Original Research Article

Evaluating the Efficiency and Economic Viability of Mustard Cultivation with a Happy Seeder

Or Field and economic evaluation of Happy Seeder for *in-situ* sowing of mustard in paddy residue

ABSTRACT

Mustard, scientifically known as *Brassica juncea*, is a vital oilseed crop sown during the Rabi season in various agricultural regions. This crop not only contributes significantly to the edible oil supply but also plays a crucial role in the agricultural economy, providing farmers with essential income and employment opportunities. However, one of the major challenges faced by farmers in mustard cultivation is the tillage process, which ~~can be~~ is both time-consuming and labor-intensive. Conventional tillage methods often require extensive land preparation, leading to increased labor costs and decreased efficiency.

In light of these challenges, this study was conducted to evaluate the efficacy of the Happy Seeder technology, a modern innovation designed to facilitate direct sowing in the standing stubble of previous crops. This research focused on the mustard variety *Pusa-27* and was executed over two consecutive Rabi seasons, specifically from 2021-22 and 2022-23. The experiment was implemented by KVK Rohtas, utilizing both long-term experimental plots and 20 different farmers' fields to ensure a comprehensive assessment across various agricultural settings. To analyze the impact of the two different sowing methods, two groups of plots were established at each site: one group employed the conventional tillage method (T1), while the other group utilized the Happy Seeder technique (T2). The experimental design followed a randomized block format, consisting of 21 replications for each treatment to ensure robust and reliable data collection.

The results of the study revealed that the Happy Seeder sowing method significantly enhanced the productivity of mustard. The average yield recorded for the Happy Seeder group was an impressive 16.25 quintals per hectare, markedly higher than the 12.70 quintals per hectare achieved with conventional tillage. This increase in yield not only highlights the effectiveness of the Happy Seeder technology but also suggests that it can potentially help meet the growing demand for oilseeds.

In addition to higher yields, the Happy Seeder method also resulted in reduced input costs, primarily due to lower labor requirements associated with its use. The reduced need for extensive tillage and the ability to sow directly into the stubble allow farmers to save on labor costs and time, making the farming process more efficient.

Moreover, the implementation of the Happy Seeder method was associated with significant improvements in soil health. The study indicated enhancements in both the physico-chemical and biological properties of the soil, which are crucial for sustainable agricultural practices. Improved soil health not only contributes to better crop yields but also promotes long-term fertility, allowing farmers to sustain their agricultural productivity over time.

In conclusion, the findings of this study strongly advocate for the adoption of the Happy Seeder sowing method in mustard cultivation. The notable improvements in productivity, reduction in input costs, and enhancement of soil health suggest that this innovative technique can play a pivotal role in transforming mustard farming into a more sustainable and profitable venture. By embracing such modern agricultural practices, farmers can significantly contribute to food security while also improving their economic viability.

Keywords: Happy seeder, mustard, tillage, physico chemical properties, productivity

INTRODUCTION

Mustard cultivation holds a significant position in agricultural economies across the globe, particularly in India, where it serves as a vital oilseed crop. It provides essential income and employment opportunities for numerous farmers, contributing to their livelihoods and the rural economy. However, with the increasing pressure to meet the demands of a growing population and evolving market needs, there is a pressing necessity to explore innovative and sustainable farming practices that can enhance productivity while ensuring profitability. As the global landscape shifts towards sustainable agriculture, traditional farming methods face scrutiny for their inefficiency and environmental impact. Among these traditional practices, tillage has been identified as a time-consuming and labor-intensive process, often leading to soil degradation and reduced agricultural output. The Happy Seeder technology presents a promising alternative to conventional tillage methods by facilitating the direct sowing of mustard crops into the stubble of previous crops. This innovation not only streamlines the planting process but also aligns with modern sustainable agricultural practices.

This study aims to comprehensively assess the economic aspects of mustard sowing using the Happy Seeder technique. Despite the cultivation of several oilseed crops in India, the nation still relies heavily on imports to meet its domestic vegetable oil requirements, fulfilling only 50% of its needs through local production. This shortfall is primarily attributed to low productivity levels, which stem from a variety of factors, including inefficient sowing methods, inadequate nutrient management, and challenges related to water and weed control. Moreover, there has been a stagnation or even decline in the area under principal oilseed crops, such as rapeseed-mustard and groundnut. The demand for vegetable oil in India is on a steady rise, increasing by approximately 4-6% annually, driven by a growing population, improved living standards, and heightened purchasing power (Agarwal, 2007). Given this context, it is crucial to enhance the productivity of oilseed crops to bridge the current demand-supply gap effectively. Addressing this challenge will require innovative solutions and a concerted effort to optimize agricultural practices.

Research has shown that better root growth is associated with improved soil conditions and reduced weed infestation, both of which contribute to enhanced crop growth and higher yields in zero-tillage or Happy Seeder systems (Singh *et al*., 1998). The in-situ application of crop residues, such as paddy straw for succeeding mustard crops and mustard crop residues for the next rainy-season crops, has become more efficient with the advent of Happy Seeder machines. These machines facilitate the direct sowing of seeds into standing residues while adhering to conservation-tillage principles (Jat *et al*., 2009).

Root development is pivotal for overall plant growth, as soil must provide adequate air, water, and nutrients for healthy root systems (Husnjak *et al*., 2002). Deeper root penetration is advantageous as it ensures better anchorage and enhances the plant's ability to absorb water and nutrients. Research indicates that finer roots with greater root length density (RLD) and surface area are more effective in extracting resources from both surface and sub-surface soil layers compared to thicker roots, which tend to remain in the upper layers, particularly under zero-tillage or Happy Seeder systems (Box and Ramseur, 1993). Zero-tillage or Happy Seeder practices, when coupled with permanent residue cover, have been shown to increase water infiltration rates. This is achieved through the formation of larger macro-aggregates in the soil, even in soils characterized by higher bulk density (Hobbs et al., 2008). Such improvements in soil structure are crucial for enhancing water availability to crops, particularly in semi-arid and rainfed ecosystems, where moisture conservation is essential for sustainable farming.

Given these considerations, adopting resource-conserving technologies such as conservation tillage and effective residue management is vital for improving root and shoot development, increasing productivity, optimizing resource-use efficiency, and achieving long-term sustainability in agricultural systems.

MATERIALS AND METHODS

The field experiment was conducted over two consecutive years during the Rabi seasons of 2021-22 and 2022-23. The study was carried out at the KVK Rohtas long-term experimental plot and on 20 additional farmers' fields to evaluate the productivity and profitability of mustard (Variety Pusa-27) sown using the Happy Seeder method. Two groups of plots were selected at each site: one group used conventional tillage, and the other employed the Happy Seeder sowing method.

The soil in the experimental plots was classified as clay-loam, with the following physico-chemical properties measured: alkaline $KMnO_4$-oxidizable nitrogen (N), $NaHCO_3$-extractable phosphorus (P), 1N NH_4OAc exchangeable potassium (K), organic carbon content, pH (measured using a soil-water

ratio of 1:2.5), and electrical conductivity (measured with an EC bridge). A rice-based cropping system was implemented, where rice, the preceding rainy season crop, was cultivated using the vattar DSR method under irrigated conditions, following other recommended practices.
The experiment followed a randomized block design with 21 replications. Each replication consisted of two treatments: T_1 - Conventional Tillage, and T_2 - Happy Seeder machine. Growth attributes of mustard, including plant height and dry matter accumulation, were measured at 90 days after sowing (DAS) using a one-meter row marked with pegs from the beginning. Primary branches per plant and siliquae per plant were counted from five randomly selected plants in each plot. The number of seeds per siliqua and the 1,000-seed weight were measured from ten randomly selected siliquae.
Seed and stalk yields, along with the harvest index, were recorded from a net plot of 10 m^2, and the seed yield was adjusted to 12% moisture content. A pooled analysis of seed yield was conducted to evaluate the year effect. Profitability analysis included calculations of the cost of cultivation, gross and net returns, and net returns per Indian Rupee (IRs) invested. The biometric data on ancillary and yield parameters were analyzed using standard statistical techniques (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Physico-chemical properties of soil:

The physico-chemical properties of the soil in the experimental fields are presented in Table 1 and Figures 1 and 2. The study compared two treatments: Conventional Tillage (CT) and Happy Seeder (HS). Various soil parameters and nutrient availability were analyzed to assess the impact of each method, including pH, Electrical Conductivity (ECe), Organic Carbon (OC), and available nutrients such as Nitrogen (N), Phosphorus (P), and Potassium (K).

The initial soil analysis revealed a pH of 5.80, ECe of 0.26 dSm^{-1}, and OC content of 0.58%. The available nutrient levels were 214.17 kg ha^{-1} for N, 36.15 kg ha^{-1} for P, and 109.43 kg ha^{-1} for K. Under CT, the soil showed a pH of 5.84, ECe of 0.29 dSm^{-1}, and OC content of 0.56%, with nutrient levels at 234.64 kg ha^{-1} for N, 38.91 kg ha^{-1} for P, and 114.43 kg ha^{-1} for K. In comparison, the happy seeder treatments exhibited a slightly higher pH of 5.90, lower ECe of 0.11 dSm^{-1}, and increased OC content of 0.61%. Nutrient availability in the HS treatment was higher, with 255.59 kg ha^{-1} for N, 42.21 kg ha^{-1} for P, and 116.29 kg ha^{-1} for K.

Statistical analysis at a significance level of 0.05 indicated significant differences ($p<0.05$) between the treatments. The happy seeder treatment demonstrated superior soil quality, with higher pH, lower ECe, and greater OC content compared to CT. Additionally, HS showed enhanced nutrient availability for N, P, and K, suggesting improved soil fertility.

These results suggest that the Happy Seeder technique offers several advantages over conventional tillage in terms of soil quality and nutrient availability. The higher organic carbon content and nutrient levels observed in the happy seeder treatment indicate enhanced productivity potential for mustard sowing. These findings underscore the importance of adopting sustainable agricultural practices like the Happy Seeder to improve both productivity and profitability, contributing to environmental sustainability and better economic returns for farmers.

Growth Attributes, Yield, and Economics:

Tables 2, 3, and Figures 3 and 4 present the data on growth attributes, yield, and the economic comparison of the two tillage practices: Conventional Tillage (CT) and Happy Seeder (HS). The data clearly show several potential benefits of the happy seeder technique for mustard sowing.

At 90 days after sowing (DAS), mustard plants in the HS treatment had an average height of 164.25 cm, compared to 157.85 cm in the CT treatment—a difference of 6.40 cm. The critical difference (CD) value of 1.27 confirms that this difference is statistically significant. The number of branches per plant was slightly higher in HS (4.92) compared to CT (4.28), with a difference of 0.64 branches. The CD value of 0.2 suggests that this difference is within the expected range of variation. These results align with the findings of Rathore *et al*. (1998).

The plant population per square meter was slightly higher in happy seeder (95.86 plants) compared to CT (91.52 plants), indicating a denser population in HS-treated plots.

Flowering was delayed in HS, with plants taking 42.38 days to reach this stage compared to 34.37 days in CT. However, the difference of 4.35 days was not statistically significant, as the CD value of 2.06 indicates that this variation is within the expected range. Similarly, plants in the HS treatment took 122.65 days to mature, 4.4 days longer than in the CT treatment, with no statistically significant difference (CD value of 1.97) (Amgain et al., 2019).

The HS treatment produced a higher number of siliqua per plant (151.45) compared to CT (145.18), with a difference of 6.27 siliqua per plant, suggesting an advantage of HS in increasing siliqua count. No significant difference was observed in siliqua length between the treatments. The HS treatment also showed a higher number of seeds per siliqua (8.02) compared to CT (7.81), and the difference of 0.21 seeds was statistically significant (CD value of 1.15). These findings are consistent with the results of Parihar et al. (2010).

The test weight of mustard seeds was slightly higher in HS (4.01 g) compared to CT (3.81 g), with a difference of 0.21 g. The HS treatment resulted in a higher seed yield per hectare (16.25 q ha^{-1}) compared to CT (12.75 q ha^{-1}), a statistically significant difference of 3.5 q ha^{-1} (CD value of 2.18).

Stalk yield was also higher in HS (43.35 q ha^{-1}) compared to CT (38.96 q ha^{-1}), with a difference of 4.39 q ha^{-1}. Both treatments had similar harvest indices, with HS at 0.27% and CT at 0.25% (Rathore *et al*., 1998).

Statistical analysis (Gomez & Gomez, 1984) confirmed significant improvements in plant height, number of seeds per siliqua, and seed yield in the HS treatment compared to CT. However, no significant differences were found in other parameters, including days to flowering and maturity, siliqua length, test weight, stalk yield, or harvest index.

The higher mustard yield in the HS treatment can be attributed to factors such as improved spacing, reduced weed competition, minimized moisture stress, better root penetration, and favorable soil conditions. HS promotes better growth by improving nutrient access, reducing weed interference, and conserving moisture. Adequate rainfall further supports growth and productivity, making HS a promising technique for mustard cultivation. Further research is needed to validate these findings and assess the long-term economic viability of the Happy Seeder technique.

Economic Analysis:

Table 3 presents the economic analysis, revealing significant differences between CT and HS treatments. The cost of cultivation was Rs 19,200 per hectare for CT, while it decreased to Rs 18,400 per hectare for HS, primarily due to labor savings and saving in diesel costs with the Happy Seeder technology.

In terms of gross returns, CT yielded Rs 61,838 per hectare, while HS generated a higher gross return of Rs 78,813 per hectare. The increase in gross return with HS is attributed to better moisture and nutrient conservation, leading to improved productivity.

Net returns were Rs 42,638 per hectare for CT, compared to Rs 60,413 per hectare for HS, indicating a clear profitability advantage for the Happy Seeder method. The benefit-cost ratio (BCR) was 3.22 for CT and 4.28 for HS, further highlighting the economic advantages of HS over CT.

These findings align with previous studies by Amgain *et al*. (2019), Saxena *et al*. (1998), Singh *et al*. (2003), and Singh et al. (2008), which support the economic benefits of adopting Happy Seeder technology for mustard cultivation.

CONCLUSION

The evaluation of mustard sowing using Happy Seeder technology underscores its transformative potential in improving both productivity and profitability when compared to conventional tillage methods. The use of Happy Seeder not only enhances the efficiency of the sowing process but also fosters better plant growth, leading to significant improvements in various growth attributes, such as plant height, number of branches, and seed production. This technology offers the dual advantage of conserving soil moisture and nutrients while minimizing soil disturbance, which creates a more favorable environment for crop growth.

The study demonstrated that mustard crops sown using the Happy Seeder consistently outperformed those cultivated using conventional tillage in terms of yield. This was attributed to several factors, including reduced weed competition, better root penetration, and improved resource use efficiency. These benefits translate directly into higher seed yields and increased biomass production, which are critical for maximizing the overall output of mustard farming.

From an economic perspective, the Happy Seeder method significantly reduced input costs, particularly by lowering labor requirements and decreasing the need for multiple tillage operations. This reduction in cost, combined with higher yields, resulted in substantially better economic returns for farmers. The benefit-cost ratio, a key indicator of agricultural profitability, was notably higher for the Happy Seeder treatment, confirming its economic viability for mustard cultivation.

These findings underscore the crucial role of sustainable farming practices in addressing the challenges of modern agriculture. By adopting technologies like the Happy Seeder, farmers can achieve higher productivity and profitability while promoting soil health and reducing the environmental footprint of their operations. In light of the growing demand for efficient and sustainable agricultural solutions, the Happy Seeder emerges as a promising tool for optimizing mustard production and ensuring long-term financial gains for farmers.

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This study is the product of collective efforts from all those acknowledged, and their contributions are deeply appreciated. However, we take full responsibility for any errors or omissions that may be present. Any such oversights are solely attributable to the authors and do not reflect on the institutions or individuals who supported this work.

Table 1. Physico-chemical properties of experimental soil

Treatment	pH	ECe	OC	N	P	K
	(1:2.5)	(dSm^{-1})	(%)	Available nutrients (Kg ha^{-1})		
Initial	5.80	0.26	0.58	214.17	36.15	109.43
CT	5.84	0.29	0.56	234.64	38.91	114.43
HS	5.90	0.11	0.61	255.59	42.21	116..29
CD (p=0.05)	0.02	0.03	0.1	1.78	0.7	3.02

Table 2: Effect of tillage practices on growth and yield attributes of mustard

Treatment	Plant Height (cm) (90 DAS)	Branches (90 DAS)		Plant Population (m^2)	Days taken for flowering	Days taken for maturity	Number of Siliqua per plant (no.)	Length of Siliqua per plant (cm)	Number of seeds per Siliqua (no.)	Test weight (gm)
		Primary	Secondary							
CT	157.85	4.28	3.22	91.52	34.37	118.26	145.18	4.37	7.81	3.81
HS	164.25	4.92	3.48	95.86	42.38	122.65	151.45	5.32	8.02	4.01
CD (p=0.05)	1.27	0.2	0.7	1.2	2.06	1.97	4.05	0.8	1.15	0.05

Table 3: Effect of tillage practices on yield and economics of mustard

Treatment	Seed yield (q ha^{-1})	Stalk yield (q ha^{-1})	Harvest Index (%)	Cost of Cultivation (Rs/ha)	Gross return (Rs/ha)	Net Return (Rs/ha)	BC Ratio
CT	12.75	38.96	0.25	19200	61838	42638	3.22
HS	16.25	43.35	0.27	18400	78813	60413	4.28
CD (p=0.05)	2.18	2.56	0.05	126	102	110.27	0.28

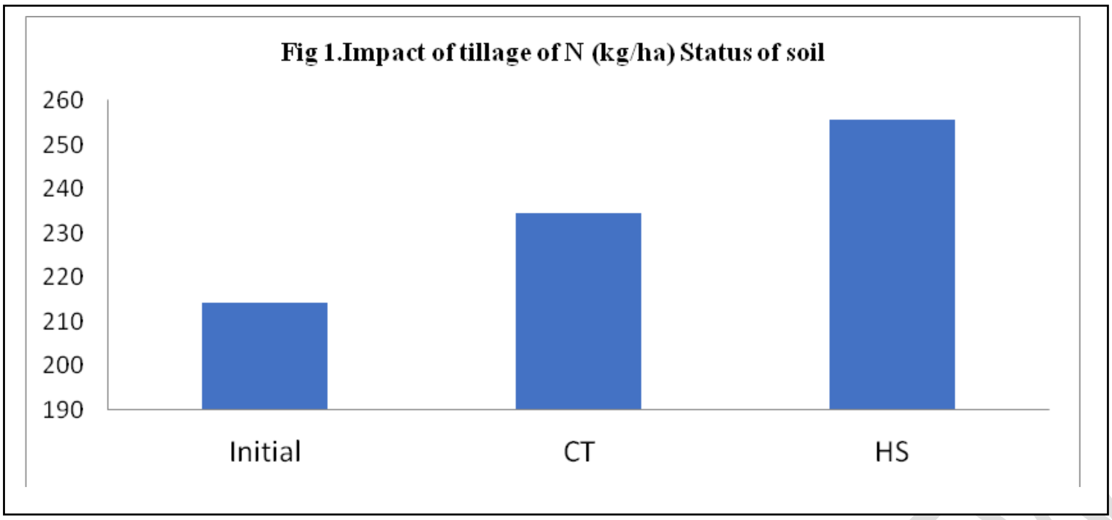


Fig 1.Impact of tillage of N (kg/ha) Status of soil
260
250
240
230
220
210
200
190
Initial
CT
HS

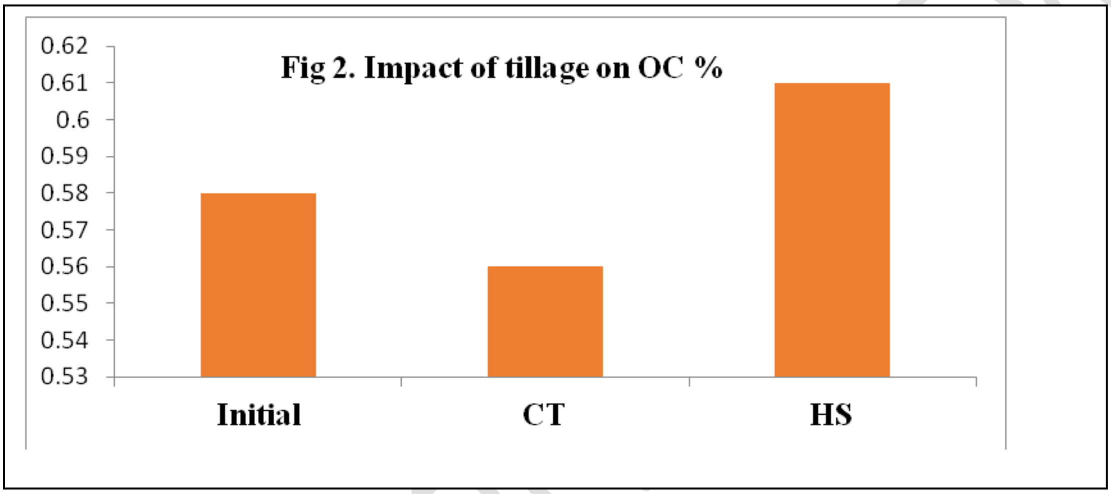


Fig 2. Impact of tillage on OC %
0.62
0.61
0.6
0.59
0.58
0.57
0.56
0.55
0.54
0.53
Initial
CT
HS

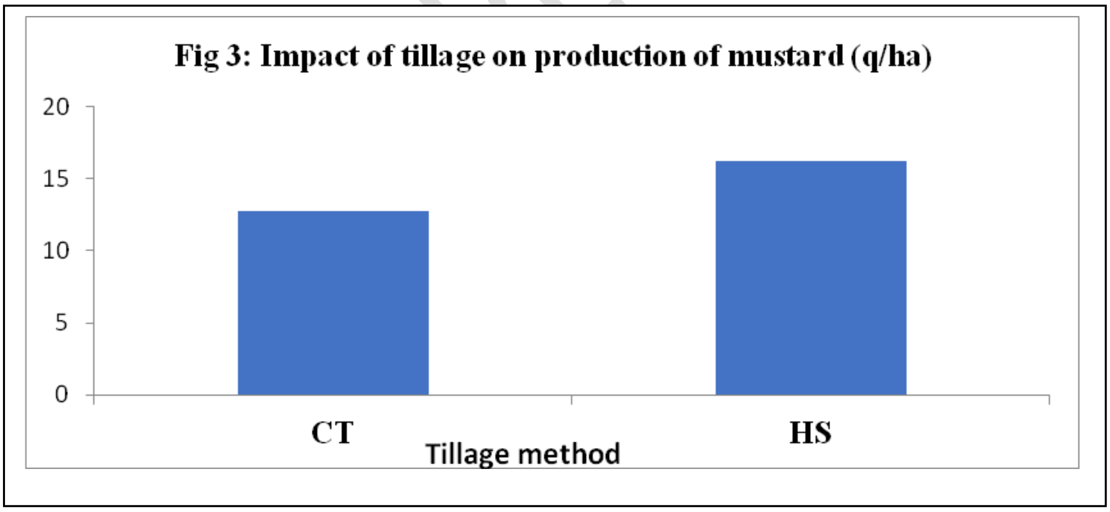
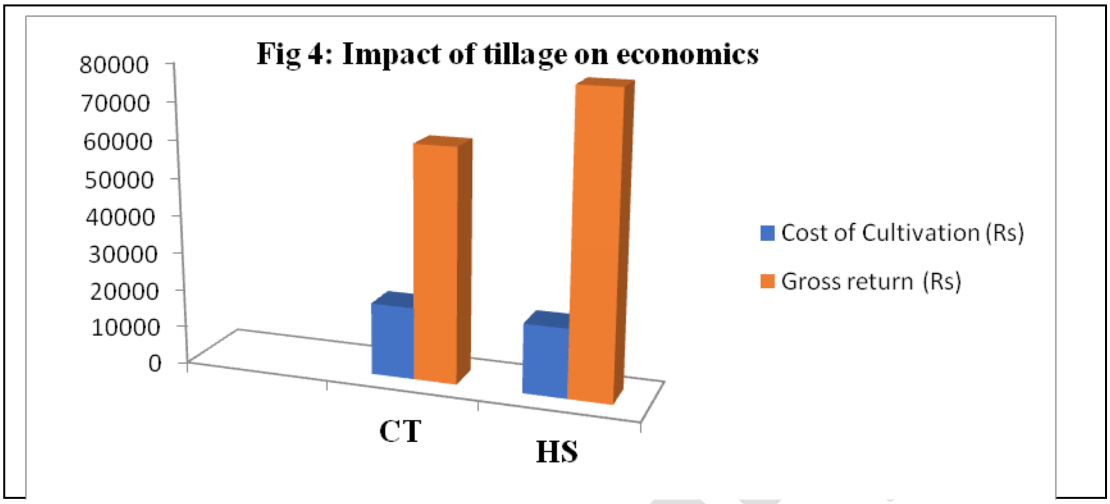


Fig 3: Impact of tillage on production of mustard (q/ha)
20
15
10
5
0
CT
HS
Tillage method



Please mention in graph that cost and gross returns as Rs/ha

Do add some pictures of mustard sowing wih Happy seeder, conventional method alongwith crop stand

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