PARTIAL BUDGETING OF DIFFERENT SOWING TECHNOLOGIES OF WHEAT

Mukhtar Ahmed*, Shahbaz Ahmad†, M.Ashraf‡ and Muhammad Aslam Gill**

ABSTRACT
In order to harvest higher yield of wheat, selection of suitable sowing technologies are of great importance. The objective of the present study was to evaluate the profitability of innovative sowing technologies for wheat cultivation with limited water application by partial budgeting. Different sowing technologies i.e. Bed planting, Conventional tillage and Zero tillage were evaluated with three wheat varieties i.e. Kohsar-95, Inqlab-91 and M.H-97. The experiment was conducted in a Randomized Complete Block Design with three replications at the experimental area of Crop Sciences Institute (CSI), National Agricultural Research Centre (NARC), Islamabad during 2000-01. Number of tillers m⁻², spikelets spike⁻¹, grains spike⁻¹ and grain yield were not significantly affected by different tillage systems. Maximum biological yield was recorded for bed planting while maximum HI was noted for zero tillage system. The difference among varieties was not significant for tillers m⁻², spike length, spikelets spike⁻¹, grains spike⁻¹, grain yield, biological yield and HI. Results revealed that zero tillage required less cost for land preparation and planting so it will be recommended as economically beneficial technology.

Keywords: Conventional, Tillage Systems, Partial Budget, Yield, Wheat, Zero Tillage

INTRODUCTION
The total cultivated area in the Pakistan is 21.1 million hectares, out of which 8.23 million hectare is under wheat with a production of 21.08 million tons. Wheat shares 4.2% of agriculture sector's contribution of 24.6% to GDP (MINFAL, 2000). Water, the basic factor responsible for crop growth and development, is becoming scarce in the world so the development of such technologies that result in sustainable crop production with less amount of water is very important. Pakistan has predominately arid and semi arid environment. The rainfall varies from less than 100 mm to 250 mm in arid regions while it is 250 mm to 500 mm in semi-arid regions. Nearly 70 million hectares of the country's land mass consists of arid and semi arid areas (MINFAL, 2000). Presently water reservoirs are not sufficient to meet agricultural needs of water. In 30% of the area, wheat production solely depends on rainfall. The problem of water shortage is severe in arid environments of Pakistan that can only be handled by conserving the available moisture, proper utilization and storage of monsoon rainfall in reservoirs and adopting suitable cropping patterns. By doing so, arid lands can be made more productive. Another important factor is the increasing energy cost on fuel. Consequently the cost of cultivation of crops is going up that can be reduced by developing innovative sowing technologies. For a cultural practice to be sustainable, it must be profitable. One factor that contributes to the sustainability of a tillage system is that crop yield that must be comparable favorably to the conventional system.

The soil management and conservation advantages of using conservation tillage coupled with economic profitability would make this farming practice both beneficial and desirable. The new technique of bed planting has proved to be less resource intensive and more sustainable (Borrell et al. 1997) and there is also significant difference in yield and quality between wheat planted on beds and planted following traditional methods. Wheat on beds saves thirty percent of water compared to conventional system. Bed planting has also been reported to hold immense potential in developing countries for better water use efficiency, fertilizer management, weed control, environment friendly as it will reduce methane production, increase productivity with less cost and increase net income of farmers (CIMMYT, 2000). Hanna and Gupta (2000) reported the impact of zero tillage on crop growth, development and yield and concluded that producers are serious about long-term productivity and "leaving the land better than they found it" and get good economic benefit. Keeping in view the importance of these innovative sowing technologies, investigations were undertaken on bed planting systems and zero tillage in comparison with farmer practices to: (i) evaluate yield of crop and (ii) study the profitability of the planting systems. The yield was subjected to partial budgeting and Marginal analysis as used within this context is a procedure for calculating marginal rates of return between technologies, proceeding in a stepwise manner from a lower-cost technology to the next higher-cost technology, and comparing marginal rates of return to acceptable minimum rates of return (Perrin, et al., 1988). The procedure is useful for making recommendations to producers and for selecting alternative technologies.

* Department of Agronomy, University of Arid Agriculture, Rawalpindi
** Commissioner for Minor Crops, Ministry of Food Agriculture and Livestock
MATERIALS AND METHODS
The experiment was carried out at the experimental area of Crop Sciences Institute (CSI), National Agricultural Research Centre (NARC), Islamabad during 2000-01. It is situated at 33°38' latitude (N) and 73°00' longitude (E). The centre lies in a sub-tropical, sub-humid continental high land climate zone characterized by hot long summers and cold winters. Soils of the area are loess in nature, slightly alkaline with pH 8.2 and low in organic matter (0.5%).

The study was designed in a Randomized Complete Block Design with three replications. The net plot size was 5m x 6m. The crop was sown on November 20th 2000, with the help of tractor drawn rabi drill, in plots of four rows 22.5 cm apart in conventional tillage while in zero tillage sowing was done with the help of zero tillage drill. On bed planting three rows with a row to row distance of 30cm was maintained and sowing was done with the help of rabi drill. An area of 3.75 m² from bed planting and 3.0m² for zero tillage and flat sowing were harvested on April 19th 2001 sundried, threshed and weighed. Grain yield was recorded on plot bases and was converted into Kg ha⁻¹.

The management practices i.e. conventional tillage, bed planting and zero tillage were compared using three wheat varieties viz., Kohsar-95, Inqlab-91 and M.H-97. The plots were irrigated after sowing and at flowering of crop. Fertilizers were applied @ 120:60:0 NPK at the time of sowing due to rainfed conditions while manual method of weed control was used. Data were analyzed by using MSTAT-C. The treatment means were compared by using LSD at 5% level of probability (Steel and Torrie, 1980). The pooled experimental data were analyzed by using the methodology described in CIMMYT (1988). The partial budgets were constructed for different tillage systems. The purpose of partial budgets was to evaluate the differences in cost and benefits among different tillage systems. In the preparation of partial budget, all the costs of production were not considered and only the cost that varied among different tillage systems were taken into account.

Yield of all crops were adjusted downward by 30% to reflect probable lower yields expected by the farmers due to differences in factors like management, plot size, harvest data and harvesting technology (Byerlee et al. 1984). The field prices of the crops were calculated by adjusting the average market prices of those crops downward by 10 percent.

To compare the costs that varied with the net benefits, marginal analysis was done. The marginal analysis involves dominance analysis, net benefits curve fitting and calculating the marginal rate of return (MRR) for the non-dominated cropping systems (CIMMYT, 1988). In order to do dominance analysis, tillage systems were arranged in order of increasing variable costs. Tillage systems were considered as dominated if its variable costs were higher than the preceding systems (Table IV). Marginal rate of returns for each non-dominated tillage system was calculated by using the following formula (CIMMYT 1988):

\[
MRR = \frac{\Delta NB}{\Delta TVC} \times 100
\]

Where:
- MRR = Marginal rate of return in percentage
- NB = Change in net benefits
- TVC = Change in total variable cost

On the basis of economic analysis the recommendations were made by arranging the tillage systems in order of increasing costs and then considering MRR between each pair of tillage systems. The tillage system with the highest net benefits and MRR was recommended. It is common in Pakistan that input and prices of agricultural commodities are subject to change from year to year and location to location. In order to test our recommendation for cropping systems its ability to withstand the possible price change “Sensitivity analysis” was performed. In this analysis, marginal analysis was redone using the alternative set of input and output prices. Different scenario assumed about the input and output prices change are listed below:

i. Output and input prices increasing by 10% from current level.

ii. Output and input increasing by 20% from current level.

RESULTS AND DISCUSSION
Grain yield is the combined product of all the yield components. The data on grain yield of the wheat varieties under different tillage systems are presented in Table II. The data revealed that the influence of tillage systems on grain yield was statistically non-significant. The results agree with the findings of Aslam et al. (1993) who concluded that overall zero tillage system produces 10 % higher grain yield but the difference were statistically non-significant. The results were contradictory with the findings of Singh (1996) and Arshad et al. (1998) who concluded that
innovative technologies had significant effect on yield of wheat.

The difference among varieties for tillers m$^{-2}$, spike length, spikelets spike$^{-1}$, grains spike$^{-1}$, thousand grain weight, grain yield and harvest index were not significant. The data related to yield under different sowing technologies was subjected to partial budgeting. The methodology involved partial budgeting and marginal analysis. The partial budgets were constructed for each sowing technology to evaluate the costs and benefits associated with different tillage systems and the results were reported in Table III. The results of partial budget analysis reported in Table III revealed that in tillage systems, the gross benefit in zero tillage was Rs. 20301.7 ha$^{-1}$ that was better than bed planting (Rs. 17136.7 ha$^{-1}$) and conventional tillage (Rs. 15537.3 ha$^{-1}$). Zero tillage gave maximum net benefit, which was Rs.19801.7 ha$^{-1}$ followed by bed planting (Rs. 14596.7 ha$^{-1}$). Similar results have been reported by Arshad et al. (1998). The minimum net benefit of Rs. 13647.3 ha$^{-1}$ was obtained from conventional tillage (Table IV). The highest net benefit in zero tillage was due to savings on land preparation. Similarly bed planting, another resources conserving technology, gave better results as compared to farmer practice of conventional tillage but its benefit was less in comparison with zero tillage that was due to cost involved in the preparation of land for bed construction. The cost of bed construction can be minimized by making permanent beds once for several seasons but even then it will involve some cost therefore it cannot be compared to zero tillage. Hobbs et al. (2000) evaluated recently promoted technique of planting wheat on raised beds that improved yields, increased fertilizer efficiency, reduced herbicide use, saved seed, saved 30% water, and reduced production costs by 25-35% when permanent beds were use. In the partial budget analysis discussed previously, total costs that vary and net benefits for each tillage systems were calculated but did not compare the costs that varied with the net benefits. For such a comparison marginal analysis was employed. The marginal analysis involved dominance analysis, net benefit curve and marginal rate of returns (MRR). To determine the most profitable tillage system, by comparing the costs that varied with the net benefits obtained, marginal analysis was performed. In order to perform dominance analysis, systems were arranged in order of increasing variable costs. A tillage system was dominated if its variable costs were higher than the proceeding tillage systems (Table IV) but its net benefit was lower (CIMMYT, 1988). Such a tillage system was termed as dominated tillage system and was donated by ‘D’. The dominance analyses of the results are presented in Table IV. The results showed that conventional method and bed planting were dominated by zero tillage indicating that bed planting and conventional tillage were less profitable than zero tillage systems (Table IV). Since there was only one profitable system so marginal rate of return cannot be calculated. According to the economic analysis, zero tillage system proved to be the best hence it can be recommended that conventional method of sowing may be replaced by zero tillage system that was superior and economically better alternative for wheat planting. These results agree with the findings of Aslam et al. (1993) who concluded that overall zero tillage system produces 10% higher grain yield but the difference was statistically non-significant. The results also agree with the findings of Arshad et al. (1998) who concluded that innovative technologies reduced tillage cost by 79% and improved grain yield by about 2%.

CONCLUSION AND RECOMMENDATIONS
Partial budgeting can aid researchers/extension agents in selecting technologies/practices that are the most profitable and have the best chance of being adopted by producers. Since the zero tillage required less cost of land preparation and planting so it is recommended as economically beneficial technology.
Table-I:  
*Effects of tillage system on yield and yield components of wheat varieties*

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Tillers m⁻²</th>
<th>Spike Length (cm)</th>
<th>Spikelets Spike⁻¹</th>
<th>Grains Spike⁻¹</th>
<th>TGW (g)</th>
<th>Grain yield Kg ha⁻¹</th>
<th>Biological Yield kg ha⁻¹</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed Planting</td>
<td>299.4</td>
<td>10.1</td>
<td>18.5</td>
<td>43.7ab</td>
<td>29.5</td>
<td>3264</td>
<td>8396.1 a</td>
<td>38.7 b</td>
</tr>
<tr>
<td>Conventional Tillage</td>
<td>373.1</td>
<td>10.3</td>
<td>19.6</td>
<td>50.8a</td>
<td>33.0</td>
<td>2959</td>
<td>7848.8 ab</td>
<td>45.5 ab</td>
</tr>
<tr>
<td>Zero tillage</td>
<td>341.4</td>
<td>9.8</td>
<td>17.4</td>
<td>43.2 a</td>
<td>33.4</td>
<td>3667</td>
<td>5874.4 b</td>
<td>61.4 a</td>
</tr>
<tr>
<td><strong>LSD</strong></td>
<td>125.9(ns)</td>
<td>1.004(ns)</td>
<td>4.379(ns)</td>
<td>4.52(ns)</td>
<td>5.019(ns)</td>
<td>1041(ns)</td>
<td>917.9(s)</td>
<td>15.27(s)</td>
</tr>
</tbody>
</table>

Varieties:

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Kohsar-95</th>
<th>Inqlab-91</th>
<th>MH-97</th>
<th>Biological Yield kg ha⁻¹</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kohsar-95</td>
<td>306.7</td>
<td>10.4</td>
<td>18.3</td>
<td>41.7</td>
<td>32.8</td>
</tr>
<tr>
<td>Inqlab-91</td>
<td>331.4</td>
<td>10.5</td>
<td>19.2</td>
<td>48.2</td>
<td>33.4</td>
</tr>
<tr>
<td>MH-97</td>
<td>375.7</td>
<td>9.4</td>
<td>18.1</td>
<td>47.9</td>
<td>29.6</td>
</tr>
<tr>
<td><strong>LSD</strong></td>
<td>74.81(ns)</td>
<td>1.97(ns)</td>
<td>2.084(ns)</td>
<td>21.26(ns)</td>
<td>4.155(ns)</td>
</tr>
</tbody>
</table>

ns = non significant  
s = significant

Table-II:  
*Grain yield (Kg ha⁻¹) of wheat varieties under various tillage systems*

<table>
<thead>
<tr>
<th>Tillage systems/varieties</th>
<th>Kohsar-95</th>
<th>Inqlab-91</th>
<th>MH-97</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed planting</td>
<td>2959.3</td>
<td>2926.6</td>
<td>3906.6</td>
<td>3264.2</td>
</tr>
<tr>
<td>Conventional tillage</td>
<td>2769</td>
<td>3352.3</td>
<td>2757.3</td>
<td>2959.5</td>
</tr>
<tr>
<td>Zero tillage</td>
<td>3595.6</td>
<td>4332.3</td>
<td>3673.3</td>
<td>3667.1</td>
</tr>
<tr>
<td><strong>Means</strong></td>
<td>3108.0</td>
<td>3537.1</td>
<td>3445.7</td>
<td></td>
</tr>
</tbody>
</table>
Table III:  
Partial Budget of Innovative sowing technologies

<table>
<thead>
<tr>
<th>Variable</th>
<th>Zero Tillage</th>
<th>Bed Planting</th>
<th>Farmer Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average yield</td>
<td>3867.1</td>
<td>3264.2</td>
<td>2959.5</td>
</tr>
<tr>
<td>Adjusted Yield (kg ha(^{-1}))</td>
<td>2706.9</td>
<td>2284.9</td>
<td>2071.65</td>
</tr>
<tr>
<td>Gross benefits (Rupees ha(^{-1}))</td>
<td>20301.7</td>
<td>17136.7</td>
<td>15537.3</td>
</tr>
</tbody>
</table>

**Cost of Land Preparation (Rs ha\(^{-1}\))**

- a. Cultivations @ Rs. 500 ha\(^{-1}\) - 1500 1500
- b. Bed preparation@ Rs. 100 hour\(^{-1}\) - 300 -
- c.2. planking @ Rs. 120 ha\(^{-1}\) - 240 -

**Cost of Planting (Rs ha\(^{-1}\))**

- a. Broadcasting - - 150
- b. Drilling @ Rs. 500 ha\(^{-1}\) 500 500 -

**Total cost that vary (Rupees ha\(^{-1}\))**

500 2540 1890

**Net benefits (Rs ha\(^{-1}\))**

19801.7 14596.7 13647.3

Benefit ratio 1.35 1.06 1

Table-IV:  
Dominance analysis of Different tillage systems

<table>
<thead>
<tr>
<th>Tillage systems</th>
<th>Costs that vary (Rs ha(^{-1}))</th>
<th>Net Benefits (Rs ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero tillage</td>
<td>500</td>
<td>19801.7</td>
</tr>
<tr>
<td>Conventional tillage</td>
<td>1890</td>
<td>13647.3 D</td>
</tr>
<tr>
<td>Bed planting</td>
<td>2540</td>
<td>14596.7 D</td>
</tr>
</tbody>
</table>

Figures followed by “D” are dominated tillage systems.

REFERENCES


CIMMYT. 1988. From agronomic data to farmer recommendations: An economic training handbook. Econ. Programme, CIMMYT, Mexico, D.F.


