Impact of Mechanization on Productivity of Major Grain Crops in Punjab (Pakistan)

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Abstract
Farm mechanization is an essential element for food security in Pakistan. Farmers adopted new technology regarding agriculture to increase their farm productivity and to increase cultivable land. Due to farm mechanization, farm production increases and barren land is converted into cultivated land. This study aims to highlight mechanization's impact on the productivity of the farm, cultivation of the farms, and the status of mechanization. Primary data was collected from three different villages of district Khushab. The results showed an increase in cultivated land, which increased production. The yield of wheat and rice also increases due to mechanization.
Keywords: Modernization, Productivity, Cultivated Land.

Introduction

Pakistan is an agricultural country and the gross domestic product (GDP) of Pakistan is linked with agricultural production. Agriculture accounts for 22.9% of the GDP [Economic Survey of Pakistan (GoP), 2023]. Chemical, biological, hydrological and mechanical inputs affect the productivity of agriculture. Agricultural mechanization is key to increasing productivity and output in developing countries (Naseer et al., 2020). Agriculture mechanization ensures higher crop production and productivity (Chaiya et al., 2023). Increasing cropping intensity, accurate sowing, and the efficient use of different crop inputs (seeds, chemicals, fertilizers, irrigation, water, etc.) within a given time frame are all made possible by agricultural mechanization, which also helps to mitigate long-term climate problems and the hard labour of people and animals (Gautam et al., 2023). Agriculture uses mechanical inputs for farm mechanization (Yamin et al., 2010). Farm mechanization plays a pivotal role in enhancing the use of chemical, biological, and hydrological inputs. During the decade of 1960, the mechanization condition was very bad, and most farm operations were performed manually (Rehman & Khan, 2019). Farm mechanization in Pakistan started in the mid-fifties as private tube wells for pumping groundwater with the help of mechanical power for irrigation purposes (Chaudhary & Hussain, 1986). However, farmers initially hesitated to use farm machinery due to their illiteracy and difficulty using traditional methods (Yamin et al., 2011). However, with the progression of time, farm mechanization proved beneficial in increasing agricultural productivity by saving agricultural resources like water, human labour and time (Peng et al., 2022).

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A lack of capital and labour mainly influences mechanization and growth in Punjab. Induced innovation (mechanization) in Punjab mainly responds to innovation and invention (Hayami & Ruttan, 1971; Binswanger & Ruttan, 1978).

As an agricultural country, Pakistan's development depends mainly on this sector. However, agricultural production in Pakistan is much lower than in other countries (Khan et al., 2012). The main hurdle to increasing agricultural productivity is the unavailability of agricultural machinery to farmers at the correct time and reasonable prices. Farm mechanization implies the utilization of machines and innovation in the agriculture sector. Farm mechanization means using mechanical technology in various farming operations like sowing, levelling, planting, harvesting, spraying, watering and other similar farm operations. Chemical technology (pesticides and weedicides), mechanical technology (tractors and their driven implements) and hydrological technology (modern irrigation systems) are included in farm mechanization (Naresh et al., 2012). Mechanization is a significant part of the strategy to accelerate growth in the agricultural sector. Field mechanization is a technology package to work in the fields promptly, increase productivity, reduce crop losses, and ensure better grain/product quality. The contributions of agricultural mechanization in different stages of crop production can be seen as seeds saving (15-20%), fertilizers saving (15-20%), time-saving (20-30%), higher productivity (10-15%), labor reduction (20-30%) and increase in cropping intensity (5-20%) (Singh, 2006; Chauhan, 2006). Other purposes of farm mechanization include increasing resource productivity, especially in cultivating land and labor, maximizing the area under cultivation, conserving energy and resources, maintaining agricultural production and protecting farmers and operators to improve and increase farm profits and protect margins and the environment. A major aspect of farm mechanization is that it boosts yields per acre and reduces losses after harvesting.

Due to a lack of proper agricultural machinery and timely supply of equipment, the productivity of farms in Pakistan is as low as that of other developed countries, thereby causing delays in fieldwork, improper selection and use of agricultural tools and machinery, not matching the field application in general, lack of appropriate operations and lack of maintenance of farm machines by the operators/farmers and low purchasing power of landholders as machines (technology) are expensive (Baruah & Bora, 2008). Agriculture mechanization in Pakistan is limited to factorization with cultivators only. In Pakistan, due to a lack of technology usage in the agriculture sector, we face the problem of crop yield gaps. The average yield production in Pakistan's agriculture sector is far below the level of those countries that use technology in their agriculture sector. The yield levels of different crops are lower (50% to 80% lower) than the average yield of other developed countries (Tewari et al., 2012; Khan et al., 2011). Using technology in the agriculture sector and realizing this unachieved potential can provide excellent opportunities in Pakistan's agriculture sector. Mechanization in agriculture has become all the more important, with fears looming large about sustainable food security, and Pakistan is no exception (Iqbal et al., 2015). Agricultural mechanization is one of the major inputs of agriculture development. Given the previous research, the present study will encompass:

- The role of mechanization in improving productivity of different cereal crops in Punjab.
- The role of mechanization in increasing the cultivated land.
- The status of mechanization in Punjab.

Methodology

The study investigates the present status of mechanization, the role of mechanization in increasing the cultivated land and the role of mechanization in improving the productivity of different cereal crops in Punjab.

The Khushab district, which is considered for the study, is a backward district of Punjab. Khushab is a Western Punjab district divided into three different irrigation farming systems. The availability of human labor and cultivable land of three representative villages of each of the irrigation farming systems are considered for the study. Rice and wheat are the main cereal crops of the Khushab district.

This study is based on primary data, which is collected through a questionnaire from three villages of district Khushab (Punjab) having different irrigation systems, i.e. surface irrigation system, underground irrigation system and mixed irrigation system. The data was collected from 50 farmer households from each irrigation-farming system. Statistical Package for Social Sciences (SPSS) version 21.0 was used to apply the descriptive statistics to analyze the data. Using descriptive statistics, the variables' frequency distribution, means and standard deviation were calculated. Descriptive statistics describes the basic features of data in a study. It is used to provide summaries of data and present its meaning in unprocessed form. Mean is the most commonly used measure of the central tendency of data, and standard deviation is the more accurate estimate of dispersion and tells us the speediness of data, e.g., how much data deviates from actual data. Moreover, descriptive statistics tells the quantitative analysis of raw data.

Figure 1 Rice and wheat productivity after introducing mechanization
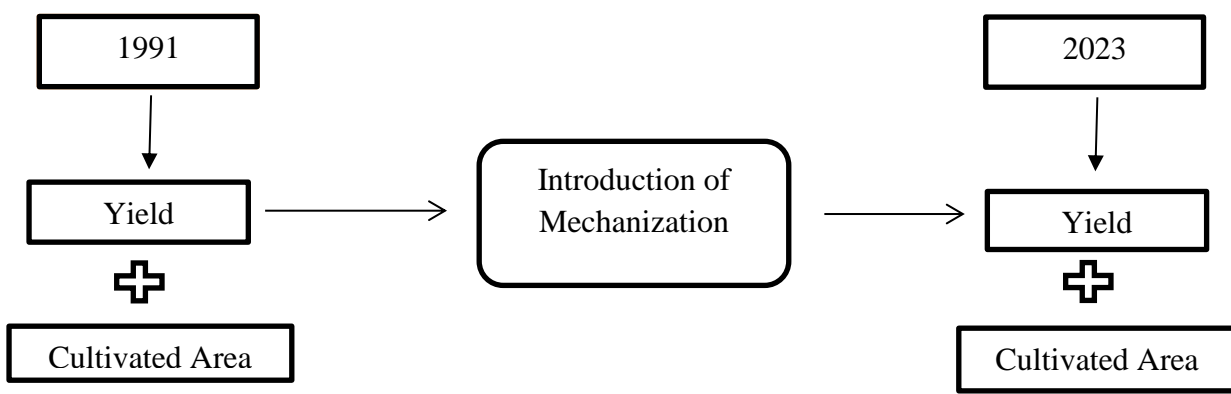
Results and Discussion
Effect of Mechanization on Agriculture
Mechanization may improve output through enhanced availability of land for cultivation. The additional power obtained from tractors may be used to cultivate barren land and increase agricultural labor productivity (Kumar et al., 2023; Chaudhry & Hussain, 1986). Farm mechanization has increased the cultivated land and yield of cereal crops such as rice and wheat to 10.4% and 0.4%, respectively (Yamin et al., 2011).

According to the present study, in 1991, 59.52% of the total land was cultivable. In contrast, in 2023, due to the modernization of tractors, this percentage increased by 10.70% and reached 70.23% in surface irrigation farming systems (Tilokar). In 1991, 88.19% of the total land was cultivable, whereas in 2023, due to modernization, this percentage increased by 2.76% and reached 90.96% in the underground irrigation system (Kurpalka). In 1991, 73.12% of the total land was cultivable, whereas in 2023, due to modernization or a tractor, this percentage increased by 6.44% and reached 79.56% in the mixed irrigation farming systems (Gunjial). Due to mechanization, the cultivated land is expanded by making barren land useful for cultivation and hence, the production of agriculture increases. The cropping intensity is raised by introducing agriculture tractors, which are used in agricultural practices like seedbed preparation and overcoming labour shortages (Devi et al., 2013). Proper mechanization can save 20 to 30 per cent of labour, 15 to 20 per cent of fertilizers, 20 to 30 per cent of working

time and 15 to 20 per cent of farm seeds. In addition, farm mechanization can raise the cropping intensity and crop productivity by 5 to 20 per cent and 10 to 15 per cent, respectively (Singh, 2006; Gautam et al., 2023).

Table 1: Change in cultivated land due to tractor

Village	% Cultivated Land (1991)	% Cultivated Land (2023)	Change in Cultivated Land
Surface Irrigation Farming System **(Tilokar)**	59.52	70.23	10.70
Underground Irrigation Farming System **(Kurpalka)**	88.19	90.96	2.76
Mix Irrigation Farming System **(Gunjial)**	73.12	79.56	6.44

Source. Field Survey 2023

Change in Rice Yield Due to Tractor or Modernization

Present research indicated that the average yield of rice in 1991 was 5.58 ±1.07 and 21.8 ±4.01 in 2023 in the Surface Irrigation Farming System (Tilokar). The average yield of rice in 1991 was 6.0 ±0.58 and 20.8 ±1.87 in 2023 in the Mix Irrigation Farming System (Gunjial). The rice production is increasing due to the modernization of agriculture in two aspects. First, due to modernization and the introduction of tractors, the cultivated land for rice crops is expanded. Second, the yield per acre also increases due to the introduction of high-yielding rice varieties. Modernization of agriculture reduces the demand for agricultural labor (Devlet, 2021) because the tractor is used as a substitute for labor (Rangi & Sidhu, 2004).

Table 2: Change in rice yield due to tractor

Village	Average yield of Rice (Mounds) 1991	Average yield of Rice (Mounds) 2023	Change in Average yield of Rice
Surface Irrigation Farming System **(Tilokar)**	5.58 ±1.07	21.8 ±4.01	16.22
Mix Irrigation Farming System **(Gunjial)**	6 ±0.58	20.8 ±1.87	14.8

Source. Field Survey 2023

Change in Wheat Yield Due to Tractor or Modernization

Farm mechanization is crucial for lowering manual labor and raising agricultural output (Yedke, 2023). Lawrence (1970) believed that introducing tractors into Pakistan's economy had been instrumental in increasing crop yields by 25 per cent and raising the existing cropping intensities to 200 per cent.

The present study revealed that the average yield of wheat in 1991 was 4.54 ±0.50 and 7.98 ±0.14 2023 in the surface irrigation farming system (Tilokar). The average yield of wheat 1991 was 4.48 ±0.50 and 14.88 ±0.48 in 2023 the underground irrigation farming system (Kurpalka). The average yield of wheat in 1991 was 4.54 ±0.50 and 11.36 ±3.46 in 2023 in the mix irrigation farming system (Gunjial).

Table 3: Change in wheat yield due to tractor or modernization

Village	1991 Average yield of Wheat (Mounds)	2023 Average yield of Wheat (Mounds)	Change in Average yield of Wheat
Surface Irrigation Farming System (**Tilokar**)	4.54±0.50	7.98±0.14	3.44
Underground Irrigation Farming System (**Kurpalka**)	4.48±0.50	14.88±0.48	10.4
Mix Irrigation Farming System (**Gunjial**)	4.54±0.50	11.36±3.46	6.82
Source. Field Survey 2023			

The yield of wheat increases due to modernization and the best technology, like high-yielding wheat varieties. The achievable yield is as close as possible to yield and is the best production achieved through the skillful use of the best available technology; on-farm yields normally realize 60 to 80 per cent of attainable yield.

Conclusion

This paper aimed to study the role of mechanization in developing the yield of major grain crops in Punjab. Initially, it elaborated on the change in cultivated land due to mechanization or modernization. The cultivated land is increased because barren land is converted into cultivable land with the help of a tractor. Secondly, the current yield of rice and wheat is compared with the yield in 1991 when no mechanization implements were used. There is a huge difference between the yield of rice and wheat in 1991 and 2023. Currently, all farmers are using mechanization methods for farming. The present study was conducted on three different irrigation farming systems. The average increase in rice yield in surface irrigation farming systems is 16.22%, whereas in mixed irrigation farming systems, it is 14.8%. This is because the canals are used for irrigation in the surface irrigation farming system. The cost of irrigation with canals is very low, approaching zero, whereas in a mixed irrigation system, tube wells are also used along with canals, and the cost of irrigation increases. The average increase in wheat yield in surface, underground, and mixed irrigation farming systems is 3.44%, 10.4% and 6.82%, respectively. The average wheat yield in surface irrigation farming systems is very low compared to other irrigation farming systems. The reason is that the wheat in SIFS is sown after harvesting rice, and there is no other source of irrigation. Hence, the yield of wheat decreases in surface irrigation farming systems.

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