# Performance of rice-wheat cropping system under different production systems in irrigated subtropics of Jammu


## Abstract

The present study was conducted during 2022-23 and 2023-24 at the Research Farm, FSR Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha. The experimental site is located at a latitude of 32°40′ N, longitude of 74°58′ E, and an altitude of 332 m above mean sea level. The region experiences an annual rainfall of 1050-1115 mm, with 70% occurring between June and September. The study evaluated the performance of a rice-wheat cropping system under four production systems: P1 (Absolute control), P2 (Organic farming), P3 (Conventional farming), and P4 (Natural farming). Results revealed that conventional farming consistently achieved significantly higher productivity in both crops. For rice, conventional farming recorded the highest grain yield (28.49 q/ha) and straw yield (55.06 q/ha), outperforming organic farming (25.53 q/ha and 53.45 q/ha) and natural farming (24.67 q/ha and 51.46 q/ha). Similarly, for wheat, conventional farming resulted in the highest grain yield (39.98 q/ha) and straw yield (53.32 q/ha), compared to organic farming (35.52 q/ha and 50.13 q/ha) and natural farming (30.87 q/ha and 48.09 q/ha). A slight improvement in grain and straw yields was observed during the second year across all production systems, except the absolute control. The findings demonstrate the superior performance of conventional farming for maximizing crop productivity in the irrigated subtropical conditions of Jammu while highlighting the potential for further optimization of organic and natural farming systems for sustainable agriculture.


**Key words-** Rice-wheat, Production system, Organic farming, Natural farming, Conventional farming



## Introduction

Rice and wheat are the staple food for almost the entire Asian population and therefore they occupy a premium position among all food commodities. The Indo-Gangetic Plains' rice–wheat farming system has been crucial to the region's food security ever since the Green Revolution began in the early 1970s with the introduction of wheat and rice. In India in general and the Jammu region of UT J&K in particular, the most significant pre-dominant cropping system is rice-wheat using inorganic fertilizers and other chemicals.

Due to its high productivity, stability, and low risk factor, this system's widespread adoption will continue to be crucial to future planning in order to maintain food grain self-sufficiency in the years to come (Singh *et al*., 2012). However, factor production is decreasing annually, and the productivity of both crops has now stagnant (Yadav, 1998). Numerous production strategies are employed to guarantee biodiversity, nutrient recycling, environmental sustainability, long-term productivity, etc. The nutrient needs of these crops can be met by chemical fertilizers. Additionally, environmental degradation brought on by the careless and continuous use of high-analysis chemical fertilizers has decreased agricultural production, soil productivity, and sustainability (Chakraborti and Singh, 2008).

Global food production per capita has expanded dramatically due to the widespread use of chemical fertilizers, insecticides, and herbicides, extensive use of water resources, and the use of genetic engineering. But these initiatives have also had some detrimental effects on biodiversity and the ecosystem, which makes them potentially dangerous for sustainability. Chemical farming regions are frequently linked to groundwater pollution, soil contamination, acidification, and the loss of beneficial microbes. One of the main issues facing agricultural sustainability today is striking a balance between environmental health, productivity, and profitability. Therefore, switching from contemporary chemically intensive agriculture to a more sustainable type of farming, mostly organic farming, seems to be the best course of action in terms of crop growth, the need for organic inputs, and sustaining the desired level of agricultural output in the future. (Modgal *et al.,* 1995). Organic agriculture can provide quality food without adversely affecting the soil health and environment.

Natural farming is one of the organic farming models. It also emphasizes that the primary goals of natural farming are to eradicate agrochemicals and maintain agricultural output using environmentally benign methods that are in harmony with the natural world. Padamshree Shubhash Palekar claims that the technique just needs one native cow and thirty acres of land. One of the main sources of organic manure for field crops is farm yard manure (FYM). FYM can be utilized to reduce heavy metal stress in plants, improve soil quality, and favourably regulate crop yield.

**Methodology**

The field experiment entitled **"Performance of rice-wheat cropping system under different production systems in irrigated subtropics of Jammu"** was carried out during the year 2022-23 and 2023-24 at Research Farm, FSR Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha, Jammu located at latitude of $32^0$.40 ' N and longitude of $74^0$.58 ' E with an altitude of 332 m above mean sea level. The mean annual rainfall of the location varies from 1050-1115 mm of which about 70 per cent rainfall is received from June to September, whereas the remaining 30 per cent of rainfall is received in few scanty showers due to western disturbances. The present study was conducted in sub plots in a split plot design with four replications.

Before the experiment was laid out, soil samples were collected at random from three different places in the experimental field at a depth of 0 to 15 cm, and composite sample was made by mixing them. This combined sample was air dried, processed ground and passed through two mm sieve and was tested for their physical and chemical properties i.e. pH-8.1, EC- Organic carbon (g/kg)-5.50, Available N (kg/ha)-216.23, Available P (kg/ha)-23.00 , Available K (kg/ha) 118.22.

**Treatment details-**

**Production System**

| | |
|---|---|
| $P_1$ | Absolute control |
| $P_2$ | Organic farming |
| $P_3$ | Conventional farming |
| $P_4$ | Natural farming |

**Cropping system-** Rice-Wheat

Rice variety- Basmati-370

Wheat Variety- HD3086

Gross plot area- 20$m^2$

**Results**

**Rice Crop**

Among the different production systems conventional farming resulted significant increase in grain yield (28.49 q/ha) and straw yield (55.06 q/ha) of rice than organic farming

(25.53), (53.45 q/ha) and natural farming (24.67), (51.46 q/ha) in comparison at harvest during both the years of experimentation (2022 and 2023) presented in (Table 1).

However, a slight improvement in grain yield (q/ha) and straw yield (q/ha) of rice was recorded during the second year of cropping except the absolute control.

**Wheat Crop**

Among the different production systems conventional farming resulted numerically higher in grain yield (39.98 q/ha) & straw yield (53.32 q/ha) of wheat than organic farming (35.52 q/ha), (50.13 q/ha) and natural farming (30.87 q/ha), (48.09 q/ha) in comparison at harvest during both the years of experimentation (2022-23 and 2023-24) presented in (Table-2) .

However, a slight improvement in grain yield (q/ha) and straw yield (q/ha) of wheat was recorded during the second year of cropping except the absolute control.

**Discussion**

The comparison of different production systems reveals that conventional farming outperformed organic and natural farming systems in terms of rice grain yield, with a significant increase in grain yield compared to organic farming and natural farming. This finding is consistent with the results of several studies that have shown conventional farming systems, which often involve the use of synthetic fertilizers and pesticides, tend to produce higher yields compared to organic or natural farming systems (Patel et al., 2020; Meena et al., 2018). Conventional farming's higher grain yield can be attributed to the more intensive management practices, including the use of chemical inputs that promote faster growth and higher productivity (Singh et al., 2019). However, the higher yield in conventional farming comes at the cost of environmental sustainability, which is a major concern in modern agriculture (Sharma & Rathi, 2019).

The increase in yield during the second year may be due to the cumulative benefits of the cropping systems, such as improved soil health and better management practices over time, which is supported by research on the carry-over effects of cropping systems on subsequent crops (Jha et al., 2017; Yadav & Singh, 2020). Additionally, the slight increase in yield could reflect the adaptive capacity of crops under varying climatic conditions, which is important for ensuring food security in the face of climate change (Verma & Bhardwaj, 2018). (Kumar et al., 2020; Singh & Gupta, 2021).

The superior yield of wheat in conventional farming can be attributed to the higher number of spikes, grains per spike, and thousand-grain weight, supported by the timely availability of nutrients. Organic farming also resulted in a respectable grain yield due to the improved soil structure and nutrient cycling over time, while natural farming yielded the lowest due to nutrient limitations. These results are consistent with those of Badiyala et al. (2021) and Mehta et al. (2022), who reported that higher yields in conventional systems are primarily driven by nutrient management efficiency. The higher straw yield in conventional farming reflects better vegetative growth due to nutrient availability, particularly nitrogen, which promotes biomass accumulation. Organic farming, with its slow nutrient release, supported moderate straw production, while natural farming lagged behind due to limited nutrient input. The slight improvement in straw yield during the second year is consistent with soil fertility improvements noted across systems, as also observed by Singh et al. (2021) and Verma et al. (2022).

## Conclusion

The results of the experimentation over two years clearly indicate that **conventional farming (P3)** consistently outperformed **organic (P2)** and **natural farming (P4)** production systems in terms of grain and straw yield for both rice and wheat crops. These findings suggest that while conventional farming remains a reliable choice for maximizing crop productivity, long-term improvements in organic and natural farming systems may offer sustainable alternatives with further optimization.

**Disclaimer (Artificial intelligence)**

**Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology**

Details of the AI usage are given below:

1. Quillbot

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**Table 1: Effect of different production system on yield of basmati rice during 2022 ($Y_1$) and 2023 ($Y_2$)**

| Treatment details | Grain Yield q/ha | | Straw Yield q/ha | | Harvest Index (%) | |
|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| ($P_1$)-Absolute control | 16.36 | 16.89 | 38.59 | 39.37 | 29.80 | 30.09 |
| ($P_2$)-Organic farming | 25.53 | 27.28 | 53.45 | 55.16 | 32.45 | 33.13 |
| ($P_3$)-Conventional farming | 28.49 | 29.29 | 55.06 | 57.16 | 34.11 | 33.92 |
| ($P_4$)-Natural farming | 24.67 | 26.02 | 51.46 | 53.04 | 32.36 | 32.89 |

**Table 2: Effect of different production system on yield of wheat crop during 2022-23 ($Y_1$) and 2023-24 ($Y_2$)**

| Treatment details | Grain Yield (q/ha) | | Straw Yield (q/ha) | | Harvest Index (%) | |
|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ | $Y_1$ | $Y_2$ |
| **($P_1$)-Absolute control** | 18.16 | 16.03 | 28.87 | 27.09 | 38.61 | 37.17 |
| **($P_2$)-Organic farming** | 35.52 | 37.80 | 50.13 | 53.30 | 41.47 | 41.49 |
| **($P_3$)-Conventional farming** | 39.98 | 41.68 | 53.32 | 56.70 | 42.85 | 42.36 |
| **($P_4$)-Natural farming** | 30.87 | 32.02 | 48.09 | 52.12 | 39.09 | 38.05 |

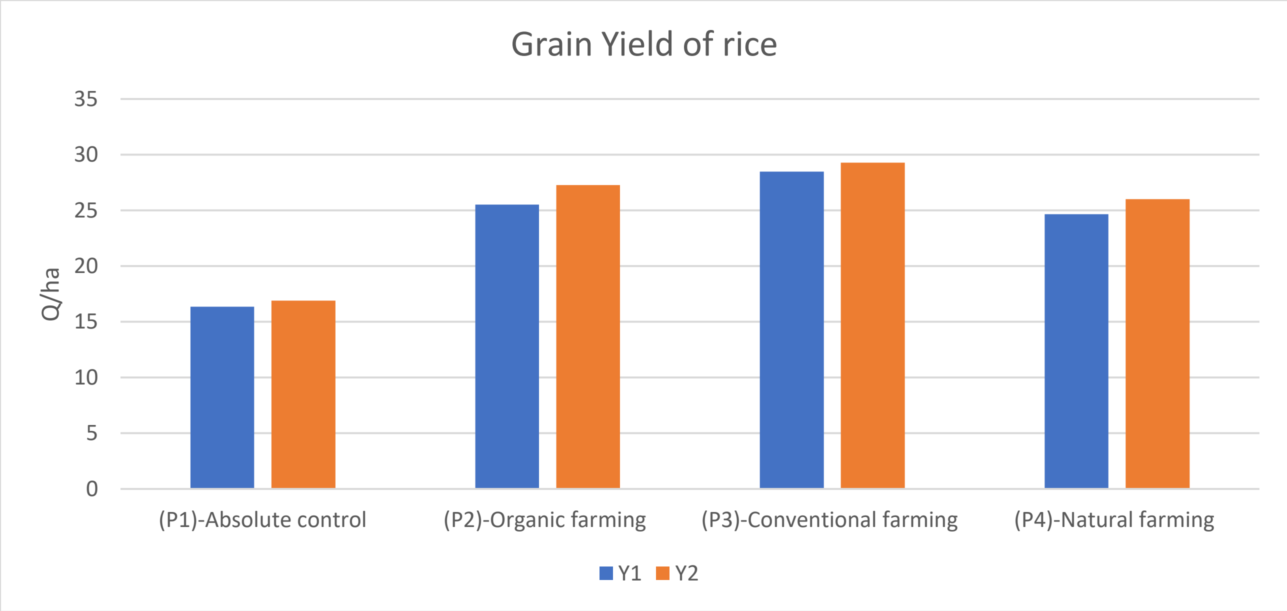


**Fig No. 1- Effect of different production system on grain yield of basmati rice during 2022 ($Y_1$) and 2023 ($Y_2$)**

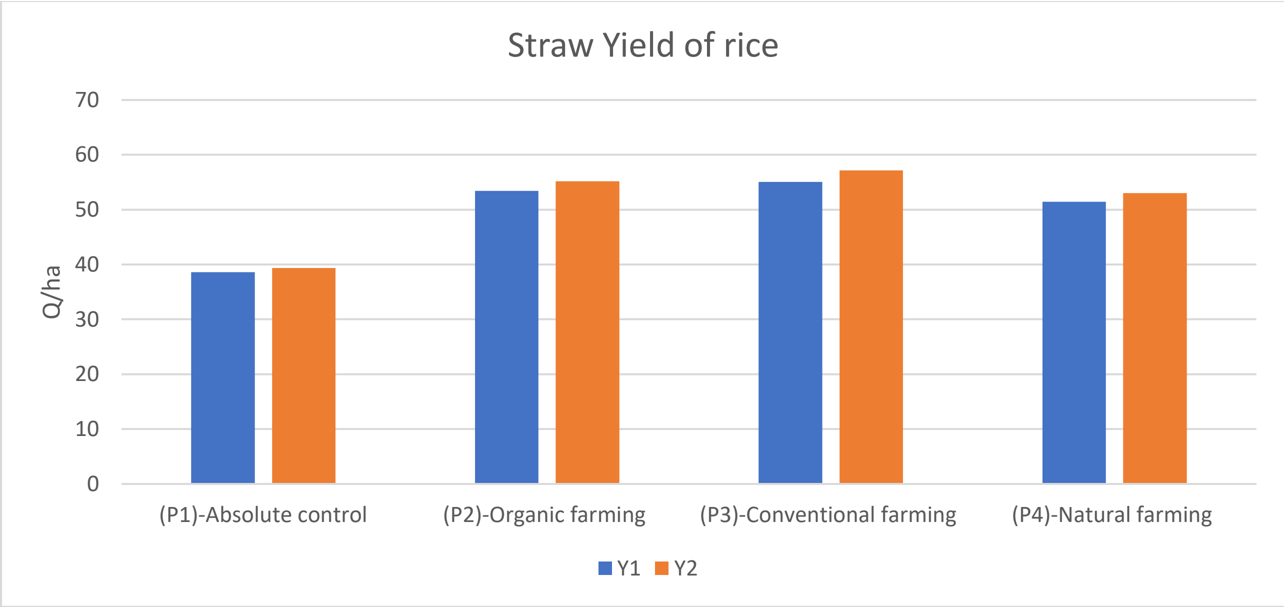


**Fig No. 2- Effect of different production system on straw yield of basmati rice during 2022 ($Y_1$) and 2023 ($Y_2$)**

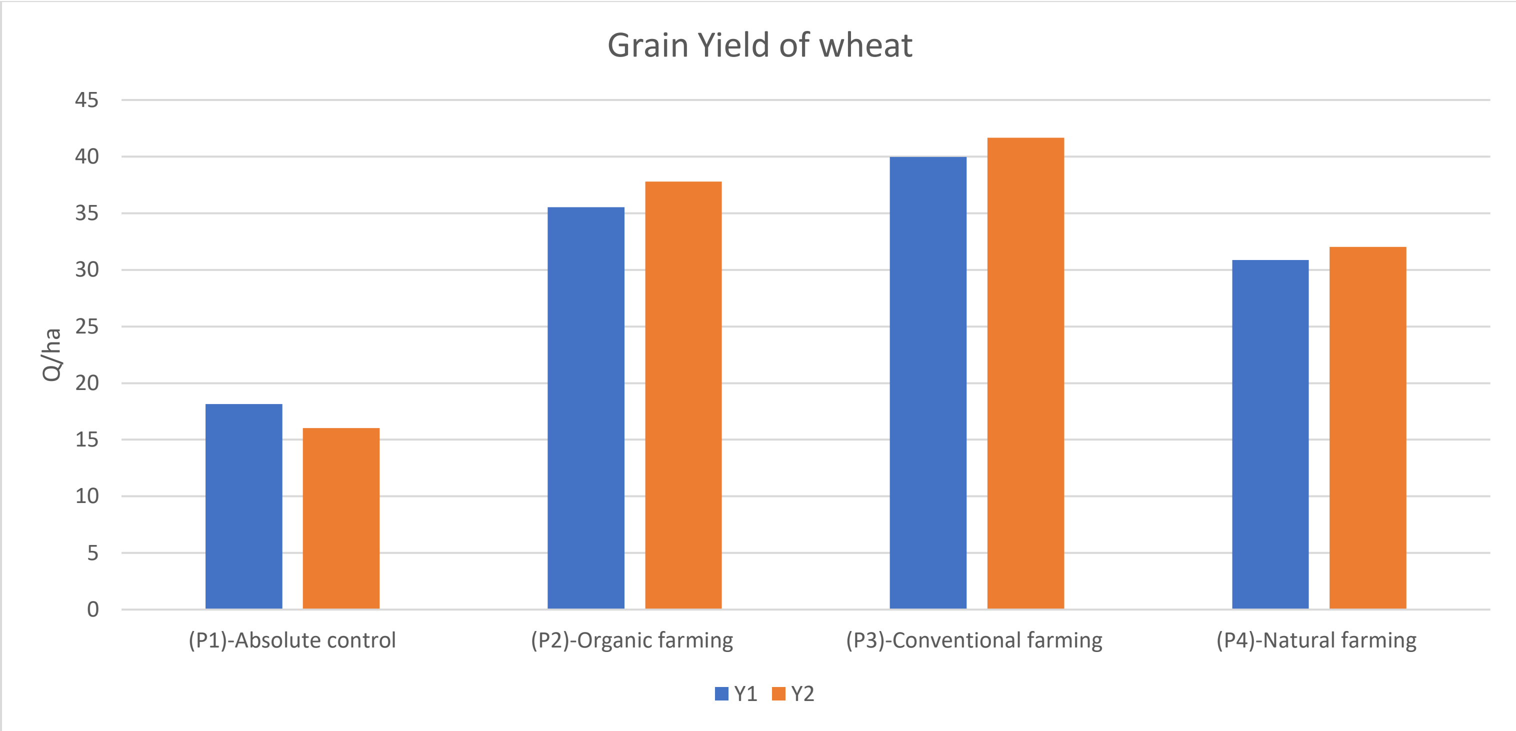


**Fig No. 3- Effect of different production system on grain yield of wheat during 2022 ($Y_1$) and 2023 ($Y_2$)**

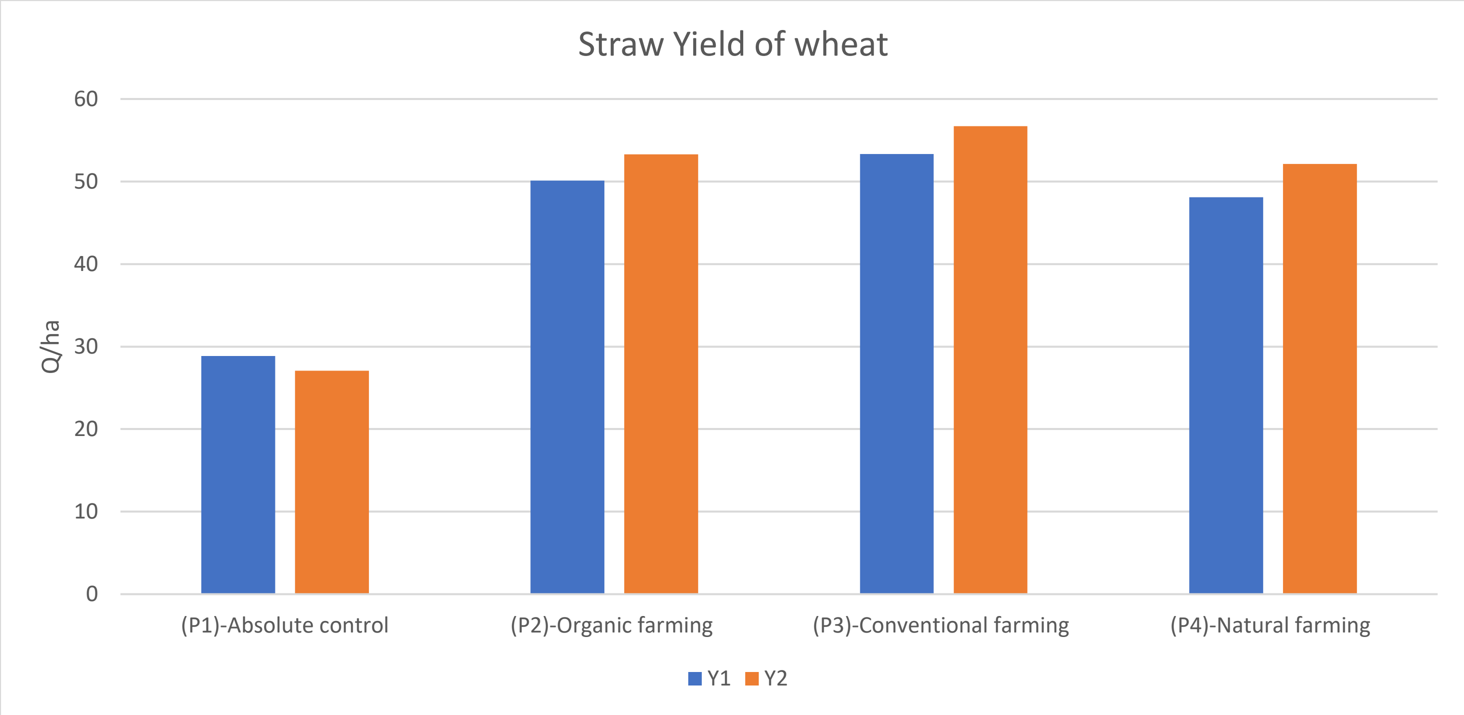


**Fig No. 4- Effect of different production system on straw yield of basmati wheat during 2022 ($Y_1$) and 2023 ($Y_2$)**