The Pakistan Development Review
40 : 4 Part II (Winter 2001) pp. 753–766

Determinants of Higher Wheat Productivity in Irrigated Pakistan

MUHAMMAD IQBAL, M. AZEEM KHAN, and MUNIR AHMAD

I. INTRODUCTION

While agriculture plays a vital role in overall performance of the economy of Pakistan, its crop sub-sector contributes the major portion to total value added in the sector. Wheat constitutes the most important crop that contributed 12.1 percent towards value added in agriculture and accounted for 37.18 percent of the total cropped area in the country during 1999-2000 [Pakistan (2001)]. The performance of wheat crop affects the overall growth rate, import bill, and nutritional standard of our people especially, the urban poor. It occupies a pivotal position for attaining national food-security goals.

Wheat management in complex farming systems is influenced by time conflicts in the harvesting of preceding crops and the sowing of wheat, and interactions due to residual effects on succeeding crops [Byerlee, *et al.* (1986]. Conventionally, less dynamism is found in wheat management practices, especially when it is grown after cash crops like cotton, rice and sugarcane. The rabi 1999-2000 was an exceptional season for wheat as rice, cotton, and sugarcane crops succumbed to market forces which ultimately resulted into heavy economic losses to the farming community. Timely announcement of a quantum increase in the support price of wheat is assumed to induce the farmers to deviate from usual wheat management practices for better production. The payback to the presumed transition in conventional wheat production practices was unprecedented.

The country experienced a record wheat production especially, in the irrigated areas during 1999-2000 (hereafter called current rabi). Many experts, till the completion of wheat harvest, could not conceive this increase in wheat production and the realised yields were even beyond the expectations of many farmers. A difference of opinion persisted among experts regarding the factors responsible for increased wheat production and the extent of contributions made by these factors

Muhammad Iqbal is currently Research Economist at the Pakistan Institute of Development Economics, Islamabad. M. Azeem Khan is Scientific Officer at the Social Sciences Institute, National Agricultural Research Centre, Islamabad. Munir Ahmad is a Senior Research Economist at the Pakistan Institute of Development Economics, Islamabad.

Authors' Note: We are thankful to Dr A. R. Kemal for encouraging us to undertake this piece of research. We are grateful to Dr M. Ghaffar Chaudhry for technical discussions with him and for his comments on an earlier draft of this paper.

towards enhanced wheat productivity. This paper presents an in-depth empirical analysis of various factors responsible for enhanced wheat productivity during 1999-2000 and provides basis for devising a strategy to sustain wheat production in future. The paper consists of four parts. Section II describes the sample and analytical techniques used. The results are discussed in Section III. Major findings and implications are concluded in the last section.

II. METHODOLOGY

The paper is based on primary data collected through a structured questionnaire from 643 wheat growers of major irrigated cropping zones of the country. The sample covered rice-wheat, cotton-wheat, and mixed cropping systems of Punjab and Sindh provinces. A due representation of wheat growers was also drawn from the maize-wheat and mixed-cropping systems of North West Frontier Province (NWFP), and the rice-wheat cropping zone of Balochistan. The overall sample included 240, 220, 110 and 73 randomly selected wheat growers from the irrigated areas of Punjab, Sindh, NWFP, and Balochistan respectively. The detailed distribution of sample and average size of farms in selected cropping zones of Pakistan are reported in Table 1.

Data were analysed using Statistical Package for Social Scientists (SPSS). Descriptive analyses as well as advanced analytical methods were used in order to assess the differentials in wheat acreage, input use and other management practices. A regression equation was also estimated assuming a modified Cobb-Douglas type production function for wheat in order to determine the contributions made by various inputs and improved wheat management practices towards higher wheat productivity. Input and output data pertaining to current and previous year wheat crops were pooled to avoid the problem of multicollinearity. The detailed model and description of the variables included in the model are presented in the relevant sub-section of Section III.

III. RESULTS AND DISCUSSION

Major increase in wheat production stemmed from irrigated farming systems of Pakistan. This study was designed to investigate the role of farmers' management practices in achieving higher wheat productivity. Variability in farmers' current wheat management practices over the previous season was analysed. The assessed factors include wheat acreage, land preparation, seed rate, planting method, fertiliser use, timely sown wheat acreage, weeding, irrigation and credit use etc. The paired sample t-tests were applied to identify the factors, which significantly differed between current and the previous rabi season.

The interaction effects of these factors may also have played a role in disguise in achieving higher wheat productivity. The variability in the use of factors such as

Table 1

Sample Distribution and Farm Size in Major Cropping Zones of Irrigated Pakistan

	Punjab				Sindh				NWFP			Balochistan	
Sample	Rice-wheat	Cotton-wheat	Mixed	All	Rice-wheat	Cotton-wheat	Mixed	All	Maize-wheat	Mixed	All	Rice-wheat	Total
Sample Size	80	81	79	240	60	100	60	220	56	54	110	73	643
Percent	12	13	12	37	9	16	9	34	9	8	17	11	100
Farm Size (ac)	12	35	13	20	15	38	27	29	7	12	9	119	32

land preparation, seed rate, planting method, and credit use was found marginally or insignificantly different. The farmers experienced shortages in irrigation water supplies during the wheat-growing season in 1999-2000. This might have least affected wheat yields as a result of favourable rainfall and temperature that prevailed during the critical crop growth stages. The direction of change and significance of various factors are listed in Table 2. These factors are discussed in detail in the sub-sections that follow.

Wheat Acreage

Support price for wheat crop of rabi 1999-2000 was increased considerably (from Rs 240 per 40 kgs to Rs 300 per 40 kgs) and was announced well before sowing time of the crop. This increase of about 25 percent in support price of wheat, with prices of other inputs more or less remaining the same, was likely to induce farmers to increase area allocation to wheat production. The results reported in Table 2 show that area allocation to wheat production during rabi 1999-2000 increased significantly in rice-wheat and mixed cropping zones of Punjab. However, change in wheat acreage was insignificant in other cropping systems and the provinces. The overall expansion in wheat acreage at the national level was insignificant, which presume the materialisation of vertical breakthrough in wheat production rather than a horizontal expansion.

Wheat Yield

Increase in wheat yield has mainly contributed towards a bumper wheat production during 1999-2000. More than 80 percent of the wheat growers reported increase in wheat yields on their farms. Wheat yields were significantly higher in the current rabi than the previous season in all the provinces except Balochistan where a negative but insignificant change in wheat yield was observed. Almost identical increase in wheat yields (over 23 percent) was observed in rice-wheat zones of Sindh and Punjab. Increase in wheat yield in the mixed cropping zones of Punjab, Sindh, and NWFP was 29, 17 and 13 percent respectively.

The highest increase in yield was experienced in cotton-wheat zones of Sindh and Punjab where wheat yield increased by 24 and 31 percent respectively. This unprecedented increase in wheat yield is further analysed and a modified Cobb-Douglas type regression equation was estimated to provide conclusive evidence about contributions of various factors towards higher wheat productivity. The results of regression analysis are presented and discussed in a later sub-section.

Land Preparation

Announcement of increase in support price well before sowing period of wheat induced farmers to make some adjustments in their land preparation practices

Table 2

Changes in Area Allocation, Wheat Yield And Farmers' Production Practices in Major Cropping Zones of Pakistan

	Punjab				Sindh				NWFP			Balochistan	
Variables	Rice-heat	Cotton-wheat	Mixed	All	Rice-wheat	Cotton-wheat	Mixed	All	Maize-wheat	Mixed	All	Rice-wheat	Pak
Wheat Acreage	↓*	↑	↑*	↑*	↑	↑	↓	↑	↑	↑	↑	↓	↑
Wheat Yield	↑*	↑*	↑*	↑*	↑*	↑*	↑*	↑*	↑*	↑*	↑*	↓	↑*
Rotavator (% Area)	–	↑	↑	↑	–	–	↑	–	↑	↑	↑	–	↑
Disc Plow (% Area)	↑*	↑	↑*	↑*	–	–	–	–	–	–	–	–	↑
Cultivations (#)	–	–	↑	↑	–	–	–	–	–	–	–	–	–
Wadwatter Sowing	–	↓	↓	↓	↑	↑	↑*	↑	↓	↓	↓	↓*	↓
Drill Sowing	–	–	↓	↓	–	–	–	–	↓	↑*	↑	↓*	–
Seed Rate (Timely Sown)	↑	↑	–	↑	↓	↑	↓	↓	–	↓	–	–	–
Seed Rate (Late Sown)	↑	↑*	↑	↑*	↑	↑	↑	↑	–	–	–	↑	↑*
Acreage Timely Sown	↑*	↑*	↑	↑*	↑	↑*	↑*	↑*	↓	↓	↓	↓	↑*
P–nutrients	↑*	↑	↑	↑	↑*	↑	↑	↑	↑*	↑	↑*	↑*	↑*
N-nutrients	↓	↑	↑	↑	↑*	↑	↑	↑	↑*	↑*	↑*	↑*	↑*
Chemical Weed Control	↑	↑*	↑	↑*	↑	↑*	↑	↑*	↑	↑	↑	↑	↑*

↑ = Increased ↓ = Declined * = Significant at 10 percent or less level of significance.
– = No change.

for attaining better yields. A slight but an insignificant increase in the use of rotavator was observed, whereas use of disc plow increased significantly in all cropping systems of Punjab except cotton-wheat. The percentage of wheat acreage prepared with disc plow increased from 35 percent to 41 percent in rice-wheat zone of Punjab during rabi 1999-2000. However, the number of common cultivations did not change much in any of the cropping systems of Pakistan.

Sowing Method

Timely sowing of wheat in some cropping systems of Sindh was managed through increased wheat acreage sown under wadwattar conditions. This was particularly observed in the mixed cropping systems of Sindh. However, an insignificant decline in wheat acreage sown under wadwattar conditions was observed in all other provinces except in Balochistan where the decline was significant. Similarly, no significant change in proportion of wheat acreage sown with drill was observed in any of the major cropping systems of Pakistan except a 5 percent increase in the mixed cropping zone of NWFP. Proportion of drill sown wheat acreage declined significantly in Balochistan.

Seed Rate and Seed Source

Given the other factors, seed rate determines the plant population in a field of certain crop and thus is an important factor in determining yield. Currently, adoption of higher seed rate is being widely emphasised especially, in case of late sown wheat. There was no significant change observed in the seed rate used for timely sown wheat. However, the farmers in the cotton-wheat zone of Punjab used slightly but statistically significant higher seed rate for late sown wheat crop. Improvement in distribution of certified seed from public and private agencies helped in enhancing use of certified seed. About 8 percent more farmers used certified seed in the cotton zone of Punjab, mixed zone of Sindh, and Balochistan. Although more farmers replaced their farm-produced seed with the seed obtained from other sources, yet adoption of newly released varieties was not significantly different from that in the previous year.

Timely Sowing of Wheat

Time of sowing is an important factor in wheat production. It is maintained that wheat sown after 20th of November suffers a loss of 35-50 Kgs per hectare for delay of each day [Aslam, *et al.* (1991) and Mehla, *et al.* (2000)]. Timely sowing of wheat in the cotton and rice based farming systems increased significantly during *rabi* 1999-2000 and may have contributed to higher wheat yields. Different factors played a role in timely planting of wheat in various cropping zones. Low prices of cotton and increased area under early maturing cotton varieties played the major role

in timely planting of wheat in the cotton-wheat systems. Price incentive along with a dry spell at wheat sowing time induced farmers to opt for an early planting of wheat crop in the rice-wheat zones of Pakistan. Shift in area from sugarcane production to wheat and other crops in the mixed zones also made timely sowing of wheat possible. A significant increase in timely sown wheat acreage was observed in the cotton-wheat zones, rice-wheat zone of Punjab and the mixed cropping system of Sindh. The shift of late-sown wheat acreage to timely plantation was 22 and 39 percent respectively, in the cotton zones of Punjab and Sindh. The same shift was 10 and 7 percent for the rice-wheat and mixed cropping zones of Punjab, respectively. Whereas, in the mixed cropping systems of Sindh an upward shift of 26 percent (from late planted to timely planted wheat acreage) was observed. However, percentage of timely sown wheat acreage declined insignificantly in the provinces of Balochistan and NWFP.

Fertiliser Use and Improved Availability of Fertilisers

A significant increase in the use of phosphatic fertiliser on wheat crop was observed during 1999-2000. This was made possible by improving the fertiliser distribution system and its timely availability to the wheat growers. Implementation of strict quality control measures improved the quality of fertilisers supplied to the farmers. About 38 percent farmers recognised that they received fertilisers of improved quality. The remaining farmers reported that the quality was either same (55 percent) or poor (7 percent) as compared with the previous year. During the current *rabi*, application of phosphatic fertilisers to wheat crop improved in all the cropping zones of Pakistan. However, the increase was significant only in rice-wheat zones of Punjab and Sindh, maize-wheat zone of NWFP, and Balochistan. In other cropping zones, improvement in the use of phosphatic fertiliser was nominal and insignificant.

Chemical Weed Control

Infestation of wheat crop with weeds is emerging as the most crucial problem in almost all the wheat-growing areas of Pakistan. Phalaris minor and wild oats are respectively a serious problem since long in rice-wheat and cotton-wheat zones of Punjab [Ahmed, *et al.* (1988)]. Rajaram, *et al.* (1998) estimated that 10 percent increase in wheat yield could be achieved by effectively controlling weeds. Higher weed infestation was reported during current wheat season. This was counterbalanced through improved chemical weed control measures in all the cropping zones. About 5 percent more wheat acreage was covered through chemical weed control measures during 1999-2000. Relatively more number of farmers applied weedicides this year (39 percent) as compared with last year (34 percent). The increase in chemical weed control coverage was significant in cotton-wheat zones of Sindh and Punjab. This significant increase in chemical weed control

coverage of wheat acreage may be responsible for enhanced wheat yields during 1999-2000.

The above analysis indicated that some of the important factors were significantly different between two seasons on the sample farms. These factors may be responsible for higher wheat yields. However, the relationship between wheat yield and these factors need to be further explored. The effect of these factors on wheat yield was investigated through regression analysis and the results are reported and discussed in the following sub-section.

Determinants of Wheat Yield

A significant increase in wheat yield was observed in almost all the cropping systems of Pakistan. The following multiple regression equation was estimated using the ordinary least squares (OLS) method and the results are presented in Table 3.

Table 3

Results of Multiple Regression

Variable	Coefficient	Standard Error	Significance
CONSTANT	1.68400	0.191	0.000
LnCULT	0.23400	0.022	0.000
LnSRATE	0.07474	0.045	0.101
LnIRRIGT	0.20200	0.026	0.000
LnTOTFER	0.17500	0.022	0.000
PNRATIO	0.08548	0.025	0.001
PLODGED	–0.05330	0.031	0.088
PCHMWEED	0.05817	0.023	0.013
PDEEPLOW	0.09049	0.023	0.000
PFYM	0.03256	0.037	0.382
PSOWNLAT	–0.12500	0.023	0.000
DTENURE	–0.04380	0.025	0.082
DCREDIT	0.03037	0.045	0.498
DLOAMLND	0.03765	0.019	0.043
DSEEDSOR	0.01716	0.020	0.389
DYEAR	0.17800	0.019	0.000

$R^2 = 0.454$. Adjusted-$R^2 = 0.446$. $F = 55.182$.

$$\begin{aligned} LnYIELD = {} & \beta_1 + \beta_2 LnCULT + \beta_3 LnSRATE + \beta_4 LnIRRIGT + \beta_5 LnTOTFER \\ & + \beta_6 PNRATIO + \beta_7 PLODGED + \beta_8 PCHMWEED + \beta_9 PDEEPLOW \\ & + \beta_{10} PFYM + \beta_{11} PSOWNLAT + \beta_{12} DTENURE + \beta_{13} DCREDIT \\ & + \beta_{14} DLOAMLND + \beta_{15} DEEDSOR + \beta_{16} DYEAR + U \end{aligned}$$

Where

LnYIELD = Natural logarithm of wheat yield in (40 Kilogram) maunds per acre.
LnCULT = Natural logarithm of number of common cultivations per acre.
LnSRATE = Natural logarithm of seed rate (Kilograms per acre).
LnIRRIGT = Natural logarithm of number of irrigations per acre.
LnTOTFER = Natural logarithm of total fertiliser nutrients applied (Kilograms per acre).
PNRATIO = P-nutrient to N-nutrient ratio.
PLODGED = Proportion of wheat acreage affected with lodging.
PCHMWEED = Proportion of wheat acreage weeded through chemical control methods.
PDEEPLOW = Proportion of wheat acreage where deep plowing practiced.
PFYM = Proportion of wheat acreage to which farm yard manure applied.
PSOWNLAT = Proportion of wheat acreage sown after November 30th.
DTENURE = Dummy variable for tenancy (Owner = 1 Else = 0).
DCREDIT = Dummy variable for institutional credit use (Credit used = 1 Else = 0).
DLOAMLND = Dummy variable for loam lands (Loam land = 1 Else = 0).
DSEEDSOR = Dummy variable for seed source (Own or fellow farmer produced Seed = 1 Else=0).
DYEAR = Dummy variable of wheat production year (1999-2000 = 1 1998-99 = 0).
U = Random error term independently and identically distributed with zero mean and constant variance.

The R^2 value of 0.45 can be regarded as quite a good fit in view of the cross-sectional data involved in this study, since it implies that about 45 percent variation in yield is explained by the independent variables included in the model. The results of the production function show that the number of cultivations with common cultivator (LnCULT) contributes positively and significantly to wheat yield. Similarly, preparation of land for wheat cultivation using deep tillage implements also has a positive impact on yield. This finding is in full agreement with Khan, *et al.* (1986) and Hobbs, *et al.* (1992) who recommended deep tillage for minimising

compaction below the plough layer and for conserving moisture under rainfed conditions.

The coefficients representing seed rate, number of irrigation and application of total chemical fertiliser nutrients were positive and highly significant except the coefficient for seed rate, which was significant at 10 percent level. The recommendations regarding application of chemical fertilisers to wheat crop also emphasise the use of balance dose of fertilisers (N:P:K). Therefore, a variable of ratio of P-nutrients to N-nutrients was also included in the model. The effect of a more balanced use of P and N-nutrients was positive and highly significant. The coefficient for proportion of wheat acreage sown later than 30th November was negative and highly significant showing that delayed sowing of wheat reduces per acre yield obtained. Similarly, any increase in wheat acreage affected with lodging affects yield adversely and significantly. The incidence of weeds in wheat crop is a growing problem in almost all wheat-growing areas of Pakistan and adoption of chemical weed control methods are increasingly becoming popular among wheat growers. The results presented in the above table reveal that additional coverage of wheat acreage with chemical weed control methods increases wheat yield significantly. However, the use of farmyard manure (FYM) has a positive but insignificant effect on wheat yield, which is quite expected due to the long lag involved in decomposition of FYM.

The coefficients of variables representing dummies for loam land and production year were positive and significant at 5 percent and 1 percent level of significance respectively, showing that wheat yields are higher on loam lands and the year 1999-2000 observed an upward shift of the function. The magnitude of year dummy indicates that the yield per unit of land was higher in 1999-2000 cropping season by about 18 percent than that obtained in the last year (1998-99), keeping use of all other inputs constant. The dummy variables representing seed source and credit use status of the wheat growers had a positive but insignificant effect on wheat yields. The coefficient for tenure dummy was negative and significant at 10 percent level of significance showing that the wheat yield was lower on owner farms than that on farms of their counterparts. This may be related to the fact that the tenants are expected to be more competitive as they can exploit their excessive as well as cheap labour source and also the capital of the landlord in case of share tenancy to obtain higher yields.

IV. CONCLUSIONS AND RECOMMENDATIONS

The wheat harvest was unprecedented during rabi 1999-2000 and beyond the expectation of many experts. The study helped to isolate the role of some of the important factors responsible for higher wheat production during 1999-2000. Factors identified are equally important in achieving short-term and long-term higher wheat productivity goals. This year increase in wheat production was

overwhelmingly vertical in nature. The share of horizontal expansion in wheat production was nominal. This vertical increase is a rich experience and could be used in devising appropriate research and development strategies for future. The following are the implications drawn from the major findings of this study.

The common conviction of wheat experts regarding early planting of wheat due to cotton crises in the previous season proved right. The results show that a considerable proportion of wheat area shifted from late sowing to early planting in the cotton-wheat cropping systems. The similar shift was also found in the rice zone of Punjab and mixed cropping zone of Sindh. The role of late planting of wheat in determining wheat yield proved to be negative and significant. It needs to be further emphasised in research and extension strategies. The provision of sufficient resources to research and extension systems is suggested for developing and promoting timely wheat planting technologies.

Moreover, reorientation of breeding research is required to evolve early maturing, high yielding, and disease resistant varieties for cotton, rice and other crops preceding wheat to improve sowing time of wheat. The significant effect of sowing time on wheat yields hints to some extent the failure of the national agricultural research system to evolve short-duration high-yielding late wheat varieties. Tested minimal tillage technologies for timely wheat planting need to be promoted. Expected shortage in canal water supplies at sowing time need to be managed rationally by making appropriate adjustments in distribution and improving its use efficiency.

The key role played by timely availability of quality inputs such as seed, phosphatic fertiliser and weedicides in wheat productivity enhancement was corroborated by the findings of this study. The efforts of agencies and departments involved in the distribution and quality control of vital inputs need to be accentuated further. This would ensure timely availability and quality of these inputs to the wheat growers. Newly released wheat varieties need rapid promotion through improving the seed multiplication and distribution systems. Improvements in institutional credit disbursement may further enhance farmers' accessibility to production inputs.

Increase in support price of wheat was the main incentive for the farmers to increase area allocation (in certain cropping zone) and higher input use in wheat production. On harvest, most the farmers in Punjab obtained lower prices for their produce of rabi 1999-2000 than the announced support price for wheat. This may have adverse affect on future price expectations and thus may result in downward adjustment in acreage and/or use of other production inputs. Stable input and output prices are needed for sustaining wheat productivity. In absence of well-developed private wheat marketing system, wheat procurement system needs to be strengthened in terms of adequate financing, storage, and haulage capacity to accommodate increased wheat production and to reduce exploitation of farmers by private buyers.

The increase in wheat acreage was insignificant during the current rabi season. This may be due to low partial adjustment coefficient. However, in the long run acreage would response to the new higher prices (as revealed by 9–15 percent increase in area allocation to wheat planned by the farmers for the coming year in major cropping zones), this increase in wheat acreage would be at the expense of some important crops like sugarcane, sunflower and other oilseeds. This requires specific considerations by the policy-makers. There is a dire need to shift emphasis from horizontal to vertical expansion in wheat productivity.

REFERENCES

Ahmad, Z., M. Sharif, J. Longmire, and K. Tetlay (1988) Weed Management Strategies for Wheat in the Irrigated Punjab: Farmers' Knowledge, Adoption and Economics. Pakistan Agricultural Research Council, Islamabad (PARC/ CIMMYT Paper No. 88-3.)

Aslam, Muhammad, Munir Ahmad, N. I. Hahsmi, M. Qasim Chatha, and V. M. Veen. (1991) Zero Tillage Wheat Pilot Production Programme for the Punjab Rice-Wheat System. Coordinated Wheat, Barley and Triticale Programme, National Agricultural Research Center (NARC), Islamabad.

Byerlee, D., P. R. Hobbs, B. R. Khan, A. Majid, M. R. Akhtar, and N. I. Hashmi (1986) Increasing wheat Productivity in the Context of Pakistan's Irrigated Cropping Systems. National Agricultural Research Center (NARC), Islamabad. (PARC/CIMMYT Paper 86-7.).

Hobbs, P. R., I. Seed, Razzaq, and U. Farooq (1992) Dynamics of Technological Change in Rainfed Agriculture: Wheat in Northern Punjab. Derek Byerlee and Tariq Hussain (eds) *Farming Systems of Pakistan*. Islamabad: Vanguard Books Pvt. Ltd.

Khan, B. R., B. M. Khan, A. Rzzaq, M. Munir, M. Aslam, S. Ahmad, N. I. Hashmi and P. R. Hobbs (1986) Effect of Different Tillage Implements on the Yield of Wheat. *Pakistan Journal of Agricultural Research* 7: 3, 141–147.

Majid, and Gill (1999) Wheat Crop Stand Establishment and Productivity Enhancement in Rice Based Cropping System of the Punjab. Wheat Programme, NARC, Islamabad.

Mehla, R. S., J. K. Verma, R. K. Gupta, and P. R. Hobbs (2000) Stagnation in the Productivity of Wheat in the Indo-Gangetic Plains: Zero-Till Seed cum Fertiliser Drill as an Integrated Solution. Rice-Wheat Consortium for Indo-Gangetic Plains, IARI, New Delhi. (Rice-Wheat Consortium Paper No. 8.)

Pakistan, Government of (2001) *Economic Survey 2000-2001*. Economic Adviser's Wing, Finance Division, Islamabad.

Rajaram, S., P. R. Hobbs, and P. W. Heisey (1988) Review of Pakistan's Wheat and Maize Research Systems. Report submitted to Pakistan Agricultural Research Council, Islamabad.

Comments

I congratulate the authors of the paper for doing an analysis of these questions often raised by the agriculture scientists. The authors have explained the increase in yield/production of wheat crop in the year 1999-2000 over the previous year in terms of changes in wheat acreage, land preparation, sowing method, seed rate and seed source, sowing time, fertiliser use and availability of fertilisers, weed control, etc., in various cropping systems practised in different provinces of Pakistan. A multiple regression model in log linear form has been estimated by taking a number of independent variables. The authors have nicely done the analysis and results are quite interesting. However, following observations are made on this paper. According to the results of the paper, wheat area allocation changed by 6.0 percent in Punjab, 2.6 percent in Sindh, 4.0 percent in NWFP and –5.2 percent in Balochistan respectively with an overall increase of 0.1 percent for Pakistan. However, if the percentage change in wheat area in each province is weighted according to wheat area in each province, the percentage overall expansion of wheat acreage is 5.10 percent. Thus the area allocation to wheat production is under estimated substantially.

Land preparation practices followed by the farmers during the year 1999-2000 for the Punjab indicate that 44 percent of wheat acreage was prepared with rotavator, 16 percent with disc and 5 percent with cultivator. More or less similar trend was observed for various provinces and zones in the country. It is surprising that the share of use of commonly owned cultivator for the preparation of wheat average is very small i.e. it ranged from 2 to 6 percent only in various zones of Pakistan. Further, it may be noted that the rotavator and disc plough are used on a very limited scale in combination with cultivator. It has been reported in other studies that the contribution of deep tillage towards the preparation of wheat fields is negligible in Punjab [Ahmed, *et al.* (1993)] and other provinces [Chaudhry, *et al.* (1992)]. Therefore, there is need to kindly check the figures about the wheat acreage prepared with various implements.

Seed rate per acre has been reported for the early wheat and late wheat sown. The same has not been reported for the timely sown wheat. Probably, the authors are using early wheat for the timely wheat sown. There is sufficient evidence that yield variations are caused by differences of weather among other factors. Particularly temperature has significant effect during growth periods of wheat. It is important to take into account its impacts at different stages of crop growth. Rising temperature during February induces early maturity, which reduces grain size and lowers the yield. During the month of March, higher temperature up to certain limits has

positive impact but beyond puts negative effect. During the month of April average maximum temperature have positive impact on the yield of wheat. However, the impact of temperature and other weather elements have been ignored in this study.

Dummy variables have been used by the authors of the paper to test the effect of tenancy, seed source, land type etc. As wheat crop is sown after different crops in various cropping systems e.g. wheat is sown after cotton in cotton zone, and it is grown after rice in the rice zone and similarly after other crops in their cropping systems. Response of wheat yield, among other factors, depends upon the previous crop grown. Therefore, cropping system effects need to be captured by using specific dummy variables. In the regression analysis, the coefficient for tenure dummy variable is negative and significant at 10 percent level of significance showing that wheat yield is lower on owner farms than on tenant farms. Explanation given by authors is that tenant, are expected to be more competitive than owners. It is simply against the economic theory relating the tenancy to output.

The authors have mentioned that regression coefficient relating to number of irrigation is positive and highly significant. However, the results reported in Table 3 show that this variable is not significant, as the value of coefficient is 0.020 compared to standard error value of 0.026.

REFERENCES

Ahmad, Bashir, Z. Hussain, and J. Longmire (1993) *Farm Management Handbook*. Islamabad: PanGraphics (Pvt.) Ltd.

Chaudhry, A. M., Bashir Ahmad, and M. A. Chaudhry (1992) *Cost of Producing Major Crops in Pakistan, 1991-92*. Faisalabad: Department of Farm Management, University of Agriculture.

Bashir Ahmad

Faculty of Agricultural Economics and Sociology,
University of Agriculture,
Faisalabad.