IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Potato Cultivation Through Mulching In The Sundarbans To Address Water Scarcity

Amitava Roy*, Aruna Kayal, Siddhartha Chatterjee

Lokamata Rani Rashmoni Mission, Nimpith, South 24 Parganas, 743338, West Bengal, India.

Abstract

Agriculture is the mainstay of livelihood for the community (80%) of Sundarban. Presently farmers of Sundarban are cultivating boro paddy depending upon ground water which causes severe water scarcity in the area. ZTSM (zero-tillage potato cultivation with paddy straw mulching) potato cultivation is conserving water, improving soil condition.

Key Words

ZTSM, boro paddy, water conservation.

Introduction

The World Heritage Site, Sundarban is not only a globally significant mangrove ecosystem and tiger habitat, but also the home of 4.4 million (World_Bank, 2014) people whose life and livelihoods are directly linked with nature. 80% households depend upon rain-fed monocrop agriculture (World_Bank, 2014), making them highly vulnerable to climate variability, salinity intrusion, extreme weather events and environmental degradation.

The effective area of agricultural land in Sundarban is 3,15,500 ha. Typically, the soils are deep fine textured, heavily structured and slow draining. Nearly 62% of total cultivable land of this region is low lying and suffers from elevated salinity during dry season, from intrusion of saline water, capillary action, and increasingly acid sulphate build up. Soil drainage is generally inadequate and deep-water stagnation occurs in monsoon season. At present nearing 20% of the agricultural land in this region is multi cropped. In this region 9% of the farmers are classified as small farmers and 35% as marginal farmers. Apart from this, the concentration of Bargadars, Patta-holders and landless agricultural labourers are very high. The farming community consisting of small and marginal framers and Bargadars are typically focused on subsistence production and their prime is food security (Department of Sundarban Affairs, GoWB, n.d.).

Agriculture Practice of Sundarban

Throughout Bengal, Aman (winter rice) varieties are grown from June to December, Boro (summer rice) varieties are grown from December to May, and Aus (autumn rice) varieties are grown from April to August (Deb, 2021).

Agriculture in the Indian Sundarbans is mainly mono-cropped with kharif (aman) rice grown in the monsoon season. Although the region receives high rainfall (about 1800 mm per annum), there is an acute shortage of irrigation water during the dry season as more than 80% of the rainfall occurs from July to September. Most of the croplands remain fallow during the post-monsoon period due to scarcity of fresh surface water for irrigation (Burman, et al., 2015).

An estimated 15,000 folk landraces are reported to have been cultivated in undivided Bengal in the 1940s in different seasons (Deb, 2021). Farmers of was Sundarban also dependent upon traditional varieties. With the advent of the Green Revolution, begun in 1965, a handful of high-yielding varieties (HYVs) replaced, and continue to replace, thousands of traditional landraces in South Asia (Deb, 2021). During 1980s - 1990s, HYVs were introduced in Sundarban, marking the starting point of regular dry-season (Boro) cropping in West Bengal's coastal regions (Basu, 2017). Till date in Sundaran the Aman cultivation mostly depend upon folk landraces and boro cultivation depend upon HYVs.

Before 1980s, farmers use to cultivate Moong dal (green gram) which is locally known as ‘choito mugh’ after amon paddy. But with the time the area under Boro paddy cultivation is increasing day by day. Therefore, farmers in the Sundarbans resort to pumping groundwater using shallow tube wells (STWs) for growing crops (mostly boro rice) during the post-monsoon period. Boro is the preferred crop as its yield (3 t ha-1) is higher than that of rice grown during the monsoon season (2 t ha-1) or during the pre-monsoon rains (aus, 2.5 t ha-1) (Burman, et al., 2015).

For increasing tendency of ground water dependent boro paddy cultivation the ground water level is depleting. Detailed study of STWs used for irrigating boro rice in 2003, 2009 and 2014 showed that the piezometric level decreased significantly from an average of 2.1 m bgl in January to 3.9 m bgl in May while the discharge rate decreased significantly from 10.8 to 7.2 ls-1. Over the same period, groundwater salinity increased significantly from an average of 2.0 to 3.7 dS m-1. Salinity (ECe) of the topsoil (0-15cm) in boro rice fields irrigated from STWs increased significantly from an average of 3.0 dS m-1 at sowing to 5.8 dS m-1 at harvest (Burman, et al., 2015).

Potato (*Solanum tuberosum*)

Genus: Tuberosum

Family: Solanaceae

It is a root vegetable plant native to America and domesticated in Peru about 6000 years ago. In the 16th century, it was introduced to Europe and became a staple food crop. This herbaceous plant grows up to 1-2 m in height with a flexible fibre stem. It bears white, blue, red, and purple colours, depending on the varieties. There are close to 4000 varieties of potatoes. However, only about 100 varieties are being grown commercially. In India the crop was introduced by the Portuguese in the 16th century and since then, this starch tuber has become an important and most familiar vegetable across India. Presently, India is the 2nd largest producer of potatoes in the world, with 44 million tons of production from 2.0 million hectares, amounting to a productivity of 22 tonnes per hectare. The higher productivity level confined to mainly the Indo-Gangetic plains and plateau regions producing about 90% of potatoes (GIZ, 2024).

The potato (*Solanum tuberosum* L.) is the world's most abundant food crop, producing 371 million tons on 18 million acres in 2019. Potato tubers contain vitamins B3, B6, and C and starch and polyphenols. According to United States Department of Agriculture (USDA) statistics, approximately 99 million metric tons (MMT) of potatoes were produced in China in 2020/21 (Waheed, et al., 2023).

India is the world's second-largest potato producer after China. Potato cultivation in India reached 585.71 lakh tonnes (58.57 million tonnes) in the 2024-25 Final Estimate. Five states — Uttar Pradesh (32.4%), West Bengal (26.9%), and Bihar (14.6%), Madhya Pradesh, and Gujarat — together account for over 80% of national output (Indian Potato, 2026) (Dey, et al., 2025). Current average yield is 22.8 t/ha and India will need to produce approximately 124.88 million tonnes of potatoes by the year 2050, from the current production status (2018–2019) of 53.03 million tonnes, to meet the food demands of its expanding population (Dey, et al., 2025).

West Bengal is India's second-largest potato producing state. contributes roughly 22–23% of India's total potato output. Potato farming in West Bengal supports millions of smallholder farmers across the state, with the crop ranking as the second-most important food item after rice. In the 2024-25 season, the state is projected to produce a record 140–150 lakh tonnes (14–15 million tonnes) from approximately 5.12 lakh hectares — a remarkable 30% increase over the previous year's estimated 115 lakh tonnes. The top five districts — Hooghly, Purba Bardhaman, Paschim Bardhaman, Paschim Medinipur, and Bankura — together account for the overwhelming majority of state output. A second tier of significant producers includes Howrah, Jhargram, Birbhum, Murshidabad, and Nadia. North Bengal districts (Jalpaiguri, Alipurduar, Cooch Behar, and Uttar Dinajpur) form the emerging third tier with rapidly expanding acreage. (Indian Potato, 2026).

Potato Cultivation under Straw Mulching

As straw mulching techniques can be used to increase soil moisture retention, control weeds, improve soil structure, and preserve nutrients for the cultivation of potatoes, this offers a significant opportunity for sustainable cultivation. In addition to enhancing root growth, straw mulching facilitates nutrient absorption and improves the plant's overall health, all of which increase potato production. It has been shown that the progressive breakdown of straw mulch results in more organic matter being incorporated into the soil, improving soil fertility and boosting microbial activity. As organic material sources, rice and maize straw have great potential. Mulching is economically advantageous because compost's high potassium content can replace costly commercial potassium (K) sources, such as KCl. Consequently, the use of pesticides can be drastically reduced while mulching application is practiced. As a result of reducing the number of agrochemicals used, after implementing integrated organic farming, pesticide concentrations will be reduced annually. Using straw mulch reduces the transmission of viruses transmitted by aphids. Potatoes are a valuable crop in organic agriculture, but their vegetative propagation makes them susceptible to several diseases. Straw mulch has been reported to increase soil moisture. Mulched soils retain up to 6% more moisture than unmulched soils (top 30 cm).

Straw mulch has been shown to benefit a variety of soil biota. Evidence shows that the earthworm populations increased under straw mulch. Mulch protects the soil from excessive desiccation by providing readily available food for earthworms. Research has demonstrated that the utilization of straw mulching has a substantial influence on the microorganisms present in the soil. Straw mulching significantly increased soil microbial biomass and activity. In addition, straw mulch has been shown to prevent virus transmission to seed potatoes.

The effects of straw mulch on soil are summarized as (1) an increase in soil moisture, (2) a decrease in soil temperature, (3) a dramatic reduction in runoff and erosion, and (4) a moderate increase in organic matter (Waheed, et al., 2023).

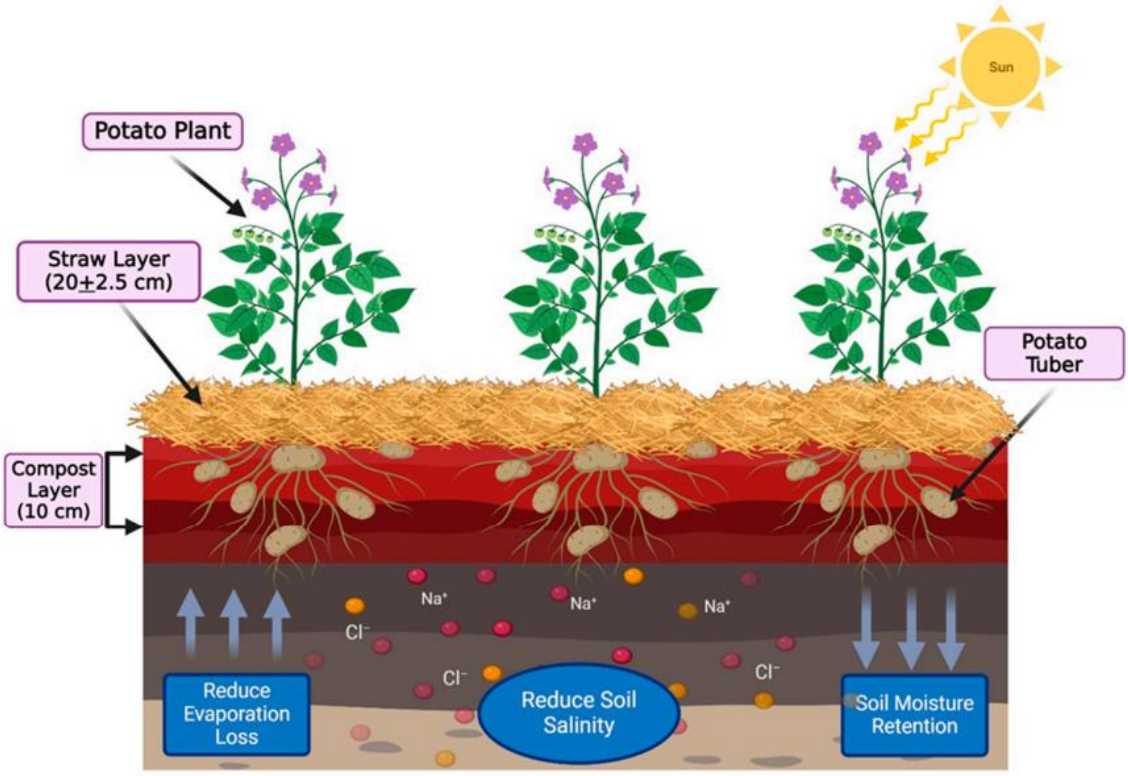

Figure 1: Working principle of zero-tillage potato cultivation with paddy straw mulching (Dey, et al., 2025)

ZTSM Potato Cultivation in Sundarban

In Indian Sundarban, during the winter season, lands mainly remain fallow due to delays in the harvesting of transplanted rainy-season rice and the wetness of the soil. The lands become free, and soils reach working conditions from the end of November to the first week of January, which is not the optimal time for sowing many winter crops (Dey, et al., 2025).

Kharif rice followed by ZTSM potato cultivation (zero-tillage potato cultivation with paddy straw mulching) and then summer moong dal (Green gram) – the cycle may provide a sustainable nature friendly solution for Sundarban. Several research and experiments have been carried out to find out the solution, eg. 'Bridging the gap: Mitigating risk and scaling-out profitable cropping system intensification practices in the salt-affected coastal zones of the Ganges Delta **(**WAC/2020/126)'; 'Cropping system intensification in the salt-affected coastal zones of Bangladesh and West Bengal, India (LWR/2014/073)'; Greening the Sundarbans: How Zero-Tillage Potato Cultivation is Strengthening Climate Resilience through Women's leadership (International Potato Centre), etc.

Without any formal land preparation immediately following the monsoon rice harvest, potato tubers were planted without the customary deep ploughing and subsequent ridge formation in the month of December. Most of the farmers follow the seed treatment as per their knowledge as most of them has no training on scientific process of potato cultivation. Farmers mainly depend upon Kufri chandramukhi, Kufri jyoti, S-52, and S-6 and local variety as per availability.

Programme Description

In December 2025, 175 farmers were provided with 10 kg of potato seed (Kufri jyoti) each. Seeds procured from local market. Preliminary training has been provided to each farmer regarding ZTSM. Every farmer cultivated potatoes on approximately one katha[1] of land total 1.17 hectare using straw and dry grasses as mulch materials. All the farmers are cultivating potato for the first time on experiment basis. The crop was harvested within approximately 90 days.

At the same time the activity of 175 boro paddy farmers also monitored for comparative study. Field workers regularly interacted with farmers and collected field level data.

In recent time tendency of cultivation of boro paddy depending upon ground water is increasing at the same time scarcity of water is increasing in Sundarban area. The local authority has very less control over shallow tube wells and the problem is increasing day by day. From Table 1 and Figure 2 it is clear that though the boro paddy in economically profitable but with the cost of environment as more water, chemical fertilizer and pesticide is required.

Photograph 1-4: ZTSM by the farmers of Kultali

[1] 20 katha = 1 Bigha = approximately 0.134 Hectares (or 7.47 Bighas equal 1 Hectare)

	Boro Paddy	Potato
Particulars	Cost/hectare (INR)	Cost/hectare (INR)
Seed	2,600	24,241
Power Tiller Operations	6,768	7,302
Water	17,726	6,604
Organic Manure & Plant Protection Chemicals	0	0
Chemical Fertilizer	19,019	16,510
Chemical Pesticide	7,687	1,952
Labour	54,337	49,340
Total Cost	1,08,136	1,05,949
Total Production (kg)	6,865	14,465
Gross Income (INR) Considering 65.73/kg	1,78,488	1,44,653
Net Profit (INR)	70,352	38,704

Table 1: Cost of cultivation boro paddy and potato

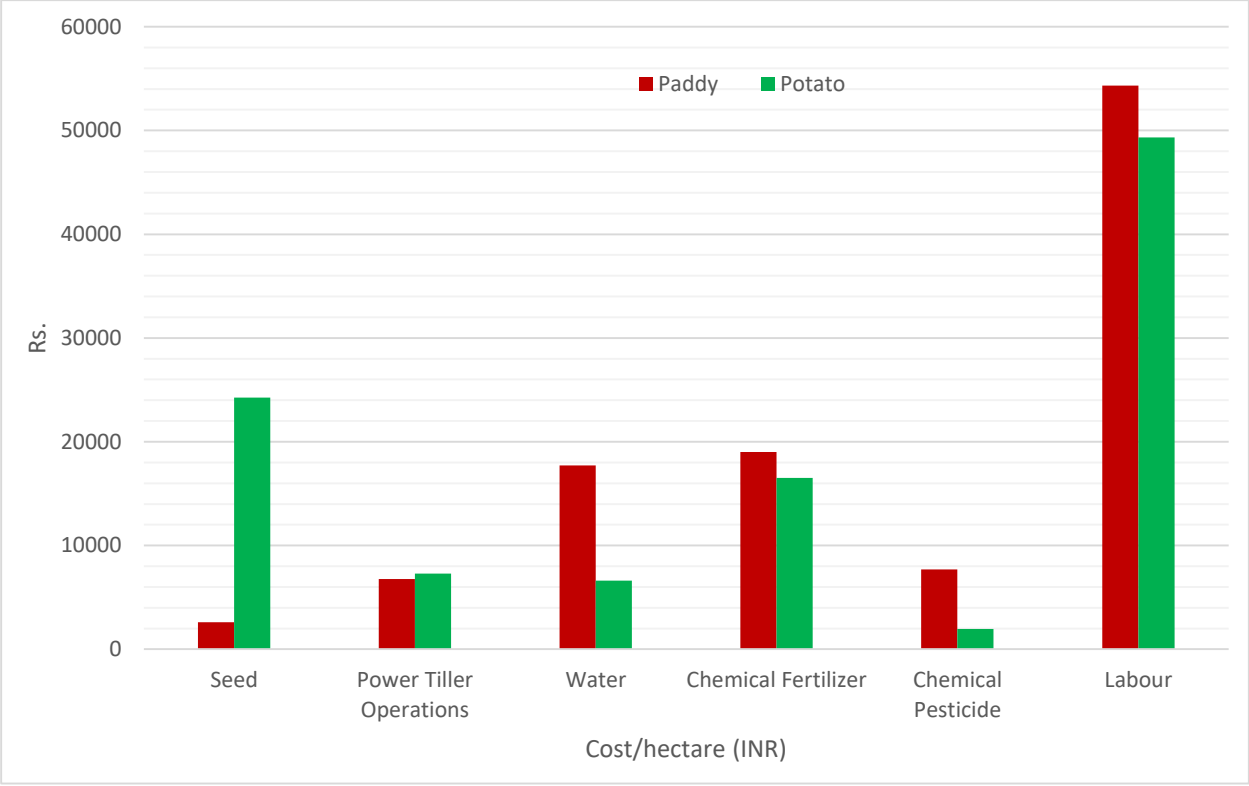

Figure 2: Comparative chart of different parameters of boro paddy and potato cultivation

Discussion

Water conservation: In Sundarban boro paddy cultivation majorly dependent upon ground water. In normal situation the potato cultivation in 01 hactare land is saving 125 ha.cm water or 1,25,00,000 liters of water in comparison with boro paddy (Konar & Dey, 2015). With our initiative in 1.17 hactare we conserved 1,46,25,000 liter of ground water. In the contest of 'global water bankruptcy' in Sundarban area cultivation of potato instead of boro paddy is the best alternate for the community of Sundarban. In study area the farmers invested Rs.6,604/ha for water for potato cultivation while Rs. 17,726/ha spent for water for boro paddy cultivation (Graph 1).

Crops	Water Requirement (ha.cm[2])
Boro Paddy	175
Green Gram	24
Potato	50

Table 2: Water requirement of different crops in West Bengal (Konar & Dey, 2015)

Improved Soil health: Mulching increase the organic content of soil and creates an ideal environment for below and above soil fauna. Farmers reported increase in number of earth worms and other insects in potato fields.

Less Chemical Input: Recommended dose of fertilizers for paddy - 60, 30 and 30 kg N, P and K ha-1 in wet season and 120, 60 and 60 kg N, P and K ha-1 in boro season (Banerjee & Pal, 2009). The recommended dose of fertilizer for potato cultivation was 100–75–75 kg N-P2O5- K2O ha−1, out of which 75–74.05–73.6 kg N-P2O5-K2O ha−1 was applied as basal dose, through 10–26–26 (N-P2O5-K2O), urea, single super phosphate (SSP), and muriate of potash (MOP) (Dey, et al., 2025). But in reality our farmers utilized less fertilizer in potato. Per hectare fertilizer investment for paddy and potato is Rs. 19,019 and Rs. 16,510 respectively and use of chemical pesticides is also less Rs. 7,687 and Rs. 1,952 respectively.

[2] One hectare-centimetre (1ha.cm) of water is the volume required to cover an area of 1 hectare (10,000m^2) to a depth of 1 centimeter (0.01m) = 100m^3 = 1,00,000 litres

Conclusion

ZTSM potato cultivation is economically not profitable in comparison with boro paddy cultivation. But considering the increasing problem of ground water farmers should encouraged regarding ZTSM potato cultivation. Moreover, advantages of mulching will provide various ecosystem services for future crops which will reduce the input cost and provide long term return. Many farmers are showing interest on ZTSM potato cultivation but they are facing the problem of increasing soil moisture due to flooded irrigation in nearby agricultural plots. However many farmers are realizing the seriousness of problem of water. Massive awareness and advocacy is required to establish Kharif rice followed by ZTSM potato cultivation and then summer moong dal (Green gram) as the ideal crop cycle for Indian Sundarban along with various vegetables as per season.

Photograph 2: ZTSM Potato cultivation in backyard

Acknowledgement

Author is thankful to the field workers of Lokamata Rani Rashmoni Mission for collection of field data. Author is also thankful to Azim Premji Foundation and HCLFoundation for their support to conduct the initiative and the case study.

References

1. Banerjee, H., & Pal, S. (2009). Integrated nutrient management for rice–rice cropping system. *Oryza, 46*(1), 32-36.

2. Basu, T. (2017). Analysis of the Changing Scenario of Cropping Pattern within the Dynamic Agro-environmental Conditions in Sundarban Region in West Bengal. *Conference: 2nd Regional Science and Technology Congress (Southern Region).*

3. Burman, D., Mahanta, K., Sarangi, S., Mandal, S., Maji, B., Mandal, U., . . . Sharma, D. (2015). Effect of groundwater use on groundwater salinity, piezometric level and boro rice. *Revitalizing the Ganges Coastal Zone: Turning Science into Policy and Prac□ces Conference Proceedings.* Colombo, Sri Lanka.

4. Deb, D. (2021). Rice Cultures of Bengal. *Gastronomica: The journal for food studies, 21*(3), 91–101.

5. Department of Sundarban Affairs, GoWB. (n.d.). *Agricultural Extension Programme*. Retrieved from Department of Sundarban Affairs, GoWB: https://www.sundarbanaffairswb.in/home/agricultural_extension_programme

6. Dey, S., Sarkar, S., Dhar, A., Brahmachari, K., Ghosh, A., Goswami, R., & Mainuddin, M. (2025). Potato Cultivation Under Zero Tillage and Straw Mulching: Option for Land and Cropping System Intensification for Indian Sundarbans. *Land, 14*(563), 1-29. doi:https://doi.org/10.3390/land14030563

7. GIZ. (2024). *Good Agriculture Practices in Potato Cultivation - A technical manual for Karnataka.* Bonn and Eschborn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

8. Indian Potato. (2026, April 25). *India's Potato Production at a Glance*. Retrieved from Indian Potato: https://indianpotato.com/potato-cultivation-india-guide/

9. Indian Potato. (2026). *Potato Farming in West Bengal*. Retrieved from Indian Potato: https://indianpotato.com/potato-farming-west-bengal/

10. Konar, A., & Dey, G. (2015). A Study on Growth of Irrigated Area under Groundwater in Some Districts of West Bengal in India. *International Journal of Ecosystem, 5*(3A), 127-131. doi:10.5923/c.ije.201501.18

11. Waheed, A., Li, C., Muhammad, M., Ahmed , M., Khan, K., Ghramh, H., . . . Zhang, D. (2023). Sustainable Potato Growth under Straw Mulching Practices. *Sustainability , 15*(13), 10442. doi:https://doi.org/10.3390/su151310442

12. World_Bank. (2014). *Building Resilience for Sustainable Development of the Sundarbans through Estuary Management, Poverty Reduction, and Biodiversity Conservation. Strategy Report. Report No. 88061 – IN.* South Asia Region Sustainable Development Departme, World Bank.