Original Research Article

Economic Assessment of Wheat Production under Contrasting Tillage Systems and Nutrient Management Strategies

**Abstract**

 A field experiment was conducted in the rabi season of 2023–2024 and 2024–2025 at the agriculture research farm of Banda University of Agriculture & Technology in Banda, Uttar Pradesh, India. The experiment was carried out in split-split plot design with two main plots (zero tillage and conventional tillage), three sub plots (wheat cultivars i.e. HD 3226, HD 3249 and DBW 187) and three sub-sub plots (NPK levels i.e. 100% NPK, 125% NPK and 150% NPK). All 18 treatment combinations were replicated thrice. The results of both years revealed that among tillage practices less cost of cultivation (5.24% and 5.13%), higher gross return (₹137127.00 and ₹141294.00 / ha), higher net return (₹ 93177.00 and ₹ 96402.00 /ha) and higher B: C ratio (2.12 and 2.14) was recorded in zero tillage than conventional tillage. Among wheat cultivars, cost of cultivation of each cultivar remains same but significantly higher gross return (₹ 139306.00 and ₹ 142111.00 / ha), higher net return (₹ 94140.00 and ₹ 96003.00 /ha) and higher B: C ratio (2.08 and 2.08) was reported with DBW 187 cultivar followed by HD 3226 and HD 3249. In nutrient management options, 150% NPK levels attained significantly higher gross return (₹ 141603.00 and ₹ 144444.00 / ha), net return (₹ 94592.00 and 96303.00 /ha) and B: C ratio (2.02 and 2.01) although the cost of cultivation (₹ 47011.00 and ₹ 48141.00 /ha) was also recorded higher at this rate of application.

***Key words:*** Zero Tillage, conventional Tillage, cost of cultivation, gross return, net return and B:C ratio.

**1. Introduction**

 Wheat (*Triticum aestivum* L.) being a important component of rice-wheat cropping system, playing crucial role in global food security by providing food to billions of people and half of the dietary protein and more than half of the calories (**Meena *et al.* 2017a Meena *et al.* 2017b**). As wheat accords 20% of the global protein and calorie diet, it is established as an impressive crop fostering hunger and enhancing food security in today's world (**Shiferaw *et al.* 2013**). Over a billion people worldwide eat it in various forms such as bread, pasta, noodles, pastries, and breakfast cereals (**Kumar *et al.* 2017**). For a sizable portion of the livestock in the country, wheat straw is an excellent source of feed. Globally wheat is occupied highest acreage among all crops and is grown in an area about 215.91 million hectares with an annual production of about 791.02 million metric tons with 3.46 tonnes per hectare productivity. Worldwide, India’s ranks second in terms of production (14%) next to China (17%). In India, wheat is occupied around 31.83 million hectares area and produces 113.29 million tonnes with a national average yield of 3559 kg/ha (**Agricultural at a glance 2023-24**). In India, Uttar Pradesh ranks first both in area and production of 9.52 Mha (30.31 %) and 33.61 mt (30.40%), respectively.

 The production and productivity of wheat largely depends upon the better crop management including tillage, use of high yielding varieties and proper nutrition. Among tillage practices, zero tillage, a component of conservation agriculture, plays a vital role in harnessing the production potential of high yielding varieties with sustainable manner. Zero tillage facilitates to sowing wheat in the standing stubbles of previous crop. It deals with the manipulation of soil in narrow strip where seeds are placed. Wheat grown after rice is generally delayed up to 15-20 days and at each day 1% yield penalty have faced by farmers if, sown after 25th November. Zero tillage technology has been evolved to makeup the time loss in pre-sowing irrigation and field preparation as sowing is done at residual moisture in unprepared field directly. It facilitates sowing of wheat on time result in good crop establishment. It also offers the benefits of retaining surface residues and reduces soil-water losses. With zero-tillage technology, up to 10% production cost is reduced in one hand and comparatively higher yields is received in another hand with improves soil health and fertility. Level of fertility in soil with proper management plays a vital role in the performance of high yielding wheat varieties. These kinds of cultivars have a high nutrient demand, especially primary nutrients i.e. N, P and K. Adequate and balanced supply of nutrients coupled with maximization of yield potential.

 Keeping in consideration of above facts the objective of this study is to economic assessment of wheat production under contrasting tillage systems and nutrient management strategies.

**2.** **Materials and methods**

 The cost of field preparation, irrigation, fertilizer application, herbicide spraying, weeding, harvesting, threshing, and bagging, as well as the cost of seed, fertilizers, pesticides, labor, fuel and depreciation all were taken into consideration for calculating the cost of crop cultivation. The total revenue generated from the sale of the crop yield, including grain and straw, was considered the gross return. The net return was computed by deducting the total cultivation cost from the gross return. The B:C ratio was computed by dividing the net return by the total cost of cultivation.

**2.1 Site for the experiment**

A two-year field experiment was carried out at the agriculture research farm of Banda University of Agriculture & Technology, Banda in Uttar Pradesh, India during rabi season of crop year 2023–2024 and 2024–2025. The farm is located at an altitude of 228.61 meters above mean sea level and lies between 25.53° N latitude and 80.33° E longitude. The climate of this area is hot and semi-arid. Rainfall in this region ranges from 750 to 950 mm per year. The soil of experimental site was sandy clay loam in texture (68.592% sand, 11.216% silt and 20.192% clay), rated as low in organic carbon (0.39%), low in available nitrogen (236 kg/ha), medium in available phosphorus (16 kg/ha) and medium in available potassium (273 kg/ha).

**2.2 Experimental design and treatments**

The experiment was plan with 18 treatments in spilt-split plot design with three factors where three wheat cultivars (sub-plots) i.e. HD 3226, HD 3249 and DBW 187 were grown by two methodologies (main plots) viz. conventional tillage and zero tillage with three NPK levels (sub-sub plots) e.g. 100% NPK, 125% NPK and 150% NPK. The recommended dose of nutrients were 120 kg/ha N, 60 kg/ha P2O5 and 40 kg/ha K2O. The treatment are: T1- Conventional Tillage + HD 3226 + 100 % NPK; T2- Conventional Tillage + HD 3226+ 125 % NPK; T3- Conventional Tillage + HD 3226 + 150 % NPK; T4- Conventional Tillage + HD 3249+ 100% NPK; T5- Conventional Tillage+ HD 3249+ 125% NPK; T6- Conventional Tillage+ HD 3249+ 150% NPK; T7- Conventional Tillage + DBW 187+ 100% NPK; T8-Conventional Tillage + DBW 187+125% NPK; T9- Conventional Tillage + DBW 187+150% NPK; T10- Zero Tillage + HD 3226+ 100% NPK; T11- Zero Tillage + HD 3226+125% NPK; T12- Zero Tillage + HD 3226+150% NPK; T13- Zero Tillage + HD 3249+100% NPK; T14- Zero Tillage + HD 3249+125% NPK; T15- Zero Tillage + HD 3249+150% NPK; T16- Zero Tillage + DBW 187+100% NPK; T17- Zero Tillage + DBW 187+125% NPK; T18- Zero Tillage + DBW 187+150% NPK.

**3. Result and discussion**

**3.1 Yield (tonnes/ha)**

 At the 5% level of significance, the yield values for grain and straw of wheat were included in the study based on the analysis of variance. During both the years of study, zero tillage produced higher grain (5.06 t and 4.96 t) and straw (5.94t and 5.93t) yield than conventional tillage. Out of three wheat cultivars, DBW 187 was noted to produce significantly higher grain yield (5.13 t) and stover yield (6.06 t) in 2023-24 and about 4.93 t grain yield and 5.98 t stover yield during 2024-25 over HD 3226 and HD 3249. In nutrient management, significantly higher grain (5.21 t & 5.01 t) and stover (6.19 t & 6.07 t) yield were found in 150% recommended dose of NPK, followed by NPK 125% and NPK 100%. The yield was attained proportionally with respect to the increasing dose of nutrients. The similar findings were observed by **Kumar *et al.* (2018),** **Dhaker *et al.* (2022).** The system of zero tillage improvise the soil organic carbon, water holding capacity, aeration, permeability and nutrient recycling that gives yield advantages over the conventional tillage. Improved soil properties related to increased or maintain good infiltration, root penetration and adequate nutrient supply was congenial to better growth attributing and yield attributing characters and finally yield.

**3.2 Economics**

 Results pertaining to economics of wheat cultivation are cited in Table (1) and Fig. (1). Total cost of cultivation, gross returns, net return and B: C ratio was affected by different treatments under study. However the interaction effect remained unaffected during both cropping seasons.

**3.2.1 Total cost of cultivation (**₹ **ha-1)**

During both the year of study (2023-24 and 2024-25), maximum cost of cultivation was recorded in conventional tillage (₹46382.00 and ₹47325.00) while zero tillage offered 5.24% (₹43950.00) and 5.14 % (₹44892.00) low cultivation cost in first year and in second year respectively. This might be due to the higher cost involved in cultivation through conventional tillage as more number of ploughing were carried out that consumed more fuel, more labor and depreciation of machines. The results are in the line of **Raju *et al.* (2012),** **Gupta *et al.* (2019), Kaur *et al.* (2022).**

Among all wheat cultivars total cost was remain static in crop year 2023-24 (₹. 45166.00) and 2024-25 (₹46108.00). During both cropping seasons, cost of nutrient treatment was recorded higher with NPK 150% (₹47011.00 and ₹48141.00) followed by NPK 125% (₹ 45166.00 and ₹ 46108. 00) and NPK 100% (₹43322.00 and ₹ 44075.00). Higher cultivation cost in 150% NPK level is due to the increased amount of fertilizers used. Since fertilizers are major component of cost in crop production, this leads to an increase in input expenditure.

 **Fig. 1** Effect of tillage and nutrient management practices on cultivation cost of wheat.

**3.2.2 Gross return (₹ ha-1)**

Table 1 illustrates that tillage, wheat cultivars and nutrient management practices affect gross economic returns in both the years of study. Both wheat cultivars and nutrient management practices had significant effect on gross return of crop in both seasons. Among the wheat cultivars, DBW 187 recorded the significantly higher gross returns (₹139306.00 and ₹142111.00) followed by HD 3226 and HD 3249. Among the nutrient management treatments, application of 150% recommended dose of NPK registered the highest gross returns (₹ 141603.00 and ₹ 144444.00) which were significantly higher than 125% recommended dose of NPK and 100% recommended dose of NPK. These results are in the line of **Singh *et al.* (2021), Prajapati *et al.* (2020).** This might be due to higher yield of wheat in respective treatments which led to proportionally higher gross return. Zero tillage wheat attained higher gross returns (₹137127.00 and ₹141294.00) than conventional til sown wheat (₹125619.00 and ₹126654.00). Gross return was higher 9.16 % in 2023-24 and 11.56% in 2024- 25 in zero tillage as compared to conventional tillage. This might be due higher yield and lower input cost in zero tillage. The similar findings were reported by **Kaur *et al.* (2022), Abhineet *et al.* (2021), Sahu (2024).**

**3.2.3 Net returns (₹ ha-1)**

 Across the investigation, the net returns weremarginally higher (₹ 93177.00 and ₹ 96402.00 in 2023-24 and 2024-25, respectively) under zero tillage compared to conventional tillage which resulted ₹ 79237.00 and ₹ 79330.00. This represented an increase of 17.59 % and 21.52 % in net returns under zero tillage compared to conventional tillage in 2023–24 and 2024–25, respectively (Table 1). Similar findings were recorded by the **Gupta *et al.* (2019), Kaur *et al.* (2022), Khan *et al.* (2017) and Kushwah *et al. (*2019).** Among the different wheat cultivars, DBW 187 achieved the significantly highest net returns, with ₹ 94140.00 and ₹ 96003.00 in 2023–24 and 2024–25, respectively, than HD 3226 and HD 3249. Regarding nutrient management, application of 150% of the NPK resulted in the significantly higher net returns₹ 94592.00 and ₹ 96303.00 during 2023–24 and 2024–25, respectively. These values were significantly higher than those recorded with 125% NPK (₹ 86096.00 and ₹ 87889.00) and 100% NPK, which yielded the lowest returns (₹ 77933.00 and ₹ 79406.00) in both years. These results are in the pattern of findings of **Dhaker *et al.* (2022), Gupta *et al*. (2011), Singh *et al.* (2017), and Singh *et al.* (2021).** The maximum return under zero tillage, wheat cultivar DBW 187 and NPK level 150% might be due to lower cost (in zero tillage) and higher yields of wheat led to proportionally higher gross returns than cost of cultivation.

**Fig. 2** Effect of tillage and nutrient management practices on gross return from wheat cultivation.

**Fig. 3** Effect of tillage and nutrient management practices on net return from wheat cultivation.

**3.2.4 Benefit cost (B: C) ratio**

 B: C ratio was affected due to different treatments under study (Table 1). Among tillage practices zero tillage sown wheat showed numerically higher B: C ratio, 2.12 and 2.14 in 2023–24 and 2024–25, respectively, compared to conventional tillage which was 1.71 and 1.67 in the corresponding years (Table 1). Similar findings was observed by **Sahu (2024), Yadav (2021),** **Gupta *et al.* (2019), Kaur *et al.* (2022), Kumar *et al.* (2020),** and **Latif *et al.* (2020).** Wheat cultivars had significant effect on B:C ratio during both years, significantly higher B: C ratio was yielded by DBW 187, with 2.08 and 2.08 in 2023–24 and 2024–25, respectively followed by HD 3226, which recorded 1.87 and 1.87 in the same periods. The lowest B: C ratio in both years was registered with HD 3249, which was 1.78 and 1.77, respectively. Regarding nutrient management, 150% NPK level resulted in maximum B: C ratio 2.02 during 2023–24 followed by RDF 125% and 100%. During second year, it produced significantly higher B: C ratio (2.01) which was statistically at par with 125% NPK level (1.91) and the lowest B: C ratio was obtained with 100% NPK level (1.81). These findings were observed by **Singh *et al.* (2017), Singh *et al.* (2021), and Usman *et al.* (2013).** The possible fact behind higher B: C ratio under zero tillage, DBW 187 and 150% NPK level is that the higher wheat yield, gross return and net returns in these treatments over others.

**Fig. 4** Effect of tillage and nutrient management practices on B:C ratio of wheat cultivation.

**Table 1** Effect of tillage and nutrient management practices on economics of wheat cultivation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Total cost of cultivation** **(₹ha-1)** | **Gross return (₹ ha-1)** | **Net Return (₹ha-1)** | **B:C ratio** |
| **Tillage methods** | **2023-24** | **2024-25** | **2023-24** | **2024-25** | **2023-24** | **2024-25** | **2023-24** | **2024-25** |
| T1: CT | 46382 | 47324 | 125619 | 126654 | 79237 | 79330 | 1.71 | 1.67 |
| T2: ZT | 43950 | 44892 | 137127 | 141294 | 93177 | 96402 | 2.12 | 2.14 |
| SEM± for Tillage | -- | -- | 3022 | 3481 | 3022 | 3481 | 0.0701 | 0.08 |
| C.D.(0.05) | -- | -- | NS | NS | NS | NS | NS | NS |
| **Varieties (V)** |
| V1: HD3226 | 45166 | 46108 | 129426 | 132225 | 84260 | 86117 | 1.87 | 1.87 |
| V2: HD3249 | 45166 | 46108 | 125387 | 127585 | 80220 | 81477 | 1.78 | 1.77 |
| V3: DBW187 | 45166 | 46108 | 139306 | 142111 | 94140 | 96003 | 2.08 | 2.08 |
| SEM± for V | -- | -- | 2387 | 2588 | 2387 | 2588 | 0.05 | 0.06 |
| C.D.(0.05) | -- | -- | 7783 | 8440 | 7783 | 8440 | 0.1636 | 0.18 |
| **Nutrient Management (N)** |
| N1: 100% RDF | 43322 | 44075 | 121255 | 123481 | 77933 | 79406 | 1.8 | 1.81 |
| N2: 125% RDF | 45166 | 46108 | 131262 | 133997 | 86096 | 87889 | 1.91 | 1.91 |
| N3: 150% RDF | 47011 | 48141 | 141603 | 144444 | 94592 | 96303 | 2.02 | 2.01 |
| SEM± for NM | -- | -- | 3226 | 1739 | 3226 | 1739 | 0.072 | 0.04 |
| C.D.(0.05)  | -- | -- | 9417 | 5076 | 9417 | 5076 | NS | 0.11 |
| **Interaction effect**  | NS | NS | NS | NS | NS | NS | NS | NS |

**4. Summery & conclusion**

 Zero tillage, wheat cultivars and nutrient management options showed the influence on the economics of wheat production. The results revealed that the among tillage practices zero tillage offered less cost of production and resulted better in terms of gross return, net return and B:C ratio. Among wheat cultivars DBW 187 recorded significantly higher gross return, net return and B: C ratio followed by HD 3226 and HD 3249. In recommended dose of NPK, 150 % registered significantly higher gross return, net return and B: C ratio over rest of NPK levels. Finally it may be concluded that the adoption of zero tillage, DBW 187 cultivar with 150% NPK level is better in terms of gross monetary return, net monetary return and B:C ratio.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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