Economics of Organic Production Systems and Policy Options in South Asia

By

Muhammad Asim Yasin
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AGRICULTURAL ECONOMICS

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2014
IN THE NAME OF THY LORD, THE MOST BENEFICIENT, THE MOST MERCIFUL
To,

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________________________________________
SIGNATURE OF THE STUDENT
Muhammad Asim Yasin
93-ag-1240
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ABSTRACT

Agriculture is predominately the main sector of South Asia which employs about 60% of the labor force and contributes 22% of the regional GDP. Most of the farmers are small who are facing the high cost of production incurred mainly on pesticides and fertilizers. Moreover, the transition from traditional agriculture to Green Revolution agriculture, led to mono-cropping patterns, loss of on farm biodiversity and dependence on capital. On the other side, organic agriculture was a possible option for the farmers in comparison with Green Revolution technologies by depending on their on-farm resources, promoting crop diversity and using environment friendly techniques.

The present study was designed to assess the profitability of Organic production systems in comparison with Conventional systems. The study was conducted in three South Asian countries including Pakistan, Bangladesh and Nepal. A multistage sampling technique was employed to select the sample farms to collect the primary data from both organic and conventional farms. The profit function approach which combines the concepts of technical and allocative efficiency was utilized to assess the profit efficiency of organic and conventional farms. The focus of the study was to estimate the profit efficiency of organic and conventional farmers along with factors affecting the profit efficiency. Cobb Douglas functional form of stochastic profit frontier function was used to determine the profit efficiency. Rice and wheat crops being both cash and staple food crops of the region were selected for the comparative analysis.

The results of the study show that the average profit efficiency of Pakistani organic wheat (0.915) was relatively higher than the conventional farmers (0.911) to conclude that organic wheat farmers are more profit efficient than conventional farmers. The average profit efficiency of organic rice farmers (0.89) was less than conventional rice farmers (0.910) in Pakistan but still comparable. The average profit efficiency of organic and conventional wheat farmers in Nepal was found to be approximately equal with efficiency scores 0.860 and 0.855 respectively while average profit efficiency (0.874) of organic rice farmers is slightly better than the average profit efficiency of conventional rice farmers (0.857). The organic wheat farmers in Bangladesh were more profit efficient with efficiency score of 0.902 as compared to conventional wheat farmers with efficiency score 0.733. Profit efficiency of organic rice farmers with efficiency score 0.748,
was better than conventional rice farmers (0.657). The results show that variable costs impact differently in both organic and conventional farming but their overall impact is found to lower the profit. Capital and soil fertility were observed to play an important role in increasing profit. The pest breakout significantly affects the profit negatively in all selected countries and requires timely application of plant protection measures.

The study also attempted to ascertain the factors affecting the profit efficiency in wheat and rice farming under organic and conventional conditions. The estimated coefficient of education is significant in all categories with negative sign indicating that education is contributing to reduce the profit inefficiency in both organic and conventional farming in the selected countries. The coefficient of experience is significant in organic and conventional wheat farming and conventional rice farming. The coefficient of experience is non-significant in organic rice farming. The negative sign in all categories indicates that experience of the farmers contributes to reduce the profit inefficiency. Experience of the farmers in wheat and rice farming, linkages with extension services and access to credit were also the important variables to affect the inefficiency negatively. Off-farm employment was found to have positive impact on efficiency especially in case of Bangladesh.

**KEY WORDS:** Organic Agriculture; Profit efficiency; Stochastic frontier profit function; Rice and wheat crops; South Asia
CHAPTER 1

INTRODUCTION

1.1 Background

South Asia comprised of seven countries, has a variety of geographical features and identity. The climate of South Asia which varies considerably from area to area, is quite suitable for agriculture and almost all main crops are grown in different areas. These crops include wheat, rice, cotton, sugarcane, all types of seasonal vegetables and fruits. Agriculture is predominately the main sector of South Asia which employs about 60 percent of the labor force and contributes 22 percent of the regional GDP. Agricultural growth is less than 3 percent, which is below the growth rates of other economic sectors. About 75 percent of South Asia’s poor live in rural areas which directly or indirectly earn their livelihood from Agriculture (World Bank, 2008).

If we see the history of South Asia’s Agriculture, the farmers were used to grow multiple crops in the fields following the techniques of ecological agriculture. Their cropping patterns were the best example of agro ecosystems but the advent of modern agriculture in the form of Green Revolution changed the whole scenario with the introduction of new high yielding varieties (HYVs), chemical fertilizers and pesticides. The first pesticides used were insecticides, applied to the so-called high value crops i.e. grown for cash. Then in the 1970s and 1980s, herbicides were introduced to save on labour (Kaosard and Rerkasem, 2000). For a few years, the production increased considerably then became stagnant but the use of fertilizers and pesticides continued to increase which resulted in high cost of production. The Green Revolution brought increase in yields for awhile, but with poisoning of people and animals, loss of local biodiversity, loss of natural fertility of soil, loss of genetic diversity, loss of indigenous knowledge and practices, farmer dependency on external inputs, and finally an increase in the number of people living in extreme poverty in many countries (IAASTD, 2008).
Decline in the use of organic fertilizers and increasing tendency of dependence on exotic chemical fertilizers have also resulted in spoiling soil structure and reducing fertility. The Green Revolution yields have not been sustainable and are now declining. During the early days of Green Revolution, 1 kg of synthetic nitrogen fertilizer produced about 20 kg of grain in Bangladesh but now, it produces only 8-10 kg (Hossain et al., 2007). This pattern is emerging throughout Asia. It is evident that the excessive irrigation needed by HYVs, use of chemical inputs and heavy machinery have had serious impacts on soil health, reducing its ability to produce healthy crops (Paul and Steinbrecher, 2003).

The Green Revolution's High Yielding Varieties also affected the agricultural biodiversity. A number of indigenous varieties disappeared gradually. Medicinal herbs that used to grow on field margins have suddenly disappeared. Many bird species have become extinct while new pests are emerging in large densities. Evidence shows that nature has been disturbed and subsequent variation is quite puzzling. ESCAP (2002) expected that India would be producing 75 percent of its rice from just 10 varieties compared to the 30,000 varieties traditionally cultivated.

The Green Revolution left many poor people and regions behind, an outcome that was aggravated by continuing population growth. It contributed to save large areas of wetlands, forests and fragile lands from agricultural conversion but it did not save all and generated environmental problems of its own, especially by the mismanagement and excessive use of modern inputs, unsustainable use of irrigation water, and the loss of biodiversity within rural landscapes and individual crop species (Kaosard and Rerkasem, 2000).

There were impacts on labour too. The Green Revolution displaced landless workers and removed an important source of employment from the rural economy by increased level of mechanization on large farms. The female labour force in particular was affected by the introduction of modern machines and technology for tasks such as weeding,
The transition from traditional agriculture to Green Revolution agriculture led to a dependence on capital required to purchase the external inputs. The capital was provided through the widespread establishment of rural credit institutions. Smaller farmers with their limited resources often became indebted that resulted in forfeiture of their farmland in many cases.

Moreover, Asia-Pacific Region is the home of nearly two-third of the world’s poor and undernourished people. The green revolution generally bypassed the vast favourable rainfed areas which were inhabited mostly by small farmers and caused water and land degradation. It generated significant inter country differences in yield and per capita calorie availability depending on policies, investments in agricultural research and development and finally the technological capacities. The situation can be more alarming in future because half of the increase in world’s population will materialize in Asia by the years 2015 and 2030, further stressing the land, water and biodiversity resources (FAO, 2002).

Most farmers in the Asia-Pacific Region are small-holders and poor. These challenges are complex and need more focused and intense research to develop small farmer oriented technologies, strategies and policies. The greater resources should be channeled to benefit the poor and the less-favoured lands but the efforts in favoured lands must not be slackened to ensure sustainable national agricultural output.

In this scenario, organic agriculture provided an opportunity to combat the aftereffects of Green Revolution by boosting the eco-friendly techniques, promoting agro-diversity and using indigenous knowledge. Realizing this many Farmer's Organizations, NGOs and other institutions started working with farmers in South Asia to transform their farming systems from conventional to organic. According to FAO (2002a), organic agriculture is a holistic production management system which promotes and enhances agro ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions and locally adapted systems.
Diversity in plants and farming systems creates diverse ecological niches leading to abundance of natural enemies of plant pests. By following diverse cropping pattern farmers can minimize the additional expenditures on synthetic and chemical fertilizers (Pretty, 1995).

The present study is designed to study the economics of organic production systems and policy options in South Asia in comparison with conventional farming systems. The study is conducted in three South Asian countries; Pakistan, Bangladesh and Nepal to assess the both farming approaches and draw results to devise recommendations for policy options. The focus of the study is to estimate the profit efficiency of organic and conventional; wheat and rice farmers in South Asia. Wheat and rice are the most important cereal crops of the region and being both cash and staple food crops are central to cropping patterns and occupy significant acreage in South Asia.

1.2 Importance of Rice-Wheat System in South Asia

The rice-wheat system has been practiced by farmers in Asia for more than 1000 years. It has since expanded and is currently estimated at 23.5 million ha. The rice-wheat system covers 13.5 million ha in South Asia: India (10.0), Pakistan (2.2), Bangladesh (0.8) and Nepal (0.5) (Arshad and Ahmad, 2011). It forms a broad swath across Pakistan, India, Nepal and Bangladesh and called the breadbasket of the region. The rice wheat farming system of South Asia is mainly characterized by a winter wheat crop followed by summer paddy crop and sometimes also a short spring vegetable crop (RWC-CIMMYT, 2003).

Over the past 30 years, the rice-wheat system has emerged as the major production system of the region, covering more than 40 percent of the total wheat area and 30 percent of the total rice area, and producing more than half of region’s wheat and nearly one-third of its rice (Ladha et al., 2009). Although rice-wheat cropped area in the Indo Gangetic Plains is irrigated or has assured rainwater in sub-humid regions, the soils and crop management undergo drastic changes during the two cropping seasons.
Table 1.1: Major Farming Systems and their potential in South Asia

<table>
<thead>
<tr>
<th>Farming Systems</th>
<th>Land Area (% of region)</th>
<th>Agric. Popn. (% of region)</th>
<th>Principal Livelihoods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>7</td>
<td>17</td>
<td>Wetland rice (both seasons), vegetables, legumes, off-farm activities</td>
</tr>
<tr>
<td>Coastal Artisanal Fishing</td>
<td>1</td>
<td>2</td>
<td>Fishing, coconuts, rice, legumes, livestock</td>
</tr>
<tr>
<td>Rice-Wheat</td>
<td>19</td>
<td>33</td>
<td>Irrigated Rice, wheat, vegetables, livestock including dairy, off-farm activities</td>
</tr>
<tr>
<td>Highland Mixed</td>
<td>12</td>
<td>7</td>
<td>Cereals, livestock, horticulture, seasonal migration</td>
</tr>
<tr>
<td>Rainfed Mixed</td>
<td>29</td>
<td>30</td>
<td>Cereals, legumes, fodder crops, livestock, off-farm activities</td>
</tr>
<tr>
<td>Dry Rainfed</td>
<td>4</td>
<td>4</td>
<td>Coarse cereals, irrigated cereals, legumes, off-farm activities</td>
</tr>
<tr>
<td>Pastoral</td>
<td>11</td>
<td>3</td>
<td>Livestock, irrigated cropping, migration</td>
</tr>
<tr>
<td>Sparse (Arid)</td>
<td>11</td>
<td>1</td>
<td>Livestock where seasonal moisture permits</td>
</tr>
<tr>
<td>Sparse (Mountain)</td>
<td>7</td>
<td>0.4</td>
<td>Summer grazing of livestock</td>
</tr>
<tr>
<td>Tree Crop</td>
<td>Dispersed</td>
<td>1</td>
<td>Export or agro-industrial crops, cereals, wage labour</td>
</tr>
<tr>
<td>Urban Based</td>
<td>&lt;1</td>
<td>1</td>
<td>Horticulture, dairying, poultry, other activities</td>
</tr>
</tbody>
</table>

Source: FAO, 2001
The success of the system is primarily based on mechanization and easy access to production inputs, extensive irrigation infrastructure and marketing and grain procurement services. However, growth rates have decreased even as there is a wider recognition of environmental issues arising from the intensive and sometimes excessive use of inputs (RWC-CIMMYT, 2003).

Many resource poor farmers rely on this system to ensure supply of cereal and food security at household level but the system also provides extra supply of rice and wheat for export and strategic food reserves. It is a strategic system for feeding the poor that meets the food needs of approximately 1.3 billion people in the region. In South Asia, both wheat and rice contribute nearly 70-95 percent of the daily calorie intake (RWC-CIMMYT, 2003).

1.3 Area, Production and Yield of Wheat and Rice in Pakistan

The area, production and yield of wheat and rice in Pakistan are presented in the Tables 1.2 and 1.3, respectively. The subsection also sheds light on importance of these crops in Pakistan.

1.3.1 Wheat in Pakistan

Wheat holds significant position in Pakistan’s economy as it is the first staple food of almost entire population having central position in formulating agricultural policies. It contributes 10.1 percent to the value added in agriculture and 2.2 percent to GDP. Wheat was cultivated in an area of 8693 thousand hectares in 2012-13, showing an increase of 0.5 percent over last year’s area of 8650 thousand hectares. The production of wheat was estimated at 24.2 million tons during July-March 2012-13 (Government of Pakistan, 2013).

The yield per hectare posted a positive growth of 2.7 percent as compared to negative 4.2 percent growth of previous year (Government of Pakistan, 2013). This is due to several factors including
the timely sowing of wheat and favourable weather conditions at the ripening stage. The overall decrease in area in the years 2011-12 and 2012-13 was due to problems faced by the farmers in the disposal of wheat produced and early sowing of Bt cotton in late February and early March.

Table 1.2: Area, Production and Yield of Wheat in Pakistan

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (000 hectares)</th>
<th>% Change</th>
<th>Production (000 tons)</th>
<th>% Change</th>
<th>Yield (Kgs/Hec.)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>8358</td>
<td>1.7</td>
<td>21612</td>
<td>10.8</td>
<td>2568</td>
<td>8.1</td>
</tr>
<tr>
<td>2005-04</td>
<td>8448</td>
<td>1.1</td>
<td>21277</td>
<td>-1.6</td>
<td>2519</td>
<td>-1.9</td>
</tr>
<tr>
<td>2006-07</td>
<td>8578</td>
<td>1.0</td>
<td>23295</td>
<td>9.5</td>
<td>2716</td>
<td>7.8</td>
</tr>
<tr>
<td>2007-08</td>
<td>8550</td>
<td>-0.3</td>
<td>20959</td>
<td>-10.0</td>
<td>2451</td>
<td>-9.8</td>
</tr>
<tr>
<td>2008-09</td>
<td>9046</td>
<td>5.8</td>
<td>24033</td>
<td>14.7</td>
<td>2657</td>
<td>8.4</td>
</tr>
<tr>
<td>2009-10</td>
<td>9132</td>
<td>1.0</td>
<td>23311</td>
<td>-3.0</td>
<td>2553</td>
<td>-3.9</td>
</tr>
<tr>
<td>2010-11</td>
<td>8901</td>
<td>-2.5</td>
<td>25214</td>
<td>8.2</td>
<td>2833</td>
<td>11.0</td>
</tr>
<tr>
<td>2011-12</td>
<td>8650</td>
<td>-2.8</td>
<td>23473</td>
<td>-6.9</td>
<td>2714</td>
<td>-4.2</td>
</tr>
<tr>
<td>2012-13P</td>
<td>8693</td>
<td>0.5</td>
<td>24231</td>
<td>3.2</td>
<td>2787</td>
<td>2.7</td>
</tr>
</tbody>
</table>

P : Provisional (July-March)
Source: Government of Pakistan, 2013

Following were the main factors that contributed to increase the wheat production in previous years, mainly due to

- Announcement of attractive wheat support price of Rs. 950 per 40 kg in 2007-08 and increased in the following years to Rs. 975 per 40 kg. It contributed significantly to increase the area under wheat. In the year 2011-12, the support price for wheat was Rs.1050 per 40 Kg and increased to Rs.1200 per 40 kg in the 2012-13.

- Supportive weather conditions and timely rainfall especially during the wheat growing season during years 2010-11, 2011-12 and 2012-13.

- Supportive measures like setting higher wheat procurement target by the public sector organizations at the announced support prices.
1.3.2 Rice in Pakistan

Rice is the third largest crop in Pakistan after wheat and cotton and second largest staple food crop. Rice is highly valued cash crop and is also major export item. It accounts for 2.7 percent of value added in agriculture and 0.6 percent in GDP. Pakistan grows enough high quality rice to meet both domestic demand and for exports. Area sown for rice is estimated at 2311 thousand hectares, 10.1 percent less than last year’s area. The size of the crop is estimated at 5541 thousand tons, 10 percent less than previous year’s production. This is mainly attributed to the late receding of water from rice fields due to heavy monsoon rains in sowing season that delayed the sowing (Government of Pakistan, 2013).

Other reasons for the decrease in production include decrease in area, attack of pests and diseases and lodging of early sown crops.

Table 1.3: Area, Production and Yield of Rice in Pakistan

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (000) hectare</th>
<th>% change</th>
<th>Production (000) tons</th>
<th>% change</th>
<th>Yield (Kgs/Hec)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>2519</td>
<td>2.3</td>
<td>5025</td>
<td>3.6</td>
<td>1995</td>
<td>1.2</td>
</tr>
<tr>
<td>2005-06</td>
<td>2621</td>
<td>4.0</td>
<td>5547</td>
<td>10.4</td>
<td>2116</td>
<td>6.1</td>
</tr>
<tr>
<td>2006-07</td>
<td>2581</td>
<td>-1.5</td>
<td>5438</td>
<td>-2.0</td>
<td>2107</td>
<td>-0.4</td>
</tr>
<tr>
<td>2007-08</td>
<td>2515</td>
<td>-2.5</td>
<td>5563</td>
<td>2.3</td>
<td>2211</td>
<td>5.0</td>
</tr>
<tr>
<td>2008-09</td>
<td>2963</td>
<td>17.8</td>
<td>6952</td>
<td>25</td>
<td>2346</td>
<td>6.1</td>
</tr>
<tr>
<td>2009-10</td>
<td>2883</td>
<td>-2.7</td>
<td>6883</td>
<td>-1.0</td>
<td>2387</td>
<td>1.7</td>
</tr>
<tr>
<td>2010-11</td>
<td>2365</td>
<td>-18.0</td>
<td>4823</td>
<td>-30.0</td>
<td>2039</td>
<td>-14.6</td>
</tr>
<tr>
<td>2011-12</td>
<td>2571</td>
<td>8.7</td>
<td>6160</td>
<td>27.7</td>
<td>2396</td>
<td>17.5</td>
</tr>
<tr>
<td>2012-13P</td>
<td>2311</td>
<td>-10.1</td>
<td>5541</td>
<td>-10.0</td>
<td>2398</td>
<td>0.1</td>
</tr>
</tbody>
</table>

P: Provisional
Source: Government of Pakistan, 2013
1.4 Area, Production and Yield of Wheat and Rice in Bangladesh

This subsection covers the importance of wheat and rice crops in Bangladesh. The data about area, production and yield of wheat and rice in Bangladesh is presented in the Tables 1.4 and 1.5, respectively.

1.4.1 Wheat in Bangladesh

Wheat is the second most important food crop of Bangladesh after rice. The cultivation of wheat increased considerably in Bangladesh in the year 2012-13 due to less cost of production and more profit in wheat production as compared to other contemporary crops. The weather condition remained favorable in year 2012-13 during sowing and harvesting period. Good management and distribution system of seed and fertilizer also contributed to significant increase in production and yield of wheat crop (Government of Bangladesh, 2013).

Table 1.4: Area, Production and Yield of Wheat in Bangladesh

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (000 Acres)</th>
<th>% change</th>
<th>Production (000 tons)</th>
<th>% change</th>
<th>Yield (Kgs/Heac)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>1380</td>
<td>-12.98</td>
<td>976</td>
<td>-22.10</td>
<td>1750</td>
<td>-10.25</td>
</tr>
<tr>
<td>2005-06</td>
<td>1183</td>
<td>-14.27</td>
<td>735</td>
<td>-24.69</td>
<td>1530</td>
<td>-12.57</td>
</tr>
<tr>
<td>2006-07</td>
<td>988</td>
<td>-16.48</td>
<td>737</td>
<td>0.27</td>
<td>1850</td>
<td>20.91</td>
</tr>
<tr>
<td>2007-08</td>
<td>958</td>
<td>-3.03</td>
<td>844</td>
<td>14.51</td>
<td>2177</td>
<td>17.67</td>
</tr>
<tr>
<td>2008-09</td>
<td>975</td>
<td>1.77</td>
<td>849</td>
<td>0.59</td>
<td>2152</td>
<td>-1.15</td>
</tr>
<tr>
<td>2009-10</td>
<td>922</td>
<td>-5.39</td>
<td>969</td>
<td>14.13</td>
<td>2597</td>
<td>20.67</td>
</tr>
<tr>
<td>2010-11</td>
<td>923</td>
<td>0.11</td>
<td>972</td>
<td>0.32</td>
<td>2601</td>
<td>0.15</td>
</tr>
<tr>
<td>2011-12</td>
<td>885</td>
<td>-4.20</td>
<td>995</td>
<td>2.39</td>
<td>2780</td>
<td>6.88</td>
</tr>
<tr>
<td>2012-13</td>
<td>1029</td>
<td>16.34</td>
<td>1254</td>
<td>26.06</td>
<td>3013</td>
<td>8.36</td>
</tr>
</tbody>
</table>

Source: Government of Bangladesh, 2013
Moreover, there was no climatic disaster during the growing stage of wheat. Total area under wheat crop has been estimated at 1029 thousand acres (416 thousand hectares) in the year 2012-13 compared to 885 thousand acres (358 thousand hectares) of previous year which shows 16.34 percent increase. Average yield rate has been estimated at 3013 kgs per hectare which is 8.36 percent higher than that of last year. Total wheat production has been estimated at 1254 thousand tons compared to 995 thousand tons of the last year, which is 26.06 percent higher than that of last year (Government of Bangladesh, 2013).

1.4.2 Rice in Bangladesh

Rice is the dominant food crop of Bangladesh and occupies country’s major area under crop production. In most parts of the country, the cropping pattern revolves around one, two and sometimes even three rice crops reflecting the paramount importance of rice in the rural economy. The rice cropping calendar varies depending on variety, planting methods, source of irrigation and other factors. The first rice crop is the spring “Aus” crop which is planted in March and April during the early part of Kharif season to take the advantage from the onset of annual monsoon rains. The second and most important rice crop is the summer “Aman” crop which is grown in the middle of Kharif season, during the period of heaviest rainfall when water supplies are most reliable. An early “Aman” crop may be broadcasted in April but usually follows “Aus” crop by transplanting in July. The third rice crop is the winter “Boro” crop, which is grown with irrigation during Rabi season. Boro rice may be planted from late December to February and harvested in April to May.

The area, production and yield of rice is presented in Table 1.5 which shows overall increasing trends in production and yield per hectare due to favourable weather conditions, timely availability of fertilizers and management of electricity in rural areas for irrigation. Apart from this, there was no crop damage recorded due to nonoccurrence of any natural calamities in the season (Government of Bangladesh, 2013).
Table 1.5: Area, Production and Yield of Rice in Bangladesh

<table>
<thead>
<tr>
<th>Year</th>
<th>Area (000) Acres</th>
<th>% change</th>
<th>Production (000) tons</th>
<th>% change</th>
<th>Yield (Kgs/Hec)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>25621</td>
<td>-4.20</td>
<td>25157</td>
<td>-3.94</td>
<td>2450</td>
<td>1.23</td>
</tr>
<tr>
<td>2005-06</td>
<td>26018</td>
<td>1.55</td>
<td>26530</td>
<td>5.46</td>
<td>2520</td>
<td>2.85</td>
</tr>
<tr>
<td>2006-07</td>
<td>26142</td>
<td>0.47</td>
<td>27319</td>
<td>2.97</td>
<td>2591</td>
<td>2.81</td>
</tr>
<tr>
<td>2007-08</td>
<td>26130</td>
<td>-0.04</td>
<td>28931</td>
<td>5.90</td>
<td>2745</td>
<td>5.94</td>
</tr>
<tr>
<td>2008-09</td>
<td>27872</td>
<td>6.66</td>
<td>31317</td>
<td>8.24</td>
<td>2787</td>
<td>1.53</td>
</tr>
<tr>
<td>2009-10*</td>
<td>28231</td>
<td>1.28</td>
<td>32257</td>
<td>3.00</td>
<td>2833</td>
<td>1.65</td>
</tr>
<tr>
<td>2010-11</td>
<td>28489</td>
<td>0.91</td>
<td>33541</td>
<td>3.98</td>
<td>2919</td>
<td>3.03</td>
</tr>
<tr>
<td>2011-12</td>
<td>28488</td>
<td>-0.004</td>
<td>33889</td>
<td>1.03</td>
<td>2948</td>
<td>0.99</td>
</tr>
<tr>
<td>2012-13</td>
<td>28228</td>
<td>-0.91</td>
<td>33834</td>
<td>-0.16</td>
<td>2972</td>
<td>0.81</td>
</tr>
</tbody>
</table>

* Adjusted
Source: Government of Bangladesh, 2013

1.5 Area, Production and Yield of Wheat and Rice in Nepal

The following subsection covers the importance of wheat and rice crops in Nepal. The data about area, production and yield of wheat and rice in Nepal is presented in Tables 1.6 and 1.7, respectively.

1.5.1 Wheat in Nepal

Wheat is the third largest cereal crop in Nepal after rice and maize. Wheat is important for Nepali farmers as food and cash crop and grown almost in all parts of Nepal. Wheat is rapidly increasing both in acreage and production and is the main winter cereal. Wheat is cultivated in 20 percent of the total cultivated land area and contributes almost 18 percent to the total national cereal production (Government of Nepal, 2010).

Before the mid sixties, wheat cultivation in Nepal was limited to mid and far-western hills only and it was considered as a minor cereal in the country.
After the introduction of HYVs, the area and production of wheat in Nepal has been increased dramatically and now it has significant contribution to the national food supply. In 1965-66, wheat area in the country was about 100,000 hectares and the production was 112,000 tons (Government of Nepal, 2010). In 2011-12, its area and production was 765,317 hectares and 1,846,142 tons, respectively with national average wheat productivity 2,412 kgs/ha (Government of Nepal, 2012).

Table 1.6: Area, Production and Yield of Wheat in Nepal

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>% change</th>
<th>Production</th>
<th>% change</th>
<th>Yield (Kgs/Hec)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-04</td>
<td>664,589</td>
<td>-0.66</td>
<td>1,387,191</td>
<td>3.19</td>
<td>2,087</td>
<td>3.88</td>
</tr>
<tr>
<td>2004-05</td>
<td>675,807</td>
<td>1.68</td>
<td>1,442,442</td>
<td>3.98</td>
<td>2,134</td>
<td>2.25</td>
</tr>
<tr>
<td>2005-06</td>
<td>672,040</td>
<td>-0.55</td>
<td>1,394,126</td>
<td>-3.34</td>
<td>2,074</td>
<td>-2.81</td>
</tr>
<tr>
<td>2006-07</td>
<td>702,664</td>
<td>4.55</td>
<td>1,515,139</td>
<td>8.68</td>
<td>2,156</td>
<td>3.95</td>
</tr>
<tr>
<td>2007-08</td>
<td>706,481</td>
<td>0.54</td>
<td>1,572,065</td>
<td>3.75</td>
<td>2,225</td>
<td>3.2</td>
</tr>
<tr>
<td>2008-09</td>
<td>694,950</td>
<td>-1.63</td>
<td>1,343,862</td>
<td>-14.51</td>
<td>1,934</td>
<td>-13.07</td>
</tr>
<tr>
<td>2009-10</td>
<td>731,131</td>
<td>5.20</td>
<td>1,556,539</td>
<td>15.82</td>
<td>2,129</td>
<td>10.08</td>
</tr>
<tr>
<td>2010-11</td>
<td>767,499</td>
<td>4.97</td>
<td>1,745,811</td>
<td>12.15</td>
<td>2,275</td>
<td>6.85</td>
</tr>
<tr>
<td>2011-12</td>
<td>765,317</td>
<td>-0.28</td>
<td>1,846,142</td>
<td>5.74</td>
<td>2,412</td>
<td>6.02</td>
</tr>
</tbody>
</table>

Source: Government of Nepal, 2012

1.5.2 Rice in Nepal

Rice production in the Nepal is very important for food supply in the country and the National Economy. Rice stands first among the cereal crops in Nepal. It is also the main staple food and provides more than 50 percent of the total calories required to the Nepalese people (Basnet, 2008).

Production of rice increased by 13.72 percent and reached 507,2248 tons as compared to the previous year’s 446,0278 tons. Major reason for such increased paddy production was the
sustained monsoon season that generally begins in June. The monsoon season remained active from June to September which contributed to increase the yield per hectare and ultimately the overall production of rice. Despite all these factors, the total paddy cultivation area increased by 2.33 percent compared to the previous year (Government of Nepal, 2012).

Table 1.7: Area, Production and Yield of Rice in Nepal

<table>
<thead>
<tr>
<th>Year</th>
<th>Area Hectares</th>
<th>% change</th>
<th>Production Tons</th>
<th>% change</th>
<th>Yield (Kgs/Hec)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003-04</td>
<td>1559436</td>
<td>0.95</td>
<td>4455722</td>
<td>7.82</td>
<td>2857</td>
<td>6.80</td>
</tr>
<tr>
<td>2004-05</td>
<td>1541729</td>
<td>-1.13</td>
<td>4289827</td>
<td>-3.72</td>
<td>2782</td>
<td>-2.62</td>
</tr>
<tr>
<td>2005-06</td>
<td>1549447</td>
<td>0.50</td>
<td>4209279</td>
<td>-1.87</td>
<td>2717</td>
<td>-2.33</td>
</tr>
<tr>
<td>2006-07</td>
<td>1439525</td>
<td>-7.09</td>
<td>3680838</td>
<td>-12.55</td>
<td>2557</td>
<td>-5.88</td>
</tr>
<tr>
<td>2007-08</td>
<td>1549262</td>
<td>7.62</td>
<td>4299246</td>
<td>16.80</td>
<td>2775</td>
<td>8.52</td>
</tr>
<tr>
<td>2008-09</td>
<td>1555940</td>
<td>0.43</td>
<td>4523693</td>
<td>5.22</td>
<td>2907</td>
<td>4.75</td>
</tr>
<tr>
<td>2009-10</td>
<td>1481289</td>
<td>-4.79</td>
<td>4023823</td>
<td>-11.05</td>
<td>2716</td>
<td>-6.57</td>
</tr>
<tr>
<td>2010-11</td>
<td>1496476</td>
<td>1.02</td>
<td>4460278</td>
<td>10.84</td>
<td>2981</td>
<td>9.75</td>
</tr>
<tr>
<td>2011-12</td>
<td>1531493</td>
<td>2.33</td>
<td>5072248</td>
<td>13.72</td>
<td>3312</td>
<td>11.10</td>
</tr>
</tbody>
</table>

Source: Government of Nepal, 2012

1.6 The Rice Wheat System and Sustainability Issues

The intensively cultivated rice wheat system in South Asia is crucial to employment, income, and livelihoods for hundreds of millions of rural and urban people in the region (Ladha et al., 2003). With the adoption of HYVs in the 1960s and 1970s, farmers in the irrigated areas of rice wheat zone got higher yields and found it more profitable and suitable to earn high income. Further, by assessing the high response of HYVs to chemical fertilizers and more irrigation, they continued to apply different types of chemical fertilizers extensively resulting in tremendous increase in the use of fertilizers for rice and wheat in the intensive rice-wheat belts. Thus the system was bit overharvested that threatened the productivity and sustainability because of the following key factors.
1- Inefficient use of inputs (fertilizer, water, labor).
2- Increasing scarcity of resources, especially water and labor.
3- Changes in climate.
4- Changes in land use (cropping practices and cropping systems) driven by various factors.
5- Socioeconomic changes (urbanization, labor migration, changing attitude of people to shun away from farm work).
6- Concerns about farm-related pollution.

The rice wheat production system of South Asia therefore suffers from conflicts in economic, social, climatic, ecological, and production-related objectives (Aggarwal et al., 2001).

The recent triple global crisis “food, financial, and economic” have also contributed to worsen the situation and adversely affected the livelihoods and threatened the existence of poor producers and consumers of developing countries. This is due to the increasing prices of farm inputs in relation to outputs, stagnant or decreasing crop productivity, fewer off-farm work opportunities for supplementing farm income, reduced remittances from relatives working outside villages, and declining income and purchasing power of poor consumers (Alam et al., 2013).

### 1.7 Organic Agriculture: Definitions and Concept

The term "organic agriculture" refers to an approach which involves the environment friendly methods from the production stages through handling and processing. Organic production is not merely concerned with a product, but also with the whole system used to produce and deliver the product to the ultimate consumer.

There are two main sources of defining general principles for organic agriculture at the international level. One is the Codex Alimentarius Guidelines for the production, processing,
labeling and marketing of organically produced foods. According to Codex, "Organic agriculture is a holistic production management system which promotes and enhances ecosystem health, including biological cycles and soil biological activity. Organic agriculture is based on minimizing the use of external inputs, avoiding the use of synthetic fertilizers and pesticides. The technologies and practices involved in organic agriculture, however, cannot ensure that organic products are completely free from chemical residues caused by general environmental pollution. These methods tend to minimize any type of impurity that is harmful to health. Organic food handlers like processors and retailers follow the specified standards to maintain the integrity of organic products. Organic agriculture is the most sustainable form of agriculture and its main goal of is to maintain health and sustain productivity of agriculture (FAO, 2002).

The second source is the International Federation of Organic Agriculture Movements (IFOAM), a private-sector international body uniting more than 750 member organizations in 116 countries. IFOAM defines and regularly reviews the basic standards for organic products. According to IFOAM, "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved” (IFOAM, 2011).

1.8 Organic Agriculture in South Asia

The Table 1.8 shows the data of certified organic agriculture in South Asia lead by India with 1180 thousand hectares followed by Sri Lanka, Pakistan, Nepal and Bangladesh. But there may be thousands of traditional farms in these countries which can be considered non-certified organic farms. Although, economic viability and profits are important to all farmers but the non-certified organic farmers who mostly produce to fulfill their domestic needs and are not market driven, strive to establish more diversified systems.
Small organic farmers in South Asia are being supported by Community Organizations, NGOs and Farmer’s Cooperatives to certify their products by developing alternative certification methods and marketing channels. Mostly, their products are marketed in the local urban markets. The International Federation of Organic Agriculture Movements (IFOAM) has introduced Participatory Guarantee System with a well developed internal control system to facilitate small farmers to grow according to the internationally agreed organic standards.

### Table 1.8: Certified Organic Area in South Asia

<table>
<thead>
<tr>
<th>Country/Year</th>
<th>2012</th>
<th>2011</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hectares</td>
<td>Producers</td>
<td>Hectares</td>
<td>Producers</td>
</tr>
<tr>
<td>India</td>
<td>500000</td>
<td>600000</td>
<td>1084266</td>
</tr>
<tr>
<td>Pakistan</td>
<td>22397</td>
<td>105*</td>
<td>24924</td>
</tr>
<tr>
<td>Nepal</td>
<td>10273</td>
<td>247*</td>
<td>9892</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>19517</td>
<td>404*</td>
<td>19469</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>6860</td>
<td>9337</td>
<td>6810</td>
</tr>
</tbody>
</table>

*: Data were provided by international certifiers. The number of producers provided in the Table is in fact the number of clients, to each of which a number of producers might be associated.

Sources: FiBi, 2012, 2013, 2014

### 1.9 Need for the Study

The comparison between the economic performances of organic and conventional farming systems in the world presents a complex situation due to variations in results by product and region. (Bayramoglu and Gundogmus, 2008). Therefore, the techniques and methods of organic
agriculture pose serious research questions regarding productivity and efficiency in comparison with conventional agriculture methods.

In spite of the application of different analytical methods, a little attention has been devoted to efficiency for the comparison of two methods of farming. Studies on comparative productivity, yields and cost of production are quite important but comparison of organic and conventional methods of farming based on efficiency would give complete information and suitability analysis of organic agriculture in different regions. So, a comparison between organic and conventional farms based on profit efficiency will be a good approach to assess the farmers’ management abilities in optimizing internal resources.

1.10 Objectives

- To analyze the comparative profit efficiency of organic and conventional; rice and wheat crops in South Asia.
- To determine the factors affecting the efficiency of organic and conventional; rice and wheat crops in South Asia.
- To analyze the present policy framework in South Asia supportive to organic production systems.
- To devise suggestions and recommendations for future policy options.

1.11 Hypotheses

The following hypotheses are presented and tested:

1- Wheat and Rice farmers following organic and conventional farming systems are not operating on efficient profit frontier.

2- Factors like education, experience, access to credit, linkages with extension services, off-farm employment and area under wheat or rice crops affect the observed level of profit inefficiency among organic and conventional; rice and wheat farmers.
1.12 Organization of Study

The study is organized into five chapters. Chapter 1 has been detailed earlier which comprised of background, importance of rice wheat farming system in South Asia, organic agriculture; definitions and concepts, need for the study, objectives of the study and different hypotheses which are tested in the study. Chapter 2 discusses the review of efficiency studies with special focus on profitability studies conducted on organic agriculture in comparison with conventional agriculture and efficiency studies on rice and wheat. Chapter 3, materials and methods, characterizes analytical foundation of profit efficiency measurement, empirical model, stochastic profit function and inefficiency model. Chapter 4 describes the results and discussion, depicting the comparative analysis of profit efficiencies of both organic and conventional farms. In this chapter, estimates of stochastic frontier profit function and inefficiency models are discussed. It also elaborates the policy framework for organic agriculture in South Asia. Chapter 5 winds up the study with summary, conclusion, suggestions and possible further research areas. References and appendices are given at the end.
CHAPTER 2

REVIEW OF LITERATURE

The main focus of this chapter is to review the past studies on efficiency and profitability of organic in comparison with conventional agriculture and efficiency studies conducted on rice and wheat. The literature on efficiency studies has been compiled by following certain criteria. The first section of this chapter focuses on efficiency and profitability studies conducted to compare the organic agriculture and conventional way of farming. The second section contains the review of efficiency studies on rice and wheat from South Asia. The third section is devoted to review of efficiency studies on rice and wheat conducted outside South Asia. The last section envelops the chapter in the form of summary.

2.1 Review of Efficiency and Profitability Studies Conducted on Organic Agriculture

Cacek and Langner (1986) suggested that according to experimental plot data organic farming gave better results than conventional farming and found economically feasible and efficient. Main objective of the study was to highlight the unseen benefits of organic farming. They concluded that organic agriculture benefited society substantially by conserving energy, soil, nutrients and wildlife, contributed to insure the supply of food for future generations and reduce the pollution and flooding. However, due to unavailability of credible and sufficient data, policy makers were unable to magnitude of these benefits and compare organic farming with other policy alternatives. They further concluded that the studies that used economic modeling based simulations only showed lower returns from organic farming and the benefits of organic production systems were underestimated by the assumptions of these economic models. The study suggested that the impact of organic agriculture on input suppliers, food market chain and rural communities should also be assessed by policy makers. The study further suggested that
policy barriers for conversion to organic farming should be identified and evaluated where it was found economically feasible.

Lampkin (1990) argued that transition from conventional to organic systems would lower the variable and fixed costs that might be the cause of overall yield decrease. He finally made a conclusion that net income of organic farming was comparable but recorded little lower than conventional farms. He further concluded that the case studies about economics of organic farming found it profitable and comparable with conventional production. It was also based on relative skills and management abilities of the farmers.

Lampkin (1999) made an assessment of the performance of organic agriculture with respect to sustainability. The main objective of the study was to analyze the organic farming in the context of supply and quality of food and fiber, the sustainability of natural resource base with organic farming, the financial viability of organic farming, the social and cultural identity of rural communities and the ecosystems influenced by agriculture. The comparison was made with conventional integrated and intensive farming systems. The study concluded that conventional and intensive farming systems might be useful in ensuring the food security due to more yield and could also be financially viable but organic farming could be more useful than conventional farming in ensuring the social and cultural identity of rural people, sustainable use of natural resources and contributing to sustain environment. The study concluded that no farming system could be defined as truly sustainable due to multi-objective nature of sustainability in agriculture and advantages and disadvantages of different approaches. Organic agriculture was often considered to be a sustainable form of agriculture but in many circumstances, conventional farming systems might also claim the title of sustainability.

Tzouvelekas et al. (2001) conducted a study to compare the technical, allocative and economic efficiencies of organic and conventional cotton farms in Greece. They used the stochastic production frontier to determine the efficiencies. The results revealed that both organic and conventional farms examined in the study were technically, allocatively and economically
inefficient. The average gross revenue for organic and conventional farms remained 74428 and 86700 drachmas per stremma respectively while the average profit was 7133 and 16082 drachmas per stremma for organic and conventional cotton farms, respectively. The results indicated that conventional cotton farms were technically, allocatively and economically more efficient with efficiency scores 80.40, 82.04 and 65.96 respectively as compared to organic cotton farms with technical, allocative and economic efficiency scores 71.63, 80.25 and 57.48, respectively. The study concluded that inefficiency in both farming approaches was due to the interventional policies of last twenty years especially the protective schemes enjoyed by the Greek cotton farmers. The study suggested that alternative strategies should be employed to sustain the economic viability of sector.

Lohr and Park (2004) assessed the production efficiency of organic farms by using a stochastic distance function approach. They evaluated the effects of farm specific attributes by using the data of national survey of organic farmers from Organic Farming Research Foundation, United States. Regional and farm specific variables like use of soil-improving inputs, farmer’s participation in research and farmer’s experience of doing organic farming were included in the model. The results revealed that input use and farm effects created differences in productivity across farmers. It was observed that participation in research significantly contributed to decrease the level of technical inefficiency. The farmers who participated in research projects had mean technical efficiency 25 percent higher than the non-participating farmers while research commitment increased the overall technical efficiency from 75 to 87 percent. The results about self-sufficiency in soil improving inputs and organic farming experience were not significant as newly converted organic farmers were more efficient than original organic farmers. The study suggested that farmer participatory research programs should be launched to improve the efficiency of organic farms.

Cisilino and Madau (2007) concluded in a study on comparison of organic and conventional production systems that overall average gross production of conventional farms were better than the organic farms but the net income of the organic farms was averagely little higher than
conventional ones but comparable. That showed a similarity in two groups in utilizing the factor resources to produce yield and finally income. They also indicated another quality of organic farms that they utilized the labour force more efficiently and contributed to increase livelihood opportunities for farm labour. They also conducted an efficiency analysis to assess the performance of two farming systems and found that organic olive farms remained more efficient in using the disposable and on-farm resources. The high efficiency on organic farms (0.709) also allowed them to compensate more labour as compared to conventional farms (0.581). The study further identified that the aspect of transition period required to convert the conventional farming system to organic should be the focus of future research.

Madau (2007) conducted a study on technical efficiency in organic and conventional farming with the application of frontier production model. A sample of organic and conventional cereal farms was used for analysis. The main objective of the study was to make an assessment on the relative efficiencies of both farming techniques. The analysis revealed that two production systems might be on different frontiers showing difference of application and factor resource use. The two techniques were also assessed separately and the analysis revealed that due to innovative and specific technology and heavy mechanization at conventional farms, they were found more efficient than organic farms, at the efficiency level 0.902 compared to 0.831 for organic farms. The study indicated that organic farms had structural inadequacies in comparison with conventional farms and inefficiency affected the production in organic farms more than in conventional farms. The study further suggested that agri-environmental subsidy was not sufficient to compensate the structural problems in organic farms and integrated policies could ensure the rational development of the sector.

Bayramoglu and Gundogmus (2008) conducted a study on cost efficiency of organic farming in comparison with conventional farming in Turkey. The study used the technique of Data Envelopment Analysis and computed relative, overall and input oriented efficiencies of both techniques in the rural areas of Turkey. The data was collected from forty four organic and thirty eight conventional farms selected by stratified random sampling. The results indicated that average cost and technical efficiency for organic farms were 0.712 and 0.862, respectively, while
average cost and technical efficiency remained 0.844 and 0.903, respectively, for conventional farms. According to the efficiency scores and different returns to scale, it was concluded that conventional households were on average more efficient than organic. The study suggested that national institutions should devise policies for the improvement of technologies especially for the organic farming. The development of specialized marketing channel for organic produce could also bring improvement in efficiency of organic farms.

McBride and Greene (2008) conducted a study on the profitability of soybean grown by organic and conventional methods by using the data from Agricultural Resource Management Survey that targeted 19 states of United States of America. They used the treatment effects models to analyze the data. The results indicated that similar yields with lower cost of production were possible by organic method as compared to conventional. The range of Organic soybean costs remained $1 to $6 per bushel higher than conventional soybeans but the average organic price premium was more than $9 per bushel in 2006 and that price premium remained high in 2007 and 2008. Due to the reason, organic farmers received higher returns by significant price premium of organic produce. The study concluded that establishment and sustainability of organic market with significant interest of the consumers in organic produce was the key for higher organic production and returns that also raised the interest of the farmers for growing organic soybean.

Sipilainen, et al. (2008) conducted a study to compare the technical efficiency of biodiversity based organic and conventional farming. They used Finnish farm data from 1994 to 2002 and applied non-parametric approach (Data Envelopment Analysis) to measure the efficiency. They argued that increase in biodiversity and enhancement of environmental quality was often ignored during measurement of efficiency that’s why they included crop diversity index as an indicator of environmental output. The results indicated that conventional crop farms were more technically efficient than organic farms in a pooled data set when only a single crop output was considered but the difference between production techniques vanished by taking the crop diversity into account. The separate analysis of organic and conventional farms also indicated
that average efficiencies of the two methods were not significantly different. The study concluded that crucial inclusion of crop diversity as a desirable output proved to increase the technical efficiency of organic farming compared to conventional. As society would prefer more diversity to less confirming that conventional farming were no longer more efficient than organic farming.

Hernandez and Cervantes (2009) examined and analyzed the process of building self sufficient food systems by organic farmers in rural zones of Mexico. The main hypothesis was that the increase in local consumption of organic products would ensure self-sufficiency in local economic systems. That notion gave an alternative to sustain local economy totally against the export oriented market and high input industrial agriculture that mainly affected the small farmers with loss of self sufficiency in food. The study analyzed that organic farming proved to be the suitable alternative due to its dependency on farm resources which reduced the financial vulnerability of small farmers. The study also revealed that socioeconomic networks were supporting he organic farming in Mexico. The study concluded that organic farming would be an alternative policy to address poverty. Organic farming would also be beneficial for health care with availability of safe food free from pesticides and fertilizers. The improvement in environmental conditions was another aspect attributed to organic farming.

Tzouramani, et al. (2009) conducted a study on policy implications for organic agriculture by using a real options approach. This paper explored the effectiveness of policy measures introduced by the Greece Government for the production of organic and conventional cherries by estimating the efficiencies. The results indicated that the economic incentives compensated for the risk and the uncertainty in the cherry production. The results revealed that the investment in conventional farming found to be profitable even with 100 percent increase of the prices of fertilizers and pesticides but that was not the case for organic cultivation. The NPV criterion showed that investment would be profitable without subsidies for organic farming but modified criterion rather resulted to a non-profitable investment. The study suggested that organic farmers should be careful about future policy options and expectation about price premium offered by
different markets. The study concluded that the use of the modified NPV criterion seemed appropriate to avoid misleading results in investment decisions in the uncertain and irreversible agriculture sector.

Vassalos, et al. (2009) conducted a study by taking a case of conventional and organic farming of Lake kerkini district, Greece by using mixed integer non-linear programming method. The main objective of the study was to compare the economic performance of multifunctional (organic) and conventional farms for farm decision-making process. The results of this study indicated that, for every farm type, multifunctional farms had better economic performance than the conventional ones. Moreover, the results illustrated that young farm managers were keener to adopt multifunctional farming compared to older ones due to risk averse nature of elderly farmers and their short planning horizon which prevented them from changing their set of enterprises and crop selection. The study concluded that difference of behavior between young and older could be attributed to the fact that older managers had learned to operate under a different environment.

Charyulu and Biswas (2010) conducted a study in four different states of India having different ecological and environmental conditions. The purpose of study was to compare the relative efficiencies of organic farming with conventional. Four major crops like sugarcane, cotton, wheat and paddy were selected with special purpose of assessing the performance of these major crops under different conditions and applying two different methods. The study was conducted in four states namely Punjab, Gujarat, Maharashtra and Uttar Pradesh. Non parametric approach (Data Envelopment Analysis) was followed to assess the data and measuring efficiency. The results showed the mixed results. The paddy and wheat organic farmers were experiencing higher cost of production than conventional farmers while cotton and sugarcane organic farmers were experiencing lower cost of production than conventional. The efficiency analysis revealed that organic farmers were less efficient than conventional farmers. The study finally concluded that there were bright chances for increasing the efficiency of organic farms.
Mayen et al. (2010) conducted a study to compare the technical efficiency and productivity of organic and conventional dairy farms in the United States by using stochastic frontier model. They used the data of about costs and returns from Agricultural Resource Management Survey 2005. They utilized propensity score matching to address the potential self selection in the choice of diary production system for comparison and tested the hypothesis that organic and conventional farms were using the homogenous technology. The results revealed that organic and conventional dairy farms were not using the homogenous technology confirming organic dairy technology was approximately 13 percent less productive than conventional farms. The average technical efficiency for organic dairy farms came out to be 81.73 percent slightly lower than the average technical efficiency of conventional farms that remained 83.60 percent. The difference between average technical efficiencies was not statistically significant. The study concluded that difference between technical efficiencies were due to difference in technology between organic and conventional dairy farms.

Reddy (2010) reviewed the past studies and attempted to discuss different issues in organic farming. The literature reviewed revealed that there was a strong consensus on availability of safe food and eco-friendly nature of organic farming but there was also disagreement on profitability and yield of organic agriculture. There was strong criticism on ability of organic farming to feed a billion people round the world, its economic viability, diffusion of knowhow and availability of inputs. On the other hand, many studies proved that organic farming was productive and sustainable. Many others recommended that conventional farms should carefully be converted to organic to avoid the yield loss. The study analyzed that there were lack of government support to promote organic farming and in Indian scenario there were very few studies available on economic viability and ecological benefits of organic farming in comparison with conventional farming. The study further analyzed that organic agriculture had been neglected in agriculture policy and all agricultural support in the form of agriculture extension services, research and subsidies, was directed for the promotion of conventional farming. The study recommended that organic farming could be promoted with proper encouragement of Government especially in dry land areas where climatic and soil conditions were feasible.
Samie *et al.* (2010) carried out a study aiming to compare the profitability and resource used efficiency of organic and conventional farming systems. The data from 15 partial organic and conventional farms was collected from District Sheikhupura for Rabi season crops. The results showed that organic farms were more profitable under the assumption of zero opportunity cost of family labour. However, conventional farms remained more profitable when family labour was evaluated at average market wage rate. The results of Linear Programming (LP) revealed that irrigation was a limiting factor. It implied that potential of organic farming could be explored by improving the availability of canal water. The results of LP for conventional farming showed that the shadow price of land followed by canal water were crucial factors to increase the profitability of poor farmers in conventional farming systems. The study did not define clearly the partial organic systems as most of the farmers in Punjab, Pakistan follow techniques of organic farming. The study also ignored some important variables like soil fertility and tillage practices that were widely discussed in the introduction of study. The sample size of 15 organic and conventional farmers was also insufficient to draw results and make conclusions.

Tzouramani, *et al.* (2010) assessed the agricultural policy incentives for organic agriculture in Greece by using a real options approach. The main objective was to analyze the effectiveness of current supportive policies for organic livestock farming to avoid the risk and uncertainty involved in organic farming. They tested the three investment opportunities to suggest actions by the farmers including the improvement of an organic sheep farm, the establishment of a new organic sheep farm and the improvement of a conventional sheep farm. The results suggested that without investment subsidies organic sheep farming was not attractive to the farmers. Subsidies on organic farming had been central to farmer’s adoption decision and remained the driving force to increase the number of certified farms. The results further revealed that organic farmers were facing greater variability in milk yield and price hence variability in annual returns. The study suggested that establishment of organic market would be an important step to save the organic farmers and use of milking machine would increase the efficiency, improve the quality of milk and farmer’s life.
Mehmood et al. (2011) attempted a study to compare the benefit cost ratios of organic and inorganic wheat production on per acre basis in District Sheikhupura. The district was divided into three strata and from each stratum two villages were selected. From each village five organic and conventional farmers were selected to collect the data. The results showed that cost of production for organic wheat on per acre basis was less than inorganic but benefit cost ratio was higher for organic wheat (1:1.08) than inorganic (1:1.01). The study just focused on calculation of cost of productions and benefit cost ratios and did not employ any advanced economic and statistical techniques to assess the significance of different explanatory variables and their relationship to the dependent variable. The other major limitation of the study was that it did not take into account the socio-economic factors that could affect the decision making at farm level, adoptability of organic farming and yield. The sample size in the study was only 30 organic and inorganic farmers that was quite insufficient to draw results and conclusions.

Mehmood et al. (2011) conducted a study to evaluate the benefit cost ratio among organic and inorganic rice farmers in district Sheikhupura, Pakistan. The data was collected from three zones of the District Sheikhupura by stratified random sampling. The results revealed that cost of production of inorganic farmers was 21.5 percent higher than the organic farms. The gross income for inorganic farms was also 15 percent higher than organic farms. The benefit cost ratio of organic farms was 1.147 higher than that of inorganic farms (1.044). The major limitation of the study was that it ignored the socio-economic variables like education, availability of capital experience which affect the farm decisions, adoptability of organic farming and yield. The sample size of 30 organic and inorganic farmers was also insufficient to draw results and make conclusions.

Singh and Grover (2011) assessed the economic viability of organic wheat farming in comparison with conventional wheat farming in Punjab, India. The data was collected from eighty five organic and seventy five conventional farmers in thirty villages of districts, Patiala and Faridkot. The major share of total operational area of organic farms was covered by wheat crop which was accounted 15 percent. It was observed that organic fields had wide varietal
distribution than conventional farms. The average variable cost for organic wheat was found to be less than conventional wheat while net returns over variable cost for organic wheat came out to be Rs. 21985/acre as compared to conventional that was Rs. 16700/acre. The crop yield of organic wheat remained 6.7q/acre less than conventional wheat but it was well compensated by premium market price received by the organic farmers. The results indicated that one percent increase in farmyard manure, jeev amrit and machine labour would increase the wheat productivity by 0.114, 0.703 and 0.556 percent, respectively. The study concluded that though the profitability of organic wheat is better than conventional wheat but significant reduction in its yield could pose serious challenge of food security at national level.

McBride et al. (2012) examined the profitability of organic wheat crop production in comparison with conventional wheat crop. They used the data from Agricultural Resource Management Survey of United States of America for 2009 crop. They used the treatment effects models to analyze the data. The results based on long-term experimental trials indicated that similar yields with lower cost of production were possible by organic method as compared to conventional but little information were available about the relative costs and returns on commercial farms. Average conventional wheat yields were much higher than for organic wheat, but per acre operating plus capital costs were lower for organic wheat. The results indicated that operating costs per bushel for conventional wheat were higher than for organic wheat, but total economic costs were about $2 to $4 per bushel higher for organic wheat. Average price premium for organic wheat remained $3.79 per bushel in 2009 and that was enough to compensate the difference in operating and capital costs of organic and conventional wheat. The study suggested that the results were based on only a single year data and a thorough study based on multi-year data was needed to assess the economic returns of organic systems.

2.2 Review of Efficiency Studies on Rice and Wheat from South Asia

Huang, et al. (1986) investigated the economic efficiency of large and small farmers in two states of India by using stochastic profit function. Results showed that the individual economic efficiencies were better for the large farms than the small farms. The average economic
efficiency was 84 percent for the large farms while it was 80 percent for the small farms. The study also indicated that there was a great scope to increase the profit both by large and small farmers with the availability of resources and technology.

Kalirajan and Shand (1989) conducted a study to estimate the technical efficiency of paddy farmers of Tinnevely district of South India by using translog production frontier model. Data of 34 farmers were collected for analysis. The average level of technical efficiency came out to be 70.2 percent with higher percentage of 91 and lower value of 64 percent. The study also took into account to test the technical efficiency was time variant. For this, stochastic frontier was estimated separately for each cross section. Chi-square was used to test the null hypothesis that parameters for each pair of frontier, one pair at a time, were the same. The pair wise comparison showed that technical efficiency was time invariant for the sample. A linear model was used to analyze the relationship between socio-economic variables and level of efficiency. The results showed the positive relationship between socio-economic variables and technical efficiency.

Battese and Coelli (1992) used the stochastic production frontier model approach to measure the technical efficiency of paddy farmer in India. An application of the model was presented by using the data from 14 farmers from the village Aurepalle, observed over a ten-year period. The results indicated that the constant terms like age, schooling of the farmers and year of observation in the models of technical efficiency effects, contributed significantly in the stochastic frontier production function. The study also showed that the model specification permitted the estimation of both technical change and time-varying technical inefficiency.

Banik (1994) estimated a stochastic model to determine the technical efficiency of individual rice farms in Choto Asulia village of Bangladesh. The data was collected from 99 farmers and average yield was estimated 2.6 tons per hectare, which was quite lower than the potential yield. The results showed the wide variation in level of technical efficiencies across the farms, e.g. the minimum efficiencies in the sample were found to be 10 percent while the maximum remained 97 percent respectively. The average technical efficiency of entire sample of farms was 78
percent, indicating that there was consideration scope for increasing the potential efficiency of small farms. The author found that inefficient extension service was responsible for the low level technical efficiency. It was found that inadequate uses of fertilizers at inappropriate timings were also among the main causes of technical inefficiency. The study revealed that the tenant farms were more efficient than owner farmers, due to high use of chemical fertilizers.

Battese et al. (1996) estimated technical inefficiencies by using a single stage model of production in a stochastic frontier production function. They analyzed the panel data of wheat farmers from selected districts of Pakistan. It was observed that the technical inefficiency effects were highly significant revealing that the traditional production function model was not adequate for the analysis of wheat production of the four districts involved. For example, in Faisalabad District, technical inefficiencies of production tended to be smaller for older farmers and those with greater formal schooling. Secondly, the wheat production level for Faisalabad farmers tended to reach their potential frontier production levels over time without any evidence of technical change. The study concluded that the mean technical efficiencies ranged from 57 percent to 79 percent in the four districts and showed considerable variation over time within each district.

Sharif and Dar (1996) computed the technical efficiency among Bangladeshi farmers in cultivation of traditional and High Yielding Varieties (HYVs) of rice by using production frontier and corrected ordinary least square (COLS) method. They observed the greater variability in technical efficiency in cultivating HYVs. They concluded that farmers growing HYVs were more technically efficient than the farmers growing traditional varieties. They further observed that education and farm size were having positive but diminishing effect on efficiency.

Ahmad, et al. (1999) used the Cobb-Douglas stochastic production frontier to estimate farm specific technical efficiency of rice farms in Punjab, Pakistan. The results indicated that mean technical efficiency of sampled farms came out to be 85 percent ranging from a minimum of 57
percent and a maximum of 96 percent. The study proved that linkages with extension services and availability of credit contributed significantly to influence the technical efficiency positively. Moreover, educated and more experienced farmers also realized high outputs and thus technical efficiency but the impact was not statistically significant. The study concluded that considerable scope existed in the sampled area to increase the technical efficiency and output of rice farmers with improvement in the farm management capacity of farmers by enhancing education and provision of other facilities like extension services and availability of credit on time to the farmers.

Kebede (2001) analyzed different distributional assumptions on the estimation of stochastic frontier models and made a comparison of estimated results for technical efficiency of paddy farms in Nepal. He obtained maximum likelihood estimates of technical efficiency from half normal stochastic frontier model. The average paddy farm efficiency came out to be 71 percent showing that improvement in the technical efficiency was possible. He concluded that large elasticity of labour and high statistical significance showed that it was an important input in paddy production. Farming experience, education and geographic location of farm remained significant variables to improve the efficiency level. In addition, availability of on time credit facility was also recommended as important variable to determine the efficiency.

Ahmad et al. (2002) used the farm-level survey data and estimated the stochastic frontier production function for wheat farmers in three provinces (Punjab, Sindh and NWFP now KPK) of Pakistan. The mean technical efficiency came out to be 68 percent implying that wheat farmers were producing 32 percent less than the achievable potential output. The results showed that balanced use of fertilizer nutrients and access to more reliable source of irrigation significantly increased the wheat productivity. The study highlighted that technical efficiency of wheat had an inverse relationship with the proportionate farm area under rice crop to raise the serious question about the sustainability of the rice-wheat cropping system and the food security goals while no relationship of wheat productivity was found with proportionate farm area under cotton crop. The results revealed that wheat farmers in Punjab were more technically efficient as
compared to wheat farmers in Sindh and NWFP due to better access to irrigation sources and linkages with extension services. The results concluded that farm size, education, linkages with extension services and access to credit negatively impacted the technical inefficiencies.

Coelli, et al. (2002) determined technical, allocative, cost and scale efficiencies of Bangladeshi rice farmers by following a nonparametric approach. In the dry season, technical, allocative, cost and scale efficiencies came out to be 69.4, 81.3, 56.2 and 94.9 percent, respectively. The results for the wet season were almost same with few changes. The results of the inefficiency effects models showed that large families were less efficient, while, the farmers who had better access to the input markets and doing less off-farm work remained more efficient by giving more time to their farms.

Rahman (2003) conducted a study on rice farmers in Bangladesh. He used the data of 1996 and applied profit frontier model to assess the efficiencies. The results showed that there were high levels of profit inefficiency in modern rice farming. The mean level of profit efficiency came out to be 64 percent ranging from 4 to 93 percent suggesting that an estimated 36 percent of the profit is lost due to a combination of both technical and allocative inefficiency in modern rice production. The mean profit efficiency for Aman rice crop was 60 percent ranging from 3 percent to 94 percent while mean profit efficiency for Aus and Boro rice crop was 64 percent ranging from 11 percent to 92 percent. The study concluded that level of infrastructure, linkages with extension services, tenancy and share of non-agricultural income largely explained the differences in profit efficiency.

Dhungana, et al. (2004) estimated the technical, pure technical, scale, allocative and economic efficiencies of rice farmers in Nepal. Date envelopment analysis approach was followed to estimate the efficiencies. Results showed that technical, pure technical, scale, allocative and economic inefficiencies were 24, 18, 7, 13 and 34 percent respectively. Mechanical power, seed, fertilizers and labour cost contributed significantly to affect the level of inefficiency across sample farms. Second stage tobit regression model was used to determine the inefficiency model.
Results further indicated that farm specific variables such as education, gender of farm managers, age and family labour endowment were directly associated with variation in the efficiency.

Hassan (2004) conducted a study to estimate the technical efficiency of wheat producers in mixed farming systems of Pakistani Punjab by using stochastic production frontier incorporating technical efficiency effect model. Given the specification of translog production frontier model, the Cobb Douglas production function was declared suitable to represent the data. The study found that wheat farmers were operating at constant return to scale with the mean predicted technical efficiency at 94 percent. Number of cultivations, fertilizers, weedicide cost and area under wheat crop were declared responsible for increasing the wheat production while the results of inefficiency model showed that technical inefficiency could be reduced by raising the education of farmers, provision of credit on time, sowing the crop on time and by drill method. The shortage of canal irrigation water was found to decrease the technical efficiency of wheat farmers in mixed farming systems of Pakistani Punjab.

Abedullah, et al. (2007) estimated the technical efficiency of rice farmers in Punjab, Pakistan. The study revealed that rice farmers were technically efficient with the score of average technical efficiency 91 percent suggesting that little potential to improve the efficiency existed in rice production that could be gained through resource use efficiency improvement. The coefficient of pesticide came out to be non-significant that might be due to heavy pest infestation. The fertilizers were found to have negative impact on rice production due to improper combination of N, P, and K nutrients. The unbalanced combination of inputs indicated the poor outreach and dissemination of extension services. The study further suggested that by strengthening the role of extension department could contribute significantly to enhance the technical efficiency and productivity of rice. The study recommended that role of agricultural credit supply institutions should be improved to enhance investment on farm machinery especially on tractors to improve the efficiency in rice production.
Singh (2007) conducted a study to estimate the farm-specific technical efficiency of wheat farmers in Haryana state at the aggregate and disaggregate levels by using stochastic frontier approach. At aggregate level, the mean technical efficiency came out to be 73 percent while it was 75, 73 and 74 percent for small, medium and large farms, respectively. The results indicated that higher level of technical inefficiency in wheat farming was due to the farmer’s inefficiency in decision making and improvement in production and efficiency was possible without increasing the quantity of inputs. The study concluded that small farmers were relatively more efficient than medium sized and large farmers due to more motivated family labour than medium and large farmers and beneficiary policies programmes for small farmers at state and central levels.

Rahman and Hasan (2008) conducted a study to analyze the impact of controlling the environmental production conditions on efficiency of rice farmers in Bangladesh. The results indicated that environmental production conditions significantly affected the parameters of the production function and technical efficiency. The improvement in efficiency by 4 points from 86 percent to 90 percent was found by controlling of environmental production conditions. The study revealed that large farms were more efficient than small and medium sized farms. They recommended that adoption of modern technology, increasing soil fertility, promotion of education, strengthening research extension links and improvement in management practices would contribute to increase the farm efficiency.

Kachroo, et al. (2010) used stochastic frontier production function to estimate the technical efficiency of wheat farmers under irrigated and dry land conditions in the Jammu district of Jammu & Kashmir state, India. The mean technical efficiency of wheat farmers under irrigated conditions was better with efficiency score of 88 percent as compared to the wheat farmers under dry land conditions with efficiency score of 84 percent implying that average output of wheat can be increased by 12 percent and 16 percent under irrigated and dry land conditions, respectively. The results confirmed that inefficiency factor was not affected by random shocks where variance ratio $\gamma$ showed that the variation in output from frontier was due to technical
inefficiency. The study concluded that education contributed significantly to increase the level of technical efficiency in both farming systems. Larger number of male workers under dry conditions also influenced the technical inefficiency negatively.

Kaur, et al. (2010) analyzed the technical efficiency of wheat farms across semi-hilly, central and south-western regions of the Punjab state for the year 2005-06. The study found that mean technical efficiency of wheat production was 87, 94, 86 and 87 percent in semi-hilly, central, south-western and Punjab state as a whole, respectively. The results indicated that in south-western regions and semi-hilly regions, the wheat yield could be improved by 15 and 13 percent with better practices of technology while the central region farmers did not have much scope to improve technical efficiency under the existing conditions. The results showed that coefficient of area under wheat crop was positive and significant for central region while the coefficient of expenditure on pesticides was significant for semi-hilly region, indicating that increase in the expenditure on pesticides would in turn increase the wheat production in the said region. It was also observed that technical efficiency could be increased by enhancing the use of fertilizers in the semi-hilly and south-western regions. The study further concluded that the education, experience, age, and percentage area under the crop contributed significantly and positively influence the efficiency.

Narala and Zala (2010) estimated the efficiency of rice farms and assessed the effect of socio-economic factors on technical efficiency in different ecological zones of India. A stochastic frontier production function was estimated to determine technical efficiency of individual farms and variance as well as regression analyses were conducted to find the influence of socioeconomic factors. The study revealed that the farm-specific technical efficiencies range from 71.39 to 99.82 percent, with the mean of 72.78 percent, which indicated that on average, the realized output could be raised by 27 percent in the region with the available technology and resources. The study found that factors like operational area, experience, education and distance of field from canal structure were the most influential determinants of technical efficiency, while
the variable, number of working family members, showed significant but negative relationship with technical efficiency.

2.3 Review of Efficiency Studies on Rice and Wheat Conducted outside South Asia

Kalirajan and Shand (1986) measured the technical efficiency of rice farmers to analyze the impact of irrigation project in Malaysia. They used maximum likelihood method to estimate the parameters and found the significant difference in frontiers of two groups of farmers. The translog production frontier was used for analysis while study found that Cobb-Douglas model was inappropriate. The results indicated the individual technical efficiencies changed from 40 to 90 percent. The results also showed that new technology did not contribute significantly to increase the efficiency. The study finally concluded that introduction of new technology needed time to harvest expected results.

Kalirajan (1990) used the translog stochastic production frontier to measure the firm specific technical efficiency for a sample of 103 Philippine rice farmers. The mean technical efficiency came out to be 92 percent. The results also indicated that the nonfarm income contributed to reduce the technical efficiency significantly by consuming the time of the farmers and adding considerable share to the overall family income.

Squires and Tabor (1991) estimated a translog stochastic production frontier, by adopting maximum likelihood procedures to estimate crop specific technical efficiency in Indonesian agriculture. The results suggested that the technical efficiency estimates were higher for production of irrigated rice to the other crops. The mean technical efficiency estimates for Java rice and non-Java rice were 69 percent and 70 percent, respectively. A second step analysis showed that technical efficiency was not significant related to farm size.
Wang et al. (1996) used a profit frontier approach to analyze the efficiency of Chinese farms. Data was taken from China’s Rural Household Survey for 1991. The result showed the estimated efficiency index ranging from 6 to 93 percent and sample average came out to be 62 percent. Per capita net income, family size and education were found to affect the efficiency positively. They concluded that giving right to the farmers to use the land holding, decreasing market interventions and increasing access to education could improve the efficiency of the farmers in agriculture.

Abdulai and Huffman (2000) conducted a study on profit efficiency in Ghana based on data collected from 256 rice farmers. They found that inefficiency parameters were related to enterprise and household characteristics. It was also estimated that age of the farmers and non-farm incomes affected the technical efficiency of the farmers. The farmers who were in touch with extension system and other services like input distribution networks, produced good outcomes and remained more efficient than others.

Bakhshoodeh and Thomson (2001) estimated the input and output oriented technical efficiencies of wheat farmers in Kerman, Iran. The Cobb-Douglas frontier production function was used to establish relationship between farm level output oriented technical efficiency measure and an input oriented measure. The average efficiencies came out to be 0.93 and 0.91 respectively. The results showed that there was limited scope to increase the profitability of wheat farmers in Iran either by increasing the product at given level of inputs or by decreasing inputs at given level of wheat production.

Wilson, et al. (2001) used the stochastic production function frontier to estimate the technical efficiency of wheat farms in Eastern England. They used the panel data for the 1993-1997 crop years. The mean technical efficiency came out to be ranging from 62 percent to 98 percent. The results indicated that maximization of annual profits and maintaining the environment were positively correlated with technically efficiency. The study concluded that managerial experience
of farmers, flow of information and large size of the farms were also related to high level of technical efficiency.

Kwon and Lee (2004) estimated comparative productivity and efficiency by using parametric and non-parametric production frontiers. They used panel data of Korean rice farmers for the study. The results indicated that parametric estimations were found to produce higher level of technical efficiency than the non-parametric estimations. The productivity measures were also found to be different significantly. Both approaches showed that technological change contributed to improve the productivity and played important role in the growth of Korean rice farming by raising the level of efficiency across farms.

O’Donnell and Griffiths (2006) estimated the technical efficiency of rice farmers in Philippine by using fixed and random effects state-contingent production frontiers. The results revealed that estimation of production frontier in a state-contingent framework gave significantly different estimates of elasticities, technical efficiency and other quantities of economic interest than conventional stochastic frontier models.

Goni, et al. (2007) conducted a study to analyze the resource use efficiency in rice production in the Lake Chad area of Borno State, Nigeria. Data for the study were collected from 100 rice farmers in four villages. The study findings revealed that the farmers were inefficient in using almost all resources. The inputs such as seed, land and fertilizer being under-utilized contributed to raise the inefficiency level. The study further revealed that there was a dire need for making inputs such as fertilizer and improved seeds affordable to the farmers to improve efficiency. They also recommended that creation of alternative employment opportunities could absorb excess labour in rice production.

Shehu and Mshelia (2007) conducted a study on technical efficiency and productivity of small farmers in Adamawa State, Nigeria using stochastic frontier production function. Primary data were collected from 180 rice farmers selected by using multi-stage random sampling technique.
The study revealed that most of the farmers were operating in the irrational stage of production. The technical efficiencies ranged from 74 percent to 98.9 percent with a mean of 95.7 percent. The study further suggested that by improving the education of farmers through literacy campaigns and adult education programmes could lead to improvement in the technical efficiency scores and productivity.

Al-Hassan (2008) compared the farm-specific technical efficiency of irrigated and non-irrigated rice farms in Northern Ghana by using the fitted cross-sectional data into a transcendental logarithmic (translog) production frontier. The results revealed that rice farmers were technically inefficient and there was no significant difference found in mean technical efficiencies for non-irrigated and irrigated farms which came out to be 53 and 51 percent, respectively. The study identified education, provision of extension services age and family size as main determinants of technical efficiency. The study recommended that efficiency can be improved with the provision of both formal and informal education and training more qualified extension agents and motivating them to deliver.

Ogundari (2008) estimated the resource productivity, technical and allocative efficiencies of rainfed farmers in Nigeria. The results revealed that the herbicides had the highest elasticities among all inputs used followed by seeds, fertilizers and land while labour had the least contribution to the output. The mean technical efficiency came out to be 75 percent implying the 25 percent improvement in efficiency was possible among the farmers. The gamma (γ) value came out to be 0.873 suggesting the high level of technical inefficiency existed among the sampled farmers. The study further suggested that improvement in efficiency was possible by provision of extension service and raising farmer’s access to credit.

Tipia, et al. (2009) conducted a study to estimate the technical and scale efficiencies of sample rice farmers in the Balikesir and Edirne provinces of Turkey. They used an input oriented data envelopment analysis to estimate technical efficiency scores. Additionally, the study also used Tobit regression to explain the variation in the efficiency scores related to farm-specific factors.
The results of the study revealed that technical efficiency scores ranged from 0.75 to 1.00 with an average of 92 percent. The calculated efficiency scores were regressed on different explanatory variables to identify the factors related to inefficiency. Resultantly, five explanatory variables were identified which were affecting the efficiency. The results of the Tobit regression showed that farmer’s age, number of plots and off-farm income were affecting the efficiency negatively while farm size and membership of cooperative showed positive impact on efficiency.

Nasurudeen (2009) conducted a study to estimate the technical, allocative and scale efficiencies of rice farmers in the Union Territory of Pondicherry by using data envelopment analysis. The study results revealed that the mean technical efficiency score was 0.64, mean allocative efficiency was 76 percent while mean scale efficiency came out to be 94 percent. The study suggested that average farm was producing only about two-thirds of the potential output level and there was potential to increase the output by 36 percent. The mean allocative efficiency measure suggested that the farmers were able to reduce the cost by 24 percent by improving the management practices and using appropriate technologies. They study indicated the overuse of labour, fertilizers and chemicals. The study recommended the policy revision of strengthening extension system and raising the awareness to adopt the appropriate technologies for the improvement in efficiency.

Rahman, et al. (2009) estimated the production efficiency of jasmine rice farmers in Northern and North-Eastern Thailand. The study results revealed the high level of inefficiency existed in jasmine rice farmers. The average technical efficiency score came out to be 63 percent of self selected jasmine rice farmers indicating the handsome scope to increase the production. The study confirmed the better irrigation and education of the farming households as the main determinants to choose jasmine rice although environmental factors and location of farm were also important to decide about the crop. The significantly high price of jasmine rice than the other rice varieties gave incentive to the farmers to grow jasmine instead of other rice varieties. The study further revealed that irrigation, fertilizers, land and environmental factors were the main determinants of efficiency. The study recommended the Policy implications that included
increasing the access to irrigation facilities and availability of fertilizers. The study further suggested investment in the education of farmers for better assessment of adoption of jasmine rice and farming productivity as well.

Dagistan (2010) carried out a study to estimate technical efficiency of wheat farmers in Cukurova region of Turkey by collecting primary data from wheat farmers. Technical efficiency was estimated by employing an input-oriented data envelopment analysis (DEA) and determinants of technical efficiency were identified by Tobit regression analysis. The results indicated that wheat farmers could maintain the same level of production by saving 20% of the variable inputs. The results revealed that out of 103 farms, 87 showed the increasing returns to scale, 13 showed constant and 3 showed decreasing returns to scale conditions. The study concluded that education and size and number of wheat plots mainly influenced the technical efficiency. The study expected that results regarding variation in technical efficiency and causes of inefficiency would be helpful for wheat farmers and policy makers to develop policies to raise the level of efficiency in wheat farming.

Tan, et al. (2010) conducted a study in South East China to estimate the impact of land fragmentation on technical efficiency of rice producers. Empirical results with the application of stochastic frontier model showed the statistically significant differences among villages in adoption of appropriate technology with the remotest village having the lowest level of technology. The average technical efficiency within villages came out to be 80 to 90 percent for three types of rice grown in the area. The study did not find any significant variation in technical efficiency for late rice producers. The study results identified the Land fragmentation as an important determinant of technical efficiency in early rice production. The study recommended that increase in plot size and exposure of the farmer to adopt latest and modern technology could be helpful in raising the rice productivity and level of technical efficiency in long run.
2.4 Summary

The literature reviewed demonstrated that studies related to different types of efficiency measures were conducted on almost all major agricultural enterprises including wheat, rice, cotton and dairy, etc. Both parametric and non-parametric approaches were adopted in these studies like data envelopment analysis and econometric frontier approach. The stochastic frontier production function approach has been noticed in most of the above mentioned studies but the present study will adopt the stochastic profit frontier approach to measure the profit efficiency to make comparison of organic and conventional farming systems.

The review of studies in the above section revealed that inefficiency remained a serious problem in agriculture and, therefore, it is of prime importance to measure profit efficiency and also explore causes of inefficiency. The main causes of inefficiency included the poor management skill of the farmers, education and access to farm inputs and their use. The efficiency in agriculture and agricultural productivity could be enhanced by improving the managerial skills and education of the farmers (Ali and Flinn, 1989).

In the pursuit of above mentioned studies, it has been noted that a few studies were conducted on comparative efficiencies of organic and conventional agriculture and related aspects. Also, it is evident that no study has been conducted to compare the profitability of organic and conventional agriculture by estimating the profit efficiencies at South Asia level. So, this study will bridge the gap in this respect and make valuable addition to the body of knowledge.

Most of the farmers in South Asia are small in size and they allocate their small land holding by assessing their domestic needs first mainly to ensure the household food security. Rice and wheat being the main staple foods of the area occupy considerable share of farm area. So, it is quite important to measure the profit efficiency of growing rice and wheat under organic and conventional techniques. Therefore, this study will explore profit efficiencies of rice and wheat and various factors affecting the profitability of the farmers and ways to improve it. The
stochastic profit function, sources and techniques of data collection, sampling and empirical models are described in detail in the next chapter.
CHAPTER 3

MATERIALS AND METHODS

This chapter starts with the concept of efficiency and historical background of different approaches to measure efficiency with details of theoretical profit function and stochastic frontier model. The next section elaborates the empirical model and the implementation of Cobb Douglas model used in this study. The chapter concludes with the description of the selection of study area and data sources.

3.1 Concept of Efficiency

According to Farrell (1957), efficiency is the assessment of economic performance of a firm, farm and organization. It usually refers to economic or productive efficiency of a firm which means that it is in production of as much as output as feasible from a given set of inputs. It has two components, technical and allocative efficiency.

Technical Efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs or capacity of firm to use as modest inputs as possible for a set level of output. The former called input oriented efficiency while latter is known as output oriented measure of technical efficiency. Allocative Efficiency (AE) reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. A firm that combines inputs and outputs in optimal combinations in the light of established prices, is allocatively efficient (Lovell, 1993). The term economic efficiency is defined as a combination of technical and allocative efficiency. So, to be economically efficient and profit maximization, a firm should produce the maximum output given the level of inputs employed (i.e., be technically efficient), use the right mix of inputs in light of the relative price of each input (i.e., be input allocative efficient) and produce the right mix of outputs given the set of prices (i.e., be output allocative efficient) (Kumbhaker and Lovell, 2000).
The input oriented efficiency measure based on Farrell’s (1957) work can be used to elaborate the concepts of technical, allocative and economic efficiency. In Figure 3.1 two inputs, $X_1$ and $X_2$, are represented on the horizontal and vertical axes, respectively to produce an output ($Y$). The isoquant ($QQ$) shows a number of different combinations of inputs ($X_1$ and $X_2$) used to produce a single level of output ($Y$). All combinations of inputs on this isoquant, reflect technically efficient production. Suppose a firm is operating at a point ($A$) that shows that the firm is working efficiently. At the point ($B$), the particular firm produces the same level of output ($Y$) as produced on point ($A$) on the isoquant ($QQ$). A line can be drawn from the origin to point ($B$) to define the technical efficiency of the observed firm. This ($OB$) line crosses the isoquant at the point ($A$) showing the same level of output that is produced by use of ($X_1$ and $X_2$). It means that firm is technically inefficient because inputs are not used efficiently by operating at point ($B$). The observed firm is actually using more inputs ($OB$) than actually needed ($OA$) to produce output ($Y$). So, the technical efficiency of the firm can be defined as the ratio of the distance from the point ($A$) to the origin divided by the distance of the point ($B$) from the origin, that is:

Figure 3.1: Input-Oriented Measures for Technical, Allocative and Economic Efficiencies Reproduced from Coelli, et al. (1998)
\[ TE = \frac{OA}{OB} \quad \ldots \ldots (3.1) \]

If the input prices are known, the allocative efficiency can also be defined. An isocost line, \((PP)\) representing the input price ratio can be drawn that intersects the \((OB)\) line at point \((C)\) and tangent to the isoquant, \((QQ)\) at the point \((D)\). The production at point \((D)\) shows the best use of inputs because it incurs the minimum cost and both technically and allocatively efficient. Therefore, the point \((A)\) is not an optimal point being technically efficient but allocatively inefficient because the distance, \((CA)\) representing extra cost can be reduced without any reduction in output.

Allocative efficiency can be defined as the ratio of the distance from origin to point \((C)\) over the distance of the point \((A)\) from the origin:

\[ AE = \frac{OC}{OA} \quad \ldots \ldots (3.2) \]

Economic efficiency is already defined as the product of technical efficiency and allocative efficiency, so:

\[ EE = TE \times AE \quad \ldots \ldots (3.3) \]

\[ EE = \frac{OA}{OB} \times \frac{OC}{OA} = \frac{OC}{OB} \quad \ldots \ldots (3.4) \]

The profit efficiency in this regard would be the ability of a firm or farm to achieve highest possible profit given the prices and fixed factors that farmers own and profit inefficiency can be defined as the profit loss due to not operating on the frontier (Ali and Flinn, 1989). The concept of profit efficiency can be illustrated by the Figure 3.2. The DD line in the figure represents the profit frontier of the farm that is industry’s best practice firm with given level of technology. The line EE represents the average profit function that does not explain the farm specific inefficiencies. The farms that are operating below DD line are not obtaining the maximum profit with given level of input and output prices. Suppose a farm is operating at point F, that farm is not efficient because with the same resources it can operate at point M that shows the maximum
profit with given level of resources and prices of inputs and outputs. So, the comparative profit efficiency is measured by

\[
\text{Profit efficiency} = \frac{FP}{MP} \quad \ldots \quad (3.5) \quad \text{(Ali and Flinn, 1989)}
\]

3.2 Approaches to Measure Efficiency

Following the Farrell’s (1957) seminal work, a number of approaches were used to measure the efficiency. On the whole, these approaches can be bifurcated into two categories, frontier and non-frontier approach. Frontier approach used to measure the absolute and relative efficiency while non-frontier approach used for the analysis of relative efficiency only. Frontier approach can further be divided into statistical and non-statistical methods. The non-statistical method has been divided into parametric and non-parametric approaches. The former takes into account the
probabilistic approach based on Cobb Douglas or any other form with dropping outliers while non-parametric approach takes into account all observations in the model having no fixed functional form for frontier. Statistical methods include stochastic and non-stochastic methods. Non-stochastic approach signifies that all deviation from frontier is only due to inefficiency while stochastic frontier function employs that variation from frontier is due to random effects and inefficiency. Maximum Likelihood and Corrected Ordinary Least Square (COLS) are used for statistical methods (Ali and Byerlee, 1991).

Two approaches, parametric and non-parametric have been widely adopted to measure the efficiency of different enterprises. Both of these approaches differ in many ways but basically, non-parametric approach involves mathematical modeling commonly known as Data Envelopment Analysis (DEA) and parametric approach involves econometric modeling. The advantages and disadvantages of both approaches are discussed by Battese (1992), Schmidt (1986), Forsund, et al. (1980) and Jafforrullah and Whiteman (1999). Some of the disadvantages of non-parametric approach are following:

1- Forsund, et al. (1980) argued that a subset of observations was used to measure the frontier. Therefore, the Farrell’s (1957) model based on non-parametric approach was sensitive to extreme observations and measurement errors.

2- Schmidt (1986) concluded that non-parametric approach made less use of information than parametric approach leading to less precise results.

3- In non-parametric approach, it is difficult conceptually to separate the effects of environmental variables that are beyond control and measurement errors from the effect of differences in farm management (Jafforrullah and Whiteman, 1999).
Figure 3.3: Methods for analyzing Technical Efficiency
Reproduced from Ali and Byerlee, (1991)
Based on the above stated disadvantages of non-parametric approach, parametric approach is used in the present study.

### 3.2.1 Deterministic Versus Stochastic Frontier Model

The parametric approach can be further divided into deterministic and stochastic frontier models. The deterministic frontier model assumes that all sample firms have the same frontier and all variation is due to the inefficiency. Aigner and Chu (1968) estimated the parametric deterministic frontier function using Cobb Douglas functional form. The deterministic frontier model for cross-sectional data is defined as:

\[
Y_i = f(X_i, \beta) e^\mu \quad \ldots (3.6) \quad i = 1,2\ldots N
\]

Where, \(Y_i\) is the actual production level, \(X_i\) is the vector of inputs of the \(i\)-th firm, \(\beta\) denotes the vector of unknown parameters to be estimated, \(\mu\) is a non-negative random error associated with the inefficiency of the \(i\)-th firm and \(N\) is the number of firms. The above stated model is deterministic frontier function. Afriat (1972) also developed same type of model, however, the \(\mu\)'s were believed to have gamma distribution. The model imposed a constraint that \(\mu \geq 0\) meaning that output was less than the potential or equal to the potential within given input and output prices. Taylor and Shonkwiler (1986) concluded that the model followed the production theory but they criticized that observed deviation was accounted for the management practices. The model did not take in account the statistical noise such as random shocks and omitted variables.

The basic assumption of the deterministic frontier functions that all firms in the sample have the same production frontier and that all the variations from the frontier is due to inefficiency only. This assumption is widely criticized and has been questioned from the empirical point of view, because in real world, production is often influenced by stochastic elements, such as environmental factors like weather, rainfall etc, mechanical problems, supply of inputs and
measurement error. This led to the development of the stochastic frontier function first proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) for cross-sectional data. The first application was carried out by Battese and Corra (1977) on farm-level data on agriculture.

The stochastic frontier model for cross-sectional data is as under:

\[ Y_i = f(X_i, \beta) e^{\nu - \mu} \quad \ldots \ldots (3.7) \]

In this equation, the error term of the stochastic model has two additive components: the \( V \) is independent and identically distributed random error that represents the factors external to the farmer following a normal distribution with zero mean and variance \( \sigma_v^2 \). The random errors account for measurement errors in production and other random factors, which are beyond the control of management of a firm or a farmer such as weather, etc. The \( \mu \) denotes the technical inefficiency effects, which are associated with the technical inefficiencies of a firm or a farm. It assumed to be identically and independently distributed as either exponential or half-normal (i.e., non-negative truncation of the \( N(0,\sigma^2) \) distribution). According to Thiam et al. (2001), the model addressed the weaknesses of the deterministic model. It also made possible to estimate standard errors and test for hypotheses that the observed inefficiency was not due to farmer’s practices only as suggested in deterministic model. So, the present study follows the stochastic parametric model and profit function frontier to examine the comparative efficiency of organic and conventional; rice and wheat crops.

### 3.2.3 The Profit Function and Stochastic Frontier Model

According to production theory, farmers choose a set combination of inputs and outputs to maximize profit with the constraint of technology. The production decisions on the quantity of inputs and outputs based on respective input and output prices formulate the profit function (Sadoulet and De Janvry, 1995). With the assumption of technology to be homogenous to all farms, the profit function would be:

\[ \pi = TR - TC \quad \ldots \ldots \ldots (3.8) \quad \ldots \quad \text{Subject to} \quad t(q, x, z) = 0 \]
\( \pi \) is the profit, \( TR \) is the total revenue and \( TC \) is the total cost subject to the homogenous technology. Where in technology equation, \( t \) denotes the technology, \( q \) is the vector of output, \( x \) is the vector of variable inputs and \( z \) is the vector of fixed inputs.

\[
TR = p \ q \quad \ldots \ldots (3.9)
\]

\[TC = w \ x \quad \ldots \ldots (3.10)\]

So,
\[
\pi = p \ q \ - \ w \ x \quad \ldots \ldots (3.11)
\]

Where, \( p \) denotes the output prices and \( w \) is the input prices.

For profit maximization, the input demand and output supply functions would be:

\[
X = x \ (p, \ w, \ z) \quad \ldots \ldots (3.12)
\]

\[Q = q \ (p, \ w, \ z) \quad \ldots \ldots (3.13)\]

Substituting equations 3.12 and 3.13 into 3.11 will give a profit function to maximize profit at given prices of output \( p \) and input \( w \) with availability of fixed factors \( z \). The function can be rewritten as

\[
\pi = p \ q \ (p, \ w, \ z) \ - \ w \ x \ (p, \ w, \ z) \quad \ldots \ldots (3.14)
\]

Under mild regularity conditions, a profit function is the logical extension of production function (Sadoulet and De Janvry, 1995). According to these conditions, a function should be convex, non-negative, monotonically increasing in output and homogenous of degree zero in all prices. In neoclassical theory, assumption is made that farmers are operating on the frontier and the prices of inputs and outputs are known but in practice some farmers are operating below the frontier. Secondly, farmers do not always operate in competitive markets especially in developing countries where prices are not known by the farmers. That violates the neoclassical assumptions (Junankar, 1989). Following developments responded to this criticism.

1- The assumption of competitive markets is not required in profit function approach but the prices of inputs and outputs should be taken as exogenous to the farms but competitively determined (Sevilla-Siero, 1991).
2- Ali and Flinn (1989) argued that individual farms might face different prices and had different endowment factors that led to appropriateness of profit function formulation of production process.

3- District dummies can be used to handle the price variation (Lau and Yotopolous, 1971; Akinwumi and Djato, 1996).

4- Unlike production function approach, profit function does not suffer from simultaneous equation bias problems.

5- Finally, the profit function approach has already been used in South Asian context to measure the profit efficiency (Rahman, 2003; Ali and Flinn, 1989).

So, in the present study, stochastic profit function is used. The study adopts Ali and Flinn’s (1989) model specified in following equation.

The stochastic profit frontier for \( j \)th farmer is written as:

\[
\pi_j = f(P_{ij}, X_{kj}, D_{nj}). \exp(\varepsilon_j) \ldots \ldots (3.15)
\]

Where,
\( \pi_j \) - is the normalized profit of \( j \)th farm which can be calculated by subtracting variable cost from gross revenue divided by farm specific price of output
\( P_{ij} \) - can be estimated by dividing price of \( i \)th variable input by output price
\( X_{kj} \) - is the \( k \)th fixed factors on \( j \)th farm
\( D_{nj} \) - is the dummy variables that affect the profitability of the \( j \)th farm.
\( \varepsilon_j \) - is the error term which is assumed to behave consistent with the frontier concept (Ali and Flinn, 1989).

\[
\varepsilon_j = v_j - u_j \ldots \ldots (3.16)
\]

Where,
\( v_j \) - is a two sided error term assumed to be normally distributed \( N(0,\sigma^2) \)
\( u_j \) - is a non-negative random variable \((u_j \geq 0)\) associated with inefficiency effects. When \(u_j = 0\), the firm lies on the profit frontier but if \(u_j > 0\) the farm is profit inefficient and incurring losses.

The profit efficiency equation of \(j\th\) farm will be

\[
\text{EFF}_j = E[\exp(-u_j) | \varepsilon_j] \quad \ldots \ldots (3.17)
\]

\(\text{EFF}_j\) denotes the profit efficiency of \(j\th\) farm that ranges between 0 and 1. \(E\) is the expectation operator.

**3.2.4 Profit Inefficiency Model**

A number of factors including the characteristics or management of a farm or firm, incomplete information, non-conducive policies, lack of expertise, environmental impacts like bad weather, floods, drought and schedule of rains and other random shocks such as war and statistical errors can affect the efficiency negatively. The study of these factors has been a topic of considerable interest. Kalirajan (1981) and Pitt and Lee (1981) proposed the two stage method and regressed the technical inefficiency effects on observable explanatory variables involving farm related factors. While others like Battese and Coelli (1995), Huang and Liu (1994) and Kumbhakar *et al.* (1991) argued for one stage modeling approaches that take the inefficiency effects as a function of various observable variables. Bravo-Ureta and Pinheiro (1993) identified the relationship between socio-economic factors like age, education, access to credit and linkages with extension services.

Battese and Coelli (1995) specified the technical inefficiency effects for panel data to estimate the stochastic frontier function and inefficiency effects in single stage. The model for cross sectional data is as follows:

\[
Y_i = \exp(x_i \beta + v_i - u_i) \quad \ldots \ldots (3.18)
\]
Here, in this model, the inefficiency effects such as farm size, age education or other socio-economic factors are explained as function of explanatory variables. The inefficiency model is specified as

\[ u_i = w_i \delta + \zeta_i \] ……..(3.19)

Where, \( w_i \) are the vector of farm specific variables like farmer's managerial abilities and household characteristics which impact the inefficiencies of ith farm, \( \delta \) denotes the parameter to be estimated and \( \zeta_i \) is the error term that is assumed to be normally distributed as \( \zeta_i \sim N(0,\sigma_\zeta^2) \). Kalirajan and Flinn (1983) included land size, credit availability, land tenure, education and linkages with extension services as determinants of efficiency. Ali and Flinn (1989) included off-farm employment, farm size and tenancy, education and credit availability while parikh et al. (1995) incorporated family size, off-farm work, fragmentation and non-farm assets in addition to the above stated variables.

Battesse and Coeli (1995) in their study about Indian paddy farmers further suggested using the method of maximum likelihood for simultaneous estimation of the parameters of the stochastic frontier and the model for the inefficiency effects model. The likelihood function for sample observations in terms of the variance parameters would be:

\[ \sigma^2 = \sigma_\nu^2 + \sigma_u^2 \] ……..(3.20)

and

\[ \gamma = \sigma_u^2 / \sigma^2 \] ……..(3.21)

The value of parameter \( \gamma \) ranges from 0 to 1.

\( \sigma^2 \) - explains the total variation in the dependent variable

\( \sigma_u^2 \) - shows the variation due to inefficiency

\( \sigma_\nu^2 \) - shows variations due to random shocks
3.3 Empirical Model

This section describes the empirical model, used to estimate the profit function, the profit inefficiency model and determinants of profit inefficiency.

3.3.1 Cobb Douglas Stochastic Frontier Profit Function

In the literature, the profit function has been estimated by different functional forms such as Cobb Douglas (C-D), normalized quadratic, translog and generalized Leontif (Hyuha, 2006). The C-D model is the most popular and has been used widely to estimate the farm efficiencies (Battesse and Hassan, 1999;Nsanzugwanko et al., 1996; Yilma, 1996; Kalirajan and Obwona, 1994; Dawson and Lingard, 1991; Saleem, 1988). The translog model has also been used frequently but the study uses the C-D model due to following reasons:

1- The comparative nature of the study between organic and conventional farming does not need any specific functional form. The comparison can be made both by C-D and translog model. The C-D model is easy to estimate and frequently used in efficiency studies as stated above.

2- The common weaknesses of translog model are its susceptibility to multicollinearity and potential problem of insufficient degrees of freedom especially when sample size is small. In these conditions, C-D model is preferred over translog.

3- The interaction terms of translog model don’t have any economic meaning (Abdulai and Huffman, 2000).

Further, Battesse and Hassan (1999) estimated both C-D and translog models and found that the C-D model was the adequate representation of data. So, this study employs C-D frontier profit function model.
The Cobb Douglas profit equation and inefficiency equation are following:

\[
\ln \pi_j = \beta_0 + \beta_1 \ln P_{1j} + \beta_2 \ln P_{2j} + \beta_3 \ln P_{3j} + \beta_4 \ln P_{4j} + \beta_5 \ln Z_{1j} + \beta_6 \ln D_{1j} + \beta_7 \ln D_{2j} + (V_j - U_j) \quad \ldots \ldots (3.22)
\]

Where,

\( \pi_j \) = Normalized profit for \( j \)th farm, is defined as gross revenue less variable costs divided by farm specific price of rice in case of rice crop and price of wheat in case of wheat crop \( (P_y) \)

\( \ln \) = natural log

\( P_i \) = Prices of variable inputs normalized by price of output where (for \( i = 1, 2, \ldots 4 \))

so that:

\( P_1 \) = Price of land preparation normalized by price of output \( (P_y) \)

\( P_2 \) = Prices of other inputs (Fertilizers/compost, pesticides/bio-pesticides and seed) normalized by price of output \( (P_y) \)

\( P_3 \) = Price of irrigation normalized by the price of output \( (P_y) \)

\( P_4 \) = Price of labour normalized by the price of output \( (P_y) \)

\( Z_k \) = are the fixed inputs

Where,

\( Z_1 \) = capital used in farm \( j \) (hand tools and light machinery)

and
D_q = are dummy variables for environmental factors

Where,

D_1 = Dummy variable for soil fertility
D_2 = Dummy variable for pest breakout

\( \beta 's \) are unknown parameters to be estimated and \( V_j \) and \( U_j \) has been defined earlier. The inefficiency effects model is defined as;

\[
U_j = \delta_0 + \sum_{d=1}^{6} \delta_d \omega_d + \vartheta \quad \text{........(3.23)}
\]

\( U_j = \) inefficiency effects
\( \vartheta = \) truncated random variable
\( \delta_0 = \) constant
\( \omega_d = \) variables explaining inefficiency effects and are defined as follows:

\( \omega_1 = \) Education (Schooling years)
\( \omega_2 = \) Experience of rice and wheat farming (Years)
\( \omega_3 = \) Access to credit (if yes = 1 otherwise = 0)
\( \omega_4 = \) Linkages with extension services (if yes = 1 otherwise = 0)
\( \omega_5 = \) Off-farm Employment (if yes = 1 otherwise = 0)
\( \omega_6 = \) Area under rice crop or wheat crop in acres for each farm \( j \)
If the equation (3.22) is estimated by OLS, an average, as opposed to best-practice frontier is derived. Therefore, frontier function must be estimated to provide an estimate of industry's best-practice profit (Ali and Flinn, 1989). So, the unknown parameters of the stochastic frontier and the inefficiency will be estimated by the method of maximum likelihood.

3.3.2 Description of Variables in Frontier Profit Function

Three types of variables are included in frontier profit function including the prices associated with variable inputs, the fixed inputs of the farm and environmental variables like soil fertility and pest breakout. The price of land preparation is included in the model because it is one of primary factors of production. The price of land preparation was computed by dividing the total cost of land preparation with number of tractor hour used. The price of land preparation was normalized by dividing with price of rice in case of rice crop and price of wheat in case of wheat crop and regarded as variable $P_1$ in the model.

The prices of fertilizer/composts, pesticides/bio-pesticides and seed were normalized by price of output and had been denoted as variable $P_2$ in the model. The prices of inputs were computed by dividing the total expenditure by total quantities of relevant inputs. The cost of home supplied inputs was imputed by market prices (Rahman 2003). According to Weier (1999), fertilizers contribute significantly to increase the output, thereby, increasing profit. Abdulai and Huffman (2000) in their study about rice farmers of Northern Ghana found the negative impact of fertilizers on the profitability. Rahman (2003) also found a week relationship between fertilizer use and profit efficiency among Bangladesh rice farmers.

Irrigation is an important factor of production in Pakistan especially in rice where it contributes around 25% of the total cost of production. It includes tubewell and canal irrigation. So, the price of irrigation was computed as the total expenditures on irrigation divided by number of hours and normalized by price of rice in case of rice crop and price of wheat in case of wheat crop and regarded as $P_3$. Irrigation is not included in the model for Nepal because data for organic and
conventional rice and wheat has been taken from rainfed areas. For Bangladesh, irrigation is also not included for the analysis of organic and conventional rice because farmers who follow the rice wheat cropping pattern, grow “Aman” rice crop in the middle of Kharif season, during the period of heaviest rainfall when water supplies are most reliable. So, the “Aman” rice farmers do not need to irrigate their fields. But irrigation is included in the wheat model for Bangladeshi farmers because they use tubewell to irrigate the wheat fields in “Rabi” season.

Labour has been included in the model as $P_4$ being one of the main factors of production. In some studies like Ali and Flinn (1989), Saleem (1988), labour cost has been disaggregated to the imputed cost of family and cost of hired labour. However, in some other studies, labour cost was computed by aggregating family and hired labour costs (Lau and Yotopoulos, 1971; Sharma et al., 1999 and Abdulai and Huffman, 2000).

In addition, it has been controversial to assign the weight when valuing men and women labour. The basic question is whether the female’s work hour can be treated equal to male’s work hour or not. In most of the cases, female’s work has been considered at 75 percent of male’s work. Abdulai and Huffman (2000) treated children’s and female’s labour as 50 percent of the men’s labour. Akinwumi and Djato (1998) gave same weights to both women and men in their study on Ivory Coast rice farmers. Ali and Flinn (1989) treated men and women labour equal in their study about Pakistani rice farmers. However, in the present study, female’s work has been considered at 75 percent of male’s work. Labour cost was computed by adding the cost of hired labour and imputed cost of family labour at market rate excluding the labour used in harvesting. The price of labour was computed as total labour expenditure divided by number of hours worked and normalized by output price.

Farm specific capital ($Z_1$) is the value of hand tools and light machinery. The value of light machinery was computed at the depreciation rate of 20 % and value of hand tools was computed at the depreciation rate of 50 percent.
Soil fertility is considered an important factor to affect the profit efficiency in the present study in line with Ali and Flinn (1989). They used dummy variable for soil condition in their study about Pakistani rice farmers. So, \( D_1 \) denotes the soil fertility and is taken as 1, if soil is fertile based on farmer’s perception otherwise zero. The dummy variable \( D_2 \) denotes the pest breakout and is taken as 1, if there is pest breakout, otherwise zero.

### 3.3.3 Description of Variables in Inefficiency Effects Model

It has been assumed that there may be many farmers who do not produce on the frontier due to certain inefficiency effects. The assumption gives logic to find out the factors responsible for the inefficiency by developing inefficiency effects model to concentrate on the issue. The socio-economic variables like education, experience, access to credit, linkages with extension services, off-farm employment and area under rice crop or wheat crop in acres, have been included in the inefficiency effects model. The said variables are detailed below with their expected effects on profit efficiency.

Education (\( \omega_1 \)) improves the quality of labour and increases the adoptability of new technology. In the literature, different questions regarding the education has been discussed e.g. what type of education simply the schooling years or other types, whose education and what should be the threshold level of education to increase the productivity. Jamison and Moock (1984) in their study about Nepali farmers found the threshold level of education to be 7 years of schooling. Appleton and Balihuta (1996) found threshold level to be 4 years schooling in their study about Uganda.

Regarding to the other questions about education, many studies discussed the education of head of the family while some studies took it for all family members. Appleton and Balihuta (1996) discussed education of the entire family and argued that years of schooling of farm workers were significant. Weier (1999) took years of schooling of households separately.
In the present study, education (in the form of number of schooling years) of head of the family being main decision maker has been considered for analysis. It is hypothesized that education affects the inefficiency negatively and contribute to increase the profit efficiency of the farmers.

Experience ($\omega_2$) of head of the family has been included in the model to study its impact on profit efficiency. Experience increases proficiency and can be the cause of higher profits but on the other hand experience is the proxy for age and can be a reason to increase the inefficiency since older farmers are considered more conservative in adopting new technology. Wilson et al. (1998) estimated the positive relationship between experience and inefficiency in their study about UK potato farmers. However, other studies found negative relationship between experience and inefficiency (Rehman, 2003). So, no priori sign for this variable is given here.

<table>
<thead>
<tr>
<th>List of Variables</th>
<th>Descriptions</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\omega_1$</td>
<td>Education in number of schooling years</td>
<td>-ve</td>
</tr>
<tr>
<td>$\omega_2$</td>
<td>Experience of the farmer measured by years</td>
<td>±ve</td>
</tr>
<tr>
<td>$\omega_3$</td>
<td>Access to Credit, if yes = 1, otherwise = 0</td>
<td>-ve</td>
</tr>
<tr>
<td>$\omega_4$</td>
<td>Linkages with Extension services, if yes = 1, otherwise = 0</td>
<td>-ve</td>
</tr>
<tr>
<td>$\omega_5$</td>
<td>Off-farm employment, if yes = 1, otherwise = 0</td>
<td>±ve</td>
</tr>
<tr>
<td>$\omega_6$</td>
<td>Area under rice crop or wheat crop in acres</td>
<td>±ve</td>
</tr>
</tbody>
</table>
Access to credit ($\omega_3$) is important to increase the farm efficiency with provision of much needed funds on time to support the production process. So, access to credit may impact inefficiency negatively. Ali and Flinn (1989), in their study about Pakistani Basmati rice farmers reported negative relationship of access to credit and farm inefficiency. Abdulai and Huffman (2000) reported the similar results about Ghana farmers. So, in this study, it is assumed that access to credit would impact the profit inefficiency negatively.

Linkages with extension services ($\omega_4$) are important for the diffusion of new and improved technologies at grassroots level. It enhances the managerial ability of the farmers to manage and use resources in an efficient way. So, the linkages with extension services are expected to impact the inefficiency negatively. Most of the studies in literature found a negative relationship between linkages with extension services and farm inefficiency (Ali and Byerlee, 1991; Bravo-Ureta and Rieger, 1990 and Rehman, 2003). In the present study, links with NGOs and Cooperatives are also considered which are involved in promoting the organic agriculture.

Off-farm employment ($\omega_5$) is also an important variable which affects the farm efficiency both in negative and positive manner. Off-farm employment is the source of extra income and availability of funds that can be used to purchase important inputs on time and impact the inefficiency negatively but on the other hand it consumes valuable time of farm manager that may be the reason for increase in inefficiency. Ali and Flinn (1989) registered a positive impact of off-farm employment on farm inefficiency. Rehman (2003) found similar results about Bangladeshi rice farmers. In the present study, it has been hypothesized to have an indeterminate impact on inefficiency and can have positive or negative sign.

Area under rice or wheat crops in acres is also included in the model to determine its impact on profit efficiency. In the present study, it is also hypothesized to have positive or negative sign.
3.3.4 Likelihood Ratio Test

To test the significance of variance parameters in the stochastic profit frontier function and other hypothesis, likelihood ratio test has been widely used. The test takes the following form of calculation (Greene, 1990).

\[
LR(\lambda) = -2 \left[ \ln\left( \frac{L(H_0)}{L(H_1)} \right) \right] \quad \ldots (3.24)
\]

\[
= -2 \left[ \ln(L(H_0)) - \ln(L(H_1)) \right] \quad \ldots (3.25)
\]

Where \( H_0 \) and \( H_1 \) are null and alternative hypothesis and \( L(H_0) \) and \( L(H_1) \) are the values of restricted and unrestricted likelihood functions respectively. The test statistic normally follows the chi-square distribution where degrees of freedom can be calculated by the difference of number of parameters between \( H_0 \) and \( H_1 \). When one or more restrictions are involved, it does not encompass chi-square distribution. So, when the null hypothesis involves \( \lambda = 0 \), the alternative hypothesis can only involve positive values of \( \gamma \). Coelli (1995) argued that the distribution of any likelihood-ratio statistic which involves the \( \gamma \)-parameter has a mixture of chi-square distributions.

In cases, where more than one parameter restrictions are involved, it is quite difficult to calculate the appropriate critical value for the mixed chi-square distribution. To avoid this, Table 1 in Kodde and Palm (1986) can be utilized that lists upper and lower bounds for the appropriate critical value in the presence of equality and inequality restrictions (Coelli, 1996).

3.4 Description of Study Area, Data and Sources

This section describes the study area, data and its sources including sampling and finally data limitations.
3.4.1 Description of Study Area

The focus of the study is to estimate the profit efficiency of organic and conventional; rice and wheat farmers in South Asia. The focus of the study is the rice-wheat zone of South Asia which covers 13.5 million hectares including India (10.0 mh), Pakistan (2.2 mh), Bangladesh (0.8 mh) and Nepal (0.5 mh) (Arshad and Ahmad, 2011). The Rice-Wheat Farming System forms a broad swath across Pakistan, India, Nepal and Bangladesh and called the breadbasket of the region. The rice wheat farming system of South Asia is mainly characterized by a summer paddy crop followed by winter wheat crop and sometimes also a short spring vegetable crop. (RWC-CIMMYT, 2003). The study is confined to three South Asian countries Pakistan, Nepal and Bangladesh. It was not possible to visit India due to political reasons between Pakistan and India while other South Asian countries (Sri Lanka, Bhutan and Maldives) were ignored due to absence of rice-wheat farming system.

3.4.2 Data and its Sources

This section describes about data and its sources covering sampling, selected Districts in three countries, development of questionnaire and data collection, data limitations and finally the data analysis.

- **Sampling**

A multistage sampling technique was adopted to select the sample farmers. At first stage, three districts from each country were selected with priority of the presence of organic farms. In the second stage, fifty farmers from each district; twenty five organic and twenty five conventional were selected randomly for data collection. Thus the total sample size from nine districts of three countries was 450 farmers comprising of 75 organic and 75 conventional farmers from each country.
Following districts were selected from each country to interview the farmers growing rice and wheat crops under organic and conventional conditions.

**Pakistan**
- District Sheikhupura
- District Gujranwalla
- District Nankana Sahib

**Nepal**
- District Kathmandu
- District Bhaktapur
- District Lalitpur

**Bangladesh**
- District Dhaka
- District Natore
- District Comilla

➤ **The Questionnaire**

A detailed questionnaire (Appendix1) was developed to seek information from organic and conventional farmers about wheat and rice operations on the farms in the study area. The questionnaire also covered the information regarding socio-economic variables like education, farming experience, access to credit, linkages with extension services, off-farm employment and area under rice or wheat crop. The input and output oriented data were collected on a per acre basis in the survey.

➤ **Pre-testing and Data Collection**

To identify the weaknesses and omissions, a newly constructed questionnaire should be pre-tested on few respondents to finalize it for the survey (Casley and Kumar, 1988). It provides an opportunity for improvement of the questionnaire with addition of missing things and deletion of
unwanted questions. In the present study, the questionnaire was pretested in District Sheikhupura, Pakistan and resultantly some minor changes were made. All interviews were taken in the local language as far as data collection from Pakistan is concerned while the information from Nepali and Bangladeshi farmers were sought with the help of local NGOs and Cooperatives.

➢ Data Limitations

In South Asia, most of farmers are illiterate and do not keep records of the inputs, outputs, prices and other factors. So, the study suffers from weaknesses associated with data accuracy that is depended entirely on respondent’s ability to recall the past information and answer the questions accurately. Efforts were made to minimize these types of errors by recollecting the information from the respondents in case of any inconsistencies. However, some errors and discrepancies are unavoidable in this kind of study, despite every precaution.

3.4.3 Data Analysis

The data were analyzed to estimate the stochastic frontier profit function and inefficiency model by using the FRONTIER 4.1 computer programme. The programme conducts a two phase grid research of $\gamma$ with the $\beta$ parameters set the OLS values while $\beta_0$ and $\sigma^2$ Parameters are adjusted according to COLS (Corrected Ordinary Least Square) formula set by Coelli (1995). Other parameters such as ($U_j$ or $\delta$’s) are set at zero in the grid search.

The values in the grid search are used as starting values in the procedure by using the Davidon-Flecher-Powell Quasi-Newton method to get the final likelihood estimates (Coelli, 1996). The likelihood function is expressed in terms of the variance parameters,

$$\sigma^2 = \sigma_v^2 + \sigma_\mu^2 \quad \text{and}$$

$$\gamma = \sigma_\mu^2 / \sigma^2$$
CHAPTER 4

RESULTS AND DISCUSSION

The main objective of this chapter is to present econometric findings and results of frontier profit function and inefficiency effects models of both organic and conventional; rice and wheat crops. The chapter starts with the socio-economic characteristics of organic and conventional growers in the study areas of Pakistan, Nepal and Bangladesh. The second part of the chapter elaborates the tests of hypotheses by using log likelihood ratio test. This is followed by results of Cobb Douglas stochastic frontier profit function and inefficiency effects models. The results of Cobb Douglas model respond to the objective number 1 while inefficiency model examines the factor affecting the farm efficiency and responds to objective number 2 respectively. At the end, the chapter reviews the present agricultural policy framework supportive to promote organic farming in Pakistan, Nepal and Bangladesh to respond objective number 3 of the study.

4.1 Socio-economic Characteristics of Farmers in Pakistan, Nepal and Bangladesh

Socio-economic characteristics of the households studied in the three countries are presented in Table 4.1. All variables are expressed in terms of means while access to credit and linkages with extension services are presented in percentages.

The mean age of both organic and conventional farmers in three countries ranged from 43 to 51 years. The organic and conventional farmers in Pakistan lie in similar age category with mean of 46 and 45 years, respectively. The age of organic farmers in Nepal is less than conventional farmers with mean of 43 years as compared to that of conventional farmers 46 years. The age of organic farmers in Bangladesh averaged at 51 years as compared to 49 years mean age of conventional farmers.
Table 4.1: Socio-economic Characteristics of Farmers in Pakistan, Nepal and Bangladesh

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Organic Farmers (Mean/%age)</th>
<th>Conventional Farmers (Mean/%age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head (Years)</td>
<td>45.76</td>
<td>44.93</td>
</tr>
<tr>
<td>Education (Schooling Years)</td>
<td>5.84</td>
<td>4.77</td>
</tr>
<tr>
<td>Experience (Years)</td>
<td>23.70</td>
<td>24.09</td>
</tr>
<tr>
<td>Credit Access (%age)</td>
<td>52</td>
<td>46</td>
</tr>
<tr>
<td>Linkages with extension Services (%age)</td>
<td>72</td>
<td>52</td>
</tr>
<tr>
<td>Total Area (Acres)</td>
<td>5.32</td>
<td>6.05</td>
</tr>
</tbody>
</table>

Pakistan

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Organic Farmers (Mean/%age)</th>
<th>Conventional Farmers (Mean/%age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head (Years)</td>
<td>43.4</td>
<td>45.82</td>
</tr>
<tr>
<td>Education (Schooling Years)</td>
<td>4.66</td>
<td>3.05</td>
</tr>
<tr>
<td>Experience (Years)</td>
<td>20.29</td>
<td>18.41</td>
</tr>
<tr>
<td>Credit Access (%age)</td>
<td>40</td>
<td>34</td>
</tr>
<tr>
<td>Linkages with extension Services (%age)</td>
<td>54</td>
<td>37</td>
</tr>
<tr>
<td>Total Area (Acres)</td>
<td>1.56</td>
<td>1.63</td>
</tr>
</tbody>
</table>

Nepal

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Organic Farmers (Mean/%age)</th>
<th>Conventional Farmers (Mean/%age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head (Years)</td>
<td>51.23</td>
<td>49.36</td>
</tr>
<tr>
<td>Education (Schooling Years)</td>
<td>4.97</td>
<td>4.02</td>
</tr>
<tr>
<td>Experience (Years)</td>
<td>24.09</td>
<td>26.40</td>
</tr>
<tr>
<td>Credit Access (%age)</td>
<td>30</td>
<td>42</td>
</tr>
<tr>
<td>Linkages with extension Services (%age)</td>
<td>53</td>
<td>36</td>
</tr>
<tr>
<td>Total Area (Acres)</td>
<td>1.73</td>
<td>1.86</td>
</tr>
</tbody>
</table>

Bangladesh

Education level of organic farmers is better than conventional farmers in all three countries with number of schooling years 6, 5 and 5 as compared to 5, 3 and 4 in Pakistan, Nepal and Bangladesh, respectively. All farmers in the study areas of selected countries have approximately the same level of farming experience.

Organic farmers have better access to credit in Pakistan and Nepal i.e. 52 and 40 percent organic farmers were able to get credit compared to conventional farmers with percentage of 46 and 34,
respectively. However, in Bangladesh conventional farmers have better access to credit with percentage of 42 than organic farmers with percentage of 30.

Similarly, organic farmers have better linkages with extension services in all three countries as most of organic farmers are working closely with NGOs, Cooperatives and farmer groups which are working to promote organic agriculture. In Pakistan, Nepal and Bangladesh, 72, 54 and 53 percent of organic farmers are linked with extension services as compared to 52, 37 and 36 percent for conventional farmers, respectively.

The average landholding for organic farmers is 5.32, 1.56 and 1.73 acres in the study areas of Pakistan, Nepal and Bangladesh respectively, which is considerably less, compared to conventional farmers in these countries.

4.2 Variable Costs of wheat and Rice in Pakistan, Nepal and Bangladesh

The cost of land preparation, cost of other inputs (cost of seed, fertilizers/composts and pesticides/bio-pesticides), cost of irrigation and cost of labour on per acre basis for wheat and rice crops in the selected study sites of Pakistan, Nepal and Bangladesh are presented in the Tables 4.2 and 4.3, respectively. It can be noticed that the cost of other inputs is lower in organic wheat and rice farming than those of conventional farming in Pakistan, Nepal and Bangladesh because organic farmers are more dependent on on-farm resources and use different types of composts and bio-pesticides instead of external inputs like chemical fertilizers and pesticides.

The cost of irrigation is also lower for organic farmers as compared to conventional farmers in Pakistan due to more water holding capacity of organic soils. Similarly, it is lower for organic wheat farmers than conventional wheat farmers in Bangladesh. The cost of irrigation is not applicable for Nepal due to rainfed nature of agriculture and also for Bangladesh rice crop because farmers totally depend on monsoon rains for Aman rice crop.
Table 4.2: Variable Costs of Wheat Production in Pakistan, Nepal and Bangladesh

<table>
<thead>
<tr>
<th>Variable Costs and Area Under Wheat</th>
<th>Pakistan</th>
<th>Nepal</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under wheat (Acres)</td>
<td>3.55</td>
<td>3.78</td>
<td>0.82</td>
</tr>
<tr>
<td>Cost of land preparation per acre (USD)</td>
<td>38.43 (3785.3)</td>
<td>37.42 (3676)</td>
<td>33.70 (2945.71)</td>
</tr>
<tr>
<td>Cost of other inputs per acre (USD)</td>
<td>45.63 (4494.4)</td>
<td>73.31 (7220.6)</td>
<td>38.39 (3355.2)</td>
</tr>
<tr>
<td>Cost of irrigation per acre (USD)</td>
<td>16.11 (1586.2)</td>
<td>17.46 (1720.05)</td>
<td>0</td>
</tr>
<tr>
<td>Cost of labour per acre (USD)</td>
<td>42.47 (4183.3)</td>
<td>41.11 (4048.5)</td>
<td>49.95 (4365.3)</td>
</tr>
<tr>
<td>Yield/Acre (Monds)</td>
<td>39.22</td>
<td>41.25</td>
<td>24.82</td>
</tr>
<tr>
<td>Wheat price per mond (USD)</td>
<td>10.08 (992.33)</td>
<td>9.94 (978.73)</td>
<td>11.48 (1003.60)</td>
</tr>
<tr>
<td>Gross Revenue (USD)</td>
<td>395.17 (38921)</td>
<td>409.96 (40377.1)</td>
<td>285.04 (24910)</td>
</tr>
<tr>
<td>Gross margin per Acre (USD)</td>
<td>252.54 (24872.5)</td>
<td>240.76 (23712)</td>
<td>162.99 (14243.8)</td>
</tr>
<tr>
<td>n</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

Source: Survey data
Note: Figures in the parenthesis are in PKR for Pakistan, NPR for Nepal and Taka for Bangladesh
Dollar Rates: 1 USD = 98.49 PKR, 1 USD = 87.39 NPR, 1 USD = 77.80 BDT

The data show that organic farmers in all three countries get better prices for wheat and rice as compared to conventional farmers.

As for as gross margin is concerned, organic farmers are getting more gross margin per acre in wheat farming in Pakistan i.e. 252.54 USD compared to 240.76 USD of conventional farming. Similarly, gross margin per acre for organic wheat farmers in Nepal and Bangladesh is better with 162.99 USD and 265.19 USD than conventional wheat farmers in these countries with 158.76 USD and 215.75 USD, respectively.
The gross margin per acre for conventional rice farmers (358.94 USD) is better than organic rice farmers (340.31 USD) in Pakistan. But organic rice farmers are getting more gross margin per acre than conventional rice farmers in the study areas of both Nepal and Bangladesh. In Nepal, organic rice farmers are getting 179.40 USD gross margin per acre as compared to 154.88 USD for conventional rice farmers while Bangladeshi organic rice farmers are getting 193.87 USD gross margin per acre for organic rice as compared 176.46 USD for conventional rice farmers.

Table 4.3: Variable Costs of Rice Production in Pakistan, Nepal and Bangladesh

<table>
<thead>
<tr>
<th>Variable Costs and Area Under Rice</th>
<th>Pakistan</th>
<th>Nepal</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under rice (Acres)</td>
<td>3.57</td>
<td>4.03</td>
<td>0.89</td>
</tr>
<tr>
<td>Cost of land preparation per acre (USD)</td>
<td>36.63 (3608)</td>
<td>34.66 (3414)</td>
<td>44.72 (3908.26)</td>
</tr>
<tr>
<td>Cost of other inputs per acre (USD)</td>
<td>46.36 (4565.8)</td>
<td>73.69 (7257.46)</td>
<td>40.77 (3563.22)</td>
</tr>
<tr>
<td>Cost of irrigation per acre (USD)</td>
<td>65.73 (6473.4)</td>
<td>79.46 (7826.33)</td>
<td>48.83 (4267.40)</td>
</tr>
<tr>
<td>Cost of labour per acre (USD)</td>
<td>41.40 (4077.7)</td>
<td>38.86 (3827.44)</td>
<td>48.83 (4267.40)</td>
</tr>
<tr>
<td>Yield/Acre (Monds)</td>
<td>37.63</td>
<td>42.17</td>
<td>35.29</td>
</tr>
<tr>
<td>Rice price per mond (USD)</td>
<td>14.09 (1388.3)</td>
<td>13.88 (1367.46)</td>
<td>8.89 (776.82)</td>
</tr>
<tr>
<td>Gross Revenue (USD)</td>
<td>530.43 (52242.5)</td>
<td>585.61 (57677.3)</td>
<td>313.72 (27416.7)</td>
</tr>
<tr>
<td>Gross margin per Acre (USD)</td>
<td>340.31 (33517.6)</td>
<td>358.94 (35352.1)</td>
<td>179.40 (15677.8)</td>
</tr>
<tr>
<td>n</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

Source: Survey data
Note: Figures in the parenthesis are in PKR for Pakistan, NR for Nepal and Taka for Bangladesh
Dollar Rates: 1USD= 98.49 PKR, 1USD= 87.39 NPR, 1USD= 77.80 BDT
The data show that both organic and conventional farmers allocate major part of their landholding to wheat in Rabi season and rice in Kharif season in Pakistan, Nepal and Bangladesh.

4.3 Tests of Hypotheses

The likelihood ratio, sigma squared and gamma parameters are important to test the different hypotheses. The log likelihood (LL) and gamma (γ) parameters are used to test for efficiency and sometimes the appropriateness of the model. The gamma (γ) is the ratio of inefficiency error term to the total sum of errors. Its value ranges from 0 to 1. If value of gamma (γ) is 1, inefficiency exists but not random and if the value of gamma is zero, inefficiency effects are not present.

The Log Likelihood (LL) test statistics is used to test various restrictions in the model. In the present study, we test firstly, whether farmers are operating on the frontier or not and secondly, whether factors included in the inefficiency model affect the profit efficiency or not. The LL statistics is

\[ LL = -2\{\log [\text{Likelihood (H}_0)] - \log [\text{Likelihood (H}_1)]\} \quad \ldots \ldots \ (4.1) \]

Where

LL (H₀) is the restricted (LLR) likelihood value under null hypothesis

LL (H₁) represents the unrestricted (LLU) likelihood value under alternative hypothesis

LL is the absolute value between LLR and LLU multiplied by 2

The first hypothesis tests whether the farmers are operating on the frontier by imposing the restrictions on the original model given by equations 3.22 and 3.23. In other words, it states that inefficiency effects are absent. The null hypothesis is:
If they are not operating at the frontier, we reject the null hypothesis in favour of alternative hypothesis at 5% confidence level using Kodde and Palm (1986) table explaining that inefficiency effects are present.

In case first null hypothesis is rejected, the second hypothesis has been designed to test the influence of farmer specific factors on the level of inefficiency at 5% confidence level with the imposition of restrictions on the original model expressed by equation 3.22 and 3.23.

To reject the null hypothesis the difference between the $LL_U$ and $LL_R$ should be greater than critical value taken from Kodde and Palm (1986). The rejection of null hypothesis would imply that the factors in the inefficiency model contribute significantly to the observed level of profit inefficiency.

The results of tests of hypotheses are presented in Tables 4.4 and 4.5 for wheat and rice crops in Pakistan, Nepal and Bangladesh. The first column of these tables shows the null hypothesis. The second column shows the calculation of Log Likelihood value, critical values taken from Kodde and Palm (1986) and decision about rejection or acceptance of null hypothesis. Third, fourth and fifth columns show the values for wheat or rice crops for Pakistan, Nepal and Bangladesh respectively and have been further divided for organic and conventional wheat or rice crop.

The values of LL statistics for Pakistani organic and conventional wheat came out to be 41.28 and 57.92, respectively for the hypothesis 1. These values are higher than the critical value taken from Kodde and Palm (1986) table. So, the null hypothesis is rejected concluding that all farms are not operating on frontier. The values of LL statistics for organic and conventional wheat in
Nepal and Bangladesh are also found to be greater than critical value. So the null hypotheses are rejected.

The second hypothesis that variables included in inefficiency effects model have no effect on the level of profit inefficiency, is tested against the critical value. The LL values for organic and

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Likelihood Values</th>
<th>Pakistan</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0: \gamma = \delta_0 = \delta_1 = \delta_2 = 0, \nabla_d )</td>
<td>LLU</td>
<td>101.68</td>
<td>103.46</td>
<td>29.96</td>
<td>17.66</td>
<td>92.99</td>
<td>41.93</td>
</tr>
<tr>
<td></td>
<td>LLR</td>
<td>80.36</td>
<td>74.50</td>
<td>8.93</td>
<td>6.82</td>
<td>59.85</td>
<td>18.46</td>
</tr>
<tr>
<td></td>
<td>LL</td>
<td>41.28</td>
<td>57.92</td>
<td>42.06</td>
<td>21.68</td>
<td>66.28</td>
<td>46.94</td>
</tr>
<tr>
<td></td>
<td>Decision</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Likelihood Values</th>
<th>Pakistan</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_0: \delta_0 = \delta_1 = \delta_2 = \delta_d = 0, \nabla_d )</td>
<td>LLU</td>
<td>101.68</td>
<td>103.46</td>
<td>29.96</td>
<td>17.66</td>
<td>92.99</td>
<td>41.93</td>
</tr>
<tr>
<td></td>
<td>LLR</td>
<td>67.24</td>
<td>74.14</td>
<td>0.25</td>
<td>-5.65</td>
<td>59.42</td>
<td>15.15</td>
</tr>
<tr>
<td></td>
<td>LL</td>
<td>68.89</td>
<td>58.64</td>
<td>59.40</td>
<td>46.63</td>
<td>67.14</td>
<td>53.56</td>
</tr>
<tr>
<td>Variables included in the inefficiency effect model have no effect on the level of profit inefficiency.</td>
<td>Critical Value</td>
<td>13.40</td>
<td>13.40</td>
<td>13.40</td>
<td>13.40</td>
<td>13.40</td>
<td>13.40</td>
</tr>
<tr>
<td></td>
<td>Decision</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
<td>Reject ( H_0 )</td>
</tr>
</tbody>
</table>
conventional wheat in all countries are higher than the critical values. So, the null hypotheses are rejected concluding that the variables included in the inefficiency model significantly affect the level of profit inefficiency.

Table 4.5: Hypotheses Testing for Rice in Pakistan, Nepal and Bangladesh

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Likelihood Values</th>
<th>Pakistan</th>
<th>Nepal</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>H&lt;sub&gt;0&lt;/sub&gt;: γ = δ&lt;sub&gt;0&lt;/sub&gt; = δ&lt;sub&gt;1&lt;/sub&gt; = δ&lt;sub&gt;2&lt;/sub&gt; = δ&lt;sub&gt;d&lt;/sub&gt; = 0, V&lt;sub&gt;d&lt;/sub&gt;</td>
<td>LL&lt;sub&gt;U&lt;/sub&gt;</td>
<td>90.10</td>
<td>133.24</td>
<td>29.17</td>
</tr>
<tr>
<td></td>
<td>LL&lt;sub&gt;R&lt;/sub&gt;</td>
<td>67.97</td>
<td>94.81</td>
<td>8.94</td>
</tr>
<tr>
<td></td>
<td>LL&lt;sub&gt;L&lt;/sub&gt;</td>
<td>44.26</td>
<td>76.86</td>
<td>40.46</td>
</tr>
<tr>
<td></td>
<td>Decision</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
</tr>
<tr>
<td>H&lt;sub&gt;0&lt;/sub&gt;: δ&lt;sub&gt;0&lt;/sub&gt; = δ&lt;sub&gt;1&lt;/sub&gt; = δ&lt;sub&gt;2&lt;/sub&gt; = δ&lt;sub&gt;d&lt;/sub&gt; = 0, V&lt;sub&gt;d&lt;/sub&gt;</td>
<td>LL&lt;sub&gt;U&lt;/sub&gt;</td>
<td>90.10</td>
<td>133.24</td>
<td>29.17</td>
</tr>
<tr>
<td></td>
<td>LL&lt;sub&gt;R&lt;/sub&gt;</td>
<td>52.21</td>
<td>94.80</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>LL&lt;sub&gt;L&lt;/sub&gt;</td>
<td>75.78</td>
<td>76.88</td>
<td>57.83</td>
</tr>
<tr>
<td></td>
<td>Decision</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Reject H&lt;sub&gt;0&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

For Pakistani organic and conventional rice farmers, the values of LL statistics are estimated to be 44.26 and 76.86, respectively to test the null hypothesis whether all farmers are operating on
the frontier. The null hypothesis is rejected at 5 percent confidence level confirming that all farmers are not operating at frontier. The null hypotheses for organic and conventional rice farmers in Nepal and Bangladesh are also rejected.

The second null hypotheses for organic and conventional rice in all three countries are also rejected at 5 percent confidence level to confirm that variables in the inefficiency model affect the profit inefficiency significantly.

To conclude this section, tests of two hypotheses show that all farmers are not operating on the frontier and in general, the factors in the inefficiency model explain the observed variation in the profit inefficiency adequately. So, the next section concentrates on the estimation of Cobb Doulas frontier profit function using MLE method.

4.4 Estimation of Frontier Profit Function

This section explains the estimation of stochastic frontier profit function to compare the profit efficiency in organic and conventional; wheat and rice crops in South Asia. The dependent variable is the profit from an output of one season. This section has been further divided into three subsections to explain the results country wise. The profit efficiency of organic wheat is compared with conventional wheat and organic rice with conventional rice. The parameters of Cobb Douglas profit function can be directly illustrated as profit elasticities of inputs.

4.4.1 Frontier Profit Function among Wheat and Rice Farmers in Pakistan

The MLE estimates of the parameters of Cobb Douglas model for Pakistan organic and conventional; wheat and rice crops are given in Table 4.6. First column of this table shows the variables included in the model. The second and third columns are referred to wheat and rice crops, respectively. Both columns have been further divided into two sub-columns explaining the
coefficients and standard errors of organic and conventional; wheat and rice crops. The t-ratios are used to test the significance of the parameters.

Table 4.6: Frontier Profit Function among Wheat and Rice Farmers in Pakistan

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th></th>
<th>Rice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Conventional</td>
<td>Organic</td>
<td>Conventional</td>
</tr>
<tr>
<td></td>
<td>(Coefficients)</td>
<td>(Coefficients)</td>
<td>(Coefficients)</td>
<td>(Coefficients)</td>
</tr>
<tr>
<td>Constant</td>
<td>6.106*</td>
<td>7.502*</td>
<td>5.074*</td>
<td>6.816*</td>
</tr>
<tr>
<td></td>
<td>(0.786)</td>
<td>(0.601)</td>
<td>(0.878)</td>
<td>(0.530)</td>
</tr>
<tr>
<td>P1 (Normalized price of land preparation)</td>
<td>-0.039* ns</td>
<td>-0.162* ns</td>
<td>-0.265***</td>
<td>0.051* ns</td>
</tr>
<tr>
<td></td>
<td>(0.115)</td>
<td>(0.145)</td>
<td>(0.186)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>P2 (Normalized price of other inputs)</td>
<td>-0.238*</td>
<td>-0.327***</td>
<td>0.032* ns</td>
<td>-0.223*</td>
</tr>
<tr>
<td></td>
<td>(0.086)</td>
<td>(0.196)</td>
<td>(0.047)</td>
<td>(0.074)</td>
</tr>
<tr>
<td>P3 (Normalized price of irrigation)</td>
<td>-0.176*</td>
<td>-0.067* ns</td>
<td>-0.013* ns</td>
<td>-0.177***</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.073)</td>
<td>(0.196)</td>
<td>(0.130)</td>
</tr>
<tr>
<td>P4 (Normalized price of Labour)</td>
<td>-0.040* ns</td>
<td>-0.394***</td>
<td>-0.376**</td>
<td>-0.306**</td>
</tr>
<tr>
<td></td>
<td>(0.111)</td>
<td>(0.235)</td>
<td>(0.189)</td>
<td>(0.139)</td>
</tr>
<tr>
<td>Z1 (Capital)</td>
<td>0.320*</td>
<td>0.247*</td>
<td>0.413*</td>
<td>0.180*</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.073)</td>
<td>(0.112)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>D1 (Soil fertility)</td>
<td>0.044**</td>
<td>0.006* ns</td>
<td>0.024* ns</td>
<td>0.013* ns</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.030)</td>
<td>(0.024)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>D2 (Pest breakouts in wheat or rice crop)</td>
<td>-0.059*</td>
<td>-0.035***</td>
<td>-0.093*</td>
<td>-0.053**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.024)</td>
<td>(0.024)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Sigma Square</td>
<td>0.030*</td>
<td>0.006*</td>
<td>0.048*</td>
<td>0.002*</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.002)</td>
<td>(0.009)</td>
<td>(0.0003)</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.981*</td>
<td>0.550*</td>
<td>0.986*</td>
<td>0.990*</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.156)</td>
<td>(0.009)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>101.69</td>
<td>103.469</td>
<td>90.107</td>
<td>133.248</td>
</tr>
<tr>
<td>Average Profit Efficiency</td>
<td>0.915</td>
<td>0.911</td>
<td>0.892</td>
<td>0.910</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant. Figures in the parentheses are standard errors.
For organic wheat, the coefficient of land preparation and labour are non significant but with negative sign. The estimated coefficient of other inputs (seed, fertilization and pesticides) is significant at 1 percent level of confidence with negative sign implying that these variables are contributing to lower the profit. This result is in line with Hyuha (2006). Madau (2007) also computed a negative impact of fertilizers on technical efficiency of organic cereal farms in Italy. The coefficient of irrigation is also significant at 1 percent level of confidence with negative sign indicating that farmers are overusing irrigation. Capital is significant at 1 percent and positive sign shows that it is affecting profit positively. This finding is in line with Rahman (2003). Soil fertility has positive sign and significant at 5 percent level. The pest breakout is also affecting the profit negatively at 1 percent significance level.

For conventional wheat farmers, the estimated coefficients of other inputs and labour are significant at 10 percent level of confidence with negative signs indicating that these costs are contributing significantly in lowering the profit. Similar results were reported by Hyuha (2006), Ali and Flinn (1989), Abdulai and Huffman (2000) and Rahman (2003).

The coefficient of land preparation and irrigation are non-significant. The capital is significant at 1 percent level of confidence with positive sign. The soil fertility has expected positive sign but non-significant. The pest breakout is contributing to lower the profit with negative sign and significant at 10 percent level of significance.

The variance parameters sigma square and gamma are significantly different from zero in both categories indicating that there are differences in the profit efficiency among organic and conventional wheat farmers. The average profit efficiency of organic wheat farmers is found to be 0.915 which is slightly higher than the conventional farmers to conclude that organic wheat farmers are more profit efficient than conventional farmers.

For organic rice, the estimated coefficient of land preparation is significant at 10 percent level while labour is significant at 5 percent level of significance. The result for labour is in line with
Hyuha (2006), Ali and Flinn (1989), Abdulai and Huffman (2000) and Rahman (2003). The coefficients of other inputs, irrigation and soil fertility are non-significant. The capital is significant at 1 percent level of confidence with positive sign. Hyuha (2006) and Rahman (2003) reported the same result about rice farmers of Uganda and Bangladesh, respectively. Pest breakout is affecting the profit negatively at 1 percent significance level.

For conventional rice farmers, the coefficients of other inputs, irrigation and labour are significant at 1, 10 and 5 percent level of confidence with negative sign implying that these variables are contributing to lower the profit. The results for other inputs and labour are in line with Hyuha (2006) while Ali and Flinn (1989), Abdulai and Huffman (2000) and Rahman (2003) reported the same results for labour and fertilizer. The coefficient of land preparation is found to be non-significant. The capital is significant at 1 percent level of confidence with positive sign meaning that increase in fixed factors would contribute to increase the profit. The result is in line with Hyuha (2006) and Rahman (2003). The impact of pest breakout on lowering the profit is significant with 5 percent confidence level.

The variance parameters for both organic and conventional rice are significantly different from zero and confirm differences in the profit efficiency. The results show that average profit efficiency of organic rice farmers is less than conventional rice farmers in Pakistan but still comparable with score of 0.89. The average profit efficiency of conventional rice farmers is found to be 0.91 due to the better yield than organic farmers.

To conclude this sub-section, we can say that organic wheat farmers are more profit efficient than conventional wheat farmers while organic rice farmers are less efficient than conventional rice farmers in Pakistan. A little difference is observed in the average profit efficiencies of organic and conventional; rice and wheat. The variable inputs impact differently in both organic and conventional farming but their overall impact is found to lower the profit. The fixed factors are also observed to play an important role in increasing profit. The pest breakout significantly affects the profit negatively and requires timely application of plant protection measures.
### 4.4.2 Frontier Profit Function among Wheat and Rice Farmers in Nepal

The MLE estimates of the parameters of Cobb Douglas model for Nepal organic and conventional; wheat and rice crops are given in the Table 4.7. The price of irrigation is not included in the analysis due to rainfed nature of agriculture in the study areas of Nepal.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Organic (Coefficients)</th>
<th>Conventional (Coefficients)</th>
<th>Organic (Coefficients)</th>
<th>Conventional (Coefficients)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.632*** (1.032)</td>
<td>-0.115 ns (1.873)</td>
<td>1.978*** (1.140)</td>
<td>2.160** (0.966)</td>
</tr>
<tr>
<td>P1 (Normalized price of land preparation)</td>
<td>-1.042* (0.251)</td>
<td>-0.699*** (0.525)</td>
<td>-1.047* (0.278)</td>
<td>0.167 ns (0.181)</td>
</tr>
<tr>
<td>P2 (Normalized price of other inputs)</td>
<td>-0.144 ns (0.241)</td>
<td>-0.746** (0.326)</td>
<td>-0.166 ns (0.249)</td>
<td>-0.496* (0.192)</td>
</tr>
<tr>
<td>P3 (Normalized price of Labour)</td>
<td>0.362*** (0.259)</td>
<td>0.094 ns (0.145)</td>
<td>0.403*** (0.272)</td>
<td>-0.079 ns (0.093)</td>
</tr>
<tr>
<td>Z1 (Capital)</td>
<td>1.201* (0.147)</td>
<td>1.526* (0.194)</td>
<td>1.148* (0.173)</td>
<td>0.809* (0.134)</td>
</tr>
<tr>
<td>D1 (Soil fertility)</td>
<td>0.227* (0.040)</td>
<td>0.040 (0.068)</td>
<td>0.240* (0.036)</td>
<td>0.055*** (0.032)</td>
</tr>
<tr>
<td>D2 (Pest breakouts in wheat or rice crop)</td>
<td>-0.319* (0.053)</td>
<td>-0.233* (0.050)</td>
<td>-0.316* (0.053)</td>
<td>-0.093** (0.039)</td>
</tr>
<tr>
<td>Sigma Square</td>
<td>0.250* (0.095)</td>
<td>0.247* (0.053)</td>
<td>0.224* (0.058)</td>
<td>0.219* (0.050)</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.961* (0.022)</td>
<td>0.927* (0.030)</td>
<td>0.956* (0.019)</td>
<td>0.991* (0.005)</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>29.966</td>
<td>17.665</td>
<td>29.173</td>
<td>53.937</td>
</tr>
<tr>
<td>Average Profit Efficiency</td>
<td>0.860</td>
<td>0.855</td>
<td>0.874</td>
<td>0.857</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant.

Figures in the parentheses are standard errors.
The estimated coefficients of land preparation and labour are significant at 1 and 10 percent confidence level, respectively for organic wheat farmers in Nepal and carry negative and positive signs. The positive sign of labour indicates that engaging more labour will increase the profit due to labour intensive nature of organic farming. The result is in line with Madau (2007). The coefficient of other inputs including seed, fertilization and pesticides is non-significant. Capital has positive sign and is significant at 1 percent level of confidence. The result is in line with Hyuha (2006) and Rahman (2003). The dummy variables for soil fertility and pest breakout are significant at 1 percent having positive and negative signs, respectively implying that soil fertility contributes to increase the profit while pest breakouts tend to lower the profit.

The coefficients of land preparation and other inputs in conventional wheat farming are significant at 10 and 5 percent level of confidence, respectively with negative signs indicating that these variables are contributing significantly to lower the profit. The result for land preparation is in line with Bakhsh (2007) while Hyuha (2006) reported similar results for other inputs. The coefficient of labour is non-significant. Capital is significant at 1 percent level of confidence to impact the profit positively. Hyuha (2006) and Rahman (2003) reported similar result for capital. The soil fertility has expected positive sign but non-significant. The pest breakout is contributing to lower the profit with negative sign and significant at 1 percent level of significance.

The variance parameters are significantly different from zero in both organic and conventional wheat and confirm the differences in the profit efficiency among organic and conventional wheat farmers. The average profit efficiency of organic wheat farmers is found to be better than conventional wheat farmers with efficiency scores 0.860 and 0.855 respectively.

The MLE results for organic rice show that the coefficient of land preparation is significant at 1 percent level with negative sign that indicates the negative impact on profitability. The result is in line with Bakhsh (2007). The coefficient of other inputs (seed, fertilization and pesticides) is non-significant. The coefficient of labour is significant at 10 percent level of confidence with
positive sign indicating that increase in labour would contribute to increase the profit. It may be due to the labour intensive nature of organic farming. Capital is also significant at 1 percent level of confidence with positive sign. The results are in line with Hyuha (2006), Abdulai and Huffman (2000) and Rahman (2003). The soil fertility and pest breakout are significant at 1 percent level of confidence with positive and negative signs, respectively.

For conventional rice farmers in Nepal, the coefficient of other inputs is significant at 1 percent level of confidence with negative sign indicating that farmers are not making optimum use of these inputs thus lowering the profit. The results is in line with Hyuha (2006) while Ali and Flinn (1989), Abdulai and Huffman (2000) and Rahman (2003) reported the same results for fertilizer. The coefficients of land preparation and labour are non-significant. Capital with positive sign contributes to increase the profit and is significant at 1 percent level. The coefficient for soil fertility is significant at 10 percent level of confidence with positive sign. The impact of pest breakout on lowering the profit is significant at 5 percent confidence level.

The variance parameters confirm the differences in the profit efficiency among organic and conventional rice farmers in Nepal. Results show that average profit efficiency (0.874) of organic rice farmers is slightly better than the average profit efficiency of conventional rice farmers (0.857).

This sub-section indicates that organic wheat and rice farming is more profit efficient than conventional rice and wheat farming in the selected study areas of Nepal. The impact of variable inputs is different for organic and conventional; wheat and rice crops but their overall effect is to lower the profit except labour in organic farming. The results for labour confirm that by increasing labour, profit can be increased in organic wheat and rice farming. The capital contributes significantly to increase the profit. The pest breakouts significantly affect the profit negatively and require timely application of plant protection measures.
4.4.3 Frontier Profit Function among Wheat and Rice Farmers in Bangladesh

The MLE estimates of the parameters of Cobb Douglas model for Bangladeshi organic and conventional; wheat and rice crops are explained in Tables 4.8. The price of irrigation is not included in the rice model because Aman rice crop, which is planted in Monsoon season does not need irrigation due to heavy rainfall in Bangladesh.

For organic wheat farmers, the coefficients of land preparation and other inputs are significant at 1 percent level of confidence with negative signs implying that these variables affect profit efficiency negatively. Bakhsh (2007) reported same result for land preparation while Hyuha (2006) reported similar results for other inputs. The coefficients of irrigation and labour are significant at 10 and 5 percent level of confidence with positive signs indicating that increase in irrigation and labour will increase the profit due to labour intensive nature of organic farming. Kaur et al. (2010) reported the similar results for irrigation. The finding for labour is in line with Ahmad et al. (1999) and Madau (2007). The capital is significant at 1 percent confidence level with positive sign. The results are in line with Hyuha (2006), Abdulai and Huffman (2000) and Rahman (2003). The dummy variable for soil fertility is significant at 1 percent and has the positive sign. The impact of pest breakout is negative on profit efficiency but it is non-significant.

For conventional wheat farmers, the coefficient of land preparation is significant at 10 percent and its positive sign indicates that more number of cultivations will contribute to increase the profit. The result is in line with Hassan and Ahmad (2005). The coefficients of other inputs and irrigation are significant at 10 and 1 percent level of confidence respectively with negative sign indicating that these variables are contributing significantly to lower the profit. The results for other inputs are in line with Hyuha (2006). The coefficients of labour and capital are non-significant with positive signs. Coefficient of soil fertility is significant at 1 percent level of
confidence indicating the positive impact on profit while coefficient of pest breakouts is non-significant with negative sign.

Table 4.8: Frontier Profit Function among Wheat and Rice Farmers in Bangladesh

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Rice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Conventional</td>
<td>Organic</td>
</tr>
<tr>
<td>Constant</td>
<td>6.652* (1.008)</td>
<td>6.370* (0.503)</td>
<td>6.328* (0.913)</td>
</tr>
<tr>
<td>P1 (Normalized price of land prep)</td>
<td>-0.463* (0.169)</td>
<td>0.277*** (0.191)</td>
<td>-0.304** (0.128)</td>
</tr>
<tr>
<td>P2 (Normalized price of other inputs)</td>
<td>-0.604* (0.124)</td>
<td>-0.294*** (0.158)</td>
<td>-0.095 ns (0.116)</td>
</tr>
<tr>
<td>P3 (Normalized price of Irrigation)</td>
<td>0.051*** (0.039)</td>
<td>-0.386* (0.093)</td>
<td></td>
</tr>
<tr>
<td>P4 (Normalized price of Labour)</td>
<td>0.374** (0.169)</td>
<td>0.557 ns (0.446)</td>
<td>0.075 ns (0.158)</td>
</tr>
<tr>
<td>Z1 (Capital)</td>
<td>0.386* (0.089)</td>
<td>0.093 ns (0.086)</td>
<td>0.293* (0.093)</td>
</tr>
<tr>
<td>D1 (Soil fertility)</td>
<td>0.083* (0.022)</td>
<td>0.176* (0.074)</td>
<td>0.045*** (0.029)</td>
</tr>
<tr>
<td>D2 (Pest breakouts in wheat)</td>
<td>-0.010 ns (0.032)</td>
<td>-0.036 ns (0.078)</td>
<td>-0.050*** (0.038)</td>
</tr>
<tr>
<td>Sigma Square</td>
<td>0.031* (0.008)</td>
<td>0.033* (0.009)</td>
<td>0.003* (0.001)</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.953* (0.016)</td>
<td>0.999* (0.001)</td>
<td>0.999* (0.054)</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>92.998</td>
<td>41.936</td>
<td>110.299</td>
</tr>
<tr>
<td>Average Profit Efficiency</td>
<td>0.902</td>
<td>0.733</td>
<td>0.748</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant. Figures in the parentheses are standard errors.
The variance parameters confirm the differences in the profit efficiency among organic and conventional wheat farmers as they are significantly different from zero. The average profit efficiency of organic wheat farmers is better than conventional wheat farmers in Bangladesh with profit efficiency score 0.902 compared to profit efficiency score 0.733 of conventional wheat farmers due to better prices of organic wheat.

The coefficient of land preparation in organic rice farming is significant at 5 percent level of confidence impacting the profit efficiency negatively. The result is in line with Bakhsh (2007). The coefficients of other inputs (seed, fertilizer and pesticides) and labour are non-significant. The capital is significant at 1 percent level of confidence with the expected positive sign. The results are in line with Hyuha (2006), Abdulai and Huffman (2000) and Rahman (2003). The soil fertility impacts the profit efficiency positively at 10 percent level of confidence while pest breakout impacts the profit efficiency negatively at 10 percent level of confidence.

For conventional rice farmers of Bangladesh, the coefficients of land preparation and other inputs are significant at 1 percent level of confidence with negative signs indicating that farmers are not making optimum use of these inputs thus lowering the profit. Bakhsh (2007) reported same result for land preparation. Hyuha (2006) reported similar results for other inputs while Ali and Flinn (1989), Abdulai and Huffman (2000) and Rahman (2003) reported the same results for fertilizer. The coefficient of labour is non-significant with positive sign. The coefficient of capital is significant at 1 percent level having positive impact on profit. The dummy variable for soil fertility is significant at 1 percent with positive sign. The impact of pest breakout is negative on profit but non-significant.

The variance parameters are significantly different from zero and confirm the differences in the profit efficiency among organic and conventional rice farmers in Bangladesh. The results show that average profit efficiency of organic rice farmers with efficiency score 0.748, is better than the average profit efficiency of conventional rice farmers with efficiency score of 0.657.
This sub-section concludes that organic wheat and rice farming is more profitable than conventional farming of the same crops in the selected study areas of Bangladesh. The overall impact of variable inputs is to lower the profit in both organic and conventional; wheat and rice indicating that both organic and conventional farmers are not using resources at the optimum level. The fixed factors contribute significantly to increase the profit in organic wheat and rice farming and conventional rice farming. The soil fertility plays significant role in increasing profit in both organic and conventional; wheat and rice farming.

4.5 Determinants of Farm Specific Profit Inefficiency

The determinants of profit inefficiency are estimated by model given in equation (3.23) for organic and conventional; rice and wheat crops for Pakistan, Nepal and Bangladesh. The inefficiency is taken as dependent variable and explanatory variables included in the model are education, experience, access to credit, linkages with extension services, off-farm employment and area under wheat or rice crop in acres.

4.5.1 Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Pakistan

The results for the determinants of farm specific profit inefficiency among organic and conventional; wheat and rice farmers in Pakistan are presented in Table 4.9.

The estimated coefficient of education is significant at 1 percent level of confidence in both organic and conventional wheat farming with negative sign indicating that education is contributing to reduce the profit inefficiency in both organic and conventional wheat farming. It implies that investment on human capital is a powerful tool to improve efficiency. Similar results were reported by Kaur et al. (2010), Hassan and Ahmad (2005).
Table 4.9: Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Pakistan

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Rice</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic (Coefficients)</td>
<td>Conventional (Coefficients)</td>
<td>Organic (Coefficients)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.268*** (0.148)</td>
<td>0.462* (0.111)</td>
<td>0.254 ns (0.256)</td>
</tr>
<tr>
<td>Education (number of schooling years)</td>
<td>-0.052* (0.018)</td>
<td>-0.028* (0.010)</td>
<td>-0.085* (0.025)</td>
</tr>
<tr>
<td>Experience of wheat/Rice farming</td>
<td>-0.013 ** (0.006)</td>
<td>-0.015* (0.004)</td>
<td>-0.002 ns (0.010)</td>
</tr>
<tr>
<td>Access to Credit</td>
<td>0.041 ns (0.130)</td>
<td>-0.057 ns (0.064)</td>
<td>-0.044 ns (0.231)</td>
</tr>
<tr>
<td>Linkages with extension services</td>
<td>-0.667*** (0.369)</td>
<td>-0.033 ns (0.061)</td>
<td>-0.818*** (0.564)</td>
</tr>
<tr>
<td>Off-farm employment</td>
<td>0.144*** (0.100)</td>
<td>0.017 ns (0.030)</td>
<td>0.0001 ns (0.155)</td>
</tr>
<tr>
<td>Area Under wheat/Rice</td>
<td>-0.009 ns (0.027)</td>
<td>-0.004 ns (0.017)</td>
<td>-0.012 ns (0.034)</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant.

Figures in the parentheses are standard errors.

The estimated coefficient of education is significant at 1 and 10 percent level of confidence for organic and conventional rice farming in Pakistan, respectively. The negative sign of the estimated coefficient implies that education contributes to reduce the profit inefficiency in both organic and conventional rice farming. The results are consistent with Ali and Flinn (1989) for Basmati rice farmers in Pakistan, Hyuha (2006) for rice farmers in Uganda and Wang et al. (1996) for rice farmers in China.

Experience of head of household is included in the model to assess the impact of experience on profit efficiency. The coefficient of experience is significant at 5 and 1 percent level of confidence in organic and conventional wheat farming, respectively. The negative sign in both
organic and conventional wheat farming indicates that experience contributes to reduce the profit inefficiency. The results are in line with Kaur et al. (2010) and Hasan and Islam (2010). The estimated coefficient of experience is non-significant in organic rice farming but it is significant in conventional rice farming at 1 percent level of confidence. The negative sign in both organic and conventional rice farming indicates that experience of the farmers contribute to reduce the profit inefficiency. Ali and Byerlee (1991) and Rahman (2003) reported the similar results.

Access to credit is important to increase the profit efficiency with timely availability of funds needed to support farming process. The access to credit is non-significant in both organic and conventional wheat farming. The access to credit is significant at 5 percent level of confidence in conventional rice farming while it is non-significant in organic rice farming. It may be due to the higher level of self sufficiency in organic farming that does not need external inputs like chemical fertilizers and pesticides. The negative sign of coefficient in both organic and conventional rice farming shows that access to credit contributes to reduce the profit inefficiency. The results are consistent with Ali and Flinn (1989) and Hyuha (2006).

Linkages with extension services are important and expected to impact the inefficiency negatively by enhancing the managerial ability of the farmers to use resources in an efficient manner. The linkages with extension service is significant at 10 percent level of confidence in both organic wheat and rice farming because most of organic farmers are working closely with NGOs and other institutions which are promoting organic farming but it is non-significant in conventional wheat and rice farming. The negative sign of the coefficients in both organic and conventional; wheat and rice farming shows the negative impact of linkages with extension services on profit inefficiency. Same results were reported by Bravo-Ureta and Rieger (1991) Seyoum et al. (1998), Rahman (2003) and Hyuha (2006).

Off-farm employment can affect the profit inefficiency in both positive and negative manner because it is the source of extra income which makes more funds available to purchase inputs and on the other hand it consumes valuable time of the farmers that affects the inefficiency
positively. For organic wheat production, the estimated coefficient of off-farm employment is significant at 10 percent level of confidence. The result is consistent with Ali et al. (1994), Ali and Flinn (1989), Wang et al. (1996) and Rahman (2003). The coefficient of off-farm employment is non-significant in conventional wheat and organic and conventional rice farming. The positive sign in all categories indicates the positive impact of off-farm employment on profit inefficiency.

The estimated coefficient of area under wheat is non-significant for organic and conventional wheat farming. The area under rice is non-significant for organic rice farming but significant at 10 percent level of confidence for conventional rice farming. The negative sign indicates that the farmers who have more area under conventional rice crop, are more efficient than other farmers. The result is in full agreement with Abdulai and Huffman (2000) and Kaur et al. (2010).

4.5.2 Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Nepal

The determinants of farm specific profit inefficiency among organic and conventional; wheat and rice farmers in Nepal are presented in Table 4.10. The impact of each variable on profit inefficiency is described below.

The results show that estimated coefficient of education is statistically significant at 5 percent level of confidence in both organic and conventional wheat farming in Nepal while estimated coefficients are significant at 1 and 5 percent level of confidence in organic and conventional rice farming, respectively. The negative sign in all categories indicates that education significantly reduces profit inefficiency in both organic and conventional farming. This implies that profit efficiency can be increased by enhancing the education level of the farmers. The results are in line with Lockheed et al. (1980), Ali and Flinn (1989), Ali and Byerlee (1991), Hassan and Ahmad (2005) and Kaur et al. (2010).
Table 4.10: Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Nepal

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic (Coefficients)</td>
<td>Conventional (Coefficients)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.397* (0.471)</td>
<td>0.724 ns (0.647)</td>
</tr>
<tr>
<td>Education (number of schooling years)</td>
<td>-0.131** (0.064)</td>
<td>-0.147** (0.063)</td>
</tr>
<tr>
<td>Experience of wheat / Rice farming</td>
<td>-0.039** (0.019)</td>
<td>-0.073*** (0.047)</td>
</tr>
<tr>
<td>Access to Credit</td>
<td>-0.299 ns (0.291)</td>
<td>-0.237 ns (0.402)</td>
</tr>
<tr>
<td>Linkages with extension services</td>
<td>-1.843** (0.801)</td>
<td>-1.323* (0.551)</td>
</tr>
<tr>
<td>Off-farm employment</td>
<td>-0.056 ns (0.212)</td>
<td>0.539*** (0.397)</td>
</tr>
<tr>
<td>Area Under wheat/Rice</td>
<td>-0.559 ns (0.507)</td>
<td>-0.200 ns (0.675)</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant.

Figures in the parentheses are standard errors.

Experience of head of the family is expected to reduce the extent of profit inefficiency as more experience brings proficiency in farming. The coefficient of experience in both organic and conventional wheat farming is significant at 5 and 10 percent level of confidence, respectively. It is also significant at 10 and 1 percent level of confidence in organic and conventional rice farming, respectively. The negative sign of estimated coefficients in both organic and conventional farming confirms that experience tends to reduce the profit inefficiency. Ali and Byerlee (1991), Rahman (2003) and Kaur et al. (2010) reported the similar results.
The estimated coefficients of access to credit are non-significant in organic and conventional wheat farming and organic rice farming in Nepal implying that organic farmers are not much dependent on external resources. It is significant at 5 percent level of confidence in conventional rice farming. The negative sign of coefficients in all categories implies that access to credit impact to reduce the profit inefficiency. Hassan and Ahmad (2005) and Huyha (2006) also registered the negative sign of access to credit.

The results show that the estimated coefficients of linkages with extension services for organic and conventional wheat farming are significant at 5 and 1 percent level of confidence. For organic and conventional rice farming, coefficients are significant at 5 and 10 percent level of confidence, respectively. The negative signs indicate that the linkages with extension services contribute to reduce the profit inefficiency in all categories. Similar results were reported by Ali and Byerlee (1991), Bravo-Ureta and Rieger (1991), Rehman (2003) and Huyha (2006).

For organic wheat and rice farming, the estimated coefficients of off-farm employment are non-significant but having negative sign indicating that off-farm employment tends to reduce profit inefficiency. The estimated coefficient for conventional wheat is significant at 10 percent level of confidence but non-significant for conventional rice farming. The positive sign in conventional wheat and rice farming indicates that off-farm employment contributes to increase the profit inefficiency. The results are in line with Ali and Flinn (1989), Wang et al. (1996) and Rahman (2003) also registered similar results for rice farmers in China and Bangladesh, respectively.

The estimated coefficient of area under wheat is non-significant for organic and conventional wheat farming. The area under rice is also non-significant for organic rice farming but it is highly significant at 1 percent level of confidence for conventional rice farming. The result is in full agreement with Abdulai and Huffman (2000) and Kaur et al. (2010). The negative sign in all categories indicates that increase in area under rice or wheat crop contribute to reduce profit inefficiency.
4.5.3 Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Bangladesh

The results for the determinants of farm specific profit inefficiency among organic and conventional; wheat and rice farmers in Bangladesh are presented in the Table 4.11.

Table 4.11: Determinants of Farm Specific Profit Inefficiency among Wheat and Rice Farmers in Bangladesh

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wheat</th>
<th>Rice</th>
<th>Wheat</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic (Coefficients)</td>
<td>Conventional (Coefficients)</td>
<td>Organic (Coefficients)</td>
<td>Conventional (Coefficients)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.057 ns</td>
<td>0.510*</td>
<td>0.799*</td>
<td>0.817*</td>
</tr>
<tr>
<td></td>
<td>(0.179)</td>
<td>(0.182)</td>
<td>(0.075)</td>
<td>(0.317)</td>
</tr>
<tr>
<td>Education (number of schooling years)</td>
<td>-0.021***</td>
<td>-0.025***</td>
<td>-0.009*</td>
<td>-0.047*</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.015)</td>
<td>(0.003)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Experience of Wheat / Rice farming</td>
<td>0.002 ns</td>
<td>0.002 ns</td>
<td>-0.003*</td>
<td>0.00029 ns</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.001)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Access to Credit</td>
<td>-0.650***</td>
<td>-0.272*</td>
<td>-0.016 ns</td>
<td>-0.146*</td>
</tr>
<tr>
<td></td>
<td>(0.349)</td>
<td>(0.093)</td>
<td>(0.022)</td>
<td>(0.045)</td>
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<tr>
<td>Linkages with extension services</td>
<td>-0.411*</td>
<td>-0.006 ns</td>
<td>-0.034***</td>
<td>-0.104***</td>
</tr>
<tr>
<td></td>
<td>(0.141)</td>
<td>(0.074)</td>
<td>(0.021)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Off-farm employment</td>
<td>0.516*</td>
<td>0.138***</td>
<td>0.043 ns</td>
<td>0.141*</td>
</tr>
<tr>
<td></td>
<td>(0.140)</td>
<td>(0.081)</td>
<td>(0.039)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Area Under wheat/Rice</td>
<td>-0.070 ns</td>
<td>-0.082 ns</td>
<td>-0.265*</td>
<td>-0.057***</td>
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<tr>
<td></td>
<td>(0.056)</td>
<td>(0.091)</td>
<td>(0.033)</td>
<td>(0.032)</td>
</tr>
</tbody>
</table>

*, ** and *** indicate that coefficients are significant at 1, 5 and 10 percent level of significance respectively and ns stands for non-significant.

Figures in the parentheses are standard errors.

The estimated coefficient of education is significant at 10 percent level of confidence in both organic and conventional wheat farming while it is significant at 1 percent level of confidence for both organic and conventional rice farming. The negative signs in all categories imply that...
education is contributing to reduce the profit inefficiency in both organic and conventional; rice and wheat farming. Similar results were reported by Ali and Flinn (1989), Wang et al. (1996), Hassan and Ahmad (2005), Hyuha (2006) and Kaur et al. (2010).

The estimated coefficients of experience of head of the family are non-significant in organic wheat, conventional wheat and conventional rice farming and have positive signs implying that experience contributes to increase the profit inefficiency. Experience is considered the proxy for age and older farmers are often conservative in adopting the new technology. So, the experience can be reason to increase the inefficiency. The results are in line with Wilson et al. (1998). Bakhsh (2007) also estimated the positive relationship between age of the farmers and inefficiency in his study about vegetable growers in Punjab, Pakistan.

The experience of farmer is significant in organic rice farming at 1 percent level of confidence with negative sign indicating that experience of the farmer tends to reduce the profit inefficiency. Ali and Byerlee (1991) and Rahman (2003) reported the similar results.

The coefficient of access to credit is significant at 10, 1 and 1 percent level of confidence in organic wheat, conventional wheat and conventional rice farming, respectively but it is non-significant in organic rice farming. The coefficients in all categories carry negative signs indicating that better access to credit contribute significantly to increase profit efficiency and help reduce inefficiency. Similar results were reported by Hassan and Ahmad (2005) and Hyuha (2006).

Linkages with extension services are important in organic farming because most of organic farmers have been converted into organic by NGOs in Bangladesh which provide extension advice to the farmers to promote organic farming. So, the estimated coefficient for linkages with extension services is significant at 1 and 10 percent level of confidence in organic wheat and rice farming, respectively while it is non-significant in conventional wheat farming and significant at 10 percent in conventional rice farming. The negative signs of the coefficients in both organic
and conventional farming confirm that linkages with extension services help reduce the profit inefficiency. Similar results were reported by Ali and Byerlee (1991), Bravo-Ureta and Rieger (1991) Rehman (2003) and Hyuha (2006).

Off-farm employment is significant at 1 and 10 percent level of confidence in both organic and conventional wheat farming in Bangladesh. The estimated coefficients are statistically significant at 1 percent level of confidence in conventional rice farming but non-significant in organic rice farming. The positive signs in all categories indicate that off-farm employment contributes to increase the profit inefficiency by consuming valuable time of the farmers in off-farm employment activities. Similar results were reported by Ali and Flinn (1989), Wang et al. (1996), Abdulai and Huffman (2000) and Rahman (2003) and Hyuha (2006).

For organic and conventional wheat farming, the estimated coefficient of area under wheat is non-significant. The area under rice is significant at 1 and 10 percent level of confidence for organic and conventional rice farming, respectively. The results are in line with Abdulai and Huffman (2000) and Kaur et al. (2010). The negative sign in all categories indicates that the farmers, who have more area under rice or wheat crop, are more efficient than other farmers.

**4.6 Key Policy Variables and Profit Loss in Wheat and Rice Production**

The previous section analyzed the factors that contributed to profit inefficiency among organic and conventional; wheat and rice farmers in the selected countries. This section, however, sheds light on contribution of key policy variables in profit inefficiency in terms of profit loss. The experience, off-farm income and area under wheat or rice crop are ignored in the analysis because these variables cannot be affected directly by policy interventions. So, the education, access to credit and linkages with extension services are included as key policy variables in the analysis.
Profit loss can be defined as the amount that has been lost due to inefficiency in production at given prices and fixed factor endowments. It is calculated by multiplying maximum profit by \((1 – PE)\). PE stands for Profit Efficiency. Maximum profit per acre is computed by dividing the actual profit per acre of individual farm by its efficiency score (Rahman, 2003). The discussion is carried out by country wise explaining the loss of profit in rice and wheat production in both organic and conventional farming.

### 4.6.1 Profit Loss in Wheat and Rice Production in Pakistan

The analysis of profit loss due to key policy variables in wheat and rice production in organic and conventional farming in Pakistan is shown in Tables 4.12 and 4.13, respectively. The results indicate that there is significant difference between actual profit, profit loss and efficiency of the farmers who have education above primary level compared to the farmers having education up to primary level in rice and wheat production in both organic and conventional farming. By raising the education of the farmers beyond primary level will increase the efficiency from 87 to 96 percent in organic wheat, 86 to 98 percent in conventional wheat, 81 to 95 percent in organic rice and 85 to 98 percent in conventional rice farming. This implies that education is an effective tool to capacitate the farmers for better utilization of resources and opportunities to improve revenue and profit.

The farmers who have access to credit experienced better profit, less profit loss and better efficiency score as compared to those who don’t have any access to credit in both rice and wheat production for organic and conventional farming. The results on access to credit show that farmers can improve profit efficiency from 87 to 96 percent in organic wheat, 86 to 98 percent in
Table 4.12: Profit-loss in Organic and Conventional Wheat Farming in Pakistan

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<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
</tr>
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Source: Survey data

Table 4.13: Profit-loss in Organic and Conventional Rice Farming in Pakistan

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Source: Survey data
conventional wheat, 81 to 94 percent in organic rice and 84 to 99 percent in conventional rice farming. These results are statistically significant at 1 percent level and clearly indicate that having access to credit would improve profit efficiency in both rice and wheat farming.

The results for linkages with extension services are also similar. The farmers who have linkages with extension services are better off than those who don’t have any links with extension services in both rice and wheat farming. The results indicate that linkages with extension services significantly contribute to improve the profit efficiency from 89 to 98 percent in organic wheat, 84 to 98 percent in conventional wheat, 84 to 98 percent in organic rice and 83 to 98 percent in conventional rice farming. All results are significant at 1 percent level of confidence.

4.6.2 Profit Loss in Wheat and Rice Production in Nepal

The results of loss in profit and efficiency due to key policy variables in wheat and rice production for organic and conventional farming in Nepal are shown in the Tables 4.14 and 4.15. The results show that education plays pivotal role in increasing the profit efficiency as there is significant difference between actual profit, loss of profit and efficiency for those who have education above primary and up to primary in rice and wheat production in both organic and conventional farming. The results indicate that the education beyond primary level can increase the profit efficiency from 82 to 93 percent in organic wheat, 83 to 92 percent in conventional wheat, 80 to 93 percent in organic rice and 83 to 93 percent in conventional rice farming. All results are significant at 1 percent except the result of profit loss in conventional wheat farming that is non-significant.

The results indicate that there is no significant difference in actual profit, profit loss and efficiency scores of wheat organic farmers in Nepal who have access to credit as compared to those who don’t have. In conventional wheat farming, farmers who have access to credit are better off as significant difference is observed in actual profit and efficiency scores which are
### Table 4.14: Profit-loss in Organic and Conventional Wheat Farming in Nepal

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<td>Efficiency</td>
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<td>Efficiency</td>
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Source: Survey data

### Table 4.15: Profit-loss in Organic and Conventional Rice Farming in Nepal

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Source: Survey data
significant at 1 and 10 percent level of confidence, respectively, implying that access to credit contribute to increase profit efficiency. Similarly, organic rice farmers who have access to credit are not significantly better off than the farmers who don’t have access to credit. In conventional rice farming, farmers with access to credit have better profit, less profit loss and better profit efficiency. The results are significant at 1 percent level. With access to credit, the efficiency level can be increased from 85 to 87 percent in organic wheat, 84 to 88 percent in conventional wheat, 84 to 85 percent in organic rice and 83 to 91 percent in conventional rice farming.

The results about linkages with extension services confirm that farmers who have linkages with extension services are better off than other farmers in both rice and wheat production for organic and conventional farming in Nepal. The results indicate that linkages with extension services can help improve the profit efficiency from 77 to 93 percent in organic wheat, 81 to 93 percent in conventional wheat, 75 to 93 percent in organic rice and 80 to 94 percent in conventional rice farming. All results are statistically significant at 1 percent level of confidence.

4.6.3 Profit Loss in Wheat and Rice Production in Bangladesh

The analysis of profit loss due to key policy variables in wheat and rice production in organic and conventional farming in Bangladesh is shown in the Tables 4.16 and 4.17. The results show that education above primary level can increase the profit efficiency significantly in wheat and rice production for both organic and conventional farming in Bangladesh. By raising education above primary level, the profit efficiency can be improved from 87 to 95 percent in organic wheat, 67 to 85 percent in conventional wheat, 81 to 90 percent in organic rice and 52 to 81 percent in conventional rice farming. All results are significant at 1 percent level of confidence.

The farmers who have access to credit are better off as compared to those who don’t have access to credit in wheat and rice production for organic and conventional farming in Bangladesh. Significant difference is observed in actual profit, profit loss and efficiency scores implying that
### Table 4.16: Profit-loss in Organic and Conventional Wheat Farming in Bangladesh

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<td>Efficiency</td>
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Source: Survey data

### Table 4.17: Profit-loss in Organic and Conventional Rice Farming in Bangladesh

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<tr>
<td></td>
<td>N</td>
<td>Actual Profit</td>
<td>Profit Loss</td>
<td>Efficiency</td>
<td>N</td>
<td>Actual Profit</td>
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<tr>
<td></td>
<td>Mean</td>
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<td></td>
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<td>Mean</td>
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<td><strong>Education</strong></td>
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<td>Above Primary</td>
<td>30</td>
<td>17429.47</td>
<td>1784.34</td>
<td>0.904</td>
<td>31</td>
<td>18672.1</td>
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<tr>
<td>Up to primary</td>
<td>45</td>
<td>13522.53</td>
<td>3013.01</td>
<td>0.814</td>
<td>44</td>
<td>10249.02</td>
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<td>t-ratio</td>
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<td>5.76</td>
<td></td>
<td>7.38</td>
<td>-10.15</td>
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<td><strong>Access to Credit</strong></td>
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<tr>
<td>Yes</td>
<td>23</td>
<td>18145.83</td>
<td>2021.28</td>
<td>0.895</td>
<td>32</td>
<td>18773.5</td>
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<td>52</td>
<td>13731.62</td>
<td>2742.81</td>
<td>0.830</td>
<td>43</td>
<td>9977.674</td>
</tr>
<tr>
<td>t-ratio</td>
<td>5.63</td>
<td>-2.21</td>
<td>3.49</td>
<td></td>
<td>8.19</td>
<td>-12.76</td>
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<td><strong>Linkages with extension services</strong></td>
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<td>40</td>
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<td>1887.96</td>
<td>0.899</td>
<td>27</td>
<td>15101.11</td>
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<td>0.793</td>
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<td>12959.63</td>
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<tr>
<td>t-ratio</td>
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<td>-5.40</td>
<td>7.25</td>
<td></td>
<td>1.46</td>
<td>-2.09</td>
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Source: Survey data
access to credit contribute to increase profit efficiency. With access to credit, the efficiency level can be increased from 87 to 98 percent in organic wheat, 66 to 86 percent in conventional wheat, 83 to 90 percent in organic rice and 51 to 82 percent in conventional rice farming. The results are significant at 1 percent level of confidence except the result for profit loss in organic rice production that is significant at 5 percent level.

The results indicate that there is significant difference in actual profit, profit loss and efficiency scores for those farmers who have linkages with extension services as compared to those who don’t have in wheat and rice production for organic and conventional farming. The results show that linkages with extension services can increase the profit efficiency from 83 to 97 percent in organic wheat, 72 to 79 percent in conventional wheat, 79 to 90 percent in organic rice and 61 to 71 percent in conventional rice farming. The results for organic wheat and rice are significant at 1 percent level of confidence. The results for profit loss and efficiency for conventional wheat and rice production are significant at 5 percent level while the results for actual profit are significant at 10 percent level of confidence.

4.7 Inter Country Comparison of Profit Efficiencies

The mean, maximum and minimum profit efficiencies of organic and conventional farmers for wheat and rice crops in Pakistan, Nepal and Bangladesh are presented in Table 4.18. The complete lists of farm wise profit efficiencies are given in Appendices. The results show that Pakistani organic wheat farmers are more profit efficient with mean efficiency score 91.5 percent than organic wheat farmers in Nepal and Bangladesh with efficiency scores 86 and 90.2 percent, respectively. Similarly, conventional wheat farmers in Pakistan are more profit efficient than conventional wheat farmers in Nepal and Bangladesh.

The profit efficiency scores of conventional wheat farmers are 91.1, 85.5 and 73.3 percent for Pakistan, Nepal and Bangladesh, respectively. In overall comparison of efficiencies of both organic and conventional wheat farmers, Pakistani organic wheat farmers lead with efficiency
score 91.5 percent followed by Pakistani conventional wheat farmers with efficiency score of 91.1 percent. The better efficiency scores for Pakistani farmers may be due to better soil fertility, access to credit, linkages with extension services, facility of canal irrigation and access to advanced technology. Bangladeshi organic wheat farmers also have high profit efficiency with score of 90.2 percent almost equal to the Pakistani organic and conventional wheat farmers due to better premium prices for organic wheat in Bangladesh than Pakistani and Nepali organic wheat farmers.

Table 4.18: Inter Country Comparison of Profit Efficiencies

<table>
<thead>
<tr>
<th>Countries</th>
<th>Wheat</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic</td>
<td>Conventional</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Mean</td>
<td>0.915</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>0.993</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>0.583</td>
</tr>
<tr>
<td>Nepal</td>
<td>Mean</td>
<td>0.860</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>0.974</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>0.163</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Mean</td>
<td>0.902</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
<td>0.991</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>0.512</td>
</tr>
</tbody>
</table>

Organic wheat farmers have higher profit efficiency scores than conventional wheat farmers, 91.5 as compared to 91.1 percent, 86 as compared to 85.5 percent and 90.2 in comparison of 73.9 percent in Pakistan, Nepal and Bangladesh, respectively. This is mainly due to less cost of other inputs (Seed, fertilizer/composts and pesticides/bio-pesticides), less cost of irrigation in Pakistan and Bangladesh for wheat and premium prices for organic wheat.
As for as rice crop is concerned, conventional rice farmers have better profit efficiency score of 91 percent compared to 89.2 percent of organic rice farmers in Pakistan while in Nepal and Bangladesh, organic rice farmers have higher profit efficiency than conventional rice farmers with efficiency scores 87.4 compared to 85.7 percent and 74.8 compared to 65.7 percent, respectively. The results show that Pakistani organic rice farmers are more profit efficient with mean efficiency score 89.2 percent than organic rice farmers in Nepal and Bangladesh with efficiency scores 87.4 and 74.8 percent, respectively. Similarly, conventional rice farmers in Pakistan are more profit efficient than conventional rice farmers in Nepal and Bangladesh. The results show that Pakistani conventional rice farmers have better profit efficiency score of 91 percent as compared to 85.7 and 65.7 percent for Nepal and Bangladesh, respectively.

The results indicate that Pakistani conventional rice farmers lead with mean profit efficiency score of 91 percent in overall comparison of efficiencies of organic and conventional rice farmers in three countries followed by Pakistani organic rice farmers with profit efficiency score of 89.2 percent. It may be due to better yield, premium price of Basmati rice, soil fertility, access to credit, linkages with extension services and facility of canal irrigation.

4.8 Organic Agriculture Policies in South Asia

The history of organic agriculture is quite old since the emergence of agriculture on this piece of land. Traditional agriculture that has been practiced for thousands of years around the world, includes management and development practices evolved through centuries to develop agricultural systems adapted to local environmental and cultural conditions. Owing to their nature, traditional systems do not use synthetic agricultural inputs.

These systems helped millions of small holders to manage their livelihood on sustainable basis and supply the food to the local market to meet subsistence needs and also most significantly contributed to manage the integrity of the natural resource base. With the advent of modern
agriculture, introduction of High Yielding Varieties, use of synthetic fertilizers and pesticides, most of these systems were converted to conventional farming systems by following the technologies of Green Revolution. But the Green Revolution neglected many small farmers in the developing world who, with their little capital and meager holdings are still practicing diverse cropping patterns which can be considered organic as they do not use chemical fertilizers and pesticides due to limited resources and rely on natural system of fertilization, use of local resources, local seeds and traditional knowledge. These farms if not certified can be said as “Non-certified Organic Farms”, however, the trend of certified organic agriculture is increasing day by day.

The labeling of food as “organic” denotes that the food has been produced and processed by following organic standards. These standards are ensured by certification bodies and fraudulent practices are managed through inspection. Many Governmental and private certification bodies are working round the world to certify the organic products. This needs a well developed regulation systems and policy framework to govern the organic processes and food labeled as "organic". This section will review present policy framework to make an analysis for its feasibility to promote organic farming in Pakistan, Nepal and Bangladesh.

4.8.1 Organic Agriculture Policies in Pakistan

Agriculture has always been the mainstay of Pakistan’s economy which contributes 21.4 percent to the Gross Domestic Product (GDP). Agriculture generates productive employment opportunities for 45 percent of the country’s labour force (Government of Pakistan, 2013). Government of Pakistan has always recommended agriculture as a priority area for addressing problems of unemployment, poverty alleviation and for fostering economic development. The agricultural policies focus on sustainable food security, increasing productivity, pricing and distribution of commodities and are developed to facilitate the different stakeholders. Generally, Government introduces three types of policies.
- Crop production policy
- Support price policy
- Procurement policy

Among these policies, the crop production policy is important that focuses on the productivity and profitability. The main purpose of the production policy is to increase the farmer’s access to modern farm inputs like seed, fertilizers and pesticides, better management of farm resources through agricultural extension services and ensuring the delivery of quality farm inputs by managing fertilizers, pesticides and seed companies. The policy also focuses on lowering the wide variations in productivity of crops at the farm of progressive growers and the subsistent growers. The production policy is made by following the recommendations of Agricultural Policy Institute (API) and action plan is strategized in consultation with Provincial Departments of Agriculture. Though this policy has an aspect to improve the productivity and profitability of the farmers by increasing the quantity of organic matter in soil and diffusion of Integrated Pest Management (IPM) techniques but does not address the promotion of organic farming anyway that requires producing and packing agricultural products by following certain standards.

The other two policies are crop specific and introduced especially for wheat crop to ensure the food security, support wheat farmers and ensure availability of wheat at reasonable price to the consumers. Support Price is a minimum guaranteed price, essential for food security of staple diet provided in a country. Support price is announced and implemented as prices generally tend to crash in post-harvest season. Support price mechanism is also adopted to ensure sufficient procurement for urban consumers and poverty alleviation.

So, at policy level, organic agriculture has never been on the agenda of Pakistan agricultural sector. Specifically, Pakistan has not yet introduced its National Organic Standards of organic agriculture production and processing and legal framework for accreditation and certification.
The role of NGOs and Farmer’s Organizations has been remarkable to promote the organic farming in the country. Most of organic farmers are following the general standards of International Federation of Organic Agriculture Movements (IFOAM) and have been certified by international organic certification agencies and Participatory Guarantee System introduced by NGOs and Farmer’s Organizations.

➢ National Institute of Organic Agriculture

At Governmental level, first step to promote organic farming was the establishment of Directorate of Organic Agriculture on August 22, 2008 at National Agriculture Research Center (NARC), Islamabad (Government of Pakistan, 2012). The Directorate conducted research on many aspects of organic farming and introduced different types of bio-fertilizers, bio-pesticides and herbicides. Later, the directorate was upgraded to form the National Institute of Organic Agriculture. The Institute provides technical support to different clients like extension agents, researchers, educationists and farmers for producing organic crops and vegetables. It offers trainings on different aspects of organic agriculture like preparation of composites and bio-pesticides. The Institute also disperses information for certification and export of organic products and facilitates farmers in marketing organic products in local markets. The major achievements of the Institution are following.

- Successful production and demonstration of organic crops at NARC with comparable yields to that are obtained by using chemical inputs.
- Successful application of organic salts to overcome the deficiency of micro-nutrients in citrus orchids.
- Application of bio-pesticides to manage the aphids and armyworms at farmer’s field.
- Installation of manufacturing units of bio-fertilizers, bio-pesticides and bio-herbicides at NARC.
- Establishment of a Network of Organic Agriculture in Pakistan (NEOAP) to launch campaign for registration of organic farmers and traders.
• More than 5000 farmers and students have been trained on Organic Agriculture Development.

4.8.2 Organic Farming Policies in Nepal

Agriculture sector continues to play an important role in the economy of Nepal which contributes more than one third to GDP of Nepal and involves more than two-third of entire population of Nepal for their employment and livelihood. The contribution of agriculture sector to GDP remained between 32 to 36 percent although various programs were launched to increase the productivity of agriculture sector and support the two third population of the country. The growth rate of agriculture sector was 4.93 percent during the fiscal year 2011-12 and its contribution of agriculture to GDP remained 35.68 percent (Government of Nepal, 2012a).

The purpose of agricultural policies in Nepal is to transform the prevailing traditional farming system to commercial agriculture to address poverty and unemployment. The main focus is to increase productivity with easy access to irrigation facilities, agricultural credit, synthetic fertilizers, improved seed, pesticides and advance farming technologies.

Agriculture in Nepal is characterized by subsistence type based on traditional knowledge with low level of productivity. These systems are generally organic by default and integrate crops with livestock. Most of farmers don’t have access to fertilizers and pesticides and maintain soil fertility by composting. The synthetic fertilizers and pesticides are used only in the commercial agricultural pockets in the accessible areas. So, the systems can easily be converted to organic with little effort by improved composting and agronomic practices (Pant, 2006).

Mainly, the Agriculture Perspective Plan (1995-2015) is considered as a guiding principle for agricultural development in the country that aims at intensive use of chemical inputs for the economic growth of agriculture sector in the country. The periodic five year plans follow the general principles set by Agriculture Perspective Plan for achieving increased agricultural
growth and addressing poverty (Government of Nepal, 2010). All these plans are apathetic to organic agriculture development by prioritizing on the use of external inputs to increase the productivity.

The National Agricultural Policy 2004, for the first time, introduced policy statement for the promotion of organic agriculture by specifying one objective on conservation of biodiversity, sustainable use of natural resources and protection of environment which vaguely laid the basis for organic agriculture development. The policy further stressed for encouraging organic farming, regulating the use of pesticides and lowering their adverse affects on livestock, land and water, use of composts and local participation to ensure quality in food (Government of Nepal, 2004). The following periodic plan emphasized on promotion of Integrated Pest Management (IPM) and Integrated Plant Nutrients through organic manures that led to introduction of feasible approaches to promote organic farming (Government of Nepal, 2007).

The commercial organic farming in Nepal started in early 1990s with the support of NGOs and cooperatives. Many of the internationally recognized certifying agencies especially, the Institute for Marketecology (IMO, Switzerland) National Association of Sustainable Agriculture, Australia (NASAA), the Ethical and Environmental Certification Institute (ICEA, Italy), Ecocert France, OneCert America are working in Nepal to certify the organic products.

The National Standards of Organic Agriculture Production and Processing were introduced in 2007 to assist the organic production and certification properly. These Organic Standards are accredited and regulated by National Accreditation Body (Pokrel and Pant, 2009). The National Standards have been developed in compliance with IFOAM general standards for organic production and processing. The main features of National Organic Standards are following:
Figure 4.1 Structural Arrangements for Organic certification in Nepal

Reproduced from Pokrel and Pant (2009)
• The standards specify the land arrangement for organic production and prohibit synthetic chemicals in crop production, product transfer and storage. The GMOs and radioactive devices and burning of organic wastes are also not allowed.

• Preference should be given to local-variety and seed source should be organic without any chemical treatment.

• There should be enough space to keep and rear animals. There should be no torture and fetal implantation. The cloning, hormonal use in animals and artificial insemination in livestock are prohibited.

• The standards also protect farmers for fair remuneration from their produces, and also the rights of employees, children, consumers and tribal groups.

• Provision of structural arrangements for organic certification and recognition of private sectors as key stakeholders in designing policies to promote organic farming and organic certification.

4.8.3 Organic Farming Policies in Bangladesh

Agriculture sector continues to play pivotal role in the Bangladesh economy and is considered lifeline of Bangladeshi people due its importance in maintaining food and nutritional security, income generation, and poverty reduction. The agriculture sector contributes 19.29 percent in the GDP and employs 43.6 percent of the total labour force (Government of Bangladesh, 2012). The broad agriculture sector can be seen as agriculture and forestry and fisheries. The agriculture and forestry sector comprises of three sub-sectors namely crops and forestry, vegetables and livestock. The direct contribution of agriculture in GDP has decreased slightly in the recent years but its indirect contribution to the overall GDP is also quite significant because agriculture supports the many other sectors like services, wholesale and retail trade, hotel and restaurants, transport and communication that also contribute significantly in the GDP.

Ministry of Agriculture, Bangladesh introduced first comprehensive National Agriculture Policy (NAP) document in 1999 since Bangladesh’s separation from Pakistan in 1971. The overall
objective of NAP was to make the nation self-sufficient in food and ensure a dependable food security system for all. The policy also had 18 subsidiary objectives and 18 programme areas. The subsidiary objectives articulated in general to achieve overall objectives. The programme areas were identified to deal with agricultural research, agricultural mechanization, crop production, minor irrigation, seeds, fertilizer, agricultural marketing, land use, pest management, agricultural credit, agricultural education and training, women in agriculture, environmental protection, government support for production and contingency plan, coordination among government agencies, food-based nutrition, NGOs and the private sector and reliable database.

The main focus of NAP was to achieve the food self-sufficiency through sustainable growth in agriculture and increase in crop production. The policy worked in line with National Strategy for Accelerated Poverty Reduction and Millennium Development Goals (MDGs) to address poverty. Following NAP, the Bangladeshi Government is basically emphasizing to introduce the modern agriculture technologies with special focus on increasing the production by availability of seeds of improved and High Yielding Varieties, seed preservation and distribution, expansion in the irrigation system and diffusion of varieties adaptable to environment of different regions. The Government has also taken steps to increase the subsidy on agricultural inputs and ensure their availability on time to increase agricultural productivity. System of Agricultural Insurance was also introduced to support the small and medium sized farmers in case of crop failure due to natural disaster.

The movement of organic farming was started by the NGOs in late 70s and early 80s. Now, a number of NGOs and cooperatives are trying to promote organic farming as sustainable form of agriculture. The role of Government in the promotion of organic farming is negligible as NAP recommended the adoption of modern technologies to increase the productivity. Only the policy of promoting Integrated Pest Management introduced in 2002 provided some space for the promotion of organic farming. However, the adoption of organic farming has been very slow in different parts of Bangladesh even though the country has great potential in this regard because of surplus labour, huge crop diversity, and considerable investment (Sarkar and Itohara 2008).
The analysis of agricultural policies of Pakistan, Nepal and Bangladesh clearly indicates that there is lack of direct policy framework for the promotion of organic farming at Government level. However, Nepal has introduced National Organic Standards for production and certification of organic produce but still missing legal arrangements for accreditation and enforcement of organic standards and certification system. The agricultural policy in these countries also ignored the fact that organic agriculture is the most sustainable and low input form of agriculture that contributes to improve the livelihood conditions and reduce poverty. Organic agriculture can also perform better in wake of climatic hazards and also contribute to mitigate climate change.
CHAPTER 5

SUMMARY

This chapter has been divided into four sections. The first section describes the summary of the study. The second section elaborates the conclusions drawn from results of the study. Recommendations and suggestions are expressed in the third section where as fourth section describes the perspective areas of future research.

5.1 Summary

In the past few decades, massive investment were made on Green Revolution based on chemical fertilizers and pesticides, extensive use of irrigation on High Yielding Varieties, Hybrid Plant Varieties and Genetically Modified Organisms. It is evident that these efforts brought substantial increase in productivity that contributed to decrease starvation in many countries but the Green Revolution has not been effective as a strategy for poor small farmers due to increase in cost of production, dependency on external inputs, loss of crop diversity and ultimately leaving fewer choices for the farmers. In this scenario, Green Revolution technologies as the major production system in the world at its worst, increased inequality, worsened absolute poverty especially in developing countries, and resulted in environmental degradation (IFPRI, 2002).

On the other side, organic agriculture was a possible option for the farmers in comparison with Green Revolution technologies by depending on their on-farm resources, promoting crop diversity and using environment friendly techniques. Realizing this many Farmer's Organizations, NGOs and other institutions started working with farmers in South Asia to transform their farming systems from conventional to organic. The present study was designed to study the economics of organic production systems and policy options in South Asia in comparison with conventional farming systems. The study was conducted in three South Asian countries Pakistan, Bangladesh and Nepal to assess both farming approaches and draw results to devise recommendations for further policy options. The focus of the study was to estimate the
profit efficiency of organic and conventional farmers along with factors affecting the profit efficiency. Rice and wheat crops were selected for the comparative analysis.

The primary data was collected from nine Districts of above mentioned countries. Cobb Douglas functional form of stochastic frontier profit function was used to determine the profit efficiency in organic and conventional farming systems. Computer package Frontier 4.1 was used to estimate the maximum likelihood estimates of parameters of Cobb Douglas stochastic function and inefficiency effects models.

5.1.1 Results Summary of Wheat and Rice Farmers in Pakistan

For organic wheat, the estimated coefficients of other inputs (seed, fertilization and pesticides) and irrigation are significant at 1 percent level of significance with negative sign implying that these variables are contributing to lower the profit significantly. The coefficient of land preparation and labour are non-significant but with negative sign. Capital is significant at 1 percent with positive sign while pest breakout is also affecting the profit negatively and significant at 1 percent level of confidence.

For conventional wheat farmers, the estimated coefficients of other inputs and labour are significant at 10 percent level of confidence with negative signs indicating that these variables are contributing significantly in lowering the profit. The coefficient of land preparation, irrigation and soil fertility are non-significant. The capital is significant at 1 percent level of confidence with positive signs. The pest breakout is contributing to lower the profit with negative sign and significant at 10 percent level of significance.

For organic rice, the estimated coefficients of land preparation and labour are significant at 10 and 5 percent level of confidence, respectively. The coefficients of other inputs, irrigation and soil fertility are non-significant. The capital is significant at 1 percent level of confidence with positive sign. Pest breakout is affecting the profit negatively at 1 percent significance level.
For conventional rice farmers, the coefficients of other inputs, irrigation and labour are significant at 1, 10 and 5 percent level of confidence with negative signs implying that these variables are contributing to lower the profit. The coefficient of land preparation is found to be non-significant. The capital is significant at 1 percent level of confidence with positive sign meaning that increase in capital will contribute to increase the profit. The impact of pest breakout on lowering the profit is significant with 5 percent confidence level.

The study also attempted to ascertain the factors affecting the profit efficiency in wheat and rice farming under organic and conventional conditions. The estimated coefficient of education is significant in all categories with negative sign indicating that education is contributing to reduce the profit inefficiency in both organic and conventional farming. The coefficient of experience is significant in organic and conventional wheat farming and conventional rice farming. The coefficient of experience is non-significant in organic rice farming. The negative sign in all categories indicates that experience of the farmers contributes to reduce the profit inefficiency.

The access to credit is non-significant in both organic wheat and rice farming. It may be due to the higher level of self sufficiency in organic farming that does not need external inputs like chemical fertilizers and pesticides. The access to credit is significant at 5 percent level of confidence in conventional rice farming. The negative sign in all categories indicates that access to credit contributes to reduce the profit inefficiency. The linkages with extension service are significant in organic wheat and rice farming because most of organic farmers are working closely with NGOs and other institutions which are promoting organic farming but it is non-significant in conventional wheat and rice farming.

For organic wheat production, the estimated coefficient of off-farm employment is significant at 10 percent level of confidence. The coefficient of off-farm employment is non-significant in conventional wheat, organic and conventional rice farming. The positive sign in all categories indicates the positive impact of off-farm employment on profit inefficiency. The estimated coefficient of area under wheat is non-significant for organic and conventional wheat farming.
The area under rice is non-significant for organic rice farming but significant at 10% level of confidence for conventional rice farming indicating that the farmers who have more area under conventional rice crop are more efficient than other farmers.

5.1.2 Results Summary of Wheat and Rice Farmers in Nepal

Results of stochastic frontier profit function show that the estimated coefficients of land preparation and labour are significant at 1 and 10 percent confidence level, respectively for organic wheat farmers in Nepal with negative and positive signs. The positive sign of labour indicates that engaging more labour will increase the profit due to labour intensive nature of organic farming. The coefficient of other inputs is non-significant. Capital and soil fertility have positive signs and are significant at 1 percent level of confidence. The pest breakout is significant at 1 percent having negative sign.

The coefficients of land preparation and other inputs in conventional wheat farming are significant at 10 and 5 percent level of confidence, respectively with negative impact on profit efficiency. The coefficients of labour and soil fertility are non-significant. Capital is significant at 1 percent level of confidence to impact the profit positively. The pest breakout is contributing to lower the profit with negative sign and significant at 1 percent level of significance.

The MLE results for organic rice show that the coefficient of land preparation is significant at 1 percent level with negative sign that indicates the negative impact on profitability. The coefficient of other inputs is non-significant. The coefficients of labour and capital are significant at 10 and 1 percent level of confidence, respectively with positive signs indicating that increase in labour and capital will contribute an increase in profit. The soil fertility and pest breakout are significant at 1 percent level of confidence with positive and negative signs, respectively.

For conventional rice farmers in Nepal, the coefficient of other inputs is significant at 1 percent level of confidence with negative sign indicating that farmers are not making optimum use of
these inputs thus lowering the profit. The coefficients of land preparation and labour are non-significant. The coefficients of capital and soil fertility are significant at 1 and 10 percent level of confidence, respectively with positive signs. The impact of pest breakout on lowering the profit is significant at 5 percent confidence level.

The results about determinants of farm specific profit inefficiency show that estimated coefficients of education are statistically significant in all categories with negative signs indicating education significantly reduces profit inefficiency in both organic and conventional farming. This implies that profit efficiency can be increased by enhancing the education level of the farmers in Nepal. Like education, the coefficients of experience in both organic and conventional; wheat and rice farming are significant with negative signs implying that experience significantly tends to reduce the profit inefficiency.

The estimated coefficients of access to credit are non-significant in organic and conventional wheat farming and organic rice farming in Nepal implying that organic farmers are not much dependent on external resources. It is significant in conventional rice farming. The negative sign of coefficients in all categories implies that access to credit impact to reduce the profit inefficiency. The results show that linkages with extension services are significantly affecting the profit inefficiency negatively in wheat and rice farming under both organic and conventional conditions.

The estimated coefficients of off-farm employment are non-significant in organic wheat and rice farming with negative signs but it is significant at 10 percent level of confidence for conventional wheat farming and non-significant for conventional rice farming. The positive sign in conventional wheat and rice farming indicates that off-farm employment contributes to increase the profit inefficiency. The estimated coefficient of area under wheat is non-significant for organic and conventional wheat farming. The area under rice is also non-significant for organic rice farming but it is highly significant at 1 percent level of confidence for conventional rice farming.
5.1.3 Results Summary of Wheat and Rice Farmers in Bangladesh

The results of stochastic profit frontier function show that the estimated coefficients of land preparation and other inputs are significant for organic wheat farmers with negative signs implying that these variables affect profit efficiency negatively. The coefficients of irrigation, capital, soil fertility and labour are significant with positive signs indicating that increase in these variables will increase the profit. The impact of pest breakout is negative on profit efficiency but it is non-significant.

For conventional wheat farmers, the coefficient of land preparation is significant at 10 percent and its positive sign indicates that more number of cultivations will contribute to increase the profit. The coefficients of other inputs and irrigation are also significant but with negative signs. The coefficients of labour and capital are non-significant with positive signs. Coefficient of soil fertility is significant with positive impact on profit efficiency while coefficient of pest breakouts is non-significant with negative sign.

The coefficient of land preparation in organic rice farming is significant at 5 percent level of confidence impacting the profit efficiency negatively. The coefficients of other inputs and labour are non-significant. The capital and soil fertility are significant with positive signs while pest breakout significantly impacts the profit efficiency negatively.

For conventional rice farmers of Bangladesh, the coefficients of land preparation and other inputs are significant with negative signs indicating that farmers are not making optimum use of these inputs thus lowering the profit. The coefficient of labour is non-significant. The coefficients of capital and soil fertility are significant having positive impact on profit efficiency. The impact of pest breakout is negative on profit but non-significant.
The results for the determinants of farm specific profit inefficiency show that the estimated coefficients of education are significant in all categories with negative signs implying that education is contributing to reduce the profit inefficiency. The estimated coefficients of experience of head of the family are non-significant in organic wheat, conventional wheat and conventional rice farming and have positive signs. It is significant in organic rice farming with negative sign indicating that experience of the farmers tends to reduce the profit inefficiency.

The coefficient of access to credit is significant in organic wheat, conventional wheat and conventional rice farming respectively but it is non-significant in organic rice farming. The coefficients in all categories carry negative signs indicating that better access to credit contribute significantly to increase profit efficiency.

The estimated coefficient of linkages with extension services is significant in organic wheat and rice farming and conventional rice farming while it is non-significant in conventional wheat farming. The negative signs of the coefficients in both organic and conventional farming confirm that linkages with extension services help reduce the profit inefficiency.

The coefficient of off-farm employment is significant in organic and conventional wheat farming and conventional rice farming in Bangladesh but non-significant in organic rice farming. The positive signs in all categories indicate that off-farm employment contributes to increase the profit inefficiency by consuming valuable time of the farmers in off-farm employment activities.

For organic and conventional wheat farming, the estimated coefficient of area under wheat is non-significant but the area under rice is significant in organic and conventional rice farming. The negative sign in all categories indicates that the farmers, who have more area under rice or wheat crop, are more efficient than other farmers.
5.2 Conclusions

The results of stochastic frontier profit function show that the average profit efficiency of Pakistani organic wheat farmers is found to be 0.915 slightly higher than the conventional farmers to conclude that organic wheat farmers are more profit efficient than conventional farmers. The average profit efficiency of organic rice farmers is less than conventional rice farmers in Pakistan but still comparable with score of 0.89. The average profit efficiency of conventional rice farmers is found to be 0.91 due to the better yield than organic farmers.

A little difference is observed in the average profit efficiencies of organic and conventional; rice and wheat. The variable costs impact differently in both organic and conventional farming but their overall impact is found to lower the profit. The fixed factors are also observed to play an important role in increasing profit. The pest breakout significantly affects the profit negatively and requires timely application of plant protection measures. Among determinants of profit inefficiency, results show that education and experience of the farmers contribute significantly to reduce profit inefficiency in both organic and conventional farming while linkages with extension service are significant in organic wheat and rice farming.

The average profit efficiency of organic and conventional wheat farmers in Nepal is found to be approximately equal with efficiency scores 0.860 and 0.855 respectively while average profit efficiency (0.874) of organic rice farmers is slightly better than the average profit efficiency of conventional rice farmers (0.857). The results indicate that organic wheat and rice farmers are more profit efficient than conventional rice and wheat farmers in the selected study areas of Nepal. The impact of variable inputs is different in organic and conventional farming but their overall effect is to lower the profit meaning that both organic and conventional farmers are not using resources at optimum level. The capital contribute significantly to increase the profit. The pest breakout significantly affects the profit negatively and requires timely application of plant protection measures.
The results about factors affecting the farm specific profit inefficiency show that education, experience and linkages with extension services significantly contribute to decrease the profit inefficiency in both organic and conventional farming.

The average profit efficiency of organic wheat farmers is better than conventional wheat farmers in Bangladesh with profit efficiency score 0.902 compared to profit efficiency score 0.733 of conventional wheat farmers. The results also confirm that average profit efficiency of organic rice farmers with efficiency score 0.748, is better than the average profit efficiency of conventional rice farmers with efficiency score of 0.657.

The results conclude that organic wheat and rice farming is more profitable than conventional rice and wheat farming in the selected study areas of Bangladesh. The overall impact of variable inputs is to lower the profit in both organic and conventional; wheat and rice farming. It indicates that both organic and conventional farmers are not using resources at optimum level. The fixed factors contribute significantly to increase the profit in organic wheat and rice farming and conventional rice farming. The soil fertility plays significant role in increasing profit in both organic and conventional; wheat and rice farming.

Among the determinants of farm specific profit inefficiency, results show that education, access to credit and linkages with extension services are important to decrease the profit inefficiency in wheat and rice farming under organic and conventional conditions while Off-farm employment contributes to increase profit inefficiency by taking valuable time of the farmers. The effect of area under wheat or rice crop is significant only in organic and conventional rice farming with negative sign implying that farmers who have more area under rice crop are more profit efficient than other farmers.
5.3 Suggestions and Policy Recommendations

Agriculture policies are often developed on the basis of quantitative analysis of agricultural production systems. These analyses may be of different types including the measurement of scale economies, changes in price of product or input and producer’s responsiveness and the relative efficiency of resource use (Russell and Young, 1983). So, there is a dire need to conduct these types of studies to facilitate the policy development process. On the basis of present study following suggestions and policy recommendation are made for organic and conventional; rice and wheat farmers and policy makers in Pakistan, Nepal and Bangladesh.

- Since land preparation and other inputs negatively influence the wheat and rice profit efficiency under organic and conventional farming systems in the selected countries except the land preparation in case of conventional wheat in Bangladesh where its impact is positive, therefore, farmers should be careful in devising optimum quantities of these inputs.

- It is observed that majority of conventional farmers in these countries use nitrogenous fertilizers ignoring other vital nutrients like potash and phosphorous. So, it is suggested that soil tests should be conducted and fertilizers should be applied on the basis of soil results.

- Organic farmers are also found conscious in application of composts due the fact that they have converted their lands from conventional to organic. In the fear that they would lose the potential yield, they apply composts and other organic fertilizers in abundance. So, the balanced use of organic nutrients needs the attention of the farmers for the improvement of profit efficiency.
The results show that the irrigation affects the profit efficiency negatively in Pakistan and Bangladesh expect in case of organic wheat in Bangladesh where its impact is positive. So, it is suggested that both organic and conventional farmers should follow the recommended number of irrigations in case of wheat and rice farming. Fields should be properly leveled to increase the water use efficiency.

In case of Pakistan, improvement in canal system would certainly be the reason to increase the level of profit efficiency. Lining of canals and water channels will certainly be the step of vital importance to decrease the seepage.

Application of latest water harvesting techniques will increase the availability of surface water and also the profit efficiency. The role of extension services is important in this regard to educate and train the farmers.

Generally, organic farming is relatively more labour intensive than conventional farming. The results show that organic farmers in Nepal and Bangladesh need to employ more labour to increase the profit efficiency. However, in context of Pakistan, labour is influencing the profit efficiency negatively in both organic and conventional farming. So, farmers in Pakistan need to reduce the labour wisely to increase the profit efficiency.

The Capital in the form of modern technology should be increased for the improvement in profit efficiency in both wheat and rice farming under organic and conventional systems.

Farmers in the respective countries need to give due attention to improve the soil fertility by increasing humous contents with composting, green manuring and mulching.

To avoid negative effects of pest breakouts, farmers need to apply plant protection measures on time and should visit extension services regularly to seek proper guidance against certain diseases and insects.
Education is found to have a positive impact on profit efficiency of wheat and rice farmers in all three countries. The significant differences in profit are observed between farmers who are illiterate or having education up to primary and those who have above primary education. The implications are very clear that to improve efficiency in wheat and rice farming, primary level of education is absolutely necessary.

To improve the efficiency, the departments providing extension service need to play a positive role in increasing their access and facilitate each and every farmer. The Government should also take concrete steps to strengthen extension services in qualitative and quantitative manner to improve the efficiency of the farmers.

Today, agriculture starts with capital and provision of quick, easy and adequate credit should be the top priority of policy makers to improve the profit efficiency.

5.4.1 Policy Recommendations for Organic Farming

Governments of Pakistan, Bangladesh and Nepal should launch comprehensive policies for organic agriculture development with the specifications of roles of Governments and private sectors. Subsidies on ground of environmental cost can be introduced to encourage organic farmers.

Marketing of organic products is complex process that needs proper certification of products to be grown by following organic standard of production, processing and packaging. In this context, national organic standards should be introduced on priority to facilitate the organic farmers and certifying agencies.

The Governments should launch proper legislative and institutional arrangements for the promotion of organic farming. The establishment of National Accreditation Body would
be the right direction to enforce organic standards and control organic certifiers to ensure quality assurance in production, processing, storage, handling and finally marketing. This will certainly help comply with international organic regulations and trade.

- Viewing a few research studies on organic farming, the main agricultural research and education institutions should start research on different aspects of organic farming to identify its potential, economic viability, social and environmental benefits and challenges. On farm research in collaboration with farmers can be another option to facilitate the farmers.

- Government should launch special capacity building programmes through extension services to educate and train farmers on different techniques of organic farming and equip them with latest technologies. Demonstration plots and layout farms should be established to demonstrate the organic technologies.

5.4 Areas for future Research

- The Food and Agriculture Organization of the United Nations (FAO) regards organic agriculture as an effective strategy for adaptation and mitigating climate change and building robust soils that are better adapted to extreme weather conditions associated with climate change (Niggli et al., 2009). So, performance of organic agriculture under changing climatic conditions can be a topic of future research.

- Organic Agriculture by its definition takes into account the sustainability of ecosystems, health of the soils, conservation of biodiversity and patterns adapted to local conditions. It utilizes ecological processes to ensure the sustainable production of agricultural products. So, organic agriculture and sustainability can be another area for future research.
• It has been observed that Green Revolution technologies performed better and farmers enjoyed substantial productivity gains, but in the long-run these gains did not always translate into sustainable improvements in rural poverty and food security. In this regard, there is a dire need to assess the potential of organic farming in reducing rural poverty and ensuring food security.

• The Green Revolution’s gains have come at the cost of extensive environmental degradation and considerable health problems were caused to the farming and rural communities due to exposure to agro-chemicals. According to IFPRI (2002), “Excessive and inappropriate use of fertilizers and pesticides has polluted waterways, poisoned agricultural workers, and killed beneficial insects and other wildlife”. So, organic farming, health and food safety can be another area of future research.
LITERATURE CITED


FiBL. 2013. The world of organic agriculture: Statistics and emerging trends 2013. Research Institute of Organic Agriculture (FiBL), Frick, Switzerland.


APPENDICES

Appendix 1: The Questionnaire of Study

Economics of Organic Production Systems and Policy Options in South Asia

Name: ____________________________ Village: ____________________________

Tehsil: ____________________________ District: ____________________________

Country: __________________________

Distance from main Road (km)__________________________________________

Distance from main market or mandi (km)_________________________________

Characteristics of Respondents & Household

Age (Years) ______________________

Educational (Years) ________________

Experience in farming (Years) ________________

Family members involved in Farming __________________________

Experience in Organic Farming __________________________

Family members involved in Farming __________________________

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Education</th>
<th>Experience in Farming</th>
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</thead>
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### Land Holding and Use

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Area owned</td>
<td>________________________(ha)</td>
</tr>
<tr>
<td>Area Ranted in</td>
<td>_____ __________________(ha)</td>
</tr>
<tr>
<td>Area rented out</td>
<td>________________________ (ha)</td>
</tr>
<tr>
<td>Shared in</td>
<td>________________________ (ha)</td>
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<tr>
<td>Shared out</td>
<td>________________________ (ha)</td>
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<tr>
<td>Net farm area</td>
<td>________________________ (ha)</td>
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<tr>
<td>Cultivated area (acres)</td>
<td>________________________ (ha)</td>
</tr>
<tr>
<td>Uncultivated area (acres)</td>
<td>________________________ (ha)</td>
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</tbody>
</table>

### Soil Fertility

(1) Fertile: __________________

(2) Poor: __________________

### Results of Soil test

______________________________________________________________________________
______________________________________________________________________________

### Irrigation

Location of farm at W/C: H M T

(1) Head: __________________

(2) Middle: __________________

(3) Tail: __________________

Area irrigated per turn: _____________ Time Allocated: ______________________

(4) Ploughed: _____________

(5) Irrigated: _____________
Irrigation sources

(a) Canal alone __________________________ (b) Tubwell alone___________________

(c) Canal + tubwell __________________________

(d) Tube well: (owned ______ shared _______ hired___________)

Do you receive sufficient quantity of canal water? (a) Yes__________ (b) No___________

If No, what is reason of low canal water supply?

(a) Less Allocation__________ (b) Conveyance Losses __________________________

(c) Tail End_________ (d) Elevated Field_________ (f) Low discharge_________

(g) Other (specify) ________________

Water Test

________________________________________________________________________

________________________________________________________________________

Availability of Credit: (yes________________ No____________________)

If yes (amount) __________________________ Interest rate(%)________________________

Purpose of credit: ______________________

Source of credit: ______________________

Link with extension services (yes________________ No____________________)

Government __________________________

NGOs __________________________

How many times extension worker visited farm during the last one year

(1) weekly _______ (2) Fortnightly_______ (3) Monthly_______ (4) Quarterly_______

(5) Other (Specify) ___________

How many times did you visit extension worker

(1) weekly _______ (2) Fortnightly_______ (3) Monthly_______ (4) Quarterly_______

(5) Other (Specify) _______________
### Cropping Pattern

<table>
<thead>
<tr>
<th>Kharif Crops</th>
<th>Acreage</th>
<th>Rabi Crops</th>
<th>Acreage</th>
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**Total Area**

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### Cost of Production of Rice

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<thead>
<tr>
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<th>Units</th>
<th>Quantity</th>
<th>Rate /unit</th>
<th>Total Cost</th>
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<tbody>
<tr>
<td><strong>Land Preparation</strong></td>
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<td>Ploughing (No.of Cultivations)</td>
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<td>Disc Harrowing</td>
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<td>Other</td>
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<td><strong>Seed Rate</strong></td>
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<td>Sowing</td>
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<td><strong>Rice Transplanting</strong></td>
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<td><strong>FYM / Composting</strong></td>
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**Gross Revenue per Acre**

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<th>Rate / unit</th>
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**Cost of Production of Wheat**

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**Gross Revenue per Acre**

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## Fixed Cost of Farm

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<tr>
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<th>Price when purchased</th>
<th>Depreciation rate</th>
<th>Current prices</th>
<th>Prices per acre</th>
<th>Cost /acre/year</th>
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Climate Hazards Faced for Wheat Crop

Erratic Rains
Increase in Temperature
Strong Winds
Pest breakouts
Severe Fungal Attacks
Expansion in summer season
Floods
Any other

Climate Hazards Faced for Rice Crop

Erratic Rains
Increase in Temperature
Strong Winds
Pest breakouts
Severe Fungal Attacks
Expansion in summer season
Floods
Any other

Constraints in Production

Socioeconomic

1. Education
2. Flow of information
3. Off-farm employment
4. On time availability of funds
## Services

1. Inadequate availability of family labor

2. Inadequate availability of causal hired labor

3. High wage rate of causal hired labor

4. Credit Unavailability

5. Unavailability of extension services

## Constraints about inputs

1. High prices of fertilizers

2. Inadequate availability of fertilizers

3. Unavailability of quality seed

4. Inadequate availability of canal water

5. Poor quality of tub well

6. High prices of diesel

7. High prices of electricity

## Other constraints in production (specify)

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## Appendix 2: Efficiency Scores of Organic Wheat Farmers in Pakistan

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