water resources of the earth. The total amount of water in the hydrosphere has been estimated at about 1500 million Km<sup>3</sup>. About 95 percent of it is contained in the oceans and seas. The remaining 5 percent is fresh water, of which (4/5) is stored in the form of snow and ice or permafrost, about half this frozen water is contained in the polar ice caps. Thus the fresh and unfrozen water of earth constitutes only 1 percent of that in the hydrosphere. Bulk of it, estimated 0.9 percent, is ground water and only percent is in lakes, river soils and atmosphere. About half of the ground water is more than 1,000 m below the surface and a good amount is between 500 to 1000 m. Water at these depths is very expensive to draw.

Precipitation in the form of rain and snowfall is the main source of water in the country, although some water flows from across the borders. The natural precipitation is highly variable and erratic over the vast Indian sub-continent. The annual rainfall varies greatly being as high as 1000 cum in Chirrapunji in eastern part of India and as low as 100 mm in the than desert of Rajasthan. The

classification of area according to rainfall indicates that about 20 percent area receive high rainfall (>1125 mm), 36 percent area comes under the category of medium rainfall (750-1125 mm), 22 percent geographical area has low rainfall of 350-750 mm and 13 percent area receives very low rainfall of <350 mm. Even under high rainfall area it is not uniformly distributed throughout the year. The pattern of rainfall indicates that this important source of water is not available uniformly in different parts of the country. In some parts, rainwater is received in excess quantity and a major part of which is lost by runoff. In other parts also, because of non-uniformity in the distribution of rain, it is lost to rivers, while in low rainfall areas it is not sufficient even to meet the daily evaporative demand of the atmosphere. Besides, more than 75 percent of the annual rainfall comes during 2-4 months between July and September. This causes many areas dry for month part of the year which necessitates the application of irrigation to help the crops grow. Provision of irrigation is possible by harnessing the surplus after the high rainfall period in the high rainfall areas as also the water that seeps into the soil and forms the water table. As per estimates of the National Commission of Agriculture (1976), the average annual rainfall (112 mm) over the total geographical area of India (328 in ha) is around 370 m ha m. To this is added another 20 m ha m which is brought in from catchment areas lying outside the country. Thus the total rainfall in India is about 400 m ha m. It is estimated that about 85 m ha m of water seeps in to the soil, contributing to the profile storage and ground water and 130 m ha m evaporates into the atmosphere. The remaining 185 m ha m contributes the average annual surface water flow in different rivers, of which only about 70 m ha m constitutes the average annual surface water flow in different rivers, of which only about 70 m ha m is utilizable owing to the topographical, hydrological, climatic, soil and other limitations. The utilizable ground water resources of the country is assessed as 45.23 m ha m. Thus the total utilizable quantum of surface and ground water is about 115 m ha m.

#### **Irrigation development in India**

After independence the main efforts of the Government of India and the various state Governments have been aimed at bringing more and more area under irrigation. As a result, the

irrigation potential increased from 22.6 m ha in 1950-51 to 96.9 m ha in 1996-97. However, the actual utilization of the irrigation potential increased from 22.6 to 86.5 m ha during the same period, leaving a gap of about 10 m ha unutilized irrigation potential at the end of 1996-97 there is an imperative need to step up the rate of utilization of the potential already created and the loss of irrigation water should be reduced. There has been a fast rate of increase in the gross as well as net irrigated area in the country during the past forty years due to the rapid development of irrigation potential. The gross irrigation area increased from 23.2 m ha in 1951-52 to 65.1 m ha in 1991-92 and the proportion of irrigated area to total cropped area increased from 17.4 percent in 1951-52 to more than 35.8 percent in 1991-92. However, the development of irrigation in all parts of the country has not been uniform and there is large disparity amongst the various zones in respect of the area under irrigation. Irrigated area during 1992 – 93 was as high as 93.3 percent in Punjab, 75.6 percent in Haryana, 65.6 percent in UP and as low as 13.7 percent in Maharashtra, 14.9 percent in Kerala and 27.6 percent in Gujarat.

### **Water used in agriculture**

Available water for agriculture was 85 percent during 1990, which is likely to decrease to 43.3 percent by 2050 AD. Agriculture therefore, will have to increasingly depend not only on a lesser share but also upon waters of poor quality. The demand of water for domestic, energy and industrial use is likely to increase from 10.7 percent in 1990 to 12.0 and 23.1 percent by 2000 and 2050 AD. Therefore, this finite and precious resource needs to be managed in the most efficient manner possible.

### **Major problems related to sustainable water development**

Agricultural production can only be sustained on long-term basis, if the land, water and forests on which it is based are not degraded. Many interrelated issues and problems which are not unfamiliar, can be identified in this regard as follows:

- i) Development of Water logging and salinity;
- ii) Deforestation, erosion and sedimentation;
- iii) Depletion of groundwater;

iv) Water pollution; and

v) Inefficient water use at the farm level

### **Water logging and salinity**

The most widespread and perhaps most serious environment problems that contributed to unsustainable water resource development in agriculture is caused by water logging, salinization and sodification. To a degree almost every irrigation system contributes to water logging and salinization but the problem is aggravated when irrigation projects are not properly planned and managed and improper water management practices are adopted.

### **Erosion and sedimentation**

Deforestation, erosion and sedimentation problems according to FAO Tropical Forest Resource Assessment Report (1996) between 1981 and 1990, India suffered deforestation to the tune of 0.6 percent per year which is equivalent to 3.37 m ha per year (Singh, 1998). Yearly cost of forest replacement (Down to Earth October 15, 1956) is conservatively estimated to be Rs. 641 crore. Deforestation can cause soil erosion 10 to 100 times greater than the 'natural' levels, leading to the salutation of river channels, lakes and dam storage schemes and to increased downstream flooding. More than 20 million of lands are flooded annually due in part to deforestation in the neighboring countries.

### **Depletion of ground water**

Ground water mining is a major problem in many parts of the country. The rate of pumping of extraction exceeds the rate of recharge of the aquifer resulting in decline of the ground water level, thus disturbing the hydrological balance. In some cases, ground water mining leads to the deterioration of water quality.

### **Water pollution**

Water pollution and the present state of water quality mis-management are of major concern to many people. Irrigated agriculture with its associated intensive cultural practices, such as high levels of fertilizers and agrochemical use and deep percolation of water contribute to water pollution. Nitrate contamination of ground water is likely to be of importance where rural water

suppliers are concerned. Major source of nitrate containing wastes are from drainage effluents, deep percolating water from high fertilized irrigated fields. These are reports that ground water is contaminated with high concentration nitrate, fluoride, arsenic and many heavy metal ions. Arsenic Toxicity of ground waters in west Bengal and fluoride toxicity in Rajasthan, Delhi and Haryana one the glaring examples of degradation of ground water by toxic ions. All the rivers in India carry the town and industrial wastes, the river water contains all sorts of pollutants both organic and inorganic in nature and is a constant threat to crop and animal productivity including human health. Degradation of water resource thus has become now a subject of major concern.

#### **Inefficient water use at the farm level**

Huge amounts of water are lost during conveyance and distribution. Water from the main reservoir is led to the field through main canals branch canals, distributories and minors, conveyance losses of water in irrigation project of the country range from 22 to 50 percent depending upon the location and level of management (Bos and Nugteren 1974). National Commission on Agriculture (1976) also has stated that in the Indo-Gangetic plains, 45 percent of the water diverted at canal head work is lost by seepage in the distribution system and 20 percent of the water diverted at the canal outlet is lost in the field water courses. The national commissions on irrigation in their report have noted that hardly 20 to 30 percent of the water resources created at a huge cost to the nation, is utilized for crop production and the rest is lost at various stages.

#### **Management of water resources**

Water is the most precious commodity and its rational development, conservation, distribution, use and management need special consideration for improving productivity of land, better efficiency and economic returns, and preserving the ecological balance. Some important management issues for better utilization of available water resources are:

- i) Exploitation of water resources;
- ii) Increasing irrigation efficiency;
- iii) Improving drainage;

- iv) Increasing water use efficiency; and
- v) Crop Planning in relation to water availability.

#### **Research Prioritization in the field of Agriculture**

1. Generation of suitable technologies on rain water harvesting and recycling of excess water for its effective use for crop production;
2. Evaluation of suitable rice and other crop cultivars along with improved agro-techniques for Coastal saline zone;
3. Study on reclamation of salinity, use of saline water for irrigation, breeding of salt tolerant varieties of crops and better agronomic practices suitable for Sundarban area for higher yield and effective utilization of saline soil;
4. Effective utilization of low land eco-system through integrated farming with rice-vegetable and fish components;
5. To mitigate the arsenic problem in water with suitable technology available to the farmers;
6. Studies on system management for scheduling irrigation to crop(s) and crop sequence(s) with judicious and conjunctive use of rain/canal and ground water keeping parity with optimum level of ground water;
7. Studies on ground water fluctuations, its adverse effect on soil health as well as to evolve the methodology to raise ground water table;
8. To studies on the crops like date palm, swamp taro, colocasia, lettuce, water chestnut and other in view to meet the ever increasing food demand;
9. Management of horticultural crops in orchards, flowers and vegetable to find out suitable alternative of rice crop and to introduce less budget high value crops;
10. Evaluation of traditional rice varieties for its selection for suitable bye-products as well as co-products employing indigenous technologies for alternate use of rice;
11. To develop suitable agro-technologies for rain fed farming based on farmers participation and introduction of crops with less water requirement;
12. To replace the summer paddy by other substitute crop(s) without hampering the economic benefits of the farmers;

13. To utilize the plant protection measures more efficiently introducing IPM;
14. To introduce pair/mixed crop in risk prone areas to ascertain the farmers benefits more effectively;
15. To increase the area under adaptive and innovative trials on several aspects of agricultural production enhancement activities based on participatory approach.
16. Development of submerged and mercy land (*jheels and beels*) having hydromorphic characteristics for its for utilisation to increase agricultural productivity.

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