Research Article

Yield and Economic Analysis of Peanut Production under Different Soil Tillage Systems in North-East Region

Rana Shahzad Noor[1,2*], Fiaz Hussain[2], Muhammad Umar Farooq[3], Irfan Abbas[4], Muhammad Umair[2], Muhammad Adnan Islam[5], Muhammad Sheraz[2]

[1]Department of Agriculture, Biological, Environment and Energy Engineering, College of Engineering, Northeast Agricultural University, Harbin 150030, China; [2]Faculty of Agricultural Engineering & Technology, PMAS-Arid Agriculture University, Rawalpindi 46000, Pakistan;[3]College of Hydraulic Engineering, Yunnan Agricultural University, Kunming Yunnan, 650204 P.R China;[4]School of Agricultural Equipment Engineering, Jiangsu University, Zhenjiang 212013, China; [5]Agricultural Engineering Institute, Pakistan Agricultural Research Council, Islamabad, 44000, Pakistan.

Abstract | This research study was carried out at greenhouse research station, Northeast Agriculture University, Harbin in 2018 and 2019 crop years with three replications according to complete randomized design (CRD). The main objective of this research was to investigate the effect of four soil tillage systems on main crop peanut and wheat + second crop peanut in order to evaluate crop yield, fuel consumption and to perform economic analysis. Two years study results showed that the main crop peanut yields changed between 4331.0 kg ha^{-1} and 5486.6 kg ha^{-1}, while second crop peanut yields changed between 2670.6 kg ha^{-1} and 3388.8 kg ha^{-1}. The highest yield for main crop and crop peanut under different tillage methods was 2097.8 kg ha^{-1}, while the lowest yield was observed as 1649.9 kg ha^{-1} respectively. The fuel consumption of main crop was measured between 33.33 l ha^{-1} and 63.48 l ha^{-1}, while second crop fuel consumption was ranged as 34.92 l ha^{-1} to 62.48 l ha^{-1}. The highest and lowest fuel consumptions levels of different soil tillage for main and second crop peanuts were 62.61 and 34.08 l ha^{-1} and 33.09 and 61.82 l ha^{-1}, respectively. The positive effects of different soil tillage were found on yield and fuel consumption of main and second crops. The economic comparison conducted for crop inputs cost for different tillage systems showed that the most positive effect in term of yield, fuel consumption, input cost and income was determined in conventional tillage system T_1 and reduced tillage system T_2.

Received | February 12, 2020; **Accepted** | June 12, 2020; **Published** | July 15, 2020
***Correspondence** | Rana Shahzad Noor, Department of Agriculture, Biological, Environment and Energy Engineering, College of Engineering, Northeast Agricultural University, Harbin 150030, China; **Email:** engr.rsnoor@uaar.edu.pk
Citation | Noor, R.S., F. Hussain, M.U. Farooq, I. Abbas, M.Umair, M.A. Islam, and M. Sheraz. 2020. Yield and economic analysis of peanut production under different soil tillage systems in north-east region. *Pakistan Journal of Agricultural Research,* 33(3): 490-497.
DOI | http://dx.doi.org/10.17582/journal.pjar/2020/33.3.490.497
Keywords | Soil tillage systems, Peanut-wheat, Yield, Economic analysis

Introduction

Peanut (Arachis hypogaea) is a perennial, oilseed cultivar of legume family. It is an oil plant in terms of nitrogen enrichment of both human food, animal feed and soil (Rui et al., 2017). The protein value of 25-36% in peanuts and the fact that the amino acids in these proteins are easily digestible (Launio et al., 2018) provide the improvement of snack quality. The seeds are rich in substances such as K, Ca, Mg, P, Fe and S, as well as vitamins (Sandefur et al., 2017).

The most important issue is the structure of the soil where climate and irrigation problems are not experienced in peanut cultivation. Soil cultivation is of great importance because it forms fruits in the soil. If the soil has a heavy clay structure, it is difficult for the seed growth in the soil and the detachment of the capsules from the soil becomes difficult that increase harvest losses. This also affects the yield of peanuts. In order to achieve success in the crops where field crops such as peanuts are grown, a good seed bed should be determined by determining the most suitable soil tillage method for seed sowing. Soil cultivation methods to be used vary according to soil structure, plant harvested before cultivation, plant to be cultivated and presence of existing mechanization. However, growing environmental awareness, economic production demands and in the end because of the necessity to go to savings in energy use, Pakistan and has begun to make radical changes in tillage (Kan et al., 2018).

Tillage system plays an important role in the sustainability of agricultural production. A reasonable tillage is an important representative of increasing agricultural production, avoiding soil problems, and inappropriate tillage cause water and environmental pollution and soil degradation. The effect of tillage on the sustainability of the production system depends on soil type, climate, crop and management factors (Kuhn et al., 2016). In traditional soil tillage method, field traffic is intense, soil erosion increases, soil physical properties deteriorate, soil organic carbon decreases and fuel consumption is high. Additional efforts are being made to ensure high activity in the use of water, nutrients and energy in tillage under the intensive production system (Fernando et al., 2018). In intensive agriculture production, input usage increases, cause environmental deterioration and the need for mechanization increases while, negatively affects the sustainability of agricultural production.

In agricultural production, emphasis has been placed on increasing productivity and production as the main objective. Besides these; improvement of product quality, reduction of production inputs, protection of natural resources, environmental factors, economic production and sustainable agriculture. Therefore, sustainable agriculture and conservation tillage are gaining increasing interest as they significantly reduce production costs compared to traditional tillage (Sessiz et al., 2008).

For these reasons, a management system that does not adversely affect or protect the quality of the environment should be developed (Kuhn et al., 2016). Most of the energy spent in agricultural production is used in soil cultivation applications. As with other enterprises, it is aimed to generate the most income with the least input in agricultural enterprises. However, energy input costs of traditional tillage methods and stubble burning costs are high, it shows that different tillage methods should be tried in growing crops (Bara and Gokdogan, 2016). Reduced and protective soil tillage methods decrease soil erosion problem, evaporation of moisture in the soil, fuel consumption is minimized (Banjara et al., 2017).

Therefore, the aim of this study was to investigate and evaluate most economical and suitable tillage method for main crop peanut and second crop peanut during growing seasons 2018 and 2019.

Materials and Methods

This research was conducted at greenhouse research station of Northeast Agriculture University, Harbin in order to evaluate the effects of different soil tillage systems on crop yield and tractor fuel consumption sown in greenhouse system. The comparative economic analysis was also performed to input and output costs determination and to suggest a most beneficial soil tillage system.

The soil physio-chemical properties were evaluated before sowing of each season's crop as mentioned in Table 1. The soil samples were collected thrice from each treatment plot within soil depth 0-30 cm. An 8 cm diameter core sampler was used to collect soil samples. The collected soil samples were pulverized and sieved through a 2 mm mesh sieve before physio-chemical analysis. Soil physical parameters were measured at two soil depths 0-15 and 15-30 cm using undisturbed core soil samples (Mondal et al., 2019) before commencement of study 2018-19. According to the soil analysis results, the saturation of the trial area was 58%, lime content is 14.15% and soil was loamy clay. Soil total soluble salt content of saturation sludge extract electrical conductivity and pH values were measured in pH meter instrument (Schultz et al., 2017). Lime ($CaCO3$) contents were measured by Scheibler calimeter (Allison and Moodie, 1965). The recommended (120 kg/ha N, 30 kg/ha P and 33 kg/ha K) were applied to the field in the form of Urea fertilizer (46% N), diammonium phosphate (DAP, 18% N and 20% P) and potash (MOP, 50% K) (Yadava et al., 2012).

Table 1: *Physio-chemical properties of soil prior to commencement of tillage systems.*

depth (cm)	Bulk density (Mgm^{-3})	EC (ds/m)	pH	Organic carbon ($g\ kg^{-1}$)	Available ($mg\ kg^{-1}$)					
					NO_3-N	NH_4-N	P	K	S	DTPA-Zn
0-15	1.47±0.05	0.90±0.06	7.4±0.02	6.5±0.11	7.7±0.18	12.3±0.05	9.9±0.07	79.2±1.12	16.7±1.18	0.7±0.05
15-30	1.50±0.04	0.93±0.05	7.3±0.04	5.2±0.19	7.2±0.14	11.9±0.03	7.6±0.06	71.4±2.41	11.8±0.44	0.6±0.05

Table 2: *Peanut yield (kg/ha) ANOVA with LSD multiple comparison test results of soil tillage applications.*

Treatments	Main crop yield		Main crop compound analysis yield	II. crop yield		II. crop compound analysis yield
	2018	2019		2018	2019	
T_1	4881.1 a	5714.1 ab	5298.0 a	3357.1 a	3285.7 a	3297.6 a
T_2	4785.4 ab	5762.1 a	5274.1 a	3309.5 ab	3476.2 a	3416.6 a
T_3	4571.2 c	4285.9 c	4429.0 b	3095.2 c	2571.4 b	2833.3 b
T_4	4666.2 bc	4714.6 bc	4690.7 b	3166.7 bc	2857.1 b	3011.9 b
P-value	0.0093**	0.0294*	0.0066**	0.0290*	0.0075**	0.0002**
LSD (0.05)	14.76	102.91	51.58	16.99	42.81	20.50

*P <0.01 (** significant at the 1% level) P <0.05 (* Important at the 5% level).*

The NC-7 peanut variety was sown both for main crop peanut and second crop peanut because it is a variety that is used by about 95% of the producers and showed a development form between semi-horizontal and horizontal. When the ripening is evaluated according to the number of days, it is medium early and completes the ripening period in 140-160 days. The snack is suitable for consumption and the yield varies between 3500-4500 kg/ha.

The experiment was conducted according to completely randomized design (CRD) with 3 replications of the main and second crop conditions (Figure 1). The total 3,035 m^2 (0.75 acres) were selected for the experiment with three replications. Sowing was carried out with a combined pneumatic single grain sowing machine with planter plates suitable for peanut seed sowing in greenhouse. Peanuts were planted to be 60 cm between row and 20 cm above row. Main crop peanut was sown in the mid of April, 90 kg seed per hectare in the main crop sowing was set to the norm of pneumatic single grain seeding machine (Pandia et al., 2015). The second crop sowing was done after the first week of September. The applied soil tillage methods were Conventional tillage (T_1), Zero tillage (T_2), Minimum tillage (T_3) and Deep tillage (T_4). The rest of the field activities were applied same in all treatments fields.

Soil tillage systems were compared in terms of yield, fuel consumption and economic aspects. Yield was calculated as kg/ha by harvesting all the plants in the middle two rows of each parcel. Fuel consumption in each tillage system was measured using "Completion Method". In the economic analysis, total expenses per unit area were determined by considering the rental costs of agricultural machinery used in tillage and sowing systems (Akbamia et al., 2013). The yields of the tillage systems and the average sales prices in the region were used in determining the total revenue (output) per unit area. The results of the study were subjected to multiple comparison (LSD) test with variance analysis.

Conventional tillage (T_1)	`Zero tillage (T_2)	Minimum tillage (T_3)	Deep tillage (T_4)
Deep tillage (T_4)	Minimum tillage (T_3)	Zero tillage (T_2)	Conventional tillage (T_1)
Minimum tillage (T_3)	Deep tillage (T_4)	Conventional tillage (T_1)	Zero tillage (T_2)

Figure 1: *Treatment layout in the field under different soil tillage treatments.*

Results and Discussion

Yield (kg/ha) variance analysis results of the main crop and second crop peanut obtained from trial applications and LSD multiple comparison test results were given in Table 2. When the variance analysis probability values are examined in Table 2, it is determined that the effect of year 2018 and two-year average (compound) tillage methods on the yield of peanut fruit were statistically significant at the level of 1% and the year 2019 was significant at the level of 5%. If the variance results of the second product peanut were examined; The effect of the 2nd year and two years average (compound) on the fruit yield of soil tillage methods was found to be statistically significant at the level of 1% and the first year was significant at the level of 5%.

The analysis of variance analysis results of the first year of the study in the main product peanut, the effect of soil tillage methods on fruit yield was found to be significant at the level of 1%, while the second year was found to be significant at the level of 5%. The highest peanut fruit yield values according to LSD multiple comparison test; The first year was obtained from the T_1 method with 4881.1 kg/ha and the second year was obtained from the T_2 method with 5762.1 kg/ha. The lowest fruit yields were obtained from T_3 method in both years.

When the effect of soil tillage methods on peanut fruit yield values were examined in terms of % difference; fruit yield difference between the method with the highest fruit yield value and the method with the lowest fruit yield value is approximately; 6% in the first year and 25% in the second year. When the average (compound) variance analysis results of all years are examined; The effect of soil tillage methods on the yield of peanut fruit was found to be statistically significant at 1% level. It was determined that the highest fruit yield value was obtained from T_1 method with 5298.0 kg/ha and the lowest fruit yield value was obtained from T_3 method with 4429.0 kg/ha. The difference between the highest fruit yield value and the lowest fruit yield value was approximately 16%. According to the variance analysis results of the first year of the study, the effect of soil tillage methods on fruit yield was found to be significant at 5% level while the second year was found to be significant at 1% level.

The highest peanut fruit yield values according to LSD multiple comparison test; first year was obtained from T_1 method with 3357.1 kg/ha, and from T_2 method with 3476.2 kg/ha in the second year. The lowest fruit yields were obtained from T_3 method in both years. When the effect of soil tillage methods on peanut fruit yield values were examined in terms of % difference; fruit yield difference between the method with the highest fruit yield value and the method with the lowest fruit yield value was approximately; 8% in the first year and 26% in the second year. When the results of the variance analysis made for the yield values, which were the average of two years; The effect of soil tillage methods on second peanut fruit yield was found to be statistically significant at 1% level. The maximum fruit yield value was collected from T_2 method with 3416.6 kg/ha and the lowest fruit yield value was obtained from T_3 method with 2833.3 kg/ha. The difference between the highest fruit yield value and the lowest fruit yield value was approximately 17%.

Fuel consumption

The results obtained for variance analysis for fuel consumptions in different tillage systems of main crop and second crop peanut with significance levels and LSD multiple comparison test was presented in Table 3. It was determined that the effect of soil tillage methods on fuel consumption in main and second crop peanuts parcels was statistically significant at 1% level considering the average years 2018 and 2019 and 2-years average.

The variance analysis probability values of the first and second years of the study in the main product peanut showed that the effect of tillage methods on fuel consumption was statistically significant at 1% level. According to LSD multiple comparison test; In the first year, it was obtained from T_4 method with 65.89 l/ha and in the second year from T_4 method with 59.33 l/ha. The lowest fuel consumption values were obtained from the T_2 method in both years with 34.96 l/ha in the first year and 33.20 l/ha in the second year. When the average (compound) variance analysis probability value of all years is examined; The effect of soil tillage methods on main product peanut fuel consumption was statistically significant at 1% level. It was determined that the highest fuel consumption value was obtained from T4 method with 62.61 l/ha and the lowest fuel consumption value was obtained from T_2 method with 34.08 l/ha.

In the first and second years of the study, the effect of soil tillage methods on fuel consumption was found to be statistically significant at 1% level. Highest fuel consumption values; The first year was obtained from T_4 method with 65.52 l/ha and the second year was obtained from T_4 method with 58.13 l/ha. The lowest fuel consumption values were obtained from T_2 method with 34.73 l/ha in the first year and 31.47 l/ha in the second year. When the average (compound) variance analysis probability value of all years

Table 3: *Peanut fuel consumption by years of soil cultivation applications (l/ha) analysis of variance and LSD multiple comparison test results.*

Treatments	Main crop fuel		Main crop compound analysis fuel	II. crop fuel		II. crop compound analysis fuel
	2018	2019		2018	2019	
T_1	57.48 b	53.86 b	55.67 b	55.81 b	51.73 b	53.77 b
T_2	34.96 d	33.20 c	34.08 d	34.73 d	31.47 d	33.09 d
T_3	38.75 c	36.66 c	37.71 c	38.60 c	33.87 c	36.23 c
T_4	65.89 a	59.33 a	62.61 a	65.52 a	58.13 a	61.82 a
P value	0.001**	0.001**	0.001**	0.001**	0.001**	0.001**
LSD (0.05)	1.78	3.80	1.87	1.51	1.67	1.00

*P <0.01 (** significant at 1% level).*

Table 4: *Comparative economic analysis ($/ha) of main crop peanut under different tillage methods.*

Crop factors	2018					2019				
	Rate	T1	T2	T3	T4	Rate	T1	T2	T3	T4
Crop production + workmanship	1160	1160	1160	1160	1160	1270	1270	1270	1270	1270
Conventional Tillage (T1)	35.4	35.4				32.9	32.9			
Zero Tillage (T2)	21.1		21.1			20.5		20.5		
Minimum Tillage (T3)	23.6			23.6		22.3			22.3	
Deep Tillage (T4)	40.8				40.8	41.3				41.3
TOTAL INPUT		1199.2	1184.9	1187.4	1204.6		1305.3	1292.9	1294.7	1309.0
YIELD		4880.9	4785.6	4571.4	4666.5		5714.3	5761.9	4285.7	4714.3
Peanut sales price ($/kg)	0.47	0.47	0.47	0.47	0.47	0.53	0.53	0.53	0.53	0.53
Output total		2272.1	2227.8	2128.0	2172.3		3014.8	3039.9	2261.0	2487.2
BCR		1.89	1.88	1.79	1.80		2.30	2.35	1.74	1.90

is examined; The effect of soil tillage methods on second crop peanut fuel consumption was statistically significant at 1% level. The highest fuel consumption value of 61.82 l/ha with the T_4 method, the lowest fuel consumption and 33.09 l/ha were obtained from T_2 method.

Economic analysis

In the economic analysis of the main crop and second crop peanut cultivation applications in the region, production input costs and product unit sales prices are taken as basis. In the economic analysis, field rent was not taken into consideration. In 2018 and 2019, economic values obtained per unit area are given in Table 4 according to the main crop and second crop peanut tillage and sowing methods.

As seen in Table 4, the highest product costs (input) during 2018 and 2019 were obtained from T_4 method (1204.6 and 1309.0 $/ha) and the lowest product costs (input) were obtained from T_2 method (1184.9 and 1292.9 $/ha). The highest income (output) were determined by T_1 (2272.1 $/ha) and T_2 (3039.9 $/ha) in 2018 and 2019, respectively, while the lowest income (output) by T_3 method (2128.0 and 2261.0 $/ha). When the benefit-cost ratios were examined, the highest ratios (1.89 and 2.35) were obtained from T_1 and T_2 tillage systems during 2018 and 2019, respectively, while the lowest ratio were obtained from T_3 method (1.79 and 1.74). These results could be correlated with Bantilan et al. (2014), who observed grain yield in traditional chickpea was 850 kg/ha, production cost per unit area was 200.5 $/ha, production cost corresponding to chickpea weight is 0.24 $/kg and demanded product price is 0.28 $/kg. Of the total production cost of chickpea, 21.4 $/ha was from tillage and sowing, 5.3 $/ha is from maintenance operations, 44.5 $/ha is from harvesting, 87.59 $/ha is from various inputs and 41.68 $/ha is they have resulted from common expenses. In this study, peanut and wheat + II. It is aimed to compare different soil tillage methods in the product peanut.

In Table 5, in the economic analysis of different tillage methods in the second crop peanut, the total input varied between (763.8-776.2 $/ha) and (832.5-843.2 $/ha), while the output total ranged between (928.56-1007.13 $/ha) and (874.27-1181.90 $/ha) in 2018 and 2019 seasons, respectively. The highest benefit-cost ratios were 1.30 with T_1 and T_2 soil tillage methods in 2018 and 1.42 with T_2 in 2019 season.

Table 5: *Comparative economic analysis ($/ha) of second crop peanut under different tillage methods.*

Crop factors	2018					2019				
	Rate	T1	T2	T3	T4	Rate	T1	T2	T3	T4
Crop production + workmanship	1160	1160	1160	1160	1160	1270	1270	1270	1270	1270
Conventional Tillage (T1)	22.3	22.3				20.6	20.6			
Zero Tillage (T2)	13.8		13.8			12.5		12.5		
Minimum Tillage (T3)	15.44			15.4		13.5			13.5	
Deep Tillage (T4)	26.2				26.2	23.2				23.2
TOTAL INPUT		772.3	763.8	765.4	776.2		840.6	832.5	833.5	843.2
YIELD		335.71	330.95	309.52	316.67		328.57	347.62	257.14	285.71
Peanut sales price ($/kg)	3	3	3	3	3	3.4	3.4	3.4	3.4	3.4
Output total		1007.13	992.85	928.56	950.01		1117.13	1181.90	874.27	971.41
BCR		1.30	1.30	1.21	1.22		1.32	1.42	1.05	1.15

(Crop production + labor= seed, fertilizer, irrigation, spraying, maintenance).

In Table 6, total wheat inputs were determined as 250.2 $/ha and 273.1 $/ha and outputs total were determined as 574.9 $/ha and 597.0 $/ha, while benefit-cost ratios were determined as 2.29 and 2.18 in years 2018 and 2019, respectively.

Table 6: *Wheat economic analysis ($/ha) under different tillage systems.*

Crop factor	2018	2019
Tillage and sowing	27.42, 42.5	27.82, 43.2
Maintenance works	5.35 08.3	5.53, 08.6
Harvesting-threshing-transport	14.57 22.6	16.66 25.9
Various inputs	113.90 176.7	125.98 195.5
TOTAL INPUT	161.24 250.2	175.99 273.1
Yield (kg/ha)	475 73.71	475 73.71
By-product revenue ($/ha)	40 62.1	40 62.1
Wheat sale price ($/kg)	0.78 0.12	0.81 0.13
Output Total	370.5 574.9	384.75 597.0
BCR	2.29	2.18

In Table 7, as a result of economic analysis of different soil tillage methods in wheat + second crop peanut, the values of input and output amounts are expressed in monetary terms. The highest input was obtained from deep tillage system (T_4) with 1461.2 and 1588.7 $/ha, while the lowest input was determined from zero tillage system (T_2) with 1441.9 and 1572.0 $/ha in 2018 and 2019 growing seasons, respectively. The highest benefit-cost ratios were obtained from conventional tillage (T_1) and zero tillage (T_2) with 1.47 in 2018, while zero tillage (T_2) showed maximum benefit-cost ratio (1.55) in 2019 crop season. The economic analysis of different soil tillage methods in wheat + second crop peanut values of input and output amounts of 2019 season are expressed in monetary terms. The results are in line with Gudadhe et al., (2016), who determined that the highest energy benefit-cost ratio of chickpea was obtained from zero soil tillage method with 2. This was followed by the reduced tillage method with 1.81, direct sowing + herbicide method with 0.87 and traditional soil tillage with 0.205, respectively.

Table 7: *Economics of wheat + II. crop peanut under different tillage methods ($/ha).*

Treatments	2018			2019		
	Input	Output	BCR	Input	Output	BCR
Conventional Tillage (T_1)	1455.2	2147.4	1.47	1584.6	2341.1	1.48
Zero Tillage (T_2)	1441.9	2125.1	1.47	1572.0	2442.0	1.55
Minimum Tillage (T_3)	1444.4	2024.9	1.40	1573.5	1962.5	1.24
Deep Tillage (T_4)	1461.2	2058.3	1.41	1588.7	2113.9	1.33

BCR: Benefit-Cost ratio.

As a result of the evaluations made in the main crop and wheat + second crop conditions grown NC-7 peanut; For the data obtained from parameters such as efficiency and fuel consumption, analyzes and evaluations were made. The effect of soil tillage applications on peanut fruit yield in the main product and wheat + second product was significant at 1% level. It was found that the highest fruit yields were obtained from T1 (conventional soil tillage) and T2 (zero tillage) systems in the same group. The lowest fruit yields were obtained by T4 (deep tillage) system. The effect of soil tillage applications on peanut fuel consumption was found to be significant at 1% in the main crop and Wheat + second crop. The highest fuel consumption values were obtained from T4 (deep tillage system) and the lowest fuel consumption values were obtained from T2 (zero tillage system). Considering energy use, T4 (deep tillage system) fuel consumption, T2 (zero tillage) system was found to be almost twice the fuel consumption. According to the results of the economic analysis in terms of production input cost, income (output) and profitability. In main crop peanut; (conventional tillage) T_1 and (zero tillage) T_2 soil cultivation systems in the first year, Wheat + second crop peanut; In first year (conventional tillage) T_1, second year (zero tillage) T_2 soil cultivation systems had positive effects on yield and fuel consumption.

Conclusions and Recommendations

In this study, four different soil tillage methods were evaluated on peanut production in greenhouse system in 2018 and 2019 seasons at greenhouse research station of Northeast Agricultural University, China. The highest fruit yield difference between main crop and wheat + second crop tillage methods was determined as 2000.4 kg/ha, while the lowest fruit yield difference was determined as 1595.7 kg/ha. The highest fuel consumption difference between the main crop and wheat + second crop tillage methods was 1.9 l/ha, while the lowest fuel consumption difference was 0.79 l/ha. As a result, the positive effects of different soil tillage methods on yield and fuel consumption of the main and second crop peanuts were determined. The economic input of the main crop and wheat + second crop different soil tillage methods were compared, and the production input cost and the monetary values of the income were determined. T1 (conventional tillage) and T2 (zero tillage) tillage methods have been found to have the most positive effect on yield, fuel consumption, production input cost and income.

Author's Contribution

Rana Shahzad Noor: Contributed in Conceptualization of research study, Design & Development of the experiment, Data collection, Formal Analysis, Investigation, Methodology, Visualization, Writing an original draft and Write-up editing.
Fiaz Hussain and Irfan Abbas: Contributed to the Investigation and Methodology of the research article.
Muhammad Umar Farooq: Contributed during the Formal Analysis of the manuscript.
Muhammad Umair: Contributed to Supervision, Visualization and Writing review of the manuscript.
Muhammad Adnan Islam: Contributed during the Formal Analysis of the manuscript.
Muhammad Sheraz: Contributed during field experiment, data collection and data analysis.
Yong Sun: Investigated, reviewed and supervised the whole research experimental study and the manuscript writing.

Conflict of interest

The authors have declared no conflict of interest.

References

Akbarnia, A., F. Farhani and B. Heidary. 2013. Economic comparison of tillage and planting operations in three tillage systems. Agric. Eng. Int. CIGR J., 15(4): 180-184.

Allison, L.E., and C.D. Moodie. 1965. Carbonate. Methods Soil Anal. Part 2 Chem. Microbiol. Prop., 9: 1379-1396. https://doi.org/10.2134/agronmonogr9.2.c40

Banjara, T.R., G.P. Pali, B.K. Tigga, S. Kumar and A. Shori. 2017. Effect of different tillage practices on growth, yield and economics of chickpea (Cicerarietinum L.) under rainfed condition of Chhattisgarh. Int. J. Curr. Microbiol. App. Sci., 6(2): 1464-1470. https://doi.org/10.20546/ijcmas.2017.602.164

Bantilan, C., D.K. Charyulu, P.M.D. Gaur, M. Shyam and J. Davis. 2014. Short-duration chickpea technology: enabling legumes revolution in Andhra Pradesh, India, research report no. 23.

Baran, M.F. and O. Gokdogan. 2016. Comparison of energy use efficiency of different tillage methods on the secondary crop corn silage production. Fresenius Environ. Bull., 25(9): 3808-3814.

Fernando, A.L., J. Costa, B. Barbosa, A. Monti and N. Rettenmaier. 2018. Environmental impact assessment of perennial crops cultivation on marginal soils in the Mediterranean Region. Biomass Bioenergy, 111: 174-186. https://doi.org/10.1016/j.biombioe.2017.04.005

Gudadhe, N., M.B. Dhonde, N.A. Hirwe and N.M. Thete. 2016. Crop energy balance study of cotton-chickpea cropping sequence under organic and inorganic fertilizer sources in western Maharashtra. Legume Res. Int. J., 39(1): 79-85. https://doi.org/10.18805/lr.v39i1.8867

Kan, M., F. Partigoc, I. Gultekin, R.Z. Arisoy, Y. Kaya, S. Gultekin and A. Taner. 2018. Economical aspects of conservation agriculture (Zero Tillage-Direct Seeding) system in Turkey. Fresenius Environ. Bull., 27(5 A): 3332-3341.

Kuhn, N.J., Y. Hu, L. Bloemertz, J. He, H. Li and P. Greenwood. 2016. Conservation tillage and sustainable intensification of agriculture: Regional vs. global benefit analysis. Agric., Ecosyst. Environ., 216: 155-165. https://doi.org/10.1016/j.agee.2015.10.001

Launio, C.C., J.S. Luis and Y.B. Angeles. 2018. Factors influencing adoption of selected peanut protection and production technologies in Northern Luzon, Philippines. Technol. Soc., 55: 56-62. https://doi.org/10.1016/j.techsoc.2018.05.007

Mondal, S.U.R.A.J.I.T., T.K. Das, P. Thomas, A.K. Mishra, K.K. Bandyopadhyay, P. Aggarwal and D.E.B.A.S.H.I.S. Chakraborty. 2019. Effect of conservation agriculture on soil hydro-physical properties, total and particulate organic carbon and root morphology in wheat (Triticum aestivum) under rice (Oryza sativa)-wheat system. Indian J. Agric. Sci., 1: 46-55.

Pandia, O., I. Saracin, I. Bozga and S.E. Tanasie. 2015. Studies regarding pneumatic equipment for sowing small seeds in cups. Agric. Agric. Sci. Procedia, 6: 690-695. https://doi.org/10.1016/j.aaspro.2015.08.122

Rui, M., C. Ma, X. Tang, J. Yang, F. Jiang, Y. Pan and B. Xing. 2017. Phytotoxicity of silver nanoparticles to peanut (Arachis hypogaea L.): physiological responses and food safety. ACS Sustainable Chem. Eng., 5(8): 6557-6567. https://doi.org/10.1021/acssuschemeng.7b00736

Sandefur, H.N., J.A. McCarty, E.C. Boles and M.D. Matlock. 2017. Peanut products as a protein source: Production, nutrition, and environmental impact. Sustainable Protein Sources Acad. Press. pp. 209-221. https://doi.org/10.1016/B978-0-12-802778-3.00013-5

Schultz, E., A. Chatterjee, T. DeSutter and D. Franzen. 2017. Sodic soil reclamation potential of gypsum and biocharadditions: influence on physicochemical properties and soil respiration. Commun. Soil Sci. Plant Anal., 48(15): 1792-1803. https://doi.org/10.1080/00103624.2017.1395449

Sessiz, A., T. Sogut, A. Alp and R. Esgici. 2008. Tillage effects on sunflower (*Helianthus Annuus* L.) emergence, yield, quality, and fuel consumption in double cropping system. J. Central Eur. Agric., 9(4): 697-709.

Yadava, D.K., S. Vasudev, N. Singh, T. Mohapatra and K.V. Prabhu. 2012. Breeding major oil crops: Present status and future research needs. Technol. Innov. Major World Oil Crops, Springer, NY. 1: 17-51. https://doi.org/10.1007/978-1-4614-0356-2_2