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TILLAGE AND MULCHING PRACTICES FOR ENHANCING PRODUCTIVITY AND PROFITABILITY UNDER RICE-WHEAT CROPPING SYSTEM – A REVIEW

Diwakar Paswan[1] and Govind Kumar[2]*

[1]*Regional Research Station, Agwanpur, Saharsa (RAU, Pusa, Samastipur, Bihar-848 125)*

[2]*KVK, Rahgopur, Supaul (RAU, Pusa, Samastipur, Bihar-848 125)*

**Corresponding Author (Govind Kumar) Email : drgovindsri@gmail.com*

ABSTRACT

This review paper is mainly aimed to find out the suitability of different need based cereals or fodder crops for substituting in existing rice based cropping system viz., rice - wheat and rice–berseem as introducing need based short duration crop varieties in existing rice based cropping systems as crop intensification. Therefore, an attempt has been made to present a brief review of the research information available on various agronomic aspects of tillage, cropping systems. It covers published literature giving effects of mulching and fertility level for enhancing Productivity and Profitability for different cropping systems.

Key words : Tillage, mulching, productivity, profitability and cropping systems.

Rice-wheat cropping system is widely practiced in the country by covering nearly 10.5 million hectare area. Both crop components contribute to major share in the food pool of the nation. This cropping system is predominant in irrigated production system of North and Central India, which is mainly, concentrated in Indo-Gangetic plains, it is also practiced under rainfed ecosystem in pockets, where rainfall is good and soils conserve adequate residual soil moisture to grow wheat succession to rice in a sequence.

Tillage is disturbance of the soil which includes all the operations and practices that are carried for modifying the soil conditions in such a manner to provide the suitable conditions for proper germination of seeds, establishment of seedlings, proper subsequent growth and development and finally higher yields of crops. Tillage operations are being done since the beginning of agriculture, but the tillage operations and equipments have been altered and specialized with the advancement in agriculture according to the need of the time. Earlier, it was considered that loose and fine seed bed prepared by extensive tillage, was good for crop production, but now it is realized that heavy and extensive tillage are not ideal. Now, minimum tillage or even no tillage is considered to be good for agriculture. Presently, zero tillage technology is gaining popularity in rice-wheat system of IGP in India, as this technology not only reduces the infestation of most problematic weed *Phalaris* minor in wheat, but also improves the input use efficiency. In zero till technology, crop seeds are sown in a single tractor operation with specially designed seed-cum-fertilizer drill directly on no-tilled fields at optimum to slightly moist soil regime even in the presence of anchored residues of preceding crop. Zero tillage saves time by 2 to 3 weeks to prepare the land for sowing of wheat. This time could be utilized for stimulating weed emergence followed by effective control with non-selective herbicides under zero tillage. Less exposure of seeds to light due to zero till sowing also triggers germination of weed seeds, where seed require less light exposure. The changes in composition of weed flora favouring species that produce seeds with light requirement for germination also have been observed following the implementation of no till system. Zero tillage significantly reduces the cost of production because of saving of time, diesel and labour, besides reduction in soil erosion and land-degradation and efficient control of weeds. Zero till sowing of crop by killing the newly emerged weeds with the use of non-selective herbicides viz., Paraquat and Glyphosate etc. after rains during Kharif season and after irrigation during Rabi season has been found quite feasible and remunerative sowing method reported by several workers. Thus, zero till sowing of crops is quite feasible in dry fields as well as wet fields during Kharif season before and after rainfall, and during Rabi season under optimum residual soil moisture.

In soil management relationships, mulching has been reported to influence organic matter content, activity of micro-organism, availability of soil nutrient, control of erosion and soil compaction. Like-wise tillage is one of the primary operation which are done to

breaks the hard pan and helps in sinking down of the rainwater in the lower layer of soil from where it is not easily lost by evaporation and aids to deeper rooting which helps in better exploitation of stored soil moisture and applied nutrient from the profile and for realizing the inherited yield potentials of high yielding rice variety, recourse must be taken to the application of fertilizers.

Thus, rice-wheat and rice-gram cropping system are not economical due to the involvement of high cost of cultivation and less market values. Keeping above facts in mind, the present paper reviewed on Tillage, Mulch and Fertility Levels for enhancing Productivity and Profitability for different cropping systems.

Effect of tillage : Kumar (2000) was conducted an experiment for two consecutive years to study the effect of different levels of tillage on wheat (Triticum aestivum L. emend. Fiori and Paol.) after paddy (Oryza sativa L.) harvest. He found that reduced tillage with two harrowing followed by two cultivator and one planking treatment was better from economic return point of view. According to Singh and Kharub (2001), zero-till sowing *of* wheat after harvesting of direct drilled rice proved to be an economically viable and ecologically feasible practice for tillage and sowing operations in comparison to conventional till sowing practice at Modipuram, Meerut (UP). Similarly Ahmad and Chatha (1992) mentioned that cost of cultivation of wheat was also relatively quite lesser by zero till than sowing after conventional tillage. According to Brar et al. (2002), the average yield of wheat in succession to maize remained the same under both conventional and zero tillage practices. They further added that wheat sown with strip till drill or zero till did not give only better grain yield than conventional till sown crop, but tillage also resulted in to the saving of diesel by 50-70% for entire rice-wheat cropping system. Tomar *et al*. (2003) revealed that the higher grain yield in the system (25.4%) was observed under T_3, (conventional puddling (4 passes of puddle) on rice and conventional tillage (2 harrow + 2 cultivator on wheat) (producing 7.99 Mg/ha) than T_1 (direct sowing (no tillage) in rice and wheat) (producing 6.37 Mg/ha). T3 and N3 produced higher total harvestable biomass in rice (9.69 and 21.39 Mg/ha, respectively) compared to the other treatments. In the rice wheat system, higher biomass (21.4%) was observed in T_3 (producing 19.91 Mg/ha) compared to T_1 (producing 16.4 Mg/ha). Kumar *et al.* (2004) studied the effect of different tillage practices on growth and yield of wheat in succession to rice and changes in soil properties at Pantnagar (Uttaranchal) for two years. Results indicated that wheat grown under conservation tillage (Zero till drill or Strip till drill) produced comparable grain yields to other intensive tillage (combine harvesting of rice followed by use of MB plough once + 4 harrowings or manual harvesting of rice followed by harrowing 6 times). Sharma *et al.* (2005 a) emphasized that rotary tillage is a resource conservation and cost effective technology and eco-friendly practice with the higher grain yields by 7 to 12% over conventional methods of tillage and sowing of both crop components in rice -wheat system. Ram et al. (2006) carried out a field experiment during 2001-02 and 2002-03 on clay loam soil at Haryana, resulted that the wheat sown after dry seeding of rice yielded significantly higher (48.4-49.6 q/ha) than when sown after transplanted (46.3 q/ha) or direct-seeded puddled rice (45.3 q/ha). In wheat, sowing by rotavator drill (reduced tillage) or by zero-till drill (zero tillage) gave significantly higher grain yield (47.4 and 49.6 q/ha respectively) than by conventional method (45.2 q/ha). Transplanting in rice and sowing by rotavator in succeeding wheat resulted in the highest total productivity and profitability of the rice-wheat system. Kato *et al.* (2007) in order to quantify the effects of deep tillage combined with deep placement of manure (50cm depth), straw mulch (6 t/ha), or their combinations on the growth and grain yield of rice. Results showed that deep tillage or mulching can improve grain yield of rice under drought-prone rainfed upland conditions in a temperate climate on an Andosol. Singh *et al*. (2008) evaluated the influence of different tillage and sowing methods of rice and wheat crops on the growth and yield of wheat under rice-wheat system at Pantnagar (Uttarakhand). From the results, they concluded that different methods of rice establishment did not affect the wheat yield, but conventional tillage for wheat establishment gave maximum wheat yield (44.0 q/ha) than zero tillage (40.2 q/ha) mainly due to better emergence and dry matter accumulation and it was at par to furrow irrigated raised bed system (43.0 q/ha) and reduced tillage (41.8 q/ha). Narayan and Lal (2009) conducted an experiment at Datia, Madhya Pradesh to evolve a suitable tillage and surface mulching practice for higher rainwater conservation for augmenting the crop growth and yield of sorghum [Sorghum bicolor (L.) Monech.] under rainfed conditions. The results indicated that improved tillage coupled with in situ surface mulching of sunnhemp was helpful for higher rain water

conservation and increasing the yield of sorghum. Subbulakshmi *et al.* (2009) revealed that conservation tillage decreases soil erosion, leaching of fertilizer, pesticides and herbicides into the ground water. Several studies have shown that crops grown under zero tillage have yielded as similar as or better than those grown under conventional tillage, while some workers revealed conventional tillage increased the yield of crops and other scientist reported there no yield difference between any tillage system**.**

Effect of cropping system : Sharma and Jain (1997) emphasized that rice-berseem (fodder) cropping system was more profitable in the areas adjoining to towns dominating in dairy farming system and associated with adequate water supplies than existing rice-wheat sequence at Jabalpur (M.P.) Kumar *et al.* (2008) conducted field experiment at Faizabad, Rice-berseem sequence was found the most efficient in terms of nitrogen-use efficiency (80.2 kg grain/kg N). Inclusion of potato or onion (vegetable crops) was found quite stable with stability index of 0.86 and 0.83 respectively. The sequences including greengram or berseem (leguminous crops) improved the availability of NPK and organic C of the soil. Shweta *et al.* (2008) studied the resource conservation technologies for higher productivity of rice in rice- wheat cropping system at Pantnager (Uttaranchal). Based on 2 years results, revealed that DSR led to record significantly higher grain yield compared to manual transplanting and transplanting by SPT. Zero till and strip till sown succeeding wheat gave the highest grain yield (43.8 and 40.6 q/ha) than conventional till and bed planting (39.5 and 36.2 q/ha. Tripathi and Singh (2008) revealed that maximum sustainable value index (SVI) (0.92) and net returns (Rs 38.6 x 103 /ha/year) were recorded in rice-Indian mustard-greengram-rice-wheat-greengram rice-wheat-greengram crop sequence.

Benefit : Cost ratio (1.74) and profitability (Rs 124/ha/day) were highest in pigeon pea-wheat-rice-wheat-rice-wheat crop sequence. Growing of berseem in the rotation reduced the weed population in the subsequent wheat cycle. After 6 years, rice-vegetable pea-wheat-greengram, rice-Indian mustard-greengram-rice-wheat-greengram-rice-wheat -greengram and pigeonpea-wheat- rice- wheat- rice-wheat showed 37.5, 25.0 and 20.0% increase, respectively in organic C content (0-15 cm) than continuous rice-wheat system.

Effect of mulch : Pramanik and Bandhopadhyay (1998) reported that plant height; leaf area index and crop growth rate of maize was significantly higher in mulched plot as compared to control. Rice straw mulching increased the cob yield of maize by 59.7% during first season and 46.8% during second season as compare to no mulch. Sheng Hai Jun *et al*. (2004) revealed that the yield components of rice grown in soil with straw mulched, such as filled grains per panicle and 1000-grain weight, were improved significantly compared with plastic film and without mulch under the aerobic cultivation treatments. Ratan Lal (2004) noticed that mulched plants had higher growth rate and vigour and chlorotic symptoms of nutritional disorders were observed only for the unmulched plants. He also reported that increase in grain yield of maize by mulching in tune of 46, 52 and 22% respectively in different years. Mulched plots also had higher soil moisture content. Rana *et al.* (2006) carried out a field experiment during the rainy season (Kharif) of 2001 and 2002 to study the relati moisture utilization by maize (Zea mays L) grown in a mixed or in a sole situation. The maize equivalent was higher in maize paired row (40/80 cm) + 2 rows of mungbean (*Phaseolus radiatus* L.) than the sole maize crop. An increase in water-use efficiency (WUE) was observed in intercropping systems. The water-use efficiency w the highest (10.14 maize equivalent use/ha/mm) in maize paired row (40/80 cm) + 2 rows of mungbean. Grow yield attributes and yields as well as maize equivalent were significantly improved with farmyard manure (FYM) dust mulch + straw mulch treatment over no mulch. Among the moisture-conservation practices, higher WL was recorded under FYM + dust mulch + straw mulch, closely followed by Kaolin + dust mulch + straw mulch.

CONCLUSION

Nearly 500 cropping systems exist in different parts of the country depending on their suitability of agro climatic conditions, socio - economic status of the farmers, development of irrigation facilities, available technologies as well as extension services. Out of them, 10 cropping systems are most predominant by covering sizeable area and rice - wheat system stands on the top among. Principally the mulching conserve the soil moisture by reducing pie evaporation, checks the runoff, soil erosion, suppresses the weed growth, changes the heat flux, add organic matter and increase the activity of soil-micro-organisms, improves the germination, saving of irrigation by increasing water use efficiency. The physical condition of the soil particularly the structure is also improved with mulching.

SUGGESTIONS

1. The present work needs to be further tested at specific location at least for 3 years to confirm the results.

2. Further needs to be modified for assessment of agronomically efficient and economically viable new emerging rice based cropping system for resource conservation and to mitigating the effect of climate change.

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