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# Technical Efficiency in North-Western Himalayan Region: A Study of Himachal Pradesh Agriculture

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## Abstract

The technical efficiency of Himachal farmers, studied using the frontier production function, has been found to vary widely across cereal crops in the state. It has been found that the average yield of all the major cereal crops is below the national average, except the maize crop, which has been found in surplus in the state. Maize → wheat and paddy → wheat have been noted as the major crop rotations being followed in the study area. The analysis of cross sectional data has revealed inefficiency in terms of inputs application. The mean technical efficiencies have revealed that a considerable portion of frontier output is left untapped, it is 35-42 per cent in maize, 44-50 per cent in paddy and 61-67 per cent in wheat. The ratio of marginal value productivity (MVP) and marginal factor cost (MFC) has been found to be more than one in case of 50 per cent inputs for all the crops. However, the female labour for most of the crops has values less than one and with negative signs as most of the work (agricultural operations) in the hills is being performed by women. The results have indicated that there is a scope to increase the returns from wheat production by using more farmyard manure, chemical fertilizers, male labour, female labour and bullock labour in zone I. Similarly, in the case of maize (local) in zone I, the yield could be increased by increasing the use of more of farmyard manure, chemical fertilizers, male labour and seeds. The analysis has also revealed that a majority of the farmers operate at low level of efficiency due to practising of traditional cultivation methods. It is felt that there is a need to educate females in resource management, preferably through female extension workers.

## Introduction

Agriculture, including horticulture and animal husbandry is the main occupation of the rural people in the North-Western Himalayan Region (NWHR), encompassing states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand. This region inhabited by 84 per cent rural people, commands over 13.15 million ha area, of which 18.5 per cent is under cultivation. Over 90 per cent of gross cropped area is under food crops out of which cereals account for 87 per cent of gross cropped area. Rice, maize and millets are the main *kharif* crops, while wheat and barley are the *rabi* crops. The productivity of these crops in the region is very low as compared to the national average. Agriculture occupies an important place in the economy of Himachal Pradesh as it contributes 20 per cent to Net State Domestic Product (NSDP) and provides direct employment to about 70 per cent of the total work force. Any fluctuation in the production of food grains affects the economy of the state significantly. Out of the total geographical area of 55.67 lakh hectares, the area under operational holdings is 11 per cent which is being operated by 8.63 lakh farm households, of whom a majority (85 per cent) belongs to the marginal and small categories. About 80 per cent of the total cultivated area in the state is rain-fed. Maize, wheat and paddy are the important cereal crops in the state, the current growth rate in these crops did not keep

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pace with the growth in population in the state and thus the per capita availability of cereals has fallen to 478 g in 2000-01 from 722 g in 1990-91. Most of the growers, due to lack of awareness, are not able to utilize their resources efficiently, causing not only low income to the households but low production also to the state, leading to a serious concern to food security. The sloppy land, harsh climate, lack of suitable crop varieties, inadequate and unbalanced use of fertilizers, low factor productivity and inadequate production and marketing infrastructure, including poor means of transport and communication, are some of the major impediments making farming inefficient in the state. A few farmers do achieve high productivity of cereals in the region, but a majority lags behind mainly because of inefficient use of resources. Therefore, to achieve the maximum realizable crop output with the given level of inputs under the existing situation and given technologies, a careful examination of the farm-specific technical efficiency and input-specific allocative efficiency of the farmers is necessary. Keeping in view the important role played by cereals in agricultural economy of the NWHR in general and Himachal Pradesh in particular, an attempt has been made to study the input efficiency with respect to cereals production in Himachal Pradesh.

## Methodology

The study was carried out in the state of Himachal Pradesh, by dividing it into four agro-climatic zones, as per the NARP classification, viz. Zone I (sub-mountain low hills, below 650 m above msl), Zone II (mid hills high humid, 650-1800 m above msl), Zone III (high hills temperate wet, 1800-2200 m above msl) and Zone IV (high hills temperate dry, more than 2200 m above msl). The multistage random sampling technique was purposively used to select a sample of development blocks, villages and the farmers in zone I and zone II where cereals are grown by a majority of farmers. In the first stage, the blocks namely Fatehpur and Ghumarwin in zone I and Rait and Sundernagar in zone II were selected at random. In the second stage, four villages in each of the selected block, i.e. 16 villages were chosen at random. In the third stage, 45 farmers from the concerned block were chosen in such a way that each village accounted for at least a random sample of 10 farmers. Thus, the sample size comprised 180 households for the study. The primary data on cultivation of major cereals collected from the farmers pertained to the 2001-02 agricultural year.

The Cobb-Douglas production function was used on per farm basis to workout resource-use efficiency, as shown in Equation (1):

$$Y = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^{u} \quad \ldots(1)$$

where,

$Y$ = Value of output in Rs

$X_1$ = Farmyard manure in quintals

$X_2$ = Cost of chemical fertilizers in Rs

$X_3$ = Human (male) labour in human days

$X_4$ = Human (female) labour in woman-days

$X_5$ = Bullock labour/ tractor charges in Rs

$X_6$ = Cost of seeds in Rs

$b_0$ = Efficiency parameter

$b_i$s (i = 1,2------,6) = Output elasticities of respective inputs, and

$u$ = Error-term.

The computation of zero-order correlation coefficient between the variables did not indicate the problem of multicollinearity.

## Resource Productivity and Allocative Efficiency

The output elasticity coefficients of different inputs used in the crop production obtained from production function [Equation (1)] of the cereal crops was used to calculate the Marginal Physical Productivity (MPP). The MPP of an explanatory variable in the function is the expected addition or reduction in the total output, which would result from the addition of one unit of that factor, keeping the level of other factors constant. It can be derived as per Equation (2):

$$b_i = MPP_{Xi} / APP_{Xi}$$

$$MPP_{Xi} = (b_i)\,(APP_{Xi}) = [b_i]\,[Y(GM) / X_i(GM)] \quad \ldots(2)$$

where, APP is the average physical productivity, Y(GM) is the geometric mean of output and $X_i$(GM) is the geometric mean of the ith resource.

## Timmer Measure of Technical Efficiency

The Cobb-Douglas production function does not distinguish between technical efficiency and allocative efficiency (Sampath, 1979; Jayaram *et al.*, 1992). It ignores the problem of technical efficiency by assuming that all the techniques of production are identical across farms and each farmer is technically efficient, which many a times may not be correct. Technical efficiency evaluates the farm's capacity to produce the maximum possible output from a given set of resources, while allocative efficiency explores the needed adjustments in equating the marginal revenue with the marginal cost for maximizing profitability.

Timmer (1971) had imposed a Cobb–Douglas type specification on the frontier and had computed an output–based measure of efficiency. The approach adopted was to specify a fixed parameter frontier amenable to the statistical analysis. The general form of the production function is given by Equation (3):

$$Y = f(X)\, e^{u} \qquad \ldots(3)$$

$$U \leq 0$$

For estimating the frontier production function, corrected ordinary least squares (COLS) is chosen as the most convenient means. As a first step, OLS is applied to the Cobb-Douglas production function to obtain the best unbiased estimates of $b_i$-coefficients. The constant (intercept) estimate is then corrected by shifting the function until no residual is positive and one function is zero. It is done by adding the largest error-term ($e_j$) of the fitted model to the intercept.

The Timmer measure of technical efficiency of a farm is the ratio of the actual output to the potential output given the level of input-use on the ith farm. It thus indicates that how much extra output could be obtained if the ith farm were to be on the frontier. Timmer measure of technical efficiency is given by Equation (4):

$$TE = Y \text{ (actual output)} / Y^* \text{ (frontier output)} \qquad \ldots(4)$$

where, Y* is the maximum obtainable output (frontier output) given the levels of the inputs.

To classify the efficiency achieved by the farmers, the criteria as used by Jayaram *et al.* (1992) was used:

High efficiency farmers : Efficiency Index > 75%

Medium efficiency farmers : Efficiency Index 50-75%

Low efficiency farmers : Efficiency Index < 50%

### Kopp Measure of Technical Efficiency

Kopp (1981) had suggested a different measure of technical efficiency in which the actual level of input used is compared to the level which would be used if the ith farm were to be located on the frontier, given the actual output of the ith farm and given the same ratios of input usage.

Kopp's measure is given by Equation (5):

$$TE_i = X_i^* / X_i \qquad \ldots(5)$$

where, $X_i^*$ is the frontier and $X_i$ is the actual use of the $i^{th}$ input.

The frontier input-use ($X_i^*$) is worked out as follows:

$$\text{If, } \ln Y = \alpha + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6$$

where, $\alpha$ is the corrected intercept, that is, $\alpha$ = [estimated $b_0$ + largest value of error-term ($e_j$)]

$$\text{Then: } b_1 \ln X_1 = \ln Y - \alpha - b_2 \ln X_2 - b_3 \ln X_3 - b_4 \ln X_4 - b_5 \ln X_5 - b_6 \ln X_6$$

By adding $b_2 \ln X_1 + b_3 \ln X_1 + b_4 \ln X_1 + b_5 \ln X_1 + b_6 \ln X_1$ to both sides, and rearranging we get:

$$[b_1+b_2+b_3+b_4+b_5+b_6] \ln X_1 = \ln Y - \alpha - [b_2 \ln X_2 - b_2 \ln X_1] - [b_3 \ln X_3 - b_3 \ln X_1] - [b_4 \ln X_4 - b_4 \ln X_1] - [b_5 \ln X_5 - b_5 \ln X_1] - [b_6 \ln X_6 - b_6 \ln X_1]$$

$$\sum_{i=1}^{6} b_i [\ln X_i] = \ln Y - \alpha - b_2 \ln[X_2/X_1] - b_3 \ln[X_3/X_1] - b_4 \ln[X_4/X_1] - b_5 \ln[X_5/X_1] - b_6 \ln[X_6/X_1]$$

$$\ln X_1 = [\ln Y - \alpha - b_2 \ln R_2 - b_3 \ln R_3 - b_4 \ln R_4 - b_5 \ln R_5 - b_6 \ln R_6] / \sum_{i=1}^{6} b_i$$

Or

$$X_i^* = \text{Antilog } \{[\ln Y - \alpha - b_2 \ln R_2 - b_3 \ln R_3 - b_4 \ln R_4 - b_5 \ln R_5 - b_6 \ln R_6] / \sum_{i=1}^{6} b_i\} \quad \ldots (6)$$

where,

$R_2 = X_2/X_1$; $R_3 = X_3/X_1$; $R_4 = X_4/X_1$; $R_5 = X_5/X_1$; $R_6 = X_6/X_1$

## Results and Discussion

### Area, Production and Productivity in Himachal Pradesh

The perusal of Table 1 reveals that the area under paddy and barley declined in both absolute and percentage basis; however, in maize and wheat, it increased with the result of overall increase in all the cereals by 2.86 per cent. The reduction in area under millets and pulses during the study period has led to a decline in area under foodgrains by 1.79 per cent. Except barley, the production of major cereals, viz, wheat, maize and paddy, has increased by 64.55 per cent, 45.80 per cent and 12.75 per cent, respectively. The area under HYVs in wheat (3.60 lakh ha, that is, 95 per cent of total) was the highest, followed by paddy (2.05 lakh ha, i.e., 93 per cent of total) and maize (0.73 lakh ha, i.e., 77 per cent of total) in Himachal Pradesh. Paddy grown under both irrigated and rainfed-condition was responsible for a lower increase in its production. The average yield of all the major cereal crops was below the national average, except maize, in Himachal Pradesh. The average yield of maize crop was 22.04 q/ha as against the national average of 19.83 q/ha (2003-04). The average yield of all the major cereals as well as food grains have increased over the study period. The percentage increase in average yield was recorded highest in wheat (45.24 per cent), followed by paddy (32.26 per cent) during the period TE 1974-75 to TE 2003-04. As a result, the productivity of food grains and all cereals has increased by 39.75 per cent and 35.63 per cent, respectively.

### Basic Data of Households

The basic statistics about the households in the selected area are given in Table 2. The average farm-size declined with the rise in altitude from 1.78 ha in zone I to 0.82 ha in zone II. Maize → Wheat and Paddy → Wheat were the major crop rotations being followed in both the situations. The average yield of paddy and wheat differed substantially in these zones. It was 24.56 q/ha for paddy and 18.72 q/ha for wheat in zone I, whereas the corresponding figures in zone II were 19.70 q/ha and 22.73 q/ha. The marketable surplus of maize was slightly higher (50.83%) in zone II than zone I (47.12%); however, for paddy and wheat, it was significantly higher in

**Table 1. Area, production and yield of important cereals (Triennium ending)**

| Sl No. | Crops | Area (lakh ha) | | | Production (lakh tonnes) | | | Yield (q/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1974-75 | 1986-87 | 2003-04 | 1974-75 | 1986-87 | 2003-04 | 1974 -75 | 1986-87 | 2003-04 |
| 1. | Paddy | 0.96 | 0.94 | 0.82 | 1.02 | 0.83 | 1.15 | 10.6 | 8.8 | 14.02 |
| | | (11.45) | (10.67) | (9.96) | (10.20) | (7.35) | (8.40) | | | |
| 2. | Maize | 2.62 | 3.04 | 2.99 | 4.52 | 5.52 | 6.59 | 17.3 | 18.2 | 22.04 |
| | | (31.26) | (34.51) | (36.33) | (45.20) | (48.89) | (48.14) | | | |
| 3. | Wheat | 3.16 | 3.78 | 3.56 | 3.30 | 4.04 | 5.43 | 10.5 | 10.7 | 15.25 |
| | | (37.71) | (43.98) | (43.26) | (33.00) | (35.78) | (39.66) | | | |
| 4. | Barley | 0.40 | 0.30 | 0.25 | 0.50 | 0.30 | 0.31 | 11.7 | 10.0 | 12.40 |
| | | (4.77) | (3.41) | (3.04) | (5.00) | (2.66) | (2.26) | | | |
| 5. | All cereals | 7.68 | 8.37 | 7.90 | 9.65 | 11.18 | 13.50 | 12.6 | 13.4 | 17.09 |
| | | (91.65) | (95.00) | (95.99) | (96.50) | (99.02) | (98.61) | | | |
| 6. | Food grains | 8.38 | 8.81 | 8.23 | 10.00 | 11.29 | 13.69 | 11.9 | 12.8 | 16.63 |
| | | (100) | (100) | (100) | (100) | (100) | (100) | | | |

*Note*: Figures within the parentheses are percentages to total food grains

**Table 2. General information about the sample farms in Himachal Pradesh**

| Particulars | Zone I | Zone II |
|---|---|---|
| No. of farms surveyed | 90 | 90 |
| Average size of landholding (ha) | 2.75 | 1.13 |
| Operational size of holding (ha) | 1.78 | 0.82 |
| Irrigated area (% of operational holding) | 60.98 | 52.25 |
| Crop rotations (% cropped area) | | |
| Maize → Wheat | 59.17 | 41.92 |
| Maize → Rabi oilseeds | - | 0.64 |
| Maize → Fallow | 1.60 | - |
| Paddy → Wheat | 33.77 | 33.98 |
| Paddy → Rabi oilseeds | 0.07 | 5.67 |
| Paddy → Barseem | 1.53 | 8.09 |
| Paddy → Barley/ Gram/ Pea / Potato | - | 2.24 |
| Paddy → Fallow | 0.14 | 2.42 |
| Yield (q/ ha) | | |
| Maize | 18.31 | 19.08 |
| Paddy | 24.56 | 19.70 |
| Wheat | 18.72 | 22.73 |
| Marketable surplus (%) | | |
| Maize | 47.12 | 50.83 |
| Paddy | 72.00 | 42.79 |
| Wheat | 70.36 | 43.44 |

zone I than zone II. The difference was due to the fact that zone I is a plain area adjoining the states of Punjab and Haryana, where market facilities are also better in comparison to zone II (mid-hills, high humid). Secondly, the operational size of holding is almost double in zone I than zone II, which leads to a higher proportion of marketable surpluses.

**Resource-use Efficiency**

The coefficients of multiple determination of the production function, barring maize (HYV) and paddy in zone I were significant at 5 per cent level of probability, indicating that the independent variables included in the models explained a reasonable percentage of variations, from 15 per cent to 50 per cent in the returns from different crops in the two situations (Table 3). The results revealed that the expenditure on FYM affected paddy and wheat significantly in both the zones, whereas for maize (HYV), it was estimated to be non-significant. This may be due to the fact that the farmers applied sufficient quantity of FYM to which various crops responded. The fertilizer application was found to be significant only in the case of maize local. It may be due to the fact that farmers in Himachal Pradesh used only urea/CAN fertilizer and the fertilizer application was highly unbalanced. As against recommendations of 2:1:1 of N:P:K, farmers were found using 16:2.5:1, and thus the response was low. Moreover, the inefficiency was also observed in terms of application. In the dry agriculture, the split doses of fertilizers were recommended, whereas farmers in the study area were found using a single dose and sometimes its application was untimely. The male and female labour was surplus in the area because of small and marginal holdings and its excessive use had a non-significant effect on the production of all the crops, except in maize (HYV) for male labour. Similarly, the expenditure on tractor was also found to be non-significant for all the crops in both the zones because of fragmented, scattered and small holdings. Since most of the area was rain-fed, farmers used higher doses of seed for all the crops. This led to a negative relationship with returns, though non-significant.

**Table 3. Frontiers production functions for cereals**

| Explanatory variables | Coefficient | Zone I | | | | Zone II | | |
|---|---|---|---|---|---|---|---|---|
| | | Maize (Local) | Maize (HYV) | Paddy | Wheat | Maize (HYV) | Paddy | Wheat |
| Intercept | $B_0$ | 6.2728** | 7.6700** | 7.9698** | 2.5381 | 5.3011** | 7.2875** | 4.6097** |
| | | (1.3046) | (1.0872) | (2.7398) | (1.8397) | (1.3170) | (1.9051) | (1.8634) |
| FYM | $B_1$ | 0.2119** | 0.0491 | 0.1584* | 0.5420** | 0.0253 | 0.1857* | 0.2613* |
| | | (0.0619) | (0.0579) | (0.0705) | (0.0958) | (0.0567) | (0.0511) | (0.1104) |
| Fertilizer | $B_2$ | 0.1326** | -0.0402 | -0.0136 | 0.1094 | 0.1329** | -0.0258 | 0.1261 |
| | | (0.0352) | (0.0829) | (0.0295) | (0.0653) | (0.0342) | (0.0203) | (0.1556) |
| Male labour | $B_3$ | 0.3005 | 0.2224 | 0.9079 | 0.3016 | 1.6167* | -0.3791 | 0.1563 |
| | | (0.3988) | (0.6598) | (0.7101) | (0.3332) | (0.7961) | (1.0849) | (0.4337) |
| Female labour | $B_4$ | -0.7328 | 0.0603 | -0.2969 | 0.3978 | -0.6152 | 0.9717 | -0.0926 |
| | | (0.4514) | (0.6254) | (0.7608) | (0.4933) | (0.7440) | (1.1609) | (0.4522) |
| Tractor/bullock charges | $B_5$ | 0.1067 | -0.0912 | 0.1143 | 0.2344 | 0.0596 | 0.0503 | 0.0957 |
| | | (0.1314) | (0.1021) | (0.2335) | (0.1319) | (0.1022) | (0.1536) | (0.1488) |
| Seed | $B_6$ | 0.4361** | 0.2051 | -0.2175 | -0.0290 | -0.0076 | -0.1680 | 0.3192 |
| | | (0.1408) | (0.1413) | (0.2882) | (0.1920) | (0.1026) | (0.0959) | (0.1801) |
| | $R^2$ | 0.4971* | 0.1094 | 0.2109 | 0.4777* | 0.3554* | 0.3852* | 0.1463* |
| Cal. F- value | | 6.7549 | 0.7577 | 1.8706 | 12.3493 | 5.0541 | 6.9960 | 2.3705 |

*Notes*: Figures within the parentheses are standard errors

* and ** denote significance at 5 per cent and 1 per cent levels, respectively

**Table 4. Ratio of marginal value productivity (MVP) to marginal factor cost (MFC) for different inputs of cereals**

| Variable | Zone I | | | | Zone II | | |
|---|---|---|---|---|---|---|---|
| | Maize (Local) | Maize (HYV) | Paddy | Wheat | Maize (HYV) | Paddy | Wheat |
| FYM | 1.48 | 0.46 | 4.55 | 4.24 | 0.25 | 5.51 | 2.41 |
| Fertilizer | 1.84 | -0.52 | -0.61 | 1.30 | 1.36 | -0.76 | 1.74 |
| Male labour | 1.20 | 1.43 | 8.88 | 3.54 | 13.14 | -4.30 | 1.93 |
| Female labour | -1.35 | 0.18 | -1.25 | 2.10 | -2.47 | 5.43 | -0.56 |
| Tractor/bullock charges | 0.56 | -0.62 | 0.74 | 1.62 | 0.38 | 0.40 | 0.86 |
| Seed | 20.29 | 3.88 | -4.70 | -0.49 | -0.14 | -6.83 | 5.75 |

The ratio of marginal value productivity (MVP) and marginal factor cost (MFC) (Table 4) was found to be more than one in the case of 50 per cent inputs for all the crops in different situations. For example, farmyard manure for all the crops, except for maize (HYV) in both the situations; the fertilizers for all crops except for maize (HYV) in zone I and paddy in both the zones for which these ratios had negative values, indicating imbalanced use of chemical fertilizers; the male labour barring paddy in zone II (-4.2997) had positive and more than one values; the female labour for most of the crops had values less than one and with negative values as most of the work (agricultural operations) in the hills was being performed by women and they could be seen on the fields quite often, so the respondents had reported quite heavy responsibility on them, sometimes they might be just supervising the crops; the tractor charges/ bullock labour input had the ratio less than one, except for wheat in zone I (1.6207); regarding seeds, these ratios were positive and greater than one for maize local (20.2872) and HYV

(3.8764) in zone I and for wheat in zone II (5.7537). However, the ratios were negative for other crops, indicating excess use of seeds.

Thus, the study has indicated that there is a scope to increase the returns from almost all the sampled cereals by managing the use of specified inputs. In particular, the wheat production can be enhanced by using more of farmyard manure, chemical fertilizers, male labour, female labour and bullock labour in zone I. Similarly, in the case of maize (local) in zone I, the yield can be increased by applying more of farmyard manure, chemical fertilizers, male labour and seeds. The lack of knowledge about using a proper mix of inputs, poor economic condition and inability to avail credit facilities have been expressed as the major constraints in the cereals cultivation. The profitability ratio in seeds and chemical fertilizers for paddy in both the zones was less than unity and negative, indicating their imbalanced use. These findings are in conformity with those of Balappa and Hugar (2005).

**Technical Efficiency**

The technical efficiency with the given level of resources and available technology was examined with the help of frontier production function in both the zones and the frequency distribution of the farm-specific technical efficiency has been shown in Table 5. It can be seen from Table 5 that technical efficiency was low (below 50%) for wheat production in 94 per cent farmers in zone I and in 79 per cent farmers in zone II. It was observed that the farmers sowed the crop with minimum cultural practices. In most of the cases, the sowing was delayed by two months because of late winter rains (mid- January) and thus, the production was adversely affected. On the other hand, in maize the efficiency was found low among a few farmers only. The technical efficiency of the majority of farmers was found in the medium range (50-70%). A few cultivators were in the high technical range (> 75%) also across the zones and crops.

In general, the analysis has revealed that most of the farmers were operating at low level of efficiency in all the cereal crops at both the locations under study, mainly due to use of traditional cultivation methods. The lack of technical knowledge about package of improved practices, low level and imbalanced use of fertilizers and non-availability of recommended inputs for timely application might have also contributed to this phenomenon. It clearly indicates that there is a scope to improve the operation of farmers and move into high technical efficiency level by adopting suitable cultivation practices. These findings were in line with those of Russel and Young (1983), Banik (1994), Talathi and Hiremath (2004) and Balappa and Hugar (2005).

The actual and frontier use of different factors of production in selected cereals under different situations, presented in Table 6, revealed that the technical inefficiency due to excessive use of resources ranged from 197 per cent in fertilizers to 228 per cent in tractor/bullock usage in maize (local) in zone I. The level of inefficiency was of marginally higher order for maize (HYV) in zone I. Maize (HYV) in zone II had shown reduced level of inefficiency among various inputs. Zone II was topographically more suitable for the cultivation of maize than other crops. Secondly, in zone I, the

**Table 5. Technical efficiency rating of the farmers in production of cereals**

| Technical efficiency rating | Number of farmers | | | | | | |
|---|---|---|---|---|---|---|---|
| | Zone I | | | | Zone II | | |
| | Maize (Local) | Maize (HYV) | Paddy | Wheat | Maize (HYV) | Paddy | Wheat |
| High (> 75%) | 8 (16) | 6 (14) | 8 (16) | - | 16 (26) | 6 (8) | 3 (3) |
| Medium (50-75%) | 19 (40) | 25 (57) | 15 (31) | 5 (6) | 40 (64) | 25 (34) | 16 (18) |
| Low (< 50%) | 21 (44) | 13 (29) | 26 (53) | 83 (94) | 6 (10) | 43 (58) | 71 (79) |
| Total | 48 (100) | 44 (100) | 49 (100) | 88 (100) | 62 (100) | 74 (100) | 90 (100) |

*Note*: Figures within the parentheses indicate percentages to total

**Table 6. Crop-wise actual and frontier usage of inputs and output**

(Rs/ farm)

| Variables | Frontier | Actual | Excess (%) | Frontier | Actual | Excess (%) |
|---|---|---|---|---|---|---|
| | | | **Zone I** | | | |
| | *Maize (Local)* | | | *Maize (HYV)* | | |
| Seed | 52.03 | 168.63 | 224.10 | 150.22 | 510.95 | 240.13 |
| FYM (q) | 19.88 | 62.48 | 214.29 | 19.19 | 62.34 | 224.86 |
| Fertilizers | 255.45 | 759.04 | 197.14 | 249.23 | 877.70 | 252.16 |
| Male labour | 9.78 | 29.92 | 205.93 | 6.51 | 22.66 | 248.08 |
| Female labour | 19.72 | 64.33 | 226.22 | 13.96 | 48.77 | 249.94 |
| Tractor/bullock charges | 464.31 | 1523.56 | 228.13 | 414.74 | 1475.84 | 255.85 |
| Output | 13810 | 8011 | - 41.99 | 16564 | 9588 | - 42.12 |
| | Paddy | | | Wheat | | |
| Seed | 258.88 | 593.77 | 129.36 | 310.62 | 655.55 | 111.05 |
| FYM (q) | 13.26 | 32.29 | 143.51 | 35.97 | 75.93 | 111.09 |
| Fertilizers | 373.05 | 727.29 | 94.96 | 498.42 | 1048.48 | 110.36 |
| Male labour | 8.59 | 19.88 | 131.70 | 7.81 | 14.64 | 87.45 |
| Female labour | 20.02 | 46.04 | 129.97 | 15.23 | 32.14 | 111.04 |
| Tractor/bullock charges | 851.80 | 2010.49 | 136.03 | 765.30 | 1615.97 | 111.16 |
| Output | 24768 | 13836 | - 44.14 | 36307 | 12038 | - 66.84 |
| | | | **Zone II** | | | |
| | *Maize (HYV)* | | | *Paddy* | | |
| Seed | 388.09 | 565.82 | 45.80 | 135.53 | 397.53 | 193.32 |
| FYM (q) | 44.51 | 65.16 | 46.39 | 10.29 | 31.96 | 210.59 |
| Fertilizers | 860.62 | 1232.61 | 43.22 | 318.23 | 871.91 | 173.99 |
| Male labour | 13.07 | 18.40 | 40.78 | 6.43 | 18.88 | 193.62 |
| Female labour | 25.60 | 37.31 | 45.74 | 13.02 | 38.27 | 193.93 |
| Tractor/bullock charges | 1120.54 | 1635.16 | 45.93 | 602.58 | 1768.89 | 193.55 |
| Output | 15624 | 10096 | -35.38 | 29130 | 14664 | - 49.66 |
| | *Wheat* | | | | | |
| Seed | 282.54 | 838.41 | 196.74 | | | |
| FYM (q) | 28.54 | 84.22 | 195.09 | | | |
| Fertilizers | 371.99 | 1099.29 | 195.52 | | | |
| Male labour | 6.78 | 18.63 | 174.78 | | | |
| Female labour | 12.75 | 37.92 | 197.41 | | | |
| Tractor/bullock charges | 572.08 | 1697.14 | 196.66 | | | |
| Output | 40510 | 15811 | -60.97 | | | |

cultivators had a preference for paddy where they were found much cautious in using the inputs. With regard to maize output in these zones, farmers had produced 42 per cent less than the frontier level of maize (local as well as HYV) output in zone I and 35 per cent less in zone II of maize (HYV), thereby indicating higher inefficiency in zone I. In paddy, the technical inefficiency in the use of resources

ranged from 95 per cent in fertilizers to 144 per cent in farmyard manure in zone I, while in zone II, it ranged from 174 per cent in fertilizers to 211 per cent in farmyard manure. In zone II, most of the paddy cultivation was done on rainfed farms and thus the farmers could not adhere to the recommended practices. The paddy output was found lower than the frontier level of output in both the situations; it was lower by 44 per cent in zone I and 50 per cent in zone II. For the wheat crop, grown in the entire state, the technical inefficiency in the use of inputs ranged from 87 per cent in male labour to 111 per cent in bullock labour/ tractor charges in zone I. It was found to be 84 – 88 per cent higher in almost all the resources in zone II; it led to produce 61 per cent less than the frontier output in zone II, and 67 per cent in zone I.

## Conclusions

The present study has concluded that the technical efficiency varies widely across cereal crops in Himachal Pradesh and is time invariant. The underutilization of human labour and excessive use of seeds have resulted in sizable deviations from the optimum allocation of input resources. This phenomenon calls for concerted efforts for dissemination of improved technology for a proper as well as judicious use of inputs. Therefore, the hill farmers should be educated on reallocation of resources and adoption of new inputs and technologies for improving production and profitability. The mean technical efficiencies have indicated that a considerable portion of frontier output is left untapped, it is 35-42 per cent in maize, 44-50 per cent in paddy and 61-67 per cent in wheat. It can be achieved with better management and awareness generation in farmers even with the existing level of resources. Since most of the farm decisions and/or operations are performed by females in the state, there is need to educate female folk in resource management, preferably through female extension workers.

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