The Pakistan Development Review
37 : 4 Part II (Winter 1998) pp. 37:4, 235–243

Maize in the Rainfed Areas of Pakistan: An Analysis for Production Sustainability

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1. INTRODUCTION

The turning issue in agriculture of this era is sustainability and self reliance. There are several definitions of sustainability described by various scientists. Broadly, it means that the improvement in agriculture should be long lasting in view of changing environmental and socio-economic conditions. The high yielding technology available today is not fully adopted because of high cost and changing price structure of the important inputs. Under the present circumstances, the need arises to tailor the production practices according to the need of the farmers for long-term adoption. Sustainable agricultural systems are those that rely on lower inputs of energy and agricultural chemicals to achieve long-term productivity and environmental compatibility. However, Balanos (1998) concludes that the low input systems are low in productivity. Firebaugh (1990) mentioned the proposals given by J.F. Pars and colleagues that the ultimate target of the farmers in sustainable agriculture is to increase productivity and profitability. He also added that we should get benefit from germplasm which can survive over a long period of time.

Maize, the major crop of the rainfed areas during summer season, is consumed as food, fodder and feed and have so many industrial uses. The scientists have been trying to search ways for enhanced production of maize under rainfed conditions. Reeves (1997) endorsed the findings of Pinstup-Anderson and Pandya-Lorch that the application of the results of agricultural research in the world is meant for enhanced food production, higher yields with reduced risks, lower production costs and ultimately for lower food prices which have benefited both rural and urban poor people. Dowswell *et al*. (1996) mentioned that the seed of improved variety and fertiliser are of over riding importance to the modernisation process. Chaudhry *et al.* (1989) concluded that maize

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Authors' Note: The excellent typing of Mr Mohammad Yousaf is appreciated. The authors are, however, responsible for any errors and omissions in the paper. This paper is a revised version of the paper presented in the 14th Annual General Meeting and Conference of PSDE.

yield per unit area could be enhanced with high yielding variety and soil fertility. CIMMYT (1994) mentioned that seed of improved variety increased the maize productivity in many developing countries. In Pakistan, improved variety of maize outyielded local farmer's variety by 62 percent [Chand and Longmire (1990)].

Majority of the farmers in rainfed areas are poor and have small landholdings. They do not invest much in agriculture, especially in maize. For such areas, an attempt has been made to identify some economical and relatively cheaper method of growing maize so that productivity of maize could be sustained for longer period. The issue of sustainability in maize under rainfed conditions is very important. Okigbo (1990) say, "*sustainability can be achieved only when resources, inputs and technology involved are within the capabilities of farmers to achieved desired level of productivity in perpetuity without adverse effect on the resource base and environmental quality*".

Section 2 describes the methodology and the procedure used. The description of results is presented in Section 3. Concluding remarks with some policy options are summarised in the last section.

2. METHODOLOGY

A superimposed maize trial was conducted at five locations in Islamabad Capital Territory (ICT) of Pakistan. The trial was conducted in single replication at each location. The trial comprised of the following production inputs superimposed in existing farmer's practices: Variety alone (T_1), Fertiliser alone (T_2), Herbicide alone (T_3), Variety plus Fertiliser (T_4), Variety plus Herbicide (T_5), Fertiliser plus Herbicide (T_6), Variety plus Herbicide plus Fertiliser (T_7) and Farmer's practice (T_8).

In the respective treatments, the seed of improved open pollinated variety (Agaiti-85) was planted at a seed rate of 30 kg/ha, the rate of fertilisers applied as nitrogen-phosphorus was 120-60 kg/ha and herbicide (Primextra) was used as a pre-emergence herbicide @ 2.0 litre/ha. The farmers planted their own local variety with their traditional methods which is with high seed rate and without application of fertiliser and herbicide, termed as check, and was used as the baseline for the comparison. They did one seel (inter-culture of maize crop with tractor-mounted cultivator) at about 3-4 leaf stage of the crop. The crop was planted by the farmers themselves according to the instructions. The improved inputs were weighed and applied by working scientist. All other cultural practices were almost the same at all locations. The environmental conditions for all the treatments were the same at every location. At maturity, the data regarding grain yield, stalk yield, and plant density were recorded. Data were subjected to statistical analysis keeping the locations as replications under Ramdonised Complete Block Design (RCBD). Economic analysis was done in 1992, and was revised in 1997 after collection of current information about the cost of inputs, grains and fodder from local market. Assuming that the cost of production inputs increases at the same rate as in 1997, the projections for the next five years have also

been made. The revised analysis is to see the most sustainable variable which can be utilised and sustained over the years in the next century without/or with less increase in the costs. The conclusions would be drawn on the basis of cost benefit analysis.

3. EMPIRICAL FINDINGS

The data regarding grain and stalk yields are statistically significant. The treatments with combination of two and three inputs are statistically at par to each other. The combination of all the three inputs (T_7) produced maximum and resulted in an increase of 43 percent and 79 percent in grain and stalk yields over the check, respectively. Javed *et al.* (1994) also studied this combination and observed 89 percent increase in grain yield. The combination of more contributing inputs i.e., variety and fertiliser (T_4) which shows 38 and 62 percent increase, respectively. The combination of improved seed and fertiliser used by Dorich *et al.* (1987); Arain *et al.* (1989); Dowswell *et al.* (1996) and Chaudhry *et al.* (1989) showed similar results. These two inputs in combination with herbicide (T_5 and T_6) show the same increased effect (31 percent) on grain yield but different effect (74 and 45 percent, respectively) on stalk yield. Tareen *et al.* (1990) observed 18 percent increase in grain yield during a study of weed control. Variety and fertilizer individually (T_1 and T_2) show statistically non-significant differences from T_5 and T_6 and have almost the same effect of 19 and 20 percent increase in grains and 24 and 26 percent increase in stalks, respectively. These results are in line with those reported by Daskalou (1986); CIMMYT (1989); CIMMYT (1994); Chand and Longmire (1990). Herbicide alone produced 9 percent grains and 17 percent stalks more than check. Khaliq and Hussain (1987) and CIMMYT (1989) reported almost similar results in their studies. It reveals from these results that variety and fertiliser play important role in increasing production in the combinations. Keeping in view the effect of selected inputs used individually and in different combinations Table 1 explains that the treatments viz. T_1 to T_7 gave an increase of 20, 6, 27, 35, 14 and 30 percent per hectare in net benefit in term of rupees over farmer's practice (T_8). The maximum increase in net benefit was achieved by the combination of variety and herbicide (35 percent). Tareen *et al.* (1990) observed 31 percent increase in net benefit using similar combination. The combination of variety and fertiliser showed 27 percent increase in net benefit. The variable cost of Rs 880 for T_5, Rs 2500 for T_7, and Rs 1960 for T_4, are considered to be beyond the reach of farmers of the area. The next higher benefit achieved by variety alone (20 percent), involved additional cost of Rs 40 only. The inputs with comparatively higher yields with lower unit cost reduced the risks and increase the farm income. Reeves (1997) also reached at the same conclusion. Considering Dominance analysis the treatments T_2, T_3, T_4 and T_7 are dominated because of high cost involved and are not economical. On account of very high Cost-Benefit Ratio (CBR), variety alone is considered to be more beneficial and economical

Table 1

Relative Impact of Production Inputs on Net Benefits: Based on the Costs in 1992

Variables		Check (T_8)	Variety Alone (T_1)	Herbicide Alone (T_3)	Variety plus Herbicide (T_5)	Fertiliser (T_2)	Variety plus Fertiliser (T_4)	Fertiliser plus Herbicide (T_6)	Variety plus Fertiliser plus Herbicide (T_7)
Grains									
Production	Kgs/ha	1907	2264	2079	2507	2284	2626	2501	2734
Increase Over Check	%	–	19	9	31	20	38	31	43
Income	Rs./ha	8582	10,188	9,356	11,282	10,278	11,817	11,255	12,303
Stalks									
Production	Kgs/ha	5040	6267	5893	8773	6373	8160	7293	9000
Increase Over Check	–	–	24	17	74	26	62	45	79
Income	Rs./ha	1890	2350	2210	3290	2390	3060	2735	3375
Gross Income	Rs./ha	10,472	12,538	11,565	14,571	12,668	14,877	13,989	15,678
Variable Costs	Rs./ha	320	360	840	880	1,940	1,960	2,460	2,500
Net Benefit	Rs./ha	10,152	12,178	10,725	13,691	10,728	12,917	11,529	13,178
Increase Over Check	%	–	20	6	35	6	27	14.0	30
Cost-benefit Ratio	%	–	50.67	–	2.91	–	–	–	–

Note: $LSD_{(0.05)}$ for Grain Yield = 316 Kgs/ha.
$LSD_{(0.05)}$ for Stalk Yield = 1577 Kgs/ha.

Table 2

Relative Impact of Production Inputs on Net Benefits: Based on the Costs in 1997 and Projected Costs in 2003

Variables		Check (T_8)	Variety Alone (T_1)	Herbicide Alone (T_3)	Variety plus Herbicide (T_5)	Fertiliser (T_2)	Variety plus Fertiliser (T_4)	Fertiliser plus Herbicide (T_6)	Variety plus Fertiliser plus Herbicide (T_7)
Based on the Costs in 1997									
Gross Income	Rs/ha	11,425	13,670	12,605	15,825	13,810	16,190	15,240	17,045
Variable Costs	Rs/ha	570	720	1,570	1,720	3,995	4,145	4,995	5,145
Net Benefit	Rs/ha	10,885	12,950	11,035	14,105	9,815	12,045	10,245	11,900
Increase Over Check	%	–	19.3	1.7	29.9	–9.6	11.0	–5.6	9.6
Cost-benefit Ratio	%	–	13.77	–	1.55	–	–	–	–
Based on the Projected Costs in 2003									
Gross Income	Rs/ha	12,484	14,928	13,760	17,218	15,079	17,649	16,662	18,584
Variable Costs	Rs/ha	1,015	1,440	2,934	3,362	8,227	8,766	10,142	10,588
Net Benefit	Rs/ha	11,469	13,488	10,826	13,856	6,852	8,883	6,481	7,976
Increase Over Check	%	–	18.0	–6.0	21.0	–40.0	–23.0	–43.0	–30.0
Cost-benefit Ratio	%	–	5.0	–	0.2	–	–	–	–

input. In the area with more weeds, it would be better to combine herbicide with improved variety. The impact of the changes in the cost of production due to the changes in input prices in 1997, and the projected prices in 2003, revised analysis is presented in Table 2. It shows that the net benefit achieved by T_1 to T_7 are 19.3, –9.6, 1.7, 11, 29.9, –5.6 and 9.6 percent, respectively in 1997 while 18.0, –40, –6.0, –23.0, 21, –43 and –30, respectively in the year 2003.

The cost-benefit ratio of variety alone and its combination with herbicide is reduced and still acceptable during 1997 while during 2003 the CBR of variety plus herbicide was very low which may become uneconomical in the next year as the prices are rising. The CBR of variety alone during 2003 is 5 which is still acceptable. This shows that variety alone sustained over the years. Though fertiliser increased the yields significantly but its cost increased rapidly and therefore, according our study it will be beyond the reach of the farmers because of their socio-economic conditions.

4. CONCLUDING REMARKS

The seed of the improved variety is the only solution for the sustainability of the maize productivity in rainfed areas of Pakistan. The farmers should change their old low yielding variety to sustain at least 20 percent increase in net benefit with very low fluctuation in the cost of production over the years. This will help a lot in changing farmer's socio-economic conditions that will encourage the farmers for adoption of new technology as suggested by Brady (1990).

It is recommended that a viable and sustainable system of production and distribution of improved quality seed of maize should be in function in order to ensure sustainable maize production in the rainfed and other ecologies of Pakistan and elsewhere in the world.

Policy-makers, when making the policy, should take this point into consideration that the prices of the seed of improved variety/hybrids must be kept within the capabilities of the farmers.

Maize Scientists/Researchers should try to find out some low cost alternative methods of soil fertility and weed control, so that more productive and sustainable technology can be devised.

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Comments

The subject of the maize production in the rainfed areas is a critical one, and the question of its sustainability deserves attention. There is interesting material in this paper on different production practices incorporated in different trails. It touches on important issue of increasing the maize grain and stalk production with respect to cost and benefits from the farmer's point of view but the subject does not come out clearly in the present structure of the paper.

First of all no description of the soil and weather conditions were mentioned which have a great impact on the productivity in the field. Secondly the paper is based on the output of the experiment with only one replication, no details of experimental design has been incorporated in the text. The statistical significance of different trails needs to be mentioned. The authors did not provide any evidence about the F-statistics, about the estimates of residual and sampling error terms, etc.; the accuracy and efficiency of the experiment cannot be perceived without proper statistical testing.

The results are presented in a fairly complicated manner. Especially, the use of variable cost is not clearly defined. It must show all the different activities and their respective costs used in order to estimate the variable costs. Additionally the estimates of variable costs used under Check (T8) and others (T1–T7) seems to be underestimated. The land preparation, seed, interculture and harvesting costs comes to about Rs 3625/Ha in Islamabad, in a study conducted by Chatha *et al.* (1987) as compared to the variable cost range from Rs 320/Ha to Rs 2500/Ha for T1–T8. The discrepancy in the calculation of variable costs have also severely effected the estimation of benefit cost ratio.

The study recommends the T5 to be the best practice, but allowing the cropping pattern on the fields of a common farmer, it does not seem Ok that the same output may be achieved (as perceived by the paper) on sustained basis for longer period without the use of fertiliser in this present era of intensive cropping pattern keeping in view the soil fertility. I hope these observations will help to improve the structure of the paper.

As already mentioned, in this paper issue of soil fertility is not considerably discussed. Since the paper recommends that the optimum way is, to use only improved variety of Maize, it greatly depend on the required nutrients availability in quite good amount, other agronomical, cultural and management practices. These practices needs further in depth look.

Finally no description of the procedure about the projection of the costs and benefits for the year 2003 is delineated. The assumption that costs of variable inputs

will be increased at same rate as in 1997 may be misleading. For example, as is the case of fuel where this assumption becomes invalid due to significant price changes in past 5 years. Although it becomes complicated to go into such details but for the perception of realistic picture this is need of the time. It becomes more important because all the findings are stressing more on Cost-benefit ratio which otherwise is misleading. I hope these suggestions will help to improve the structure of the paper.

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