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Sustainable Intensification of Potato in Rice based System for Increased Productivity and Income of Resource-poor Farmers in West Bengal, India

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ABSTRACT: *The aim of present study was conducted was to increase productivity of exiting cropping systems and farmers' income by expanding potato in non-traditional potato growing regions by adopting an innovative technology "Double-Transplanting (DT)of Rice and planting early maturing potato between two rice crops. Thiscropping pattern will enhance productivity of system without sacrificing area or productivity of either of the two crops. Similar work has been done earlier (Robin et al. 2007 and BurdhanRoy et al. 2007). The field trials were carried out at three locationsSiliguri Subdivision ofDarjeeling district to and Rajgunj block of Jalpaiguri districtto introduce potato as sand-witch crop between two rice crops. Eighty five farmers planted 18.6 acres land under rice-potato-rice system in 2013-14. Cost-benefit of different cropping systems was analyzed. Results revealed that "Potato-DT Rice" produced higher income/ha compared to traditional potato-boro rice and kharif (monsoon) rice-boro rice. The DT rice-potato system generated 27% higher income over traditional potato-boro rice and 290% over mono boro rice system. The gender responsive meetings, trainings and demonstrations were conducted. The farming community was motivated to adopt this new profitable cropping system in the region.*

INTRODUCTION

India is the second largest potato producer in the world after China. Recently potato cultivation is adoptedmore aggressively by farmers, even in non-traditional potato growing areas since potato crop offers better margins of profit in short duration and therefore there is a major shift to utilize potato for processing.Potato is one of the most important food security options in the country especially for the poor (Thiele et al.; 2010 and Singh and Rana, 2013). It is true in case of West Bengal, where the number of small, fragmented land holders is very high. Potato production in West Bengal rankssecond in India after Uttar Pradesh in both area and productivity 30.22 t/ha.

An effort has been made to help the farmers to grow potato in lowland rice system in non-traditional potato growing areas of Northern West Bengal to improve the income of resource-poor farmer by adoption of potato and boro rice on the same field to obtain higher yield of potato and boro rice without sacrificing either of the two crops thus expanding potato area and increasing farmers' incomeby introducing new cropping sequence, kharif (monsoon) rice- potato - boro (summer) ricein Darjeeling and Jalpaiguridistrict. By introducing new cropping sequence, kharif (monsoon) rice- potato - boro (summer) rice, on the same piece of land, remuneration can be enhanced for marginal and small farmers. Some small and marginal farmers prefer for early harvesting of potato at 60-70 days after planting with a compromise of 30 to 40% lower yield compared to fully mature crop due to higher price they get for this potato in market. To increase national potato productivity to 34 ton/ha by 2050 is agreat challenge under this scenario. To bridge the gap between demand and production, there is a need to intensify research efforts for high yielding early maturing potato varieties alongwith DT rice.Kharibari and Phansidewa blocks are non-traditional potato area in south-east of Siliguri. While Rajganj block of Jalpaiguri district in South-West of Siliguriis

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predominantly potato and boro rice growing areausing underground water for irrigation. The project sites have farmer clubs run by NABARD (National Bank for Agriculture and Rural Development). These clubs play animportant role to bring farmers together for theexperimentof new cropping sequence adopting participatory approach. The project was implemented through 30 such farmer clubs. It has been easy to hold meetings with the farmers and convince large number of them through the progressive farmers of the club. Project could motivate large number of farmers to adopt this profitable new cropping sequence and get good yield and more farmers are coming up with great enthusiasm to get involved in the project. In the second year, the demand for potato tuber seed has multiplied manyfolds. The farmers could realize benefits in many ways by adopting the sequence of rice-potato-rice system; i) potato ascash crop in between two rice cropsgiveadditional large income for small landholders; ii) cold injury to boro nursery is avoided due to early planting as in traditional boro system delayed nursery bed get affected by cold injury due to low temperature.; iii) early harvested potato fetches good market price; iv) the yield of boro rice is high in double transplanting system as rice crop matured 15-20 days earlier and panicles were lengthier and number of filled grain/panicle were more as compared to normal boro rice; v) The boro rice was grown with minimal additional fertilizers as left over fertilizer of potato were utilized by boro rice.

Comparative profitability over land lying idle between two rice crops play an important role to influence farmers' decision to adopt the potato on fallow farms. In order to assess socio-economic feasibility of growing potatoes in the non-conventional potato growing districts of West Bengal,the field data has been analyzed for the yields and profits of the farmers who have adopted potato and those who have not adopted potato in between the two rice crops.However, early maturing CIP clone, which are location specific with earlytuberisation need to be identified so as to make it fit in the cropping system to facilitate early maturity of potato, alongwith the DT borowhich helpsto leave field free for the potato to obtain full maturity and growth hence leading to higher productivity by growing boro rice in the nurseries in the initial 70-75 days.Maximum yield of paddycan be obtainedin DTboro paddy, if the crops are kept in the nursery bed at least for 42 to 45 days. However, the right time for first transplantation is around 40 to 45 days, and second transplantation it is70 - 75 days with approximately 15 - 20% increase in yield. Weeding and spraying cost is also reduced. Fertilizer cost can also be reduced-however some potash would be required still.Urea, SSP and Phosphate are required during land preparation. Farmers lack information about pesticides, correct dozes and the right time of applications it leads to damages of 50% crop damages.

MATERIAL AND METHODS

Sixteen ton of potato seeds of KufriPukhraj were provided to eighty six farmers with partial financial assistance in November, 2013. Each farmer was given 150 kg of potato tuber to cover 1338 m2 (33decimal) each. For economic analysis, 22 farmers were identified from all 3 sites (Phansidewa,kharibari and Rajunj). Gross and net income for potatoes was analyzed based on cost of cultivation and total yield. The potato yield varied among farmers. Overall, the yield ranged between 28-30 t/haof Kufri Pukhrajin Phansidewa and Kharibari blocks. In Rajgunj block, potato yieldswere recorded higher and varied between 30-38t/ha of same variety. The demonstration of 'double transplanting' technology for boro (summer rice) was done on 6.6 acres of land, involving 20 farmers in first year.The seed of three early varieties of boro rice: MTU1010, Satabadi and IET-4094were sown for nursery after 15 days of potato planting.Due to late boro nursery,first and second transplanting were delayed. and that led to lower bororice yield. Boro nurseries in beds were affected by soil moisture stress, low temperature, and remained dormant for longer period. Farmers were advised to apply fertilizer and irrigation to get four leaf stagefast for timely transplanting.In Raigunj block, first transplanting was done timely on 30th Januaryusing irrigation.In Kharibari andPhansidewa blocks,first transplanting was done in the main field around middle of February. In Phansidewablock, many farmers could not follow double transplanting due to non-availability of irrigation water.Farmers' interactive visits were organized at the flowering stage of double transplanted boro rice.

RESULTS AND DISCUSSION

Growing Environment of Potato and DT Boro Rice

November is the sowing time for potato and as well as boro rice nursery since temperature start to decline affecting both potato and rice seedling growth in later monthIn November, temperature remained between 25-30°C at the higher side and 20°C at minimum and

these optimum temperature for both potato and boro rice. December temperature slide down further. The maximum temperature remained around 25°C and minimum temperature around 15°C or less in late December and early January. Potato and boro rice nursery planted in this period resulted in poor initial growth. February also remained cooler, minimum temperature recorded between 10-15°C. In March the maximum temperature increased to 25-30°C and minimum less than 15°C and the diurnal gap of these temperatures was favorable for boro rice growth.

The detailed cultivation cost and profitability of the potato cultivation in the system were collected from 22 farmers from all the three sites.

Double Transplanted Boro (summer) Rice on Potato Fallow Land

The boro rice nurseries were established by early December, 2013 at Phansidewa and Kharibariproject sites, mostly using residual water in natural reservoir and streams at Kharibari. Under ground water or canal water used at Rajgunjdue to scarcity of water at the sources and late sowing of potato delayed the seeding. Many of the farmers' nursery bed was prepared on dry seed bed, where low temperature, moisture stress, weed infestation inhibited proper seedling growth which delayed 1st transplanting after potato harvest. The expenditure in double transplantingafter potato remains lower because most of the growing period of boro rice spent in smaller area requiring little inputs. However, cost of nursery bed was higher in dry seed bed at Rajgunj. In this area bororice is entirely grown with Teesta canal water for which no revenue was given. As such, net income in Potato – double transplanting boro rice system is higher (almost 5 times to normal boro). The double transplanted boro yield in Goursinghjote was higher than Rajgunj since boro seed nurseries were raised timely than Rajgunj and therefore , the net income of this system was also higher. The higher net income was recordedat Moynaguri in double transplanted boro rice (Table 1). At Phansidewa, double transplanted boro rice after potato was not very successful due to lack of irrigation water sources. Many of the participant farmers left out either in first transplanting or in double transplanting stages. The study reveals from all the sites, the cost of double transplanting of boro rice was less compared to kahrif (monsoon)rice-boro rice andpotato-boro rice system. The yield under double transplanting was also significantly higher than normal boro rice.

CONCLUSION

The average productivity of potato was 24-33 t/ha in the demonstration which was at par or higher than average production at these locations. It was observed that among the various cost components, labour cost specially hired labour took the major share of the cost of production followed by irrigation cost. The greater variability (CV%) was observed in irrigation cost, selling price of the produce (GSP), and net income. However, cost benefit ratio was positive in all the sites and in all the farmers. At all project sites,potato-double transplanted system produced higher net income/ha compared to other two systems viz, traditional potato-boro rice and kharif-boro rice. The new technology produced 27% higher income over traditional potato-boro rice and 290% over monobororice.

Table 1
Net income (US$/ha) from Potato-Boro rice obtained from different cropping system, 2013-14

Site	*System*	*GVP* (US$/ha)*	*Total expenditure (US$/ha)*	*Net income (US$/ha)*
Rajgunge	potato-DT boro rice	1326	250	1076
	potato-bororice	1222	658	564
	rice-boro rice	1108	777	330
Kharibari-Goursinghjote	potato-DTboro rice	1910	420	1491
	potato-boro rice	1422	354	1068
	rice-boro rice	1443	496	947
Kharibari-Moynaguri	potatp-DT boro rice	1971	305	1666
	potato-boro rice	1362	478	884
	rice- boro rice	1385	503	881

GVP* (Gross Value of Product)

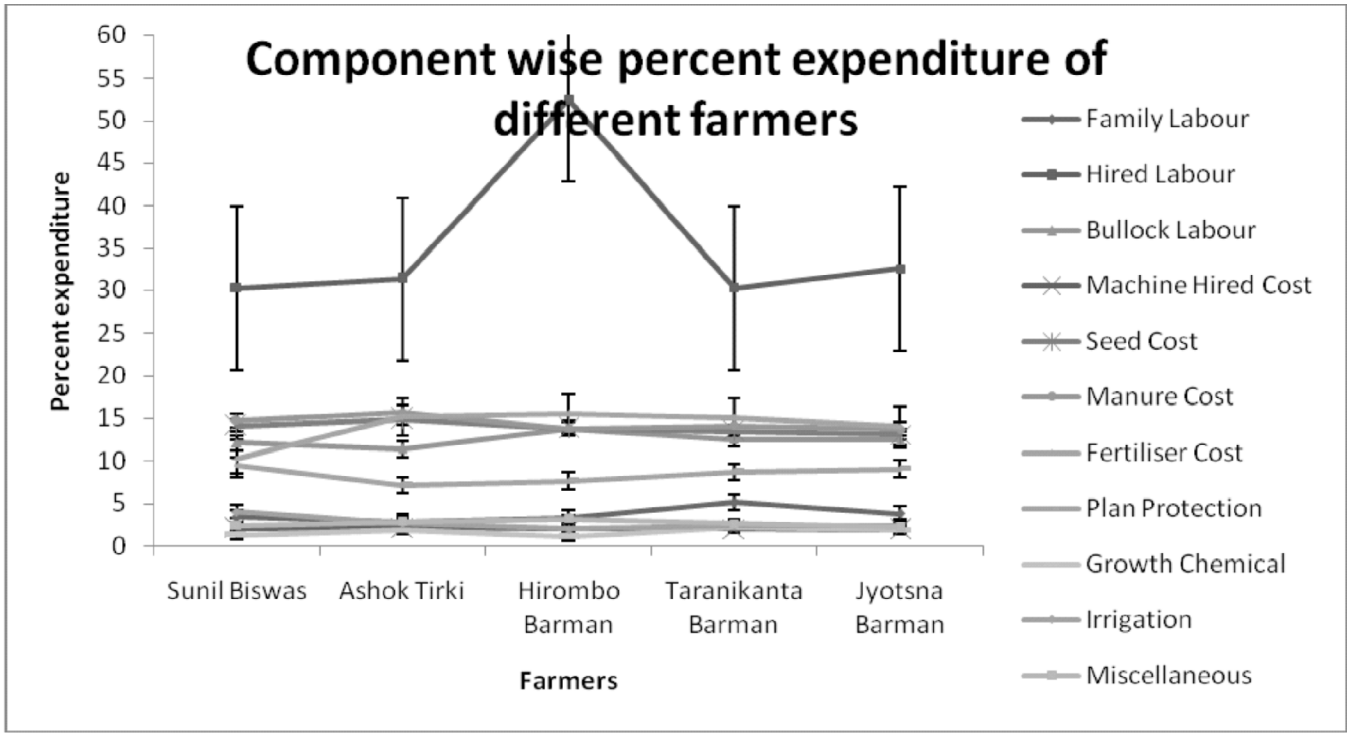

Figure 1: Component wise percent expenditure of different farmers at Moynaguri (the vertical bars showing SD values)

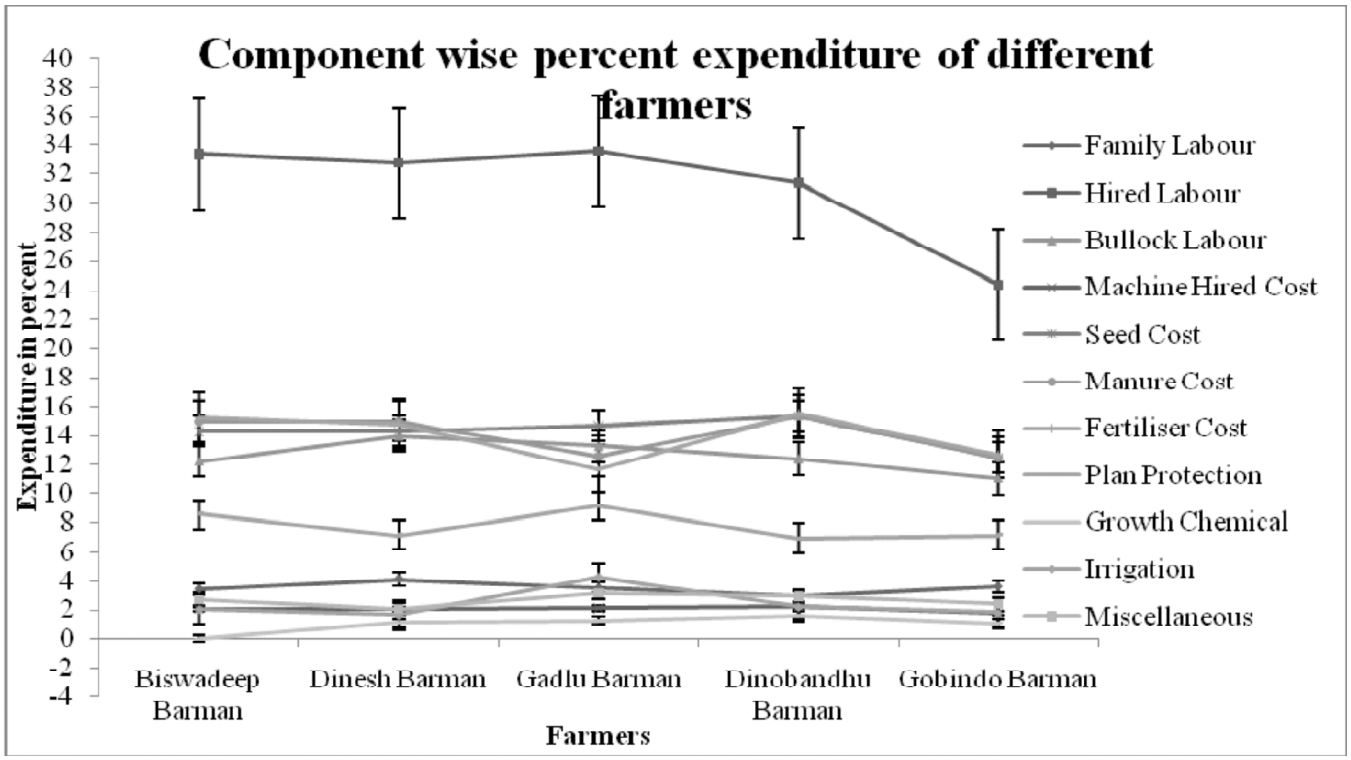

Figure 2: Component wise percent expenditure of different farmers at Goursinghjote (Vertical bars showing SD values)

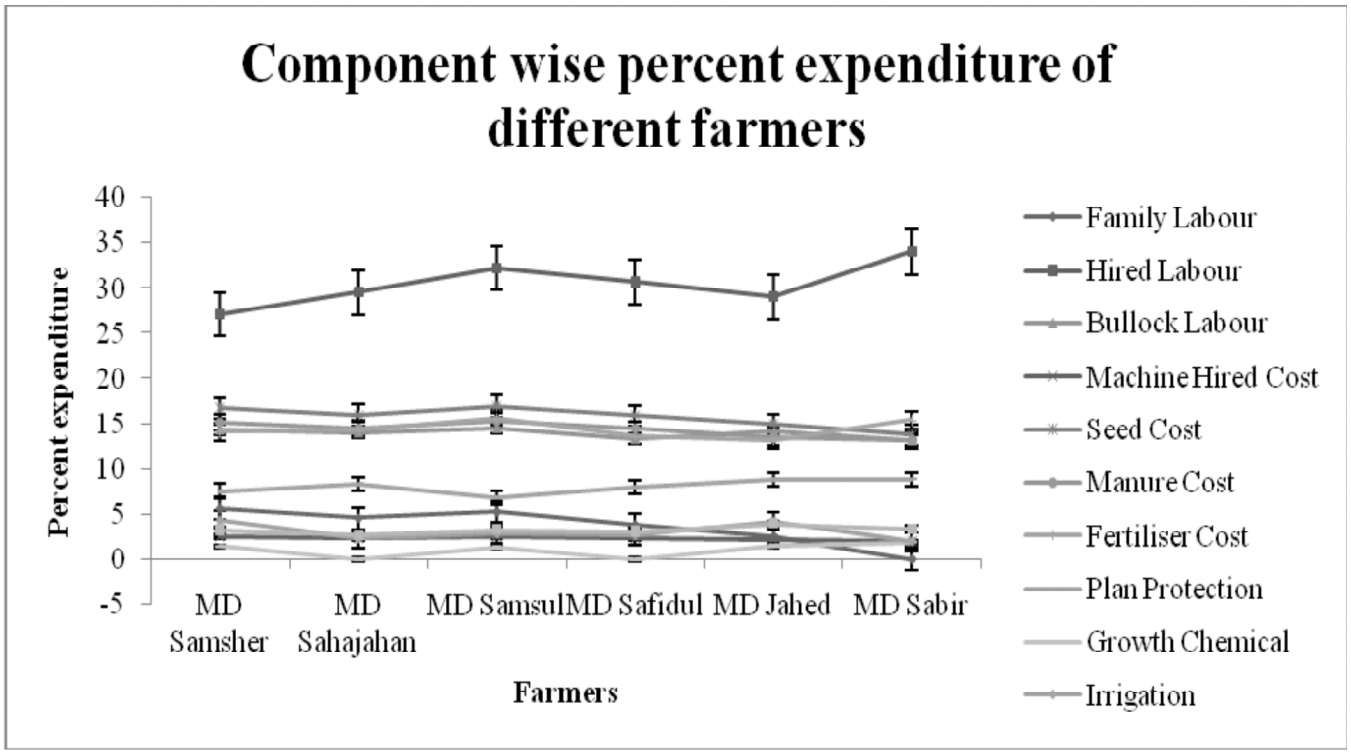

Figure 3: Component wise percent expenditure of different farmers in Phasidewa block (Vertical bars showing SD values)

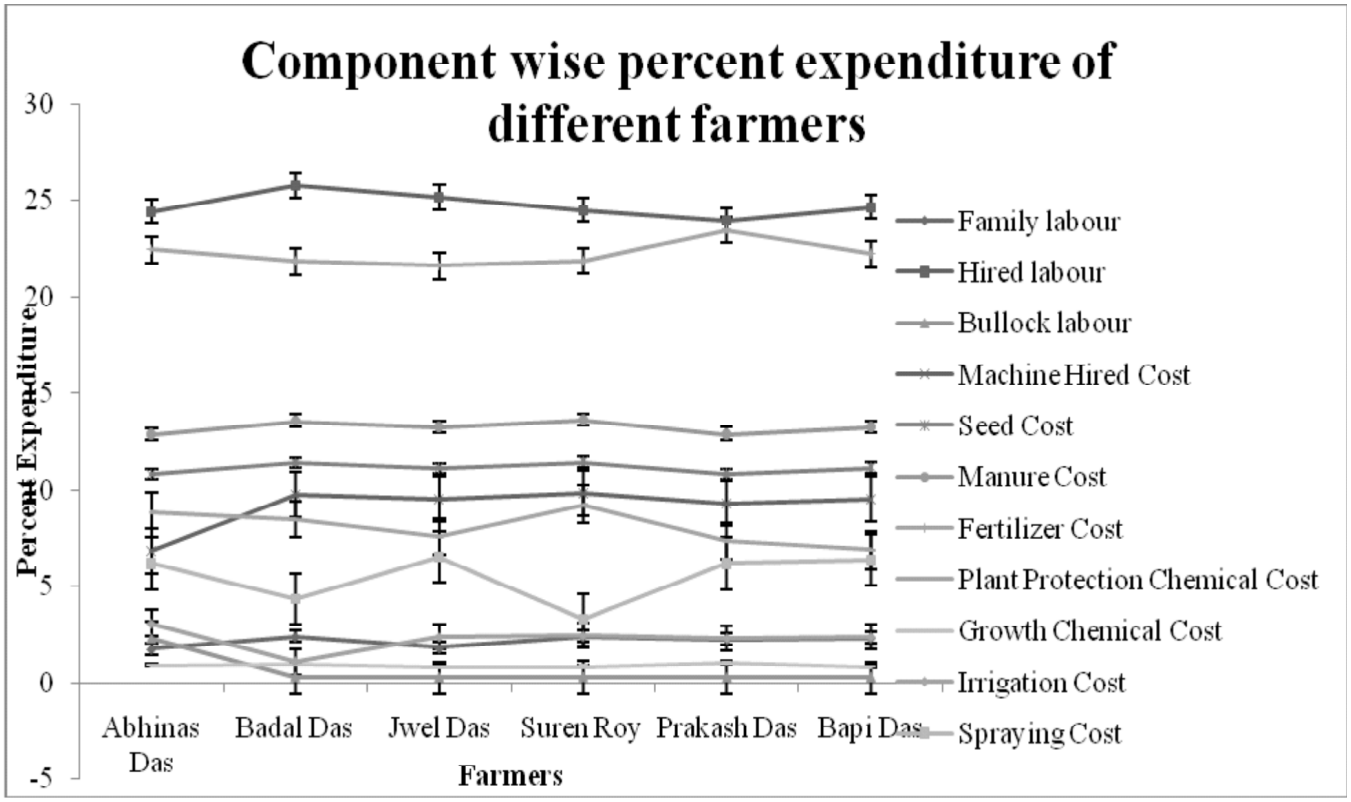

Figure 4: Component wise percent expenditure of different farmers in Rajgunj block (Vertical barsshowing SD values)

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REFERENCE

Robin D. Graham, Ross M. Welch, David A. Saunders, Ivan Ortiz-Monasterio, Howarth E. Bouis, Merideth Bonierbale, Stef de Haan, Gabriella Burgos, Graham Thiele, Reyna Liria, Craig A. Meisner, Steve E. Beebe, Michael J. Potts, Mohinder Kadian, Peter R. Hobbs, Raj K. Gupta and Steve Twomlow. (2007), Nutritious Subsistence Food Systems.Advances in Agronomy. Vol.92. PP 1-74.

Bardhan Roy, S.K., Saha, N.K., Kadian, M.S., Quiroz, R., Ilangantileke, S.G. (2007), Improving livelihood of farmers by intensifying the rice-potato-rice system through double transplanting of rice in West Bengal, India.Working Paper.2007-1.International Potato Center. ISBN: 978-92-9060-314-6. pp. 24.

Singh BP, Rana Rajesh K (2013), Potato for food and nutritional security in India. *Indian Farming* 63(7): 37-43.

Thiele G., Theisen K., Bonierbale M., Walker T. (2010), Targeting the poor and hungry with potato science. *Potato Journal* 37(3-4): 75-86.