[Article ID : 01/I/08/0121]

PULSE CROP INTENSIFICATION IN RICE-WHEAT CROPPING SYSTEM: ROLE AND SIGNIFICANCE

Bishesh Rai* and Niraj Biswakarma**

Ph.D. Scholar, Dept. of Ag. Met. And Physics, Bidhan Chandra Krishi Viswavidyalaya-741252.
**Ph. D scholar, Division of Agronomy, ICAR-Indian Agricultural Research Institute-110012.
Corresponding author email: biswaniraj666@gmail.com

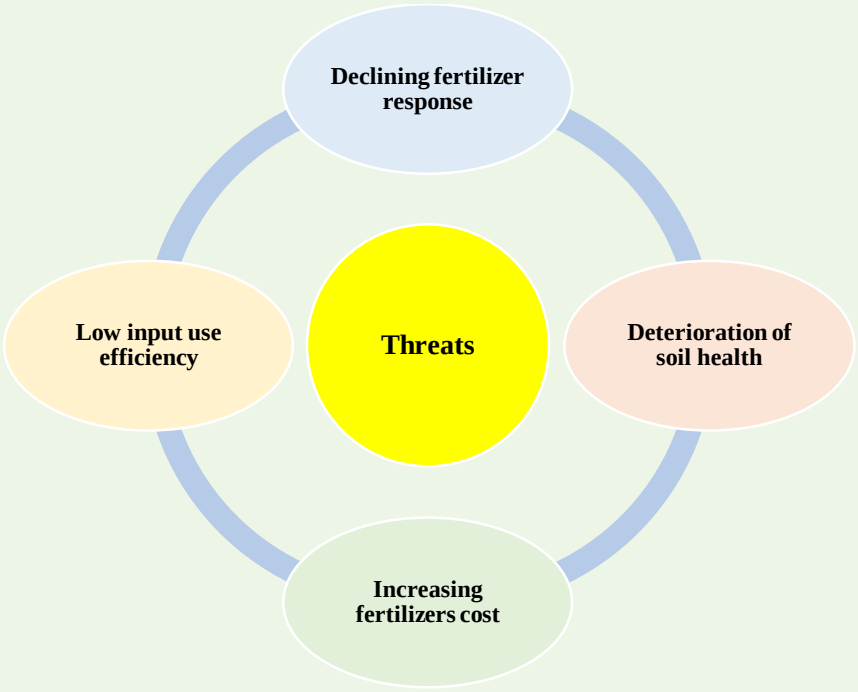
Abstract

Crop intensification involving pulses need to be popularized in larger scale chiefly under existing rice-wheat rotation for making farming more attractive, remunerative and sustainable. Crop intensification practices not only have positive impact on soil health but also hold potential to provide higher crop productivity and farm income per unit area. Keeping the above facts in view this article aims to highlight the role and significance of sustainable pulse crop intensification in rice-wheat rotation.

Introduction

Rice-wheat cropping system (RWCS) occupies almost 10.5 million hectares and is contributing ~75% to the national food basket. However, practicing intensive rice-wheat rotation over time leads to lower input use efficiencies, soil heath degradation, receding groundwater table and declining factor productivity. Therefore, crop intensification in the existing system with lower input demanding crop such as pulses is needed for sustaining food security and minimizing over-exploitation of natural resources. In India, pulse crop are grown under diversified agro-ecologies with reasonable external inputs and residual soil moisture. It provides multiple benefits such as better human nutrition, higher yield per hectare, increasing farm income, improves resource use efficiency and restoring soil fertility through the addition of soil organic matter (SOM). As they are more biologically efficient and resource conservative sequences to cereals.

Threats due cereals based cropping system



Why pulses ???

Nutritionally rich : In India, the vast majority of the population relies on the plant-based protein, pulses provide an excellent source of protein of high biological values, amino acid, vitamins and other essential minerals. Besides, the number of non-nutritional biomolecules such as saponins, and tannins present in pulses act as an antioxidant and may have anti-carcinogenic effects. Pulse crops can potentially help improve human health and nutrition, reduce hunger and help in eradicating malnutrition.

Sustain soil health : Pulse crop is known to fix atmospheric nitrogen, and increasing mineralization of organic–P and solubilization of inorganic–P. It improves the micronutrient availability in the soil due to the release of organic acid, phytosiderophores, and expands the surface area of a plant root system. Subsequently, it adds organic matter into the soil and promotes the growth and activity of soil micro-organism. The beneficial soil microbes regulate important processes such as soil nutrient cycling, nutrient acquisition by the plants and stimulates enzymatic activities; e.g. dehydrogenase, acid and alkaline phosphatase. Therefore, integration of pulses in the cereal-based system can constitute an effective strategy for improving soil health.

Table 1. Effect of different crop rotations on SOC (Mg C ha^{-1}) and other nutrients (kg ha^{-1}).

Treatments	SOC (Mg C ha^{-1})	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (kg ha^{-1})
Rice-wheat	13.7^{d}	231.6^{b}	15.4^{c}	164.7^{b}	10.6^{c}
mungbean	13.7^{d}	266.2^{a}	21.7^{a}	164.8^{b}	12.2^{a}
Rice-wheat-rice-chickpea	14.6^{c}	238.4^{b}	16.5^{bc}	173.8^{a}	11.9^{b}
Rice-chickpea	16.3^{b}	260.2^{a}	17.0^{b}	172.2^{a}	11.5^{ab}

(Ghosh et al., 2019)

Mini fertilizer factory : Biological nitrogen fixation (BNF) is a biochemical mechanism by which legume crop fixes atmospheric nitrogen symbiotically in the presence of nitrogenase enzyme and supplies nitrogen to the plants. Pulse cultivation increases soil nitrogen status and thus minimize the load of N fertilization of succeeding crop. This reduces the production cost and helps in improving farm profitability.

Fodder : Besides its role in human nutrition, pulses can be a good source of palatable feed and fodder for livestock and thus indirectly contribute to food security. The legume straws have higher dry matter digestibility and contains a good amount of protein and other minerals, which helps in improving the nutritional value of milk and milk products.

Improving productivity : The ever increasing population, changes in dietary pattern and limited available land resources possess a threat to global food and nutritional security. Diversifying crops fulfil dietary requirement protect soil quality, stabilized income and productivity. Thus, sound agronomic practices is an important driver determining crop productivity. Pulse crops are the integral component of many cropping systems and its intensification gives higher system productivity than existing system. Prior studies suggested that, increment in system productivity can reach up to 45 % due to the additional yield provided by pulse crop.

Table 2. Pooled rice equivalent yield (REY) (Mg ha^{-1}) affected by different cropping system.

Cropping system	2 years pooled REY(Mg ha^{-1})			
	Rainy	Winter	Summer	Total
Rice-wheat	4.6	3.3	-	8.0
Rice-wheat-mungbean	4.8	3.4	0.5	8.9
Rice-potato-mungbean	5.0	6.2	1.9	13.1
Rice-rapeseed-mungbean	4.8	3.1	1.9	9.8
Rice-clover	4.9	6.4	-	11.3
SEm ±	0.05	0.20	0.07	0.23
LSD (*p*= 0.05)	0.16	0.66	0.27	0.75

(Sharma et al., 2005)

Approaches to crop intensification

Crop intensification aims to achieve higher output from a given amount of inputs and reduces expenditure by making modifications in crop management practices. It offers a wider choice in the production of a variety of crops per unit area in a given time and reduces the risk of crop failure, provides improved nutrition, product diversification and value addition. It can be achieved through two basic approaches:

Horizontal diversification : is the common and main approach of crop diversification in which diversification takes place through substitution of a crop variety with the other.

Vertical diversification : In vertical diversification, various downstream activities are undertaken and the existing economic produce of different crops is refined and manufactured products and additional values to the produce.

Benefits of crop intensification

- Better utilization of natural resources which helps in ecological sustainability.
- Alternate crops may enhance profitability.
- Stabilized farm income and productivity
- Better human nutrition and health.
- Reduced pest incidence (Diseases, insects, weeds etc).
- Enhanced employment opportunities
- Reduced crop failure risks in dry lands.

Constrains

- Predominantly rainfed cropping: >60% crops are rainfed
- Over exploitation of soil & water resources that undermines overall sustainability
- Impeded modernization & mechanization due to small holdings and illiteracy of farmers.
- Lack of well-developed agro-based industries
- Infrastructure (Roads, power and communication) bottlenecks.
- Lack of market information support system
- Continuously decreasing agricultural investment.

Conclusion

Inclusion of pulses in rice-wheat cropping system enhances profitability, productivity and sustainability over the long run by reducing cultivation cost, enhancing input use efficiency, and

improvement in different soil properties. Thus it is concluded that pulse crops are more biologically efficient and resource conservative sequences to cereals.

References

Benbi, D.K. and Senapati, N. 2010. Soil Aggregation and Carbon and Nitrogen Stabilization in Relation to Residue and Manure Application in Rice–Wheat System in North– Western India. Nut. Cyc. Agro. Eco. **87**: 233–247.

Ghosh, P.K., Hazra K.K., Venkatesh M.S., Praharaj, C.S., Kumar, N., Nath, C.S and Singh. U. 2019. Grain Legume Inclusion in Cereal–Cereal Rotation Increased Base Crop Productivity in the Long Run. Exp. Agri. 1–17.

Janick, J., M.G.Blase., D.L.Johnson., G.D.Jolliff and R.L.Meyers. 1996. Diversifying U.S. crop production. Issue Paper No. 6. Council for Agricultural Science and Technology. pp.11.

Kaur, R., Shivay, Y.S., Singh, G., Virk H.K., Sen, S. Rajni. (2018) Increasing area under pulses and soil quality enhancement in pulse-based cropping systems–Retrospect and prospects. Indian J. Agri. Sci 88:10–21

Kumar, V., Jat, H.S., Sharma, P.C., Singh, B., Gathala, M.K., Malik, K.R., Kamboj, B.R., Yadav, A.K., Ladha, J.K., Raman, A., Sharma, D.K. and McDonald. A. 2018.Can Productivity and Profitability be enhanced in Intensively Managed Cereal Systems While Reducing the Environmental Footprint of Production? Assessing Sustainable Intensification Options in the Breadbasket of India. Agri. Eco.& Env.**252**: 132–147.

Sharma, S.K. and Sharma. S.N. 2005. Effect of Crop Diversification of Rice-Wheat System on Productivity and Profitability. J of Sus Agri. **26**(1): 39–48.

Sharma, S.N., Prasad, R., Dwivedi, M.K, Kumar S, Davari M.R, Shukla. L. (2010) Crop diversification and residue incorporation for making rice–wheat cropping systems sustainable. J Sus. Agr. 34:342–364

Subbarao, N.S. 1988. Biological Nitrogen Fixation: Recent Developments. *Oxford and IBH*: pp. 1-19.

Swarnalakshmi, K., Pooniya, V., Paul, S. (2017) Synergistic interaction of *Piriformospora indica* and microbial inoculants on symbiotic potential, plant nutrition and productivity of chickpea (*Cicer arietinum*). Indian. J. Agron. 62(4):481–488.