Popular Kheti
Volume -1, Issue-3 (July-September), 2013
Available online at www.popularkheti.info

ISSN:2321-0001

Resource Conservation Technologies in Rice–Wheat Cropping system

Imtiyaj Ahmad[1]*, S. K. Chongtham[1], Y.V. Singh[2], M.A. Ansari[3] and H. Singh[1]

[1*]Ph.D. Scholar, Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi-221005 (U.P.) India.

[2]Senior Scientist (Agronomy), Centre for Conservation and Utilization of Blue Green Algae, Indian Agricultural Research Institute, New Delhi-110012, India

[3]ICAR Research Complex for NEH Region, Imphal- 795004, Manipur, India

***Email of corresponding author: imtiari8@gmail.com**

Rice-wheat cropping system is the pre-dominant cropping system in India as both rice and wheat are main staple food for the people of the country. The continued adoption of exhaustive rice-wheat cropping system has resulted in declined factor productivity and thus poses a serious threat to sustainable food production. Concerns of stagnant productivity, increasing production costs, declining resource quality, receding water table and increasing environmental problems are the major drivers to search for alternative technologies that can address all these problems. This article focuses on various resource saving yet efficient technologies that can be adopted in rice-wheat system for improving and sustaining higher yields.

Introduction

Rice-wheat (RW) is the most important cropping system practised on 13.5 m ha area in South Asia, out of which 10.3 m ha is in the Indo-Gangetic plains (IGP) of India. The rice-wheat cropping system (RWCS) of India is vital for national food security contributing more than 70% of total cereal production in India (Singh and Kaur, 2012). A decline in land productivity of RWCS has been observed over the past few years due to continued cereal-cereal cropping system. Depleting soil organic carbon status, ground water, decreasing soil fertility and reduced factor productivity are other issues of concern (Prasad, 2005). These evidences indicate that RWCS has weakened the natural resource base and its sustainability. To achieve sustainable higher productivity, efforts must be focused on reversing the trend in natural resource degradation by adopting resource conservation technologies (RCTs) in RCWS. RCTs are the practices, when followed results in saving of energy, cost and also reduces the environmental pollution over the conventional practices. Zero tillage (ZT) is a widely used RCT in Indo-Gangetic Plains (IGP), in which wheat is directly seeded in to the undisturbed soil after rice harvesting. ZT generally saves irrigation water in the range of 20–35% in the wheat crop compared to conventional tillage (CT). Adoption of furrow-irrigated raised-bed system (FIRBS) of wheat saves 25-30% seed, 30-40% water and 25% nutrients without affecting the yield (Jat *et al*., 2012)

Brown manuring is highly beneficial for soil and water conservation, weed control and nutrient supplementation. Alternative wetting and drying (AWD) in rice reduces seepage, deep drainage losses and save water by 10 to 30% (Chopra *et al.*,2012) Direct seeded rice (DSR) followed by ZT wheat reduced the global warming potential of rice-wheat system by 41% as compared to conventional system (Bhatia *et al.*, 2012). Leaf colour chart (LCC) can reduce nitrogen dose in crops without adversely affecting grain yield. Followings are the brief account of RCTs feasible for sustainable rice and wheat production:

System of Rice Intensification (SRI)

This method of rice cultivation was developed in 1983 in Madagaskar and has now spread too many parts of the world. There is a notion that higher yields in rice come with high investments on seed, irrigation, high doses of fertilizers and pesticides. Contrary to this popular view, SRI method of cultivation produces higher yields with less seed and less water. SRI emphasizes on the need to shift from chemical fertilizers to organic manures. Increased soil aeration and organic matter help in improving soil biology and thus help in better nutrient availability. Pest incidences are lesser due to increased spacing, thus drastically reducing the need for pesticides. SRI is showing promising results in all rice varieties local or improved varieties and can be helpful in addressing the problems of water scarcity. Government of Andhdra Pradesh has recently endorsed SRI and announced the state's policy of promoting and supporting SRI.

Important features of SRI

- ❖ Low seed requirement (5 kg ha^{-1})
- ❖ Low water requirement (soil sufficiently moist but not continuously flooded, mostly aerobic and not saturated)
- ❖ Transplantation of tender/ young seedlings (8-12days)
- ❖ Transplanting at wider spacing (10 x 10 inches or 25 x 25 cm)
- ❖ Incorporating weeds into the soil while weeding with cono-weeder/ rotary hoe
- ❖ Organic manures in place of chemical fertilizers
- ❖ Pest management without chemicals
- ❖ Other beneficial practices get recommended for use with SRI, such as selection of most suitable varieties, good seed selection, seed priming and seedbed solarization (Culman *et al*., 2005).

Brown Manuring

Traditionally, dhaincha (*Sesbania aculeata*) is sown during mid May for the purpose of green manuring and is incorporated 45 days after sowing before transplanting of rice crop. However, due to dearth of irrigation water during summer, majority of the rice farmers are not able to raise the green manure crop. Brown manuring is a new innovative approach where both rice and *Sesbania* crops are seeded together. *Sesbania* is then knocked down by spraying 2, 4-D (0.5 kg ha^{-1}) at 25-30 days after sowing. It exerts smothering effect on weed species and is capable of reducing weed population by nearly half without any adverse effect on rice yield. Use of 2, 4-D further enhances the weed suppressive effect as 2, 4-D is effective against sedges and broad leaf weeds. *Sesbania* surface mulch decomposes very fast to supply N. As a legume, it also fixes atmospheric nitrogen into the soil but is of lesser significance due to shorter of growth period.

Leaf Color Chart (LCC)

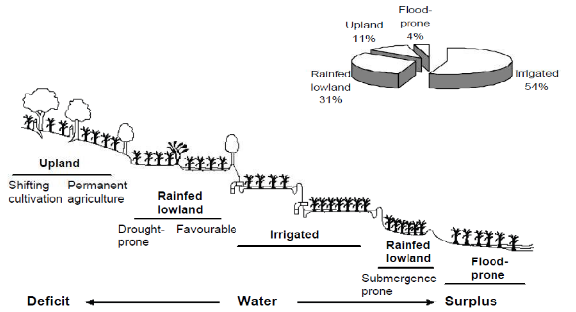
LCC is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status (Alam *et al.*, 2005). Leaf N status of rice is closely related to photosynthetic rate and biomass production. As a sensitive indicator of change in crop N demand within a growing season, it rapidly assess leaf N status and thereby guide the application of fertilizer N to maintain an optimal leaf N content, which is vital for achieving high rice yield with effective N management.

How to use the LCC

- ❖ Randomly select at least 10 disease-free rice plants or hills in a field with uniform plant population.
- ❖ Select the topmost fully expanded leaf from each hill or plant. Place the middle part of the leaf on a chart and compare the leaf color with the color panels of the LCC. Do not detach or destroy the leaf.
- ❖ Measure the leaf color under the shade of your body, because direct sunlight affects leaf color readings. If possible, the same person should take LCC readings at the same time of the day every time.
- ❖ Determine the average LCC reading for the selected leaves.

Aerobic Rice

Aerobic rice is a new system of growing rice in non-puddled, non-flooded, aerobic soils under irrigation with high external inputs that require less water than transplanted rice. (Bouman *et al.*, 2002). Fields are kept non-flooded throughout the season as in upland crops like wheat and maize. This eliminates continuous seepage and percolation losses, puddling and reducing evaporation. Nitrogen is key input in nutrient management and its application determines the yield of aerobic rice. Successful aerobic rice systems will largely depend on effective weed management. Direct weed management methods include chemical, physical and biological practices of weed control while indirect methods include crop rotation, weed prevention, selection of cultivar, land preparation, irrigation and fertilizer management. Both pre-emergence herbicides and post-emergence herbicides can be used in aerobic rice fields, and are effective if they are properly used (Baltazar and De Datta, 1996). The adoption of integrated weed management and weed-competitive genotypes is regarded as an effective tool in weed control. Aerobic rice cultivation results in saving of 60% water and 80-85% lesser methane emission (Pal *et al.*, 2012). RCTs like SRI in rice and FIRBS in wheat are superior for improving the crop yield, water and nutrient use efficiency (NUE). It improves soil physical conditions and makes rice production possible in light soil. But it is also associated with many disadvantages like severe weed problem and shift in weed population, more incidences of soil born diseases like nematode, root aphids and fungi, low availability of nutrients like P, Zn, Fe and N fixation and reduction in soil organic matter and pH



Rice ecosystems and their percentage of world area (source: IRRI, 2001, derived from FAO data).

Zero Tillage/Reduced Tillage

ZT has been established as cost saving, yield boosting and eco-friendly RCT in the entire IGP. A major driver for adoption is increased profitability as a result of lower establishment costs. In this system, no preparatory tillage (ploughing, harrowing, planking) is done and there is slight soil disturbances associated with creating a narrow slit for planting seeds.

ZT is generally reported to save irrigation water in the range of 20–35% in the wheat crop compared to conventional tillage (CT), reducing water usage by about 10 cm ha^{-1}, or approximately 1 million liters ha^{-1} (Mehla *et al.*, 2000). ZT typically improves soil quality in various dimensions, including soil structure, soil organic carbon, higher stability of soil aggregates, soil fertility and soil biological properties (Chauhan *et al.*, 2002). Studies have reported that the upper soil surface for ZT was comparatively soft, had higher moisture content, and there was no significant difference in bulk density under ZT and CT systems.

Furrow Irrigated Raised Bed System (FIRBS)

This method has been evolved to economize irrigation water in which raised beds are prepared to accommodate 2 or 3 rows of wheat between two furrows. The irrigation is done only in furrows. Thus, about half of the irrigation required may be saved by this method without any loss to the productivity of wheat grain. A machine has been developed to make raised bed and sowing of wheat simultaneously. This method helps in economizing water required by the crop besides giving better germination. After its successful stint in wheat production in IGP, evaluation of this method on rice production is recently going on at different parts of north-western IGP.

System of Wheat Intensification (SWI)

SWI is feasible and can prove to a boon for poor and marginal community eastern IGP, where average productivity is low. This method is more labour-intensive than traditional techniques, but it requires less seeds, water, pesticide and fertiliser.

Modified practices adopted in SWI are lower seed rate, sowing of seeds at proper spacing, good control of water in the crop field, hoeing for weed control, higher ratio of tillers to mother seedlings and increased number of effective tillers/hill.

Moisture availability in soil is required when the germinated seeds are sown @ 2 seeds $hill^{-1}$

Surface Seeding

Surface seeding is the simples ZT system being followed which involves placement of wheat seed on to a saturated soil surface without any land preparation. This is a traditional farmer practice for wheat, legume and other crop establishment in eastern India and Bangladesh. Wheat seed is either broadcasted before the rice crop is harvested or after the harvest of the rice crop. Surface seeding of wheat on unploughed, wet soil before or after rice harvest is working very well in heavy, poorly drained soils.

Benefits

- ❖ No equipment is needed.
- ❖ Heavy textured soils are more suitable.
- ❖ Suitable for areas where land preparation is very difficult and costly.

Precautions

- ❖ Key to success is correct soil moisture at sowing
- ❖ Less moisture reduces germination, higher moisture can cause rotting of seeds
- ❖ Rice straw mulch after seeding ensures better germination

Crop Residue Management in RWCS

About 400 million tons of crop residues are produced in India alone. In areas where mechanical harvesting is practised, a large quantity of crop residues are left in the field, which can be recycled for nutrient supply. About 25% of nitrogen (N) and phosphorus (P), 50% of sulfur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Both rice and wheat are exhaustive feeders, and the double cropping system is heavily depleting the soil of its nutrient content. Traditionally, wheat and rice straw were removed from the fields for use as cattle feed and for other purposes in South Asia. Recently, with the advent of mechanized harvesting, farmers have been burning *in situ* large quantities of crop residues left in the field as crop residues interfere with tillage and seeding operations for the next crop. Unlike removal or burning, incorporation of straw builds up soil organic matter, soil N, and increases the total and available P and K contents of the soil. Application of 15 to 20 kg N ha^{-1} as starter dose with straw incorporation increases yields of wheat and rice compared to either burning of straw or its incorporation in the soil.

Conclusion

Adoption of RCTs leads to sustainable improvements in RWCS by improving soil health, nutrient and water use efficiency with higher sustained yields. RCTs reduce cost of cultivation by saving in labour, diesel, time, fertilizers, pesticides and farm power and also reduce environmental pollution.

References

Alam MM, Ladha JK, Rahman Khan S, Foyjunnessa, Harun-ur-Rashid, Khan AH. and Buresh RJ. 2005. Leaf color chart for managing nitrogen fertilizer in lowland rice in Bangladesh. *Agronomy Journal* **97**: 949–959.

Balasubramanian, V, Ladha, JK, Gupta, RK, Naresh, RK, Mehla, RS, Singh Y. and Singh B. 2003. Technology options for rice in rice–wheat systems in Asia. ASA, Special Publication No. 65. *ASA, CSSA, SSSA, Madison, WI, USA*. pp. 115–172.

Baltaza AM. and De Datta SK. 1996. Weed control technology as a component of rice production systems. In: Auld, BA, Kim, K-U. (Eds.), Weed management in rice. FAO *Plant Production and Protection Paper* **139,** Rome, pp. 27-52.

Bhatia A, Kumar A, Das TK, Singh J, Jain N. and Pathak H. 2012. Resource conservation technologies for reducing the global warming potential of rice-wheat soils. In: *Extended Summaries* Volume **3**: (Eds. Prasad *et al*., 2012) 3rd *International Agronomy Congress*, 26-30, November 2012, New Delhi, India. pp. 796-797.

Bouman BAM, Wang H, Yang X, Zhao J. and Wang C. 2002. Aerobic rice (Han Dao): A new way of growing rice in water-short areas. In: Proceedings of the 12th International Soil Conservation Organization Conference, 26-31 May 2002, Beijing, China. Tsinghua University Press, pp. 175-181

Chauhan P M, Mohan RK, Sarangi B, Kumari S, Nayak and SGP. Matondakar. 2002. Surface chlorophyll estimation in the Arabian Sea using IRS-P4 Ocean Color Monitor (OCM) satellite data, *International Journal Remote Sensing*, **23**: 1663 – 1676.

Chopra S, Singh S. and Singh J. 2012. Evaluation of wheat-mint intercropping under different crop establishment methods. In: *Extended Summaries* Volume **3**: (Eds. Prasad *et al.*, 2012) 3rd *International Agronomy Congress*, 26-30, November 2012, New Delhi, India. pp. 695-696.

Jat SL, Shivay YS, Parihar CM. and Meena HM. 2012. Evaluation of summer legumes for their economic feasibility, nutrient accumulation and soil fertility. *Journal of Food Legumes* **25**(3): 239-242.

Mehla R, Verma J, Gupta R. and Hobbs P. 2000. Stagnation in the productivity of wheat in the Indo-Gangetic plains: zero-till-seed-cum-fertilizer drill as an integrated solution. Rice-Wheat Consort. Paper Series **8:** 1-12.

Culman SW, Duxbury JM, Lauren JL. and Thies JE. 2005. Microbial community response to soil solarization in Nepal"s rice-wheat cropping system. *Soil Biology and Biochemistry* **38**: 3359–3371 Development Notes, Issue 70 (Jan).

Pal SS, Rai PK, Kumar P. and Singh, K. 2012. Resource conservation techniques on crop yield, CO_2 efflux and soil fertility in rice-wheat system of Indo Gangetic Plains in India. In: *Extended Summaries* Volume **3**: (Eds. Prasad *et al*., 2012) 3rd *International Agronomy Congress*, 26-30, November 2012, New Delhi, India. pp.778-779.

Prasad R. 2005. Rice-wheat cropping system. *Advances in Agronomy* **86**: 255-339.

Singh A. and Kaur J. 2012. Impact of conservation tillage on soil properties in rice-wheat cropping system. *Agricultural Science Research Journal* **2**(1): 30-41.