



Land and Water Management Strategies for Improving Agricultural Productivity of Farmers

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INTRODUCTION

Land, water, air and energy are the important resources, essentially required for sustenance of life on this planet. Without these resources, existence of life can't be imagined. These resources are diminishing due to indiscriminate and unscrupulous exploitation. Immense pressure on our resources can be gauged from the fact that India shares 2.5% geographical area and 4% water resources of the world but supports 16% human population and 18% livestock of the world. In order to feed ever increasing population there is a need to develop a comprehensive strategy so that the available resources are utilized efficiently, judiciously, equitably and sustainably.

The term 'Sustainable Management' is defined as conservation, utilization and equitable sharing of benefits from natural resources in such a way that needs of present are met without compromising the ability of future generations to meet their own needs. There are many dimensions of sustainability. These dimensions are (i) Physical, (ii) Economic, (iii) Environmental, (iv) Social, (v) Scientific, (vi) Professional, (vii) Technological, (viii) Institutional, (ix) Legal, and (x) Political. Sustainable management requires combined and joint consideration of all the dimensions of sustainability with respect to land and water resources under specific national and local conditions.

Physical sustainability means long term integrity of quality and quantity of the resources; dealing with spatial and temporal variability including extremes. Economic sustainability means resources should be beneficial to consumers as well as nation with affordable cost. Environmental sustainability is possible when long term viability of bio diversity and environmental quality is achieved. Social sustainability means land and water management suited to cultural and social conditions taking into account intra-generational and inter-generational equity. Scientific sustainability means possession of knowledge and ability to generate knowledge about these resources. Professional sustainability can be achieved if capacity to use the knowledge is generated. Technological sustainability means possession and control of technologies to implement the knowledge. Institutional sustainability means capability for developing and executing policies. Legal sustainability means ability to manage resources legally and political sustainability refers to policy making and execution of policies.

Land and Water Resources of India

In India, out of 328.7 M ha of geographical area, 142 M ha is the net cultivated area. Of this about 57 M ha (40 percent) is irrigated and the remaining 85 M ha (60 percent) is rainfed. About 146 M ha is classified as degraded although varying estimates have been provided by different agencies. The ownership of land is highly skewed, nearly 65% of the rural households owning less than one ha. The landless population amounts to over 12% of rural households. Fragmentation of farm holdings continues unabated. Per capita land availability has also dropped from 0.48 ha in 1951 to 0.16 ha in 1991 and is projected to drop to 0.08 ha in 2035. The soil health has been deteriorating, especially widespread micro-nutrient deficiencies (hidden hunger) and fast depleting carbon content, resulting low and decelerated total factor productivity growth rates.

India annually receives total precipitation of 4000 BCM but more than half of it finds its way back to sea and total water availability is estimated as 1869 BCM. Out of this total utilizable water is 1122 BCM (690 BCM surface water and 432 BCM

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ABSTRACT

Land and water are finite natural resources but due to indiscriminate and unscrupulous use, these resources are diminishing at a faster pace. Immense population pressure, over exploitation of mother earth and water resources, deterioration in quantity and quality of these resources resulting in pollution of soil, water and environment due to greedy nature of human beings, gap in availability, accessibility and affordability of resources and latest technologies, lack of extension, training and awareness campaigns to demonstrate suitable land and water management technologies/ strategies/ policies are some of the major bottlenecks and need to be addressed continuously. Many land management technologies including, proper allocation of land under different climate resilient crops to maximize net return, medicinal and aromatic plantation in waste lands, optimum utilization of waterlogged lands, soil health and nutrient management technologies, land reclamation, promotion to organic farming as well as soil conservation measures need to be adopted. Similarly some water management technologies including rain, surface, ground water and on farm water management technologies conjunctive use and multiple uses of water, efficient and appropriate irrigation methods and scheduling, water auditing and water budgeting, Participatory Irrigation Management (PIM) in canal command, Integrated Participatory Watershed Management (IPWM), solar energy utilization are required to be adopted. there is sufficient scope to improve agricultural productivity, provided land and water resources are utilized efficiently and judiciously.

KEYWORD

Land, Water, Management, conjunctive, irrigation

Ground water). Per capita water storage in India is only 262 m³ against 1111 m³ in China, 3145 m³ in Brazil and maximum 6103 m³ in Russia.

Gross irrigated area went up by over 300 percent from 22.6 M ha in 1950-51 to 57 M ha (gross irrigated area over 75.1 M ha) in 2000-01, using over 80% of all fresh water, India ranks first in the world in irrigated acreage. The ultimate irrigation potential for the country has been estimated at about 140 M ha (59 M ha through major and medium irrigation projects, 17 M ha through minor irrigation schemes and 64 M ha through ground water development). So far irrigation potential of nearly 100 M ha has already been created, but only 86 M ha is being utilized, thus leaving a gap of 14 M ha between created and utilized potential. While the north zone of India has already developed 87% of its groundwater, the east zone has over 70% of its groundwater unexploited for irrigation purposes. The irrigation intensity is only 135 percent. Besides low water use efficiency, there is high inequity in water use and irrigation development. Over 29% of the blocks in the country are in the category of overexploited area of groundwater use. Nearly 60% of the blocks in Punjab and 40% of the blocks in Haryana have turned "dark" and overexploited in the heartland of green revolution.

Strategies for Sustainable Land and Water Resources Management

In order to address various issues like scientific land use planning, reclamation of soil acidity, salinity and alkalinity, proper diagnosis of soil, judicious use of chemical fertilizers and irrigation water, deficiency of micro-nutrients and maintenance of soil health for improved soil and land productivity and to develop sustainable land management strategies, reliable database and information on soil and land mapping need to be generated using 1:50000 scale after following three steps i.e. (i) Delineation and codification of sub-watershed/micro-watershed that allows to have a viable hydrological unit for planning and development purposes, (ii) Identification and demarcation of priority watersheds to adopt selective approach in development programme, and (iii) Generation of data on soil and land characteristics on 1:50000 scale that provide the status of catchment area. Out of the above datasets, broad land capability classes could be derived that would guide in soil and water conservation planning at micro-level.

To develop and manage the degraded lands that are suffering from acidity, salinity, alkalinity, waterlogging, soil erosion etc., it is essential to generate database on degraded lands with spatial extent using remote sensing techniques on 1:50000 scale. Subsequently, to develop the priority watersheds or degraded lands, soil database on larger scale preferably on 1:4000/1:10000 is essential that would allow proper diagnosis of soil and to adopt suitable soil and land reclamation measures, scientific land use planning vis-à-vis the diversification in crop planning. Such detailed database is essential not only for the degraded lands in rainfed area but also for command area where salinity, alkalinity and waterlogging are acute in nature. It would also allow generating soil health card and reclamation of problem soils.

In addition to this, there is a need to address the issues related to land reform with particular reference to tenancy laws, land leasing, distribution of ceiling surplus land and wasteland, providing adequate access to common property and waste land resources. Moreover, as far as possible, agricultural land should not be diverted to non-agricultural use and organic farming, farming of medicinal and aromatic plants on waste lands, Integrated Farming System should be promoted to optimally utilize the land and improve income and livelihood of poorest of the poor in the country.

Chandra *et al.* (2007) reported that various resource conservation technologies like zero tillage and bed planting when applied on wheat crop in Haryana saved precious water and ultimately land and water productivity enhanced substantially.

Excessive and imbalanced use of inorganic fertilizers is responsible for deteriorating health of soil and ultimately resulting in soil pollution. There is a need to shift towards organic farming slowly and gradually because it is a system based approach. Upadhyaya (2012a) developed a conceptual integrated organic farming model for an acre plot in such a manner that output of one component was input to other components and wastage was minimum. This model was environment safely too.

Laser land leveling removes unevenness of fields, which is primarily responsible for inefficient use of water. It has been reported that Laser land leveling when applied under various crops and cropping patterns has resulted in water saving up to 15-30%. Besides this, it facilitates better crop establishment and enhanced input use efficiency as compared to traditional land leveling. Evenly distributed irrigation water on laser-leveled field reduces weeds in cropped field. It also reduces farm operating hours, saves labour cost and increases productivity.

Upadhyaya (2017) and Upadhyaya and Roy (2018) formulated problems of land allocation under different crops subject to prevailing constraints of farmers and solved these problems employing simplex method of linear programming. The optimum solution gave the land area allocated under different crops, which maximized the net returns and land productivity.

For sustainable water resource management following strategies and actions are recommended.

- (i) Upadhyaya (2007) suggested the need to explore and promote rain water harvesting, ground water recharging techniques and watershed management in rainfed areas.
- (ii) Water auditing (actual assessment/measurement of water consumed under different activities in agriculture) and water budgeting (estimate to water to be allocated under different activities) need to be monitored and evaluated to understand the gaps and misuse of water. This will lead to water conservation and efficient water utilization ultimately resulting in

enhanced income per unit of water consumed and thus enhancement in agricultural productivity.

- (iii) Prevent/ discourage unsustainable use of ground water resources in critical zones, develop the resource in unexploited zones, and increase awareness of farmers and other stakeholders about the value and scarcity of water and negative fallouts of improper use.
- (iv) Possibilities for conjunctive use of rain, surface and ground waters should be explored in good quality shallow ground water zones. Upadhyaya (2012b) developed a Decision Support Tool to explore and promote conjunctive use in canal command and reported that the developed DST is quite convincing to the farmers to adopt conjunctive use. Upadhyaya (2017) demonstrated the DST with the help of an example in which data collected from farmer was used.
- (v) Upadhyaya (2015) discussed various water management technologies like (i) raising bund height around rice fields to arrest maximum rain water in the fields and minimize runoff, (ii) conjunctive use of rain, canal and ground water for timely rice establishment, (iii) multiple uses of water by rearing fish in pond, growing horticultural and vegetable crops on bunds of pond and irrigation through pond water, (iv) application of efficient pressurized irrigation system like Drip, micro sprinkler and Low Energy Water Application (LEWA), (v) lining of water channels to reduce seepage losses, (vi) mulching to minimize evaporation and conserve moisture, (vii) efficient water pumping, distribution and storage devices, (viii) irrigation scheduling, and (ix) integrated water resources management approaches.
- (vi) Upadhyaya (2016a) reported that water availability in canal is inadequate, untimely, unreliable and irregular. Due to this, there is a large gap in water supplied and

water required by users. Adequacy, equity, flexibility and timeliness were reported to be the most important factors for efficient utilization of canal water management. Need for formation of Water Users Associations (WUAs) and frequent dialogues among water suppliers and water users was mentioned to improve canal water utilization.

- (vii) Upadhyaya (2016b) discussed that by applying limited irrigation water at the critical crop growth stages, when water is essentially required, lot of water can be saved without adversely affecting the crop yield thus improving water productivity. So there is a need to develop and adopt water use efficient cost-effective and eco-friendly crops, cropping patterns and technologies.
- (viii) Upadhyaya (2016c) presented integrated water resources management and climate change adaptation strategies. Since climate change is being realized more frequently occurring phenomenon, strategies to minimize the adverse impact of frequent floods, droughts and other calamities should be chalked out and implemented.
- (ix) Institutionalize participatory management of water (Water Users Associations, including proactive women's participation), rationalize water pricing and operational and maintenance charges and distribution of irrigation water and equitable access to water as a common resource.
- (x) Upadhyaya and Sikka (2017) presented the concept of land, water and energy productivity. Since resources are shrinking and population pressure is increasing, only way for survival is to efficiently and sustainably utilize land and water resources by minimizing wastage and conserving these resources quantitatively and qualitatively.

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