

## **BENEFIT COST ANALYSIS OF THE MAIZE CROP UNDER MECHANIZED AND TRADITIONAL FARMING SYSTEMS IN THE NWFP**

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### **ABSTRACT**

Maize is one of the major staple food items in the NWFP. The crop is also utilized as a fodder for animals and as a raw material by manufacturing units. For the cultivation of the crop both mechanized and traditional methods are used. For the present study 200 respondents (130 mechanized and 70 traditional) were randomly selected. The field data (2004, Kharif) of Peshawar District showed significant differences in inputs use and output at the mechanized and traditional farms. At both the mechanized and traditional farms the benefit cost ratio of small farms size was higher than that of the large farms. Similarly the ratio of tenant farms was higher than that of the owner farms. Yield per hectare of the mechanized farms was 27.66 % higher than that of the traditional farms. The benefit cost ratio of mechanized farms was higher (26.6 %) than that of the traditional farms. This means that mechanized farms have enhanced their income and also benefit cost ratio by using agricultural machinery.

### **INTRODUCTION**

Maize is a staple food in Pakistan and particularly of its North West Frontier Province (NWFP). Maize is also used as a raw material by many manufacturing units like cooking oil, confectionary and backers. The maize crop is employed as feed for livestock. Green ears are also fed to animals but mostly its stalks and leaves (green or dry) are employed for this purpose. Maize, thus serves as an important source of fodder supply.

In terms of area allocation, maize is the second largest crop in the Province. At the national level, the NWFP has a very important position in the production of maize. On the yearly average of 2000-2003, for example, nearly one million hectares of land was devoted to the maize crop at the country level. Of the total area the provincial share was as high as 56.5%. However, per hectare (ha) yield of the country (also of the Province) is much lower than that of the maize producing countries' average (Govt. of Pakistan, 2004). The yield / ha<sup>-1</sup>. can considerably be increased if proper arrangements are made. In this regard a benefit cost analysis was conducted to find out net income and expenditure of the mechanized verses traditional farming system.

Singh (1974) observed that in India yield and hence income was higher on mechanized farms when compared to traditional farms. Salam (1978) estimated that in Punjab-Pakistan farm mechanization has increased farmers income.

Buchhoiz (1983); Shah (1993); Shrivastva and Shrivastva (1998); and Jehanzeb (1999) have also presented similar view and concluded that mechanization has helped in increasing farmers' income. However, very little information has been presented about the net income etc; of the maize crop grown under mechanized and traditional farming systems in the NWFP. The present study is an attempt in this direction to fill in this gap for the maize crop in the NWFP.

### **MATERIALS AND METHODS**

#### ***Sampling Procedure***

Universe of the study is the NWFP where maize is grown on a large area and more than 52 % of the country production is obtained from this Province. Maize is also the second largest crop of Peshawar District (i.e. study area). Moreover, this area is well known for its good fertile soil (Hussain, 1990).

For this study mechanized farms are those where the farmers generally use agricultural machinery and do not use the traditional methods of cultivation or use it but very rarely. Traditional farms in the present case are those where the cultivators oftenly do not use agricultural machinery or use it but very sparsely. In the case of maize crop the mechanized farms use machinery (i.e. tractor with appliances) for land preparation (ploughing, planking, leveling and ridges), sowing, weeding and threshing. The

traditional farms use bullock power and labour for all the stated activities.

Union Council (UC) Gulbela was randomly selected from the list of all the Union Councils in Peshawar District. The number of house holds involved in agricultural activities in the UC was nearly one thousand which was about 70% of the total population of the UC. Nearly 65% of the agricultural related population was applying mechanized and the rest traditional methods of cultivation. Sample size

$$\{n = K^2 S^2 N / (Ne^2 + K^2 S^2)\}$$

assuming  $e = 0.4$ ,  $S = 3$  and  $K = 2$  ( $K$  takes values from 1 to 3)} arrived at about 200 (Parel, 1973). The sample size was proportionally divided in mechanized and traditional farms. In each category (i.e. mechanized and traditional) the farms were proportionally divided in small (less than 5 ha) and large (5 ha and above) farm sizes (Govt. of Pakistan 2003). Each size was proportionally divided in owner and tenant cultures as shown in Table I below:

**Table I** *Sample distribution of the respondents*

Farming System	Small Farms			Large Farms			All Sizes		
	OC	Tenants	All	OC	Tenants	All	OC	Tenants	All
Traditional	32	16	48	14	8	22	46	24	70
Mechanized	64	30	94	20	16	36	84	46	130
<b>All</b>	<b>96</b>	<b>46</b>	<b>142</b>	<b>34</b>	<b>24</b>	<b>58</b>	<b>130</b>	<b>70</b>	<b>200</b>

**OC : Stands for Owner Cultivators**

Sources: Survey (Kharif, 2004)

#### **Data collection**

The study is primarily based on farm level data collected through the sample survey. Sample respondents were selected from the irrigated area of Peshawar District where both mechanized and traditional farming methods are practiced. The data were collected from the farmers through a structural profarma by interview them in Kharif, 2004.

#### **Description of the Variables**

The list of the input variables included labour, animal power, use of machinery (i.e. tractor along with accompanied appliances), seed, Farmyard manure (FYM), Chemical Fertilizers, Irrigation, and other costs (i.e land rent, expenditure on refreshment serves to labour and Pest/Inst.). The output included main product and by product. The cost incurred on inputs was measured in terms of the prices paid by the respondents for each input. However, for some of the family provided resources like labour, animal power and FYM, the local market prices were used to impute a cost to these inputs (Binswanger 1974; Khan & Iqbal 1981).

#### **Analytical Framework Of The Study**

##### **Basic Tests and its Application on the Field Data**

Primary data were collected from both mechanized and traditional farms. However, before going to analysis it is necessary to test whether there is any difference between the mentioned groups or not. If the tests show that the groups are similar then the data would be pooled otherwise it would be treated separately. For this purpose our hypothesis that there was no difference between the two groups (i.e. mechanized and traditional farms) was tested for its validity on the assumption of normally distributed population. The original hypothesis was equivalent to two hypotheses:

- (a) No differences between the means; and
- (b) No differences between the variances.

A t-test was used for (a) and Chow test was used for (b) (Gujrati 1995). Both the tests and its applications are summarized below:

##### **Test For Difference Between The Two Means**

As the number of observations regarding mechanized farms, ( $n_1$ ) is not equal to that of traditional farms, ( $n_2$ ), therefore, two unpaired, independent samples t- test was used:

(t-test):  $t = \frac{\bar{X}_1 - \bar{X}_2}{\delta \sqrt{1/n_1 + 1/n_2}}$  distributed as  $t(n_1 + n_2 - 2)$

where as  $\delta$  is unknown and  
 $= \sqrt{\frac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2}}$

$\bar{X}_1, \bar{X}_2$  are the sample means of mechanized and traditional farms respectively and  $S_1^2$  and  $S_2^2$  are the respective sample variances. The null hypothesis to be tested is that the two population means are identical i.e.  $H_0: \mu_1 = \mu_2$ . The results of the test are presented in Table II below:

**Table II** *Test of equality of means of the crop*

Variables	Mean values of		
	Mechanized farms	Traditional farms	T-ratio
Area (Ha)	1.89	1.43	2.99*
Seed (Kg)	27.35	28.0	2.51*
Farm Yard Manure (trolley)	1.55	1.0	1.76**
Fertilizer (bag)	5.7	4.95	3.76*
Water (Rs.)	199.98	428.5	5.53*
Other (Rs.)	6905.5	7141.5	6.45*
Labour (Hrs)	231.5	473	62.6*
Animal power(Hrs)	0.0	15.6	684.8*
Tractor use (Hrs)	9.7	0.0	856.0*
Output (Rs.)	31023	24554.5	28.8*
No. of observations	130	70	-

Source: Based on Tables IV & VI

\* Significant at 5 %

\*\* Significant at 10 %

#### ***Test for differences between variances***

The hypothesis of “no differences between the two variances” was tested here by using Chow-test. The null hypothesis  $H_0: \delta_1^2 = \delta_2^2$  was tested against the alternative hypothesis  $H_1: \delta_1^2 \neq \delta_2^2$ . The Chow-test, was used to test the hypothesis of similarity (Gujrati, 1995). The Chow - test is as:

$$F = \frac{S_a / k}{S_b / (n_1 + n_2 - 2k)}$$

Where as F is distributed with (k,  $n_1 + n_2 - 2k$ ) degree of freedom

S: stands for Residual Sum of Square (RSS);  
 $n_1$  = sample size of 1st population.  
 $n_2$  = sample size of 2nd population.  
k = number of parameters estimated.  
 $S_b = S_1 + S_2$  [Residual Sum of Square

(RSS) of the respective population]

$S_a = S_c - S_b$  [where as  $S_c$  is the RSS of the combined Regressors]

The results of the tests are given below:

**Table III** Test of equality of variances between sizes and tenancies of the mechanized and traditional farms: maize crop

Farming system/grouping	R.S.S.	D.F	F (Chow-values)
<b>Mechanized farms</b>			
Size wise			
Small farms	0.037	87	2.01*
Large farms	0.013	29	
Combine	0.057	123	
Tenancy wise			
Owner cultivators	0.038	77	5.7 *
Tenant cultivators	0.002	39	
Combine	0.056	123	
Traditional farms			
Size wise			
Small farms	0.008	41	2.94 *
Large farms	0.005	15	
Combine	0.019	63	
Tenancy wise			
Owner cultivators	0.003	39	2.35*
Tenant cultivators	0.014	17	
Combine	0.024	63	
<b>All</b>			
Mechanized	0.057	123	5.72*
Traditional	0.019	63	
Combine	0.095	193	

Source: Based on Tables IV and VI

\* Significant at 5 %

The general impression of the results (means test-Table II) supports the differences between means of mechanized and traditional farms. The test shows significant differences in mechanized and traditional farms in the use of all inputs and also in outputs. There are also significant differences between variances of mechanized and traditional farms. As there are significant differences in the mechanized and traditional farms and also in their respective farm sizes and tenancies, so the result and discussion on the issue is considered accordingly.

#### **Benefit Cost Ratio**

This is the Ratio obtained when the benefit stream is divided by present worth of cost i.e. B.C Ratio (in our case) is Benefits/Costs. If the ratio is less than one then the costs exceed the benefit. However, if the Ratio is more than one then the Benefits exceed the costs (Gittenger,1982; Jehanzeb,1999).

## **RESULTS AND DISCUSSION**

In the sample area a total of 325.84 hectares was devoted to the maize crop. Of the total area 70.6, per cent was covered by mechanized farms and the rest was accounted for traditional farms. In the following paragraphs the cost and return are briefly described by taking 1st the mechanized category, followed by traditional farms.

#### **Mechanized Farms**

The mechanized farms devoted 230.04 ha. of land to the crop. Total production cost/ha. stood at Rs.16805.0 which gave a gross income of Rs.31025.0 and yielded a net profit of Rs.14220.0 per ha.. The overall accounts of expenditure and quantity of various inputs and output value / ha<sup>-1</sup>. are given in Table-IV below.

The table provides information about inputs and its costs by farm sizes and tenancies. The over all labour requirements of the owner cultivators were

lower than that of the tenants. However, the tractor input of the latter was lower than that of the former. This means that labour and tractor are substituting each other. The fertilizer input of the owner cultivators was higher than that of the tenant cultivators. However, the FYM input of the former was lower than that of the latter.

The production cost of the small owner cultivators was higher than that of the large owner cultivators; similarly the production cost of the small tenant cultivators was higher than that of the large tenant cultivators. The same trend existed in the net

income of the respective categories. The net income / ha<sup>-1</sup> of the small owner cultivators was higher than that of the large owners. Similarly the net income of the small tenant was higher than that of the large tenant cultivators.

The highest output / ha<sup>-1</sup> was achieved by the small tenant cultivators which may be attributed to their higher care and seed quantity. The lowest yield / ha<sup>-1</sup> was that of the owner cultivators of large farm size which may be due to comparatively small quantity of FYM and seed.

**Table IV** *Per hectare inputs, its cost and output qty of maize crop mechanized farms*

Category	Labor		Tractor		Seed		Fertilizer		FYM		Water cost Rs.	Other cost Rs.	All cost	Output				Net income	
	Time	Cost Rs.	Time	Cost Rs.	Qty	Cost Rs.	Qty	Cost Rs.	Qty	Cost Rs.				Main		By product			All values
														Qty	Val.	Qty	Val.		
OC small	45.34	376	2.05	859	5.50	137	1.23	538	0.33	80	48	1377	3415	13.71	6170.30	4.81	55.39	6225.69	2809.6
OC large	45.5	381	1.94	823	5.40	135	1.24	569	0.27	69	45	1382	3404	13.41	6035.30	4.51	56.41	6091.71	2688.74
Tenant small	48.4	497	1.91	829	5.64	68	1.0	422	0.31	78	36	1399	3329	13.95	6276.10	5.26	55.60	6331.70	3002.52
Tenant large	47.4	476	1.81	808	5.46	66	1.0	420	0.36	89	26	1376	3261	13.73	6178.20	5.03	57.20	6235.40	2975.19
All	46.3	420	1.94	832	5.47	109	1.14	501	0.31	78	40	1381	3361	13.66	6148.50	4.84	56.10	6204.60	2844.14

Source: Survey

Note: Qty stands for quantity, seed qty is in kg; fertilizer qty in bags (1 bag = 50 kg); FYM qty in trolley (1 trolley = 50 maunds); Main qty in maunds, by product qty in bundle; val = values in Rs

### Benefit Cost Analysis

In the study Benefit cost ratio has been calculated as the ratio of total revenue to total expenditure. The detail is given in the table below:

**Table-V** *Benefit, cost ratio by farm size and tenancy of mechanized farms*

Tenancy	Farm Size		All
	Small	Large	
OC	1.82	1.79	1.80
Tenant	1.91	1.90	1.90

Sources: Based on Table-IV

The table shows that both the owner and tenant cultivators have received good income from the crop. The aggregate productivity of the owners for all sizes stood at 1.80, or in other words, with the cost of one rupee, the owners earned a net income of Rs. 0.80. The ratio was slightly higher on small farms as compared to the large farms. The over all productivity of the tenant cultivators arrived at 1.90, which shows that the investment of one rupee provided income of Rs. 1.90. This means

that by spending one rupee the tenant received a net income of Rs. 0.90. Thus the net income of tenant cultivators was higher than that of the owners which may be due to the higher care of the former.

### Traditional Farms

The traditional farms devoted 95.8 ha. of land to the maize crop. Total production and gross income per hectare arrived at Rs.16450.0 and

Rs.24555.0 respectively where as it gave a net return of Rs.8105.0 / ha<sup>-1</sup>.

All the quantity and cost incurred on inputs and value received for all sizes and tenancies are given in Table VI. As can be seen in the table that both

the labour and animal power inputs of the tenant cultivators were higher than that of the owner cultivators.

**Table VI** *Per jareeb inputs cost and return of maize crop: traditional farms*

	Labor		Animal power		Seed		Fertilizer		FYM		Water cost Rs.	Other cost Rs.	All cost	Output			Net income		
	Time	Cost Rs.	Time	Cost Rs.	Qty	Cost Rs.	Qty	Cost Rs.	Qty	Cost Rs.				Main		By product		All values	
														Qty	Val.	Qty			Val.
OC small	91.43	1044	2.80	106	5.74	87	1.04	432	0.15	46	70	1420	3205	10.57	4756.10	6.63	72.3	4828.40	1625.65
OC large	87.2	1009	2.77	104	5.83	88	1.14	492	0.05	15	62	1437	3207	10.45	4700.80	6.75	63.5	4764.3	1558.18
Tenant small	100.3	1149	3.43	120	5.57	95	0.82	347	0.26	79	115	1425	3330	11.10	4993.30	6.46	71.6	5064.9	1737.40
Tenant large	101.5	1149	3.61	126	5.50	93	0.91	392	0.38	116	106	1431	3413	11.10	4993.30	4.61	44.66	5037.96	1623.65
All	94.6	1084	3.12	113	5.60	90	0.99	431	0.19	58	86	1428	3290	10.7	4848.60	6.07	62.3	4910.90	1622.66

Source: Survey

Note: Qty stands for quantity, seed qty is in kg; fertilizer qty in bags (1 bag = 50 kg); FYM qty in trolley (1 trolley = 50 mounds); Main qty in mounds, by product qty in bundle, val = values in Rs.

The chemical fertilizers consumption of the owner cultivators was higher than that of the tenant cultivators. However, the FYM application on the tenant cultivators was higher than that of the owners. The over all net income of the tenant cultivators was higher than that of the owner

cultivators which may be attributed to the higher inputs utilization of the former.

#### **Benefits Cost Analysis**

The benefit cost ratio of the traditional farms is given in Table-VII.

**Table-VII** *Benefit, cost ratio by farm size and tenancy of traditional farms*

Tenancy	Farm size		All
	Small	Large	
OC	1.50	1.48	1.49
Tenant	1.52	1.48	1.50

Source: Based on Table-VI

The above table shows that both the owner and tenant cultivators have got income from the crop. The aggregate productivity of the owners for all sizes stood at 1.49, or in other words, with the cost of one rupee, the owners earned a net income of Rs. 0.49. The over all productivity of the tenant cultivators arrived at 1.50, which shows that the investment of one rupee provided income of Rs. 0.50.

This means that by spending one rupee the tenant received a net income of Rs. 0.50.

A comparison of Table V and Table VII shows that the benefit cost ratios of the mechanized farms are higher than that of the traditional farms as shown below diagrammatically.

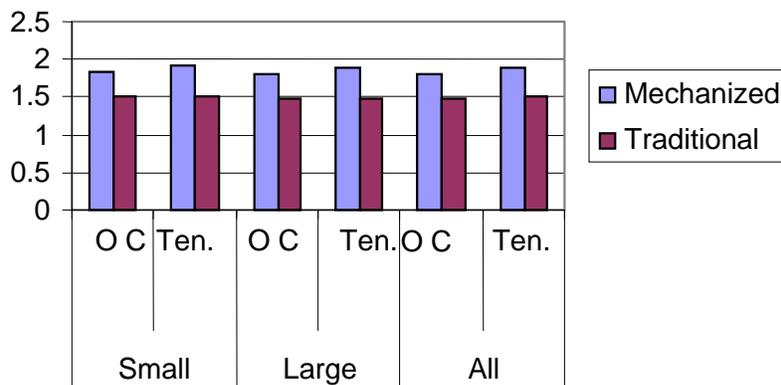


Figure 1. Benefit cost ratios of mechanized and traditional farms  
 Note: OC means owner cultivators; and Ten. means tenant cultivators.

## CONCLUSION

Both mechanized and traditional farms have generated net income from the crop.

The net income of the mechanized farms was higher than that of the traditional farms because the former got higher yield/ha. This may be attributed mainly to the in time land preparation, better tillage practices, and shilling etc; by the mechanized farms. The labour requirements and hence its cost of the traditional farms were higher than that of the mechanized farm. Also the animal power was limited to traditional farms. This shows that machinery is a closed substitute for labour and animal power. The mechanization can thus helps in the increase of output and hence income. The increase in input and income can encourage the labour requirements.

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