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Sustainable Farming and Water Management of Wheat, Rice, Sugarcane and Potato

Sachin Gangwar

MBA (ABM), Faculty of Commerce and Management, Rama University, Kanpur, Uttar Pradesh, India

ABSTRACT

The study to evaluate the sustainable farming and water management with reference to crops wheat, rice, sugarcane, and potato. Water availability is detrimental to agricultural development and food production. The ever-increasing population pressure leading to enhanced demand for food production mandates increase in irrigated area. However, menace of pollution and diversion of fresh water for other uses like industry has stressed the fresh water resources. Low irrigation efficiency, usually less than 65% of the applied water is actually used by the crops necessitates enhancement in sustainable use of irrigation water.

Efforts are being made by various stakeholders for better management and optimization of water consumption in agriculture. Better management usually refers to improvement in irrigation techniques and water use efficiency of crops. The former is closely related to the type of irrigation technology, environmental conditions and the scheduling of water application and latter involve Agricultural practices, such as soil management, fertilizer application and disease and pest control.

Socio-economic factors and climate change influence the pattern of agricultural water use. Sustainable Agriculture and water management is heavily dependent on social behaviour of rural communities, economic constraints and legal & institutional framework that may favour the adoption of some measures over others.

Sustainable water management in agriculture, which has a multi-functional role, can be achieved by adopting improvements in irrigation application, soil and plant practices, water pricing, reuse of treated wastewater, farmers' participation in water management and capacity building. Equitable distribution and technological application of above initiatives is necessary for the most sought results.

This paper focuses on key factors which influences agriculture productivity and discusses State-of-Art technologies that are economically viable for sustainable agriculture. The adoption of these techniques can improve the agriculture output mitigating the adverse impact of climate change and constraints imposed by socio-economic factors.

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INTRODUCTION

The concept of sustainable farming has come up because yields from modern farming technique (modern Commercial Farming) reaching a plateau and the environment problems due to excessive use of chemicals and fertilizers and pesticides residue in food chain.

Sustainable agriculture is that form of farming which produces sufficient food to meet the needs of the

present generation without eroding the ecological assets and productivity of life supporting system of future generations.

Natural farming is an excellent illustration of sustainable agriculture. It is also known as ecological farming/eco farming or organic farming or permaculture.

Exploitation of Water Resources

The annual precipitation, which is ultimate source of water, is estimated for the country at 400mha. The average natural runoff as per estimate of CWC (1987) is 180mha, while annual replenishable ground water is about 60mha. At the end of 1996-97 the total irrigation potential created is 97.8mha, which is 81 percent ultimate potential of 113mha (Raddy, 1998). Irrigation at present accounts for nearly 84 per cent of water requirements (Hashim, 1998). As a result of ineffective water management, there is a gap of about 9.8mha between the water resources created and utilized by 1996-97 (Reddy, 1998). Irrigation efficiency in India is estimated between 38 to 40 per cent for canal irrigation and about 61 per cent for ground water schemes (Hashim, 1998). Optimum efficiency is about 60 per cent for canal schemes and 75 per cent for ground water schemes. Low irrigation efficiency in the Canal Command Area (CCA) is an important source of water logging, land degradation and soil salinity (Yadav, 1998).

Problems of Water Management in Agriculture

1. Scarcity of good quality irrigation water.
2. Poor quality of ground water.
3. Erratic, ill distributed and highly undependable rainfall pattern.
4. Semi-arid to arid climate in most part of the state.
5. Inadequate natural drainage and lack of outlets for drainage.
6. Rise of water table in canal irrigated areas at an alarming rate posing serious problem aggravating the situations in areas having brackish underground water.

REVIEW of LITERATURE

Irrigation is the artificial application of water to land for growing crops or trees.

Israelsen and Hansen (1962), the artificial application of water for the purpose of supplying moisture essential to plant growth is called Irrigation.

- **Free or gibbs free energy:** The free energy of a saturated soil is zero but in unsaturated soil, it is less than 0, hence its value is negative.
- **Matric Potential:** The portion of total water potential that is attributable to the solid colloidal matrix of the soil system. It is negative pressure potential which results from the capillary and adsorptive forces emanating from the soil matrix.
- **Capillary Potential:** Buckingham (1907) introduced the concept of capillary potential to define the energy with which water is held by soil.
- **Gravitational Potential:** Due to gravitational force field and is dependent on the evaluation.
- **Seepage:** Horizontal flow of water in channel is called seepage. Water loss from the irrigation channel or canal is mainly due to seepage.
- **Percolation:** Vertical movement of water in the soil i.e. downward flow of water in the soil is called percolation. It occurs in water saturated soil.
- **Infiltration:** Downward movement of water from the upper layer of soil is called Infiltration. It occurs in unsaturated soil.
- **Leaching:** Downward movement of nutrients and salts from the root zone with the water is called leaching.

Schofield (1935) PF is the scale like PH through which we measure the force with which water is retained is capillary or soil. F denotes 'force'. It is an exponential expression of a free energy difference (based on height of a water column above free water level in cm). It is defined as the logrithm to the base 10 of the numerical value of the negative pressure of the soil moisture expressed in centimeter of water.

Briggs and Shantz (1912) Proposed the Permanent Wilting Point (PWP). They utilized dwarf sunflower (Helianthus anus) as indicator plant.

Higher the clay content of a soil, higher its hygroscopic coefficient. Organic matter also enhances it.

Objective of Study

Identify best sustainable practices

- To protect, conserve & improve the land resources for efficient and sustained production.
- To protect and enhance water resource, moderate floods & reduce silting up of tanks, increase irrigation and conserve rainwater for crops and thus mitigate droughts.
- To utilise the natural local resources for improving agriculture and allied occupation or industries so as to improve socio-economic conditions of the local residents.

Compare water efficiency among crops

Water Harvesting/Runoff Concentration/Rainfall Precipitation in humid climates, runoff usually occurs

only when rainfalls on a saturated soil. Under semi-arid conditions, the total annual precipitation may or may not be sufficient, but most of the rain falls in a short period causing humid climate conditions and resulting into runoff. In both conditions, the excess rain water should be safely guided and collected in nearby ponds for recycling in drier period for life saving irrigation.

Examine the crops-specific water requirement

Rice:	1200-1500 mm
Sugarcane:	1500-2500 mm
Wheat:	450-650 mm
Potato:	500-700 mm

To analyze the role of climate and soil conditions

That portion of the precipitation which is not absorbed by the soil but finds its way into the streams after meeting the persistent demands of evapo-transpiration including interception other losses. In another words, runoff is the excess water from precipitation that moves out of field and finds its way to river, lakes and oceans etc.

Research Methodology

Primary and secondary data collection methods were little use as well as some frameworks including those pertaining to social-ecological systems, agrarian systems or evolutionary economic geography. To remedy this, under-used methods would benefit from being pro-actively promoted and taught, and from concerted efforts to build shared, stable nomenclatures about meanings and protocols. Data is collected from the field (directly from the farmers) and some of the data is taken from the research paper by ICAR, articles of FAO, agriculture and agronomy books, journals etc.

Sustainable Farming and Water Management in with Reference to Wheat, Rice, Sugarcane, and Potato.

WHEAT

Wheat is a stable food for a significant portion of the world's population, making its production crucial for global food security. However, conventional wheat farming practices often contribute to environment degradation, including soil erosion, water depletion, and greenhouse gas emissions. To address these challenges, farmers are increasingly adopting sustainable practices that promote environmental stewardship, economic viability and their benefits.

Sustainable Farming in Wheat

Sustainable farming is an approach of farming that aims to minimize soil disturbance, maintain soil cover, and diversity crop rotations. In sustainable farming systems, and increase water retention. By preserving soil health, sustainable enhances the long-term productivity and sustainability of wheat farming.

Water Management in Wheat

Majorly used irrigation methods in wheat are flood irrigation and sprinkler irrigation:

Flood Irrigation: Flood irrigation is an ancient, low-tech method of watering crops where water is delivered to a field via ditches or pipes and flows across the ground using gravity.

Sprinkler Irrigation: Sprinkler irrigation is a method of applying water to crops in a controlled manner that mimics natural rainfall. Water is pumped under pressure through a network of pipes and sprayed into the air through nozzles, allowing it to fall as small droplets over a wide area, suitable for most crops and uneven. Water is applied as a spray or as rain over the crop. Rate of water delivery is more than 1000 litre/hour. It operates at pressure of more than 2.5atm & throw water as a spray up to the distance of more than 10 metre.

Irrigation stages

1. CRI (crown root initiation): 20-25 Days After Sowing (DAS)
2. Tillering stage: 40-45 DAS
3. Jointing stage: 60-65 DAS
4. Flowering stage: 80-85 DAS
5. Milking stage: 105-110 DAS
6. Dough stage: 120-125 DAS

RICE

Rice is a vital tropical cereal crop, providing -rice is cultivated in kharif season in hot & humid conditions temperature ranges between 21°C to 37°C.rice is a crop that need Extensive water, flooded fields are used to manage weeds & pests. Major rice Producing countries are China, India, Indonesia etc. nearly 90% of world's total Rice is grown in Asia. The crop is harvested once the grains turned golden and the Plant matures. Rice is rich in carbohydrates, moderate protein & low fiber.

Sustainable Farming in Rice

Rice farming is the cultivation of rice, but in Asia it goes far beyond the field, and it is not just a staple crop. It is a livelihood for millions of smallholder farmers who depend on it not only for food, but also for income. When we talk about climate change - rising temperatures, unpredictable rains, more frequent droughts and floods - we're not just talking about abstract global trends. We're talking about very real, very personal impacts on the people who grow our food and safeguard the food security we all depend on.

That's why in rice farming, sustainability isn't just an environmental target to hit. It's about helping farmers weather the storms - literally and figuratively - while still putting food on the table and securing their future.

Water management in Rice

Methods of Irrigation in Rice:

Direct Seeded Rice: DSR is a modern rice cultivation technique where rice seeds are directly sown into the field, replacing the traditional method of transplanting seedlings. These methods use less amount of water than the other methods of irrigation such as flood irrigation.

- Restoring irrigation to a maximum depth of 2.5cm after development of hairline cracks in the soil until panicle initiation.
- Increasing irrigation depth to 5.0cm after panicle initiation one day after disappearance of ponded water.

Irrigation Stages

1. Booting stage: Most critical stage for water critical stages.
2. Tillering stage (0-20 days)
3. Growth to flowering (40-60 days) in dwarf rice. At these stages, submergence (5cm) of water is must.

SUGARCANE

Sugarcane is one of the important sugar crops. Sugarcane is mainly produced for its juice that contain 10% to 20% of sucrose and 85% of water content. Sugarcane is such type of crop that has a great economic importance. Its juice used to produce white sugar, jaggery etc. Its bagass is used in electricity production and paper industry while its molasses is used to produces alcohol. The top part that is green is used for fodder purpose. Major sugarcane produces nations of the world are India, Brazil, China, and Cuba. India grows nearly 24% of total area of sugarcane growing in the world. Major sugarcane producing state of India are Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka etc.

Sustainable Farming in Sugarcane

The Sustainable Sugarcane Initiative (SSI) aims at providing practical options to the farmers in improving productivity of land, water and labour, all at the same time. SSI is also expected to reduce the overall pressure on water resources and contribute to recovery of ecosystems. Sustainable Sugarcane Initiative is an innovative method of sugarcane production using less seeds, less water and optimum utilization of fertilizers and land to achieve more yields.

- Raising nursery in portrays using single budded chips
- Transplanting young seedlings (25-30 days old)
- Maintaining wider spacing (5*2 feet) in the main field
- Providing sufficient moisture through efficient water management technologies viz., drip fertigation (sub or sub surface)
- Encouraging organic method of nutrient and plant protection measures
- Practicing intercropping with effective utilization of land.

Water Management in Sugarcane

Methods of Irrigation in Sugarcane:

Furrow Irrigation: Furrow irrigation is most commonly used and is particularly effective for early plant crop.

Reduced furrow length is sometimes used to allow better distribution of water over the field in a later stage.

Surface Drip: The application of water to the soil surface as drops or a tiny stream through emitters placed at predetermined distance along the drip lateral is termed as surface drip irrigation.

POTATO

Potato is most important food crop of the world. It is economical crop and referred as poor man friend. Its origin is in South America. It is rich source of starch and vitamin. It is used as vegetable also used for making chips. It is used for several industrial purposes for production of starch and alcohol. Potato is grown almost in all states. Uttar Pradesh, West Bengal, Punjab, Karnataka, Assam, and Madhya Pradesh are major potato growing states.

Sustainable Farming in Potato

Potato farmers use sustainable growing techniques to ensure healthy crops for generations. The soil is cared for year-round and involves the addition of compost, rotation of crops, and growing cover crops. This approach reduces erosion and adds nutrients to the soil naturally. Great care is taken to conserve water and reduce evaporation with constant irrigation monitoring.

Farmers use innovative technology, including tools to track rainfall and subsurface irrigation, allowing him to grow a bountiful crop using less irrigation and fertilizer.

Water Management in Potato

Irrigation has a special significance in the potato production as the plant ha shallow and sparse root

system. First irrigation should be light and given 5-7 days after planting and subsequent irrigation are given at 7-15 days interval depending upon the climatic condition and soil type.

The drip system of irrigation is most economical giving highest productivity and saving almost 50% water. It also enables application of fertilizer through irrigation water.

The sprinkler system gives uniform distribution of water and reduces water losses by percolation and runoff. Sprinkler irrigation is beneficial on frosty nights as it reduces frost damage in potatoes. It is recommended for area with undulating topography, extremely sandy soil and scarce water supply. Under such situations, the use of sprinkler systems increases water use efficiency by 40% as compared to furrow irrigation.

Result and Discussion

With the adoption of intensive agriculture the problems like water logging, salinity, nutrient deficiency, soil sickness, etc., have developed which need attention for sustaining the productivity rate. Conservation farming with emphasis on efficient/ safe use of water resources seems to be the desirable and feasible solution to these problems. The issues for attention are:

1. Identification of efficient crop zones and adoption of efficient cropping systems.
2. Efficient use of water with increased emphasis on rainwater harvesting and it's recycling; WUE in relation to cropping pattern.
3. Making provision of sufficient funds creating effective drainage system in all the irrigated areas.
4. Control of rise in water table in canal irrigated areas of arid and semiarid regions having brackish ground water.
5. Perfecting technology for safe use of brackish water and development of salt, drought and pest tolerant varieties of field crops.

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