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Impact of Various Farm Inputs on Paddy Yield

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ABSTRACT

Ten years input and output data from 1985 to 1994 of paddy crop was statistically analyzed to evaluate the impact of various farm inputs on paddy yield in Bhalwal area. The results indicated that July 1st to 15th was the best transplanting period for rice crop. Transplanting before and after this period, reduced the paddy yield 754 kg ha^{-1} in case of late transplanting and 287 kg ha^{-1} in case of early transplanting. The study also revealed that the rice variety B-385 is the most popular and productive as it gave more yield in comparison with other varieties in the study area. Irrigation water supply from canal, tubewell and mixed irrigation from 17 to 20 numbers produced a yield of 3484, 2756 and 3342 kg ha^{-1} respectively. In perennial area, the maximum yield obtained was 2797 kg ha^{-1}, followed by non-perennial with 2635 kg ha^{-1} and un-commanded with 2271 kg ha^{-1}. The study indicates that timely transplanting of approved varieties of paddy with the recommended inputs of seed, fertilizer, weeding and water application can give better yield.

Key Words: Farm inputs; Paddy; Yield

INTRODUCTION

Inspite of favourable land and water resources and conducive climate, yields of the major crops in Pakistan rank among the lowest as compared with the developed countries. There are a variety of factors that influence crop yield. These include fertilizers (Iqbal *et al*., 1987; Chaudhry *et al*., 1990; Chaudhry & Rafique, 1990), plant density (Kahlown *et al*., 2000), optimum farm management (Kahlown *et al*., 1997), timely availability of agricultural inputs (Ali *et al*., 1994), resource conservation (Raza *et al*., 2001), and farmers inputs (Junejo *et al*., 2001).

This paper aims at analyzing the impact of various farm inputs on paddy yield and determining optimum level of farm inputs to maximize paddy yield and production. Recommendations for the optimum level of farm inputs conducive to higher yield and net return have been presented. Accordingly farmers can make adjustments in their input levels for increasing paddy yield.

MATERIALS AND METHODS

To evaluate the impact of various farm inputs on paddy yield 10 years field data were collected through field surveys. The yield was estimated through stratified sampling with probability proportional to the ratio of cropped area to culturable area giving due weightage to area under the crop being surveyed and the culturable area commanded by an outlet or a tubewell (William, 1977; Junejo, *et. al*., 2001). Methodology adopted for acquisition of field data was as under.

Design of survey. Three distinct irrigation regions i.e., perennial, non-perennial and uncommanded (rain fed areas) were selected. In order to have representative samples of the project area, a multi-stage stratified random sampling with probability proportional to the ratio of cropped area to culturable area was adopted. As a first step, number of tubewells and watercourses were selected randomly for each region. Then from command areas of these, number of squares and number of fields were selected at random. However, where square demarcation did not exist, sample fields were selected with respect to nakka numbers chosen at random.

Sample size. A sample of 84 fields was chosen each year for survey of rice crop. The sample size was determined on the basis of minimum variance. The decision regarding number of samples was made on the basis of sample yields and their standard error rate being less than 7.5%. This statement has been practically checked and found true for all years.

Allocation of samples from irrigation regions. Out of total 84 samples in the project area 42, 21 and 21 samples were taken from perennial, non-perennial and un-commanded area respectively. The ratio being 2:1:1 looks suitable because it gives an appropriate weight to command area of each region and its yield variance.

Field survey. For the purpose of field survey, the size of each plot was fixed 2 marlas as this plot size showed least standard error. Crop harvested from each plot was weighed and plants alongwith number of tillers was counted. These informations were recorded on a proforma while informations regarding farm inputs were collected on a pre-planned questionnare. Data collected from the field was analysed in a systematic way by using computer package SPSS (Statistical package for social scientists).

RESULTS AND DISCUSSION

Bullock ploughing. Out of 613 sample farmers, 97 percent project farmers used bullock ploughings between the range 3-5 and received 2448 kg ha^{-1} yield. While the farmers who used more ploughings i.e. 6-8 had more yield by 129 kg ha^{-1} (Table I).

Tractor ploughing. As indicated in Table I, the farmers are switching from old types of agricultural implements to modern equipments. About 98% farmers prepare their rice fields with tractor ploughing 3 to 5 times and obtain average yield of 2769 kg ha^{-1}. Number of ploughings in the range of 6-8 can give higher average yield of 3736 kg ha^{-1}. The increase in yield is 45% higher due to 6-8 ploughings with tractor as compared to that of bullock ploughings. However, economic analysis of increased tractor use can further help in optimizing the optimal number of ploughings to get maximum yield. Variation in yield due to bullocks and tractor ploughing is shown in Fig. 1. Average yield is significant. The dispersion in the data of yield was calculated and tested with the help of t-test.

Chemical fertilizer. The production function continued to increase as the fertilizer doses were increased from 11 to 150 kg ha^{-1} for nitrogen and from 11 to 100 kg ha^{-1} for phosphorus. The paddy yield was maximum in case of 100-150 kg ha^{-1} of nitrogenous fertilizer and 50-100 kg ha^{-1} in case of phosphorus. It indicates that comparative increase of phosphorous cannot help in increasing the yield. Optimal combination of fertilizers is necessary for better yield. Effect of increase of paddy yield with respect to increase in fertilizer is given in Table II. Comparative yield increase by increasing nitrogen and phosphorus is shown in Fig. 2. Average returns are significant. Statistical test shown as t-test was used to determine the significance of the dispersion in yield.

Seed Rate and Sowing Practices

Seed rate. About 50 percent farmers use seed rate in the range of 15-20 kg ha^{-1}. As a result, they obtain maximum yield of 2631 kg ha^{-1}. While the remaining 50% farmers use higher or lower seed rate, get less yield. Use of excessive seed rate may not help in increasing the yield. Effect of seed rate on yield is given in Table III and also shown in Fig. 3. Significance of the variation in yield was determined with the help of t-test.

Sowing date. Yield difference in the three sowing dates i.e. early (June 15 to 30), normal (July 1 to 15) and late (after July 15) is given in Table III. Timely sowing gave maximum yield (2800 kg ha^{-1}) while late sowing fell short of 300 to 700 kg ha^{-1}, respectively. Sixteen percent farmers transplanted the rice in normal time. Majority of the farmers (83%) transplanted rice late and lost paddy yield of approximately 27%. Variation of yield with respect to sowing time is shown in Fig. 4.

Tiller. Table III and Fig. 5 shows the paddy yield affected by number of tillers. Survey data indicated that 85% fields with plant density in the range of 0.125 to 0.150 million ha^{-1} and number of tillers in the range of 1-1.23 million ha^{-1} brought the lowest yield of 2483 kg ha^{-1}, while plant density in the range of 0.15 to 0.25 million ha^{-1} and number of tillers in the range of 1.23 to 1.62 million ha^{-1} brought the maximum yield of 3255 kg ha^{-1}. Majority of the farmers have less plant density and tillers per hectare. Use of appropriate plant density and tillers can help in increasing approximately 24% paddy yield. Average yield levels achieved through various seed rates, sowing dates and tillers are significant at 1% levels of probability.

Table I. Effect of cultural practices on paddy yield

Item	Bullock Ploughings		Tractor Ploughings		Plankings *
Ploughings (No.)	3-5	6-8	3-5	6-8	3-5
Farmers (No.)	592	21	342	08	852
Percent	97	03	98	02	100
Yield (kg ha^{-1})	2448	2577	2769	3736	2550
Std. Dev. **	787	794	764	1173	801
t_c ***	25.7	14.8	67.0	9.0	92.0
t_t ****1%	3.3	3.8	3.3	4.8	3.3
Result	Sig.	Sig.	Sig.	Sig.	Sig.

* Includes planking both with bullocks and tractor; **Std. Dev. = Standard Deviation; ***t_c = Calculated value of t distribution; ****t_t = Tabulated value of t distribution; Sig. = Significant

Table II. Effect of nitrogen and phosphorus fertilizer on paddy yield

Item	Nitrogen fertilizer (kg ha^{-1})			Phosphorus fertilizer (kg ha^{-1})	
Fertilizer (Kg ha^{-1})	11 to 50	50 to 100	100 to 150	11 to 50	50 to 100
Farmers (No.)	155	547	15	46	250
Percent	22	76	02	15	84
Yield (Kg ha^{-1})	2411	2674	3477	2718	2872
Std. Dev.	731	556	1265	542	802
t_c	41.06	112.48	10.6	34.01	56.6
t_t 1%	3.3	3.3	4.1	3.46	3.3
Result	Sig.	Sig.	Sig.	Sig.	Sig.

Sig. = Significant

Table III. Effect of seed rate, sowing dates and tillers on paddy yield

Item	Seed Rate (kg ha^{-1})			Sowing dates			Tillers (million ha^{-1})	
	10-15	15-20	20-25	Normal[1]	Early[2]	Late[3]	1-1.23	1.23-1.62
Farmers (No.)	297	418	125	139	10	710	734	129
Percent	35	50	15	16	01	83	85	15
Yield (Kg ha^{-1})	2483	2631	2554	2799	2512	2046	2483	3255
Std. Dev.	846	758	795	908	586	769	773	1421
t_c	50.58	70.96	35.92	36.34	13.55	70.96	87.02	26.02
t_t 1%	3.3	3.3	3.3	3.3	4.6	3.3	3.3	3.3
Result	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

1. July1 to July 15, 2. June 15 to June 30, 3. After July 1, Sig. = Significant

Fig. 1. Paddy yield as affected by number of ploughings

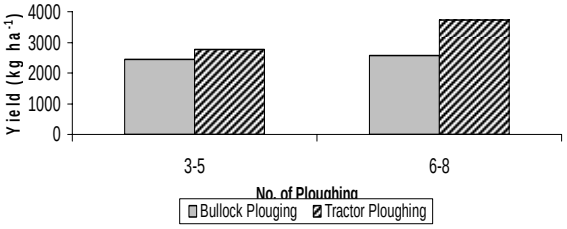
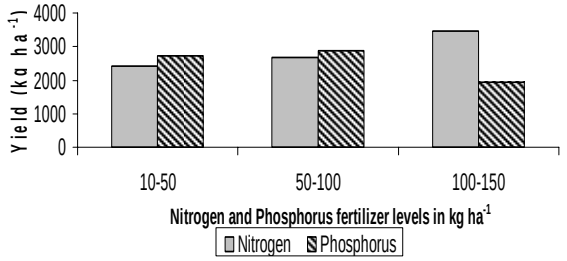


Fig. 2. Paddy yield as effected by different levels of nitrogen and phosphorous fertilizers



Irrigation. Number of irrigation water supplies is the main factor contributing to final crop yield. The effect of irrigation frequency and quantity of water on paddy yield is given in Table IV. Sixty two percent farmers used 11-16 numbers of irrigations irrespective of source of irrigation. Most of the farmers used mixed irrigations to meet the crop water requirement. As the number of irrigations increased, yield was also increased. Decrease in the number of irrigations reduced the yield. Only 1% farmers who applied number of irrigations in the range 17-20 received more yield than the others applying less number of irrigations. Yield trends in the range of 11-16 irrigations for the tubewell, mixed irrigation and canal irrigation are 2288, 2688 and 2978 kg ha^{-1}, respectively. Canal irrigation response is higher than other means of irrigation i.e. tubewell and mixed (canal + tubewell) irrigation. It indicates that purely canal water irrigation can help increasing paddy yield by 23%. The next choice is mixed irrigation as compared to purely tubewell supplies. Variation in yield with respect to number of irrigations is shown in Fig. 6. Average yield levels achieved through canal, tubewell and mixed irrigation are significant except the yield level obtained from 17-20 numbers of irrigations with canal water. Average yield levels were tested with the help of t-test.

Source of seed. It is apparent from Table V that seed provided by the Agricultural Development Corporation (ADC) gave maximum yield of 3607 kg ha^{-1}. The table also reveals that 86% farmers are using the home produced seed

Table V. Paddy yield from various sources of seed

Source of seed	Avg. yield (kg ha^{-1})	Farmers (No)	Per cent	Std. Dev.	t_c	t_t 1%	Result
Market	2695	19	02	813	14.4	4.0	Sig.
Mona Project	3191	07	01	681	12.4	5.4	Sig.
ADC	3607	11	01	126	94.9	4.4	Sig.
Home	2510	729	86	780	86.9	3.3	Sig.
Other farmers	2691	79	09	806	29.6	3.3	Sig.

Table VI. Soil Texture and yield Trends

Soil classes	Avg. yield (kg ha^{-1})	Farmers (No)	Per cent	Std. Dev.	t_c	t_t 1%	Result
Clay-loam	2712	187	22	750	49.4	3.3	Sig.
Loamy	2617	439	52	753	72.8	3.3	Sig.
Sandy Loam	2345	192	23	840	38.6	3.3	Sig.

Table VII. Paddy yield in various irrigation regions

Irrigation region	Ave. yield (kg ha^{-1})	Farmers (No)	Per cent	Std. Dev.	t_c	t_t 1%	Result
Perennial	2797	343	40	712	20.7	3.3	Sig.
Non-perennial	2635	393	45	897	58.2	3.3	Sig.
Un-commanded	2271	128	15	813	31.6	3.3	Sig.

Table VIII. Paddy yield of various crop varieties

Crop varieties	Ave. yield (kg ha^{-1})	Farmers (No.)	Per cent	Std. Dev.	t_c	t_t 1%	Result
Irri-6	2729	13	02	133	14.0	4.2	Sig.
B-385	2980	249	30	825	56.9	3.3	Sig.
B-370	2317	322	39	706	58.8	3.3	Sig.
B-Pak	2848	12	01	384	25.6	4.3	Sig.
Kernal Basmti	2466	209	26	701	50.8	3.3	Sig.
Super	1868	06	01	626	7.3	5.6	Sig.
Irri-4	2131	05	01	554	8.4	6.8	Sig.
B-198	3262	01	-	-	-	-	-

Table IV. Paddy yield as affected by type and number of irrigations

Item	Canal Irrigation			Tubewell Irrigation			Mixed Irrigation		
Irrigation (No)	**< 10**	**11-16**	**17-20**	**< 10**	**11-16**	**17-20**	**< 10**	**11-16**	**17-20**
Farmers (No)	69	114	02	44	112	05	138	432	08
Percent	37	62	01	27	70	03	24	75	01
Yield (Kg ha^{-1})	2454	2978	3484	2136	2288	2756	2352	2638	3342
Std. Dev.	821	867	585	1166	711	701	891	704	540
t_c	24.8	36.6	8.4	12.2	34.1	7.2	31.0	77.9	17.5
t_t 1%	3.4	3.4	31.6	3.5	3.4	6.9	3.4	3.4	5.04
Result	Sig.	Sig.	Insig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

Sig. = Significant; Insig. = Insignificant

Fig. 3. Paddy yield as effected by different levels of seed rate

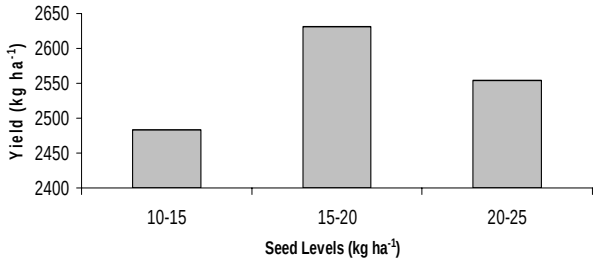


Fig. 4. Paddy yield as effected by different sowing dates

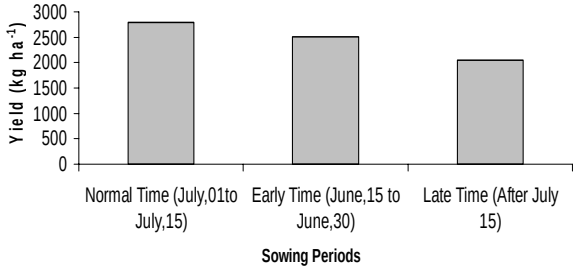


Fig. 5. Paddy yield as effected by number of tillers

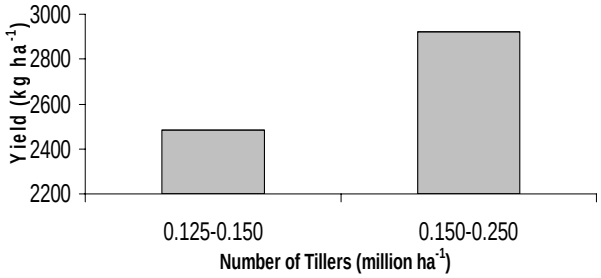


Fig. 6. Paddy yield by different irrigation levels and irrigation sources

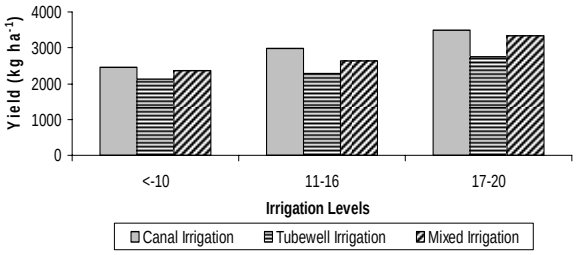


Fig. 7. Paddy yield as effected by different sources of seed

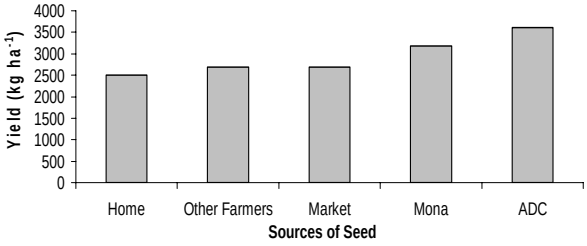


Fig. 8. Paddy yield as effected by soil types

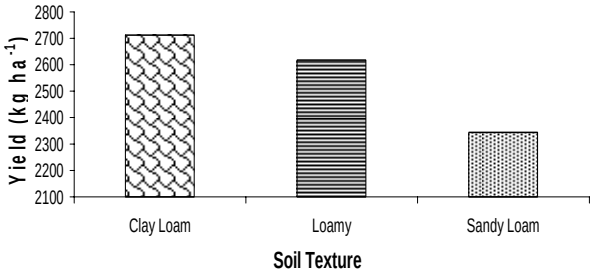


Fig. 9. Paddy yield in different irrigation regions

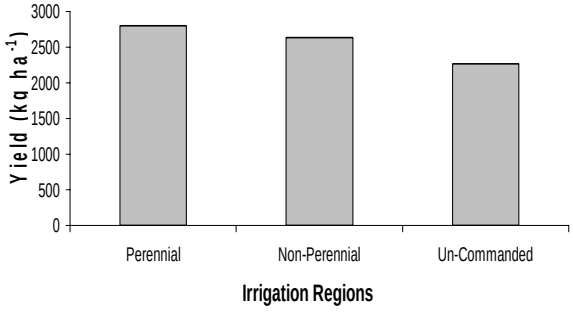
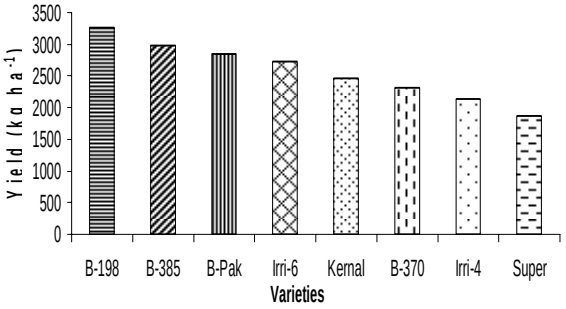


Fig. 10. Paddy yield of different crop varieties



(which is usually impure). It gave 2510 kg ha^{-1} yield which was the lowest in comparison to other sources. It can be concluded that certified recommended seed can help in improving the paddy yield. Yield variation with respect to

source of seed is shown in Fig. 7. Average returns obtained from all sources of seed are significant at 1% level of probability. Significance of the variation in yield was evaluated with t-test.

Effect of soil texture. Clay loam was found the best soil for rice crop because it retains the water for a longer period than other types of soils i.e., loamy and sandy loam. Yield trend with respect to Soil types is presented in Table VI. Clay loam stands first in respect of its yield return i.e. 2712 kg ha^{-1} followed by loamy with 2617 kg ha^{-1} and sandy loam with 2345 kg ha^{-1}. Variation in yield with respect to soil type is shown in Fig. 8. Mean returns through three types of soil texture are significant. Variation in yield levels was tested by using t-test.

Irrigation regions. Yield and input data was collected from three irrigation regions i.e. perennial, Non-perennial, and un-commended areas of Mona and Shahpur units. Maximum yield was reported in the perennial area to the level of 2797 kg ha^{-1}. It is apparent from the yield data trends mentioned in Table VII and shown in Fig. 9 that perennial area is playing dominant role over all other regions. Increase of yield in perennial area over non-perennial and un-commanded is 6 and 19%, respectively. Three irrigation regions give significant yield levels at 1% level of probability. To measure the dispersion in yield levels t-test was applied.

Crop varieties. Eight different varieties of rice were sown in Mona Project area. Rice variety B-370 covered the maximum area followed by the B-385 and Kernal Basmati. Rice variety B-198 produced the highest yield of 3262 kg ha^{-1}. However, throughout the 10 years survey data, it was found that only one farmer sowed this variety, therefore result of this particular variety can not be generalized. This followed B-385 with average yield of 2980 kg ha^{-1}, B-Pak with 2848 kg, Irri-6 with 2729 kg and Kernal with 2466 kg ha^{-1} yield. The remaining three varieties i.e. B-370, Super-8 and Irri-4 were less important with respect to yields. The varieties such as B-370, B-385, Kernal Basmati are more popular in the area. The yield potential is high in B-385 as compared to other popular varieties in the area. Although B-198 is the highest yielding variety, however, only less than 1% farmers have grown it (Table VIII; Fig. 10). Yield levels achieved through all varieties are significant at 1% level of probability. To determine the significance of the yield difference t-test was applied.

CONCLUSIONS AND RECOMMENDATIONS

Ten years yield and input data from 1985 to 1994 for paddy crop was analyzed and the following conclusions and recommendations were drawn;

- July 1 to July 15 is the best period for transplanting paddy nursery. Paddy yield was reduced upto 754 kg ha^{-1} and 287 kg ha^{-1} in early or late sowing respectively.
- 15-20 kg ha^{-1} seed rate raising for nursery performed the best.
- Rice variety B-385 was the most popular and productive as it gave more yield in comparison to other varieties except B-198 which was grown only by one farmer.
- Agriculture Development Corporation proved the best source of seed to obtain higher yield followed by Mona project, market, home produced and other farmers.
- Farmers who used farmyard manure got 85 kg ha^{-1} more yield than those who did not apply farmyard manure.
- Nitrogen fertilization in the range of 100-150 kg ha^{-1} resulted in maximum yield (3477 kg ha^{-1}) while, the Phosphorus in the range 50-100 kg ha^{-1} resulted in maximum yield of 2872 kg ha^{-1}.
- Canal, tubewell and mixed irrigations from 17-20 numbers produced a yield of 3484, 2756, 3342 kg ha^{-1}, respectively.
- Weeding gave 448 kg ha^{-1} more yield as compared to " no weeding".
- Plant density in the range of 0.125 to 0.150 million ha^{-1} and number of tillers in the range of 1-1.23 million ha^{-1} brought the lowest yield of 2483 kg ha^{-1}, while plant density in the range of 0.15 to 0.25 million ha^{-1} and number of tillers in the range of 1.23 to 1.62 million ha^{-1} brought the maximum yield of 3255 kg ha^{-1}.
- Clay-loam proved better for paddy production than other types of soils i.e. loam and sandy loam.
- Perennial area brought better yield than other regions i.e., non-perennial and un-commanded.

Recommendations

- To increase the paddy yield, it is recommended that, farmers should use 4 to 7 bags i.e., (250 to 350 kg) of urea and 2 to 4 bags i.e., 100 to 200 kg ha^{-1} of DAP.
- Emphasis should be laid on use of better practices for land preparation (i.e., plowing, planking) and weeding.
- Nursery should be transplanted from July 1 to 15. Late or early sowing lower the paddy yield.
- Timely and adequate application of chemical fertilizer, tractor cultivation, optimum number of irrigation and weedicides/pesticides contribute a lot in enhancing paddy yield.
- The farmers facing financial hardships may be provided credit facilities to purchase the aforementioned farm inputs.

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