Agricultural Systems Analysis and Constraints Identification

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Legesse Dadi
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Ethiopian Agricultural Research Organization
Agricultural Systems Analysis and Constraints Identification

Part 1

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Preface

A coordinated Research in Socio-economics was initiated in 1968 at the then Institute of Agricultural Research. During that time, a lot of socio-economic research information that helped in understanding farmers perceived problems in the process of agricultural production were generated and published. The information generated and published was also used to reorient the focus of agricultural research activities and to assist in prioritizing the research agenda.

After the reorganization of the research system in 1997 with the establishment of the Ethiopian Agricultural Research Organization (EARO), socio-economics research is given high priority. Long-term socio-economics research strategic plan is developed based on gap and constraint analysis and researchable thematic areas were identified and prioritized. Based on the strategic plan and the priority thematic areas identified three programs and nine projects were developed for implementation depending upon the availability of resources and trained manpower. Under these research programs and projects, a number of research activities or research sets (surveys, experiments and trials) were initiated and executed in various agro ecologies by economists of both federal and regional research centers and the Department of Agricultural Economics of Alemaya University.

Some of the research activities that were initiated were completed and the respective researcher prepared draft reports. In order to disseminate the information generated from 1998 to 2002 a workshop was organized in August 2002. The workshop brought together all those involved in socio-economics research, agricultural development and policy-making institutions in Ethiopia. The workshop in addition to disseminating the information generated elicited constructive comments and suggestions for the improvement of the draft completed research reports. All the papers were edited for their technicalities and English and published in two volumes. The objective of this publication is to present the results generated by socio-economists of both regional and federal research centers and to collate a comprehensive bibliography of local publications on socio-economics research. To this effect, authors were encouraged to include as much data as possible in tabular form and to be exhaustive in their reference lists. We feel that this publication serves as source of information for policy makers, planners, development workers, teachers, researchers.

The editors are grateful to the authors of the respective papers, the management of EARO and regional research centers for encouraging and supporting the socio-economics research and the Information and Communication Department of EARO for copyediting the manuscript, designing and making the publication ready for printing. This proceeding is the outcome of the unreserved cooperation and conscientious efforts of all involved in the various studies.

Tesfaye Zegeye
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Ethiopian Agricultural Research Organization
Grass Pea Production, Consumption and Indigenous Processing Methods in Ethiopia

Legesse Dadi1, Hailemariam Teklewold2, Aden Aw-Hassan3, Ali Abdel Moniem2 and Geltu Bejiga1

Introduction

Grass pea (Lathyrus sativus) is one of the important legumes produced by small farmers for human consumption. As reported by Elizabeth et al. (1994), grass pea is rich in protein (about 23.7%), which is higher than chickpea (16.3%) and field pea (20.7%). Grass pea is cultivated in areas having altitude ranging from 1700 to 2200 meters above sea level and grows in areas with adverse environmental conditions such as moisture stress, poor soil fertility and waterlogging (Asfaw, 2000 unpublished). In addition, grass pea is said to be more productive on fertile soils compared to other legumes grown in the same agro-ecology. Despite its nutritional advantage, excessive consumption of grass pea (usually more than 30% of the diet) for a prolonged period, 3-4 months, causes lathyrism (Redda et al., 1994; Wuletaw et al., 1997).

Field observations and statistics on area and production show that in recent years, area and production of grass pea were increasing. The production and consumption decisions are generally influenced by economic and social considerations. One reason why grass pea production has increased could be its more reliable returns under harsh environments compared with other food legumes. This is partly related to its resistance to diseases and insects and higher performance than other legumes under harsh environmental conditions. Generally, consumers prefer faba bean, field pea, chickpea and lentils than grass pea. Nevertheless, increasing economic hardships in rural areas means that few consumers can afford these more expensive food legumes. Poor farmers who produce preferred legumes usually tend to sell preferred legumes at higher price and purchase low value grain including grass pea. We therefore, aim to document farmers’ production practices of grass pea and find out reasons for increase in grass pea production. Farmer’s preference of grass pea consumption will also be documented. The study also aims at documenting grass pea processing and preparation methods.

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**Methodology**

**The Study Area**
Grass pea is widely produced in Amhara and Oromiya Regional States. Based on grass pea area, four Zones were selected from the two regional states. The study was conducted in East Gojam, South Gonder and South Welo Zones of the Amhara Regional State and East Shewa Zone of Oromiya Regional State from March 2000 to July 2000. The first two Zones are located in the northwestern and South Welo in the northeastern part of the country, while East Shewa Zone is found in the central part. One wereda was selected from each Zone. Fogera wereda (district) in South Gonder, Jama wereda in South Welo, Bichana wereda in East Gojam and Ada-Liben, Ginbichu and Akaki weredas in East Shewa Zone were selected for the study.

**Sampling and interviews**
Initially a rapid rural appraisal method was used to assess grass pea production and consumption. For the sample survey, a combination of probability random sampling and non-probability sampling methods has been used. Study weredas were selected purposively based on status of grass pea production and their accessibility during dry season. A multistage random sampling method was employed to identify sample Peasant Associations (PAs) and sample farmers. First, two PAs were randomly selected from each wereda. Secondly, sample farmers were selected using a systematic random sampling technique. A sample size of 402 farmers, 100 farmers from each Zone, was considered.

Information relating to grass pea processing, preparation, and consumption, was collected from women while information referring to grass pea production was collected from men. The data were collected using a standard questionnaire where female enumerators administered the interviews to women and male enumerator to men. In addition to primary data, secondary data have been gathered from different sources. For this purpose, guidelines were developed and used. Simple descriptive statistics such percentage and mean were used to analyze the data.

**Household and Farm Characteristics**

**Description of households**
The sample households have an average family size of 6 persons. The average family size in East Shewa Zone is 7, which is greater than the national average of 5 persons. In the remaining three Zones, the average family sizes were close to the national average (Table 1). On average, 3 persons (1.73 males and 1.35 females) per household are potentially active agricultural workers (i.e., between 15 and 60 years of age).

The average ages of household head are 53 in South Welo, 49 in East Shewa, 44 in South Gonder and 43 in East Gojam. Most of the sample households are headed by male (92%). The proportion of female-headed household is less than
10% in East Gojam, South Gonder and East Shewa. Concerning the educational backgrounds of the sample household heads, about 65% in South Welo, 58% in South Gonder, 51% in East Gojam and 57% in East Shewa cannot read and write (Table 1).

Table 1. Sex, education, ethnic group and religion of sample household heads by Zone

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases</td>
<td>100</td>
<td>100</td>
<td>102</td>
<td>100</td>
<td>402</td>
</tr>
<tr>
<td>Family size (Number)</td>
<td>5.46</td>
<td>5.28</td>
<td>4.76</td>
<td>7.18</td>
<td>5.67</td>
</tr>
<tr>
<td>Sex (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>13.00</td>
<td>6.00</td>
<td>3.92</td>
<td>9.00</td>
<td>7.98</td>
</tr>
<tr>
<td>Male</td>
<td>87.00</td>
<td>94.00</td>
<td>96.08</td>
<td>91.00</td>
<td>92.04</td>
</tr>
<tr>
<td>Illiterate</td>
<td>64.65</td>
<td>58.05</td>
<td>50.98</td>
<td>56.84</td>
<td>57.58</td>
</tr>
<tr>
<td>Read and write</td>
<td>28.28</td>
<td>31.18</td>
<td>36.27</td>
<td>28.42</td>
<td>31.11</td>
</tr>
<tr>
<td>Education level (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary school (1-6)</td>
<td>4.04</td>
<td>10.75</td>
<td>7.84</td>
<td>5.26</td>
<td>6.94</td>
</tr>
<tr>
<td>Junior secondary (7-8)</td>
<td>0</td>
<td>0</td>
<td>2.94</td>
<td>3.16</td>
<td>1.54</td>
</tr>
<tr>
<td>Secondary school (9-12)</td>
<td>3.03</td>
<td>0</td>
<td>1.95</td>
<td>6.32</td>
<td>2.83</td>
</tr>
<tr>
<td>Religion (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthodox</td>
<td>34.00</td>
<td>98.00</td>
<td>88.24</td>
<td>92.93</td>
<td>78.30</td>
</tr>
<tr>
<td>Muslim</td>
<td>86.00</td>
<td>2.00</td>
<td>11.76</td>
<td>1.01</td>
<td>20.20</td>
</tr>
<tr>
<td>Protestant</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6.06</td>
<td>1.60</td>
</tr>
<tr>
<td>Amhara</td>
<td>100.00</td>
<td>98.97</td>
<td>100.00</td>
<td>16.09</td>
<td>80.16</td>
</tr>
</tbody>
</table>

The number of years of schooling for most of those farmers who reported they could read and write is one to two years. Most of them have benefited from the literacy campaign undertaken in the early 1980s and can only sign their names since there was no follow up on literacy program. Nearly all the sample households in South Welo, South Gonder and East Gojam belong to the Amhara ethnic group. About 84% of the sample household in the East Shewa Zone belongs to the Oromo ethnic group. In terms of religion 98% in South Gonder, 93% in East Shewa, 88% in East Gojam and 34% in South Welo are followers of the Ethiopian Orthodox Church, while 66% of the sample households in South Welo are Muslims.

Description of the farms

Table 2 presents information that helps to characterize farm type, land use patterns and tenure arrangements in the study areas. The average farm sizes range from 1.28 ha per household in South Welo to 2.21 ha per household in East Shewa. The relatively high standard deviation in East Shewa Zone indicates a large variation in farm sizes among farm households. In East Shewa, land has not been re-distributed since 1991. As there are several landless farmers, there are also farmers who depend on small plot of land given to them by their parents; such farmers were not included in the sample. In many ways landless young farmers depend on their parents or depend on additional off-farm income i.e. income from petty trade. However, in South Welo, South Gonder and East Gojam land has been redistributed and all farmers who depend on farming for living were included. The redistribution of land explains the smaller average farm size per household in the three Zones. In all the study areas, the proportions of farmers who practice fallowing and the land left under
fallow were negligible, reflecting the population pressure on land. Across the study areas, small amount of land around homestead were set aside for grazing. In Fogera wereda, South Gonder Zone, there are common grazing lands. In the other study areas, communal grazing areas are taken over by crop production. In South Welo, South Gonder, East Gojam and East Shewa, substantial number of farmers exercised sharecropping. The practice of rent-in land is more prevalent in East Shewa and this practice is negligible in South Welo and South Gonder. Out of the total sampled farmers in South Welo, only one person reported renting-out land.

Table 2. Household land use pattern and land under share cropping (ha), 1990/2000

<table>
<thead>
<tr>
<th>Land use/tenure</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Farm size-owned</td>
<td>1.28 (.51)</td>
<td>1.28 (.56)</td>
<td>1.59 (.68)</td>
<td>2.21 (1.30)</td>
<td>1.59 (.91)</td>
</tr>
<tr>
<td>Cultivated area</td>
<td>1.19 (.48)</td>
<td>1.21 (.52)</td>
<td>1.59 (.68)</td>
<td>2.04 (1.21)</td>
<td>1.51 (.85)</td>
</tr>
<tr>
<td>Grazing land</td>
<td>0.21 (.18)</td>
<td>0.29 (.39)</td>
<td>0.37 (.22)</td>
<td>0.37 (.22)</td>
<td>0.28 (.26)</td>
</tr>
<tr>
<td>Fallow land</td>
<td>0.50 (.02)</td>
<td>0.19 (.03)</td>
<td>0.41 (.23)</td>
<td>0.83 (.22)</td>
<td>0.38 (.24)</td>
</tr>
<tr>
<td>Rent in land</td>
<td>0.50 (.02)</td>
<td>0.40 (.24)</td>
<td>0.49 (.19)</td>
<td>0.86 (.14)</td>
<td>0.60 (.43)</td>
</tr>
<tr>
<td>Share in land</td>
<td>0.56 (.27)</td>
<td>0.47 (.28)</td>
<td>0.73 (.55)</td>
<td>0.49 (1.23)</td>
<td>0.60 (.43)</td>
</tr>
<tr>
<td>Share out land</td>
<td>.81 (.40)</td>
<td>.56 (.33)</td>
<td>.98 (.46)</td>
<td>1.00 (.54)</td>
<td>.79 (.42)</td>
</tr>
</tbody>
</table>

The term rent denotes transaction in terms of money while the term sharecropping implies sharing of output produced. S.D.

Farmers use large proportion of their land for crop cultivation. The principal cereal crops grown in the study areas include tef and maize in South Gonder and tef and wheat in the other three locations. The major food legumes grown are grass pea, chickpea, lentils and faba bean. Some farmers in South Gonder Zone also grow finger millet and rice. Grass pea growers allocated an average of about 0.25-0.41 hectare to grass pea production (Table 3).
Grass pea production, consumption and processing

Table 3. Crops grown and area (ha) allocated to crop by sample households across the Zones, 1999/2000

<table>
<thead>
<tr>
<th>Crops grown</th>
<th>South Welo Mean (S.D.)</th>
<th>%</th>
<th>South Gonder Mean (S.D.)</th>
<th>%</th>
<th>East Gojam Mean (S.D.)</th>
<th>%</th>
<th>East Shewa Mean (S.D.)</th>
<th>%</th>
<th>All locations Mean (S.D.)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tef</td>
<td>0.48 (.19)</td>
<td>92</td>
<td>0.44 (.27)</td>
<td>90</td>
<td>1.02 (.49)</td>
<td>100</td>
<td>0.57 (.68)</td>
<td>99</td>
<td>0.74 (.53)</td>
<td>94</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.42 (.22)</td>
<td>90</td>
<td>0.10 (.04)</td>
<td>2</td>
<td>0.26 (.11)</td>
<td>29</td>
<td>0.52 (.30)</td>
<td>90</td>
<td>0.44 (.26)</td>
<td>52</td>
</tr>
<tr>
<td>Maize</td>
<td>0</td>
<td>0</td>
<td>0.22 (.11)</td>
<td>88</td>
<td>0.14 (.03)</td>
<td>25</td>
<td>0.26 (.21)</td>
<td>23</td>
<td>0.22 (.13)</td>
<td>44</td>
</tr>
<tr>
<td>Millet</td>
<td>0.25 (.06)</td>
<td>22</td>
<td>0.25 (.13)</td>
<td>39</td>
<td>NG</td>
<td>0</td>
<td>0.25 (.12)</td>
<td>5</td>
<td>0.25 (.12)</td>
<td>5</td>
</tr>
<tr>
<td>Faba bean</td>
<td>0.23 (.08)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.25 (.11)</td>
<td>15</td>
<td>0.22 (.06)</td>
<td>10</td>
<td>0.22 (.06)</td>
<td>10</td>
</tr>
<tr>
<td>Chickpea</td>
<td>0.21 (.07)</td>
<td>3</td>
<td>0.24 (.14)</td>
<td>22</td>
<td>0.31 (.11)</td>
<td>49</td>
<td>0.41 (.36)</td>
<td>57</td>
<td>0.34 (.26)</td>
<td>23</td>
</tr>
<tr>
<td>Lentils</td>
<td>0.25 (.06)</td>
<td>2</td>
<td>0.21 (.06)</td>
<td>27</td>
<td>0.19 (.09)</td>
<td>2</td>
<td>0.15 (.09)</td>
<td>11</td>
<td>0.19 (.08)</td>
<td>11</td>
</tr>
<tr>
<td>Grass pea</td>
<td>0.26 (.16)</td>
<td>69</td>
<td>0.41 (.21)</td>
<td>96</td>
<td>0.36 (.22)</td>
<td>62</td>
<td>0.25 (.15)</td>
<td>66</td>
<td>0.30 (.20)</td>
<td>76</td>
</tr>
<tr>
<td>Rice</td>
<td>0.38 (.18)</td>
<td>2</td>
<td>0.25 (.12)</td>
<td>40</td>
<td>0.30 (.11)</td>
<td>1</td>
<td>NA</td>
<td>0</td>
<td>0.27 (.13)</td>
<td>11</td>
</tr>
<tr>
<td>Other crops</td>
<td>0.25 (.06)</td>
<td>7</td>
<td>0.15 (.11)</td>
<td>22</td>
<td>0.09 (.03)</td>
<td>2</td>
<td>0.31 (.23)</td>
<td>27</td>
<td>0.24 (.18)</td>
<td>14</td>
</tr>
</tbody>
</table>

Note: NG = crop is not grown in the area; NA = Data not available; S.D - Standard Deviation.

Grass pea and chickpea are widely produced and about 10% of farmers produced lentils and faba bean in 1999/2000 in the study areas. Based on figures in Table 4, the weighted average area allocated to legumes was 0.31 ha/household. In the same year, around 60% of total legume area was allocated to grass pea.

Table 4. Area and production estimates of the major pulses in Ethiopia

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba bean</td>
<td>348.91</td>
<td>280.19</td>
<td>298.20</td>
<td>298.71</td>
<td>359.15</td>
<td>426.24</td>
</tr>
<tr>
<td>Field pea</td>
<td>174.09</td>
<td>130.74</td>
<td>139.10</td>
<td>141.95</td>
<td>152.20</td>
<td>204.76</td>
</tr>
<tr>
<td>Chick pea</td>
<td>138.09</td>
<td>132.00</td>
<td>109.70</td>
<td>167.70</td>
<td>184.79</td>
<td>211.91</td>
</tr>
<tr>
<td>Lentils</td>
<td>70.42</td>
<td>44.86</td>
<td>44.80</td>
<td>47.90</td>
<td>72.22</td>
<td>90.21</td>
</tr>
<tr>
<td>Grass Pea</td>
<td>32.29</td>
<td>65.46</td>
<td>70.40</td>
<td>95.05</td>
<td>110.58</td>
<td>114.08</td>
</tr>
<tr>
<td>Haricot bean</td>
<td>25.06</td>
<td>45.53</td>
<td>39.80</td>
<td>129.50</td>
<td>166.04</td>
<td>186.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba bean</td>
<td>469.94</td>
<td>233.33</td>
<td>312.10</td>
<td>285.82</td>
<td>398.68</td>
<td>452.84</td>
</tr>
<tr>
<td>Field pea</td>
<td>163.07</td>
<td>69.26</td>
<td>103.74</td>
<td>100.08</td>
<td>116.00</td>
<td>141.37</td>
</tr>
<tr>
<td>Chick pea</td>
<td>101.37</td>
<td>88.40</td>
<td>60.09</td>
<td>138.64</td>
<td>164.63</td>
<td>175.73</td>
</tr>
<tr>
<td>Lentils</td>
<td>51.60</td>
<td>25.87</td>
<td>25.03</td>
<td>28.38</td>
<td>49.77</td>
<td>55.29</td>
</tr>
<tr>
<td>Grass Pea</td>
<td>21.37</td>
<td>41.73</td>
<td>44.16</td>
<td>70.62</td>
<td>107.48</td>
<td>99.42</td>
</tr>
<tr>
<td>Haricot bean</td>
<td>11.75</td>
<td>23.34</td>
<td>31.45</td>
<td>116.61</td>
<td>132.69</td>
<td>148.42</td>
</tr>
</tbody>
</table>

Source: CSA, various bulletins

Production Status and Practices

Status and trends
Grass pea is grown and produced nearly in all administrative Zones of Ethiopia. However, its production is more common in the central and northern parts of the country. In terms of geographical distribution, it is widely grown in the
northwestern (58%), the central (16%) and the northeastern (13%) parts of the country. The northern as well as southeast parts of the country accounts for the remaining 13% (Wolde-Amlak et al., 1991).

In Ethiopia, grass pea ranks fourth in total area among legumes (Table 4). Its area increased from 70,400 ha in 1992 to 114,060 ha in 2001, with an average annual growth rate of 5.36% (Table 5). As shown in the table, the area growth rate of grass pea was consistently positive, but this was not the case for the other legumes. The factor underlying this growth rate is the relative performances of grass pea under adverse environmental conditions such as moisture stress, water logging, insufficient soil fertility, disease and pests damages (Asgelil et al., 1994). Other legumes do not perform well under such adverse environmental conditions.

Annual grass pea production accounts for 10.5% of the food legumes and it occupies 11% of the total area under legumes. These figures are higher than what Wolde-Amlak et al. (1991) and Asgelil et al. (1994) reported. They quoted 6% to 8% for production and a maximum figure of 8.7% for area under grass pea. The expansion of grass pea area and production in recent years indicates the importance of grass pea in the farming systems of poor smallholder farmers either due to increased level of poverty or decline (or stagnant growth) in production of other legumes. Table 5 compares annual growth rates of area and production of major legumes over the period 1980s and 1990s. In the period from 1981 to 2000, grass pea production increased from 21,000 to 99,420 tons. The production growth rate for the same period was 9.02%. The major source of growth in grass pea production was through expansion in area.

Farmers in the study areas have long experience (on average 14 to 22 years) in grass pea farming. They cultivate grass pea for consumption, cash income, soil fertility maintenance, and for livestock feed (Table 6). It appears that consumption; generation of cash income and soil fertility maintenance (amelioration) is the main driving forces for production of grass pea. In South Gonder, the importance of grass pea for soil fertility maintenance was not appreciated, as soil fertility is not a problem at that specific study site. As clearly depicted in Table 6, the use of grass pea as fodder is not the primary purpose for its cultivation.
Table 5. Comparison of area and production growth for the major pulses

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faba bean</td>
<td>-4.39</td>
<td>0.78</td>
<td>3.97</td>
<td></td>
</tr>
<tr>
<td>Field pea</td>
<td>-5.37</td>
<td>0.78</td>
<td>4.29</td>
<td></td>
</tr>
<tr>
<td>Chick pea</td>
<td>-0.90</td>
<td>-2.31</td>
<td>7.32</td>
<td></td>
</tr>
<tr>
<td>Lentils</td>
<td>-9.02</td>
<td>-0.02</td>
<td>7.78</td>
<td></td>
</tr>
<tr>
<td>Grass Pea</td>
<td>14.13</td>
<td>0.94</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>Haricot bean</td>
<td>11.94</td>
<td>-1.68</td>
<td>17.18</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba bean</td>
<td>-0.14</td>
<td>3.63</td>
<td>4.14</td>
<td></td>
</tr>
<tr>
<td>Field pea</td>
<td>-0.17</td>
<td>5.05</td>
<td>3.44</td>
<td></td>
</tr>
<tr>
<td>Chick pea</td>
<td>-0.03</td>
<td>-4.82</td>
<td>11.92</td>
<td></td>
</tr>
<tr>
<td>Lentils</td>
<td>-0.14</td>
<td>-0.41</td>
<td>8.81</td>
<td></td>
</tr>
<tr>
<td>Grass Pea</td>
<td>13.38</td>
<td>0.71</td>
<td>9.02</td>
<td></td>
</tr>
<tr>
<td>Haricot bean</td>
<td>13.72</td>
<td>3.73</td>
<td>17.28</td>
<td></td>
</tr>
</tbody>
</table>

Source: Estimated based on data shown in Table 4

Table 6. Farmers main reasons for cultivating grass pea (% of respondents)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>40.0</td>
<td>45.1</td>
<td>39.2</td>
<td>36.5</td>
<td>40.2</td>
</tr>
<tr>
<td>Generates cash income</td>
<td>24.3</td>
<td>42.8</td>
<td>32.8</td>
<td>30.8</td>
<td>32.7</td>
</tr>
<tr>
<td>Soil fertility</td>
<td>25.7</td>
<td>5.1</td>
<td>25.4</td>
<td>25.0</td>
<td>20.3</td>
</tr>
<tr>
<td>Fodder</td>
<td>10.0</td>
<td>7.0</td>
<td>2.6</td>
<td>7.7</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Household data on grass pea area shows that either substantial number of farmers increased or maintained area allocated to grass pea. The proportion of farmers reported increasing area allocated to grass pea was 55% in East Shewa and 36% in East Gojam. These two zones are known for their chickpea and lentils production and grass pea is partly replacing the other two crops. In South Welo and South Gonder, most farmers reported steady change in allocation of land to grass pea in recent years (Table 7). Farmers pointed out four reasons for the increase of grass pea cultivation. First, the market price of grass pea has increased in recent years because of increased demand. It has to be noted that the price of grass pea is still lower than that of other legumes such as lentils, chickpea, fava bean and field pea. Second, grass pea does not require intensive management and make little competition for labor with other crops. This occurs because planting and harvesting grass pea is usually done after all operation of other crops are over. Third, grass pea resists insects and diseases better compared to chickpea and lentils. Grass pea is planted in September and October on residual moisture, which cannot sustain other crops if planted at the same time. Therefore, farmers favor cultivation of grass pea to ensure the supply of legumes for home consumption.
Table 7. Trend in allocation of area to grass pea production, and reasons given by farmers for the increase in grass pea area (% of respondents)

<table>
<thead>
<tr>
<th>Trend/reasons</th>
<th>Overall locations</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trend in grass pea area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>18</td>
<td>16</td>
<td>36</td>
<td>55</td>
<td>30</td>
</tr>
<tr>
<td>Decreased</td>
<td>28</td>
<td>9</td>
<td>32</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>No change</td>
<td>54</td>
<td>75</td>
<td>32</td>
<td>33</td>
<td>49</td>
</tr>
<tr>
<td>Reasons for increase in grass pea area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fetch higher price</td>
<td>20</td>
<td>27</td>
<td>39</td>
<td>53</td>
<td>38</td>
</tr>
<tr>
<td>Averse risk</td>
<td>4</td>
<td>24</td>
<td>29</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Require less management</td>
<td>36</td>
<td>32</td>
<td>23</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>Less compete for labor</td>
<td>40</td>
<td>16</td>
<td>9</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

Production practices

Grass pea and chickpea are widely produced and about 10% of farmers produced lentils and faba bean in 1999/2000. The proportion of grass pea growers ranged from 66% in East Shewa to 96% in South Gonder in 1999/2000. In all four-study areas, the proportions of farmers who grew chickpea were less than the proportions of farmers who grew grass pea, in the 1999/2000-crop season.

Soil fertility status and drainage problems appear to be the major criteria used by farmers for deciding where to grow grass pea. Grass pea is believed to restore and ameliorate soil fertility and about 40% of farmer's plant grass pea on less fertile land to improve soil fertility. As shown in Table 8, planting grass pea on less fertile field is more common in East Gojam (73%) and East Shewa (56%). In South Gonder, 82% of farmers planted grass pea on waterlogged land, while 49% of farmers in South Welo planted grass pea in similar types of land. Farmers believe that grass pea improves soil fertility and gives better yield compared to other pulses when planted on less fertile field. Substantial number of farmers also grew grass pea on fertile land. For instance, 28% of the sample farmers from South Welo grew grass pea on fertile land in 1999/2000. This indicates the value or importance farmers attach to grass pea in their crop mix.

Table 8. Type of fields farmers allocate to grass pea production by Zone (% of respondents), 1999/2000

<table>
<thead>
<tr>
<th>Type of Field</th>
<th>Overall locations</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertile</td>
<td>28</td>
<td>14</td>
<td>25</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>Less fertile</td>
<td>26</td>
<td>9</td>
<td>73</td>
<td>56</td>
<td>41</td>
</tr>
<tr>
<td>Flooded</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Waterlogged</td>
<td>49</td>
<td>82</td>
<td>0</td>
<td>37</td>
<td>42</td>
</tr>
</tbody>
</table>

Grass pea fields are ploughed two-three times, including the plowing operation to cover seeds at planting. In South Welo, grass pea fields are ploughed once or twice before planting. The frequency of land preparation for grass pea is less
Grass pea production, consumption and processing

compared to frequency of land preparation for chickpea across locations (Table 9). In all study areas, grass pea is commonly produced on residual moisture and planted from September to October when main rains are over. Very few farmers in South Gonder practiced supplementary irrigation for grass pea production. Grass pea is not irrigated in other parts of the country.

Grass pea fields are not weeded across the study Zones with the exception in East Gojam Zone where 78% of the sample farmers weeded grass pea once. Therefore, grass pea's demand for labor and draught power is less compared to other legumes. In addition, grass pea is cultivated without application of modern inputs such as fertilizer, improved seeds, and pesticides. Since grass pea is planted late in the season on residual moisture, there would not be sufficient moisture for the development of aphids. Therefore, the crop escapes aphid infestation. It is also more tolerant to aphids compared to lentils (Personal communication, Entomology section of Debre Zeit research center). It is not common to apply pesticides to control disease or insect on grass pea.

Table 9. Frequency of plowing and weeding of grass pea and other legumes by Zone

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Zone</th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South Welo</td>
<td>South Gonder</td>
</tr>
<tr>
<td>Plowing</td>
<td>1.81 (32)</td>
<td>(0)</td>
</tr>
<tr>
<td>Faba bean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickpea</td>
<td>1.58 (12)</td>
<td>3.05 (44)</td>
</tr>
<tr>
<td>Lentil</td>
<td>1.83 (12)</td>
<td>3.03 (34)</td>
</tr>
<tr>
<td>Grass pea</td>
<td>1.50 (68)</td>
<td>2.28 (64)</td>
</tr>
<tr>
<td>Weeding</td>
<td>1.04 (27)</td>
<td>(0)</td>
</tr>
<tr>
<td>Faba bean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chickpea</td>
<td>1.00 (1)</td>
<td>1.00 (3)</td>
</tr>
<tr>
<td>Lentil</td>
<td>1.00 (2)</td>
<td>(0)</td>
</tr>
<tr>
<td>Grass pea</td>
<td>1.00 (3)</td>
<td>1.00 (6)</td>
</tr>
</tbody>
</table>

Figures in parentheses indicate number of respondents

Since the 1980s, research on grass pea has been underway to reduce its β-ODAP content. Some promising lines were identified but not officially released for production. Therefore, improved varieties are not available and farmers grow local cultivars. Farmers keep their own seed and, if at all seed is purchased, it is the only purchased input for grass pea production. There is no recommended seeding rate for grass pea, but farmers use seed rates ranging from 64 kg/ha in South Welo to 106 kg/ha in East Shewa (Table 10).

In the study Zones, grass pea is cultivated as a sole crop. Inter-cropping grass pea with other crops is not common, although farmers may maintain any type of voluntarily grown crops in grass pea fields or vice-versa. Double cropping is practiced only in South Gonder, where farmers grow grass pea after tef or barley in the same year. Double cropping is not practiced in South Welo, East Shewa and East Gojam Zones. However, WoldeAmlak and Alelign (1990) reported such practice for East Gojam Zone. This
study reveals that sample farmers in East Gojam Zone, (Bichena wereda), do not plant grass pea after tef or wheat.

Table 10. Average seed rates (kg/ha) for grass pea and other legumes by Zone

<table>
<thead>
<tr>
<th>Type of legume</th>
<th>South Welo Use</th>
<th>South Gonder Use</th>
<th>East Gojam Use</th>
<th>East Shewa Use</th>
<th>Overall Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba bean</td>
<td>170 (20)</td>
<td>NR</td>
<td>120 (1)</td>
<td>94 (10)</td>
<td>144 (31)</td>
</tr>
<tr>
<td>Chickpea</td>
<td>108 (10)</td>
<td>84 (41)</td>
<td>81 (60)</td>
<td>145 (42)</td>
<td>101 (153)</td>
</tr>
<tr>
<td>Lentil</td>
<td>69 (9)</td>
<td>116 (31)</td>
<td>32 (1)</td>
<td>77 (5)</td>
<td>100 (46)</td>
</tr>
<tr>
<td>Grass pea</td>
<td>64 (46)</td>
<td>167 (56)</td>
<td>81 (67)</td>
<td>106 (46)</td>
<td>79 (215)</td>
</tr>
</tbody>
</table>

Figures in parentheses indicate number of respondent. NR = Not reported.

Grass pea restores soil fertility. As a result number of farmers in all locations include grass pea in their crop rotation sequences. In the study areas, farmers practice different crop rotation sequences (Table 11). Cereals and legumes are included in most of the farmers’ cropping systems. Depending on location and types of crops grown, finger millet is also used as the preceding crop. As a trap crop, grass pea is also planted along chickpea and lentil fields. This has been a common practice in East Shewa, though grass pea is replacing chickpea in recent years. Grass pea is harvested using sickle or hand picked when dry. Harvesting time extends from February to March and this activity is done late compared to similar activities for other crops. Grass pea is threshed manually and by using animals, mainly oxen and bulls.

Grass pea gives higher yield compared to chickpea and lentils in South Welo and South Gonder Zones (Table 12). The yields of grass pea and chickpea are similar in East Gojam and East Shewa Zones too. Adaptation areas for lentils, chickpea and grass pea are also similar. Lentil and chickpea require more fertile soils than grass pea. Although, faba bean grow in agro-ecologies where grass pea grows, it is more adaptable in other agro-ecologies. Therefore, the yield indicated here for faba bean refers to Vertisols only.

Table 11. Crop rotation practices as reported by some farmers

<table>
<thead>
<tr>
<th>Zone</th>
<th>Rotation sequence</th>
<th>Proportion reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Welo</td>
<td>Wheat → tef → wheat → tef → wheat</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Wheat → tef → grass pea → wheat → tef</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Tef → wheat → grass pea → wheat → wheat</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Tef → wheat → grass pea → tef → wheat</td>
<td>5</td>
</tr>
<tr>
<td>South Gonder</td>
<td>Tef → grass pea → tef → grass pea → tef</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Tef → grass pea → tef → chickpea → tef</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Rice → grass pea → Rice → grass pea → Rice</td>
<td>16</td>
</tr>
<tr>
<td>East Gojam</td>
<td>Tef → grass pea → tef → grass pea → tef</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Tef → wheat → tef → wheat → tef</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Tef → wheat → tef → tef → wheat</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Tef → tef → tef → tef → tef</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Tef → tef → grass pea → tef → tef</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Tef → tef → tef → chickpea → tef</td>
<td>5</td>
</tr>
<tr>
<td>East Shewa</td>
<td>Tef → wheat → tef → grass pea → tef</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Tef → tef → tef → chickpea → tef</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Wheat → tef → chickpea → tef</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: Farmers' crop rotations practice; here only crop rotation sequences that were reported by four or more farmers are presented.
Grass pea production, consumption and processing

Processing and Preparation

Methods
Grass pea grain is mainly used for human consumption and is consumed in the form of a sauce, made of finely ground flour (shiro wot); as sauce made of splits of legumes (kik wot); as boiled grain (nifro); as roasted grain (kollo); or as a pancake (kitta). Different processing and preparation methods are used. Processing of grain and preparation of food may be done to change the grain to a required form and shape, to facilitate consequent processing, to make the grain and food tender and soft. Grass pea is processed into either big splits or fine flour. Some of the conventional processing methods are more rigorously applied in case of grass pea. For instance, grass pea grain and/or splits are more frequently washed or soaked for longer hours compared to other legumes. When grass pea is consumed in nifro (boiled grain) or kollo (toasted grain) forms, relatively minimum processing is involved. The processing and preparation methods of grass pea into different forms can be generalized into the following steps.

Shiro
Foreign materials (stones, trash, etc.) removed → grain washed and/or soaked → grain lightly toasted → grain set aside for cooling → toasted grain dehusked using a stone hand mill → the splits of grass pea washed with cold/hot water → sun dried → dried splits mixed with spices → ground into flour. Once shiro from grass pea alone or mixture of grass pea and other legumes is processed and made ready, shiro wot (sauce) is prepared in one of the following two methods.

In the first method, a clean clay pot, destined for preparations of wot is put on a stove. Spiced pepper powder or dillih (red pepper paste) is added and fried for few minutes by adding oil (if available) or little water at a time. Enough water is then added. When the water starts to boil shiro is added a little at a time and stirred continuously. Salt is added and cooked until done and eaten with enjera.

In the second method, chopped shallot or onion is fried in a pot by adding oil (if available) or a little water is added at a time. Spiced pepper powder or dillih is added and fried. Depending on the family size, enough water is added and when the water starts to boil shiro flour is added a little at a time and stirred continuously. Salt is added and cooked until done. Shiro wot is served with enjera.

Nifro
Initially grass pea grain is made clean through washing (washed 2-3 times) and soaking; enough water is added and cooked until tender. In some case, water is added and cooked for few minutes. The cooking water drained off and fresh water is added and cooked until tender. Wheat or chickpea is sometimes mixed with grass pea to prepare nifro. Grass pea nifro is cooked on average for 2-3 hours.
Foreign materials such as stones, trash etc. are removed from grass pea grain washed or soaked and the washing or soaking water is discarded. The grain is then toasted until it becomes light brown on clay or flat metal pan. Some times grass pea is toasted dry. Out of farmers who reported consuming grass pea in forms of kollo in South Welo and South Gonder Zones, 37% and 71% practiced soaking. On average, the grain is soaked for ten hours.

Table 12. Average yields of legumes as reported by farmers (kg/ha)

<table>
<thead>
<tr>
<th>Legume</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>Mean (S.D.)</td>
<td>N</td>
</tr>
<tr>
<td>Faba bean</td>
<td>521.48 (281.42)</td>
<td>752.10 (399.99)</td>
<td>987.18 (391.49)</td>
<td>12 (381.39)</td>
<td>614.59 (345.16)</td>
</tr>
<tr>
<td>Chickpea</td>
<td>500.00 (200.00)</td>
<td>466.69 (306.20)</td>
<td>571.43 (335.23)</td>
<td>12 (391.49)</td>
<td>525.00 (362.76)</td>
</tr>
<tr>
<td>Lentil</td>
<td>620.00 (365.88)</td>
<td>895.82 (435.51)</td>
<td>925.90 (362.76)</td>
<td>78 (541.08)</td>
<td>944.85 (474.36)</td>
</tr>
<tr>
<td>Grass pea</td>
<td>746.30 (429.74)</td>
<td>752.10 (399.99)</td>
<td>987.18 (391.49)</td>
<td>12 (381.39)</td>
<td>614.59 (345.16)</td>
</tr>
</tbody>
</table>

S.D - Standard Deviation

Regarding scale and type of processing, with the exception of small flourmills, which are available in rural areas, agro-industry based processing of grains into different products is not well developed in Ethiopia. Therefore, grass pea is mainly processed into splits and fine flour at home using stone hand mills. Whether it is ground at home or changed to flour using services of small-scale flourmills, usually grass pea is lightly toasted to ease the process of de-husking or making splits or fine flour. Women or girls usually perform the processing at home. Male are rarely involved in grass pea processing activities.

There are slight variations between Zones and even among farmers within the same location in terms of methods and sequence of processing grass pea. Hours of soaking and frequency of washing varies across locations and households. Many farmers irrespective of how grass pea is processed or consumed practice washing across the Zones. Substantial proportions of farmers in South Gonder who reported consuming grass pea in forms of nifro (22%) and kollo (71%) do exercise soaking. Similarly, 37% of farmers in South Welo who consume grass pea in forms of kollo practice soaking the grain before toasting it. Soaking is also done in East Gojam in processing grass pea for kik (splits) and kitta (bread) preparation. Grass pea's grain splits, or both may be soaked or washed for shiro making (Table 13). On average grass pea for shiro is soaked for two hours (Table 14). The average soaking time is longer for East Shewa. Cold and/or hot water is used for washing and soaking.
Grass pea production, consumption and processing

Table 13. Proportion of farmers washing and soaking grass pea grains/splits for shiro

<table>
<thead>
<tr>
<th>Processing method</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soak Grain</td>
<td>22</td>
<td>9</td>
<td>0</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td>Splits</td>
<td>78</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Both</td>
<td>0</td>
<td>68</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Wash Grain</td>
<td>0</td>
<td>51</td>
<td>68</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Splits</td>
<td>100</td>
<td>17</td>
<td>1</td>
<td>63</td>
<td>45</td>
</tr>
<tr>
<td>Both</td>
<td>0</td>
<td>32</td>
<td>31</td>
<td>36</td>
<td>25</td>
</tr>
</tbody>
</table>

Reasons for applying different processing methods

The main reasons for washing and soaking grass pea is to remove dust and to reduce the toxic compound found in grass pea (Tables 15 and 16). Some farmers also do washing and soaking to avoid unpleasant flavor and to make it tender. Roasting is done to facilitate de-husking and for ease of grinding using stone hand mill. Boiling grass pea is mainly done to make the grain tender and palatable. During nifro preparation, the cooking water is drained and fresh water is added. This is done because farmers assume that draining the water washes away the toxic compound. In addition, in South Welo, drop of water is thinly spread on lightly or deeply toasted grass pea grain to let the toxic compound evaporate. Substantial proportion of interviewed women believes that repeated washing and soaking reduces the toxic compound and improves flavor of grass pea dishes (Tables 15 and 16). However, they do not realize that soaking and repeated washing reduces nutritive value of the grass pea dish.

Farmers claim that their indigenous grass pea processing and preparation methods reduce its neurotoxin content. Empirical research dealt with this aspect confirms the positive impact of food processing and preparation in reducing toxin content of grass pea. Research done in Ethiopia and elsewhere confirmed that soaking, toasting and boiling reduces the toxic compound (β-ODAP) found in grass pea (Berhanu et al., 1997; Kelbessa et al., 1994; and Kelbessa and Mengistu, 1993; Srivastava and Khokhar, 1996; Girma et al., 1997; Arvind et al., 1997). The results of their research can be summarized as follows:

- Soaking grass pea in water before processing reduces the β-ODAP content up to 60%.
- Cooking or pressure-cooking presoaked seeds reduce about 60-90% of the β-ODAP content.
- Roasting the grain reduces its β-ODAP content between 14 and 80%, with high temperatures and longer time giving higher reductions.

Table 14. Average frequency and average hours of soaking grass pea for shiro

<table>
<thead>
<tr>
<th>Frequency/time</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D</td>
<td>N</td>
<td>Mean</td>
<td>S.D</td>
</tr>
<tr>
<td>Washing Grain</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>2.79</td>
<td>.41</td>
</tr>
<tr>
<td>Splits</td>
<td>2.94</td>
<td>.25</td>
<td>94</td>
<td>2.94</td>
<td>.24</td>
</tr>
<tr>
<td>Soaking hour</td>
<td>1.50</td>
<td>.58</td>
<td>4</td>
<td>1.06</td>
<td>.24</td>
</tr>
<tr>
<td>Grain</td>
<td>1.33</td>
<td>.58</td>
<td>3</td>
<td>1.10</td>
<td>.31</td>
</tr>
<tr>
<td>Splits</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 15. Reasons for soaking and washing grass pea for nifro and kollo (% of respondents)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nifro – soaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To remove dusts</td>
<td>0</td>
<td>72</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>To remove toxic compound</td>
<td>67</td>
<td>56</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>Quick boiling</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Nifro – washing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To remove dusts</td>
<td>50</td>
<td>65</td>
<td>100</td>
<td>71</td>
</tr>
<tr>
<td>To remove toxic compound</td>
<td>50</td>
<td>67</td>
<td>13</td>
<td>43</td>
</tr>
<tr>
<td>Make better taste</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Kollo – soaking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To remove dusts</td>
<td>0</td>
<td>36</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>To remove toxic compound</td>
<td>31</td>
<td>91</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>To make it tender/soft</td>
<td>39</td>
<td>18</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Kollo – washing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To remove dusts</td>
<td>50</td>
<td>71</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>To remove toxic compound</td>
<td>83</td>
<td>76</td>
<td>0</td>
<td>53</td>
</tr>
</tbody>
</table>

Note: The figures do not add up to 100 due to multiple responses

It was found that most women respondents have wrong impression regarding concentration of toxic compound found in different parts of grass pea seeds. They feel that the toxic compound of grass pea is concentrated in husk; hence, they try to remove the husk during processing. Their knowledge and consequent actions are not in line with existing research findings regarding distributions of β-ODAP in seed husk (testa), embryo, and cotyledons. As indicated by Pandey et al. (1997), the β-ODAP distribution in embryo, cotyledons and husk was 0.751%, 0.353% and 0.037%, respectively. This reveals that the concentration of the toxic compound is much higher in the embryo than in other parts of the seed. As they noted, the embryo’s weight is only 1.6% of the seed, and contains only 2.91% of the β-ODAP content in the whole seed. Nearly 71% of the β-ODAP content was found in the cotyledons, while only the remaining 1.38% was found in the husk.

Consumption

Forms
Grass pea is consumed in different forms. Grass pea is widely consumed in the form of shiro across the study areas (Table 17). In South Gonder and South Welo Zones, it is also widely consumed in the form of nifro, mixed either with other cereals or alone. Consumption of grass pea as kollo is more common in South Welo followed by South Gonder.
Table 16. Reasons for washing and soaking grass pea used for Shiro (percentage responded)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soaking - grain Remove dusts</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Remove toxic compound</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>For facilitate grinding</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Improve flavor*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1.2</td>
</tr>
<tr>
<td>Soaking - splits Remove dusts</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Remove toxic compound</td>
<td>5</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Washing - grain Remove dusts</td>
<td>0</td>
<td>60</td>
<td>97</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>Remove toxic compound</td>
<td>0</td>
<td>43</td>
<td>9</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Improve flavor</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Facilitate grinding</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Washing - splits</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>71</td>
<td>21</td>
</tr>
<tr>
<td>Remove dusts</td>
<td>92</td>
<td>46</td>
<td>30</td>
<td>26</td>
<td>48</td>
</tr>
<tr>
<td>Remove toxic compound</td>
<td>20</td>
<td>5</td>
<td>0</td>
<td>33</td>
<td>14</td>
</tr>
<tr>
<td>Improve flavor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The percentages do not add up to 100 due to multiple responses.

*, The flavor is improved when unpleasant smell is washed out away.

Depending on the levels of income of a household, nifro and kollo may be served as snacks or main dish. For the poorest of the poor, they are served as main dish. The poor households consume grass pea as kitta during acute food shortage period.

In the East Shewa Zone, grass pea is not consumed as nifro, kollo and kitta. In this Zone grass pea is consumed more as shiro, mostly mixed with chickpea. Very few farmers reported consuming grass pea in forms of elbei, which is fermented grass pea paste usually consumed by the Orthodox Christians during fasting. One farmer in South Welo indicated use of grass pea for areke, which is a local brewed alcoholic drink prepared by distilling fermented flour diluted with water.

Spatial variations

There exists spatial variation in quantity and forms in which grass pea is consumed. The amount of other legumes, consumed by farmers also varies across locations. In the study areas, per capita grass pea consumption was the highest in East Gojam Zone followed by South Gonder (Table 18). Per capita chickpea and faba bean consumption is higher in East Shewa and East Gojam. As noted above, and with the exception of shiro wot, there is variation in terms of how grass pea is consumed. Shiro wot made of grass pea is widely consumed across the study Zones, while consumption of grass pea as nifro and kollo is more prevalent in South Welo and South Gonder. Many farmers (43%) in East Gojam also consume grass pea as nifro. Recently, consumption of grass pea appears to increase more in East Shewa followed by South Gonder (Table 19).
Table 1. Distribution of farmers (%) consuming grass pea in different forms by Zone

<table>
<thead>
<tr>
<th>Forms</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>South Welo</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sample</td>
<td>100</td>
<td>102</td>
<td>100</td>
<td>100</td>
<td>402</td>
</tr>
<tr>
<td>Shiro</td>
<td>100</td>
<td>99</td>
<td>97</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>Nifro</td>
<td>88</td>
<td>43</td>
<td>58</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Kollo</td>
<td>17</td>
<td>0</td>
<td>43</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Kik</td>
<td>62</td>
<td>80</td>
<td>32</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>Kitta</td>
<td>0</td>
<td>20</td>
<td>3</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Elbet</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>Areke</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Consumption by high- and low-income groups
Grass pea is the cheapest legume available in Ethiopia. It was assumed in the past that grass pea is produced and consumed by low-income groups only. This is only partially true, since some better-off farmers also produce and sell grass pea to generate income. In terms of consumption, farmers falling in high-income groups do not consume grass pea, but such farmers are few. In urban areas medium to high-income, consumers do not consume grass pea. Low-income urban dwellers consume grass pea as shiro wot. They make shiro wot from grass pea alone or grass pea blended with other legumes.

Low-income groups in rural areas commonly consume kitta, kollo and nifro made from grass pea alone, or its mixture with other crops. In general, these types of food are consumed as snacks. However, may be served as main meal depending on the income level of the household. Poor households consume grass pea as main dish. Shiro wot (sauce) made of grass pea is widely consumed by medium and poor households in rural areas.

Time of consumption
Most of the farmers in South Welo and East Shewa, and 50% of farmers in East Gojam consume grass pea as shiro wot throughout the year (Table 20). Shiro wot is mainly prepared from grass pea alone or grass pea mixed with other legumes. Nearly half of the sample households in East Gojam and 59% of sample household in South Gonder reported consuming grass pea before harvest. This time is when grain is in short supply and legumes price is high. When adequate grain supply is available, grass pea is not consumed except as shiro. This implies that grass pea is consumed when other legumes are in short supply.

Farmers' preferences
This study revealed farmers prefer to consume faba bean, field pea, lentil and chickpea. About 79% of the consumers in South Welo prefer to consume faba bean while 49% of the consumers in East Shewa and 46% of consumers in East Gojam prefer to consume field pea. They ranked faba bean, field pea, lentils and chickpea first for consumption (Table 21). Lentil and chickpea are more

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1 Farmers who cannot produce sufficient amount for consumption for the year round considered as low income; those farmers who produce sufficient amount for their consumption taken as medium income group and those farmers who produce excess of their consumption are considered as better-off farmers.
Grass pea production, consumption and processing

preferred in South Gonder. In the study areas, and elsewhere in the country, grass pea is the at least preferred legume for human consumption, compared to other legumes. Despite this, most households in rural areas and low-income urban dwellers consume grass pea at least in one form. About 86% of sample women in South Welo and East Gojam, 76% in East Shewa and 38% in South Gonder (Table 22) ranked grass pea fifth in relation to faba bean, field pea, lentil and chickpea. As pointed out by many farmers, the preferred legumes are not produced in sufficient amount due to insects and disease problems. In addition, most households cannot afford buying the preferred legumes due to relatively higher prices compared to grass pea.

Table 18. Annual per capita consumption of grass pea and its substitutes by Zone (kg)

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Zone</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South Welo</td>
<td>South Gonder</td>
</tr>
<tr>
<td>Fababean</td>
<td>10.12*</td>
<td>12.36</td>
</tr>
<tr>
<td>Field pea</td>
<td>0.64*</td>
<td>2.02</td>
</tr>
<tr>
<td>Chickpea</td>
<td>0.59ab</td>
<td>3.18</td>
</tr>
<tr>
<td>Grass pea</td>
<td>18.59a</td>
<td>26.74*</td>
</tr>
<tr>
<td>Lentil</td>
<td>0.27*</td>
<td>1.44</td>
</tr>
</tbody>
</table>

Means followed by the same letter within the same row are significantly different at 0.05 levels.

Table 19. Trend in grass pea consumption in recent years by Zone (percentage of respondents)

<table>
<thead>
<tr>
<th>Trend</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased</td>
<td>14 29</td>
</tr>
<tr>
<td>Decreased</td>
<td>14 20</td>
</tr>
<tr>
<td>No change</td>
<td>43 51</td>
</tr>
</tbody>
</table>

Table 20. Time of consumption of grass pea by Zone (percentage of respondents)

<table>
<thead>
<tr>
<th>Time</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year round</td>
<td>92 65</td>
</tr>
<tr>
<td>Before harvest</td>
<td>7 31</td>
</tr>
<tr>
<td>After harvest</td>
<td>1 4</td>
</tr>
</tbody>
</table>

The survey shows that grass pea is, however, the cheapest legume and this accounts for its wide consumption. In absolute economic value terms, the gap between the prices of legumes, particularly of chickpea, is getting narrower as the production of chickpea declines and consumers shift from chickpea consumption to grass pea consumption. Shift in production mix and consumption was reported in East Gojam.

Table 21. Proportion of sample women who ranked faba bean, field pea, lentils and chickpea first in terms of preference

<table>
<thead>
<tr>
<th>Preferred legumes</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba bean</td>
<td>80</td>
<td>4</td>
<td>10</td>
<td>16</td>
<td>29</td>
</tr>
<tr>
<td>Lentil</td>
<td>1</td>
<td>60</td>
<td>31</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Field pea</td>
<td>0</td>
<td>4</td>
<td>46</td>
<td>49</td>
<td>25</td>
</tr>
<tr>
<td>Chickpea</td>
<td>18</td>
<td>35</td>
<td>13</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Grass pea</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 22. Rural consumers' preference for grass pea in relation to faba bean, field pea, lentil and chickpea
(percentage of respondents)

<table>
<thead>
<tr>
<th>Rank</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>0</td>
<td>18.0</td>
<td>0</td>
<td>12.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Second</td>
<td>1.1</td>
<td>19.0</td>
<td>1.1</td>
<td>3.3</td>
<td>6.3</td>
</tr>
<tr>
<td>Third</td>
<td>3.2</td>
<td>18.0</td>
<td>2.1</td>
<td>3.3</td>
<td>6.9</td>
</tr>
<tr>
<td>Fourth</td>
<td>9.6</td>
<td>7.0</td>
<td>10.6</td>
<td>5.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Fifth</td>
<td>86.2</td>
<td>38.0</td>
<td>86.2</td>
<td>75.8</td>
<td>71.0</td>
</tr>
</tbody>
</table>

Conclusions and Recommendations

Grass pea production has been increasing for the last few years because of its performance under adverse environmental conditions, fewer requirements for modern inputs and nutritional and market values. If current trend continues, grass pea may partially replace the preferred legumes such as lentils and chickpeas and its importance as protein food for low-income households will increase in the future.

Despite being the at least preferred legume for human consumption, grass pea is widely consumed by low-income farmers in several local preparations such as shiro, nifro, kollo and kitta while middle-income farmers consume it only as shiro. Farmers cannot produce the preferred legumes, chickpea and lentils, in sufficient amounts due to insects and disease problems. Grass pea is more readily available because of its better tolerance to insects and diseases. Second, low-income farmers cannot afford to buy preferred legumes because of their relatively high prices.

Farmers' choice to cultivate grass pea is determined by the performance of the crop under marginal conditions where it outperforms other legumes and its effect on food security compared to other legumes. Thus, farmers weigh these benefits against the risk of lathyrism. However, the economic and nutritional benefits of grass pea production greatly depend on its productivity, availability of low neurotoxin varieties, availability of viable processing options and farmers ability to minimize the risk of lathyrism by avoiding the high risk consumption behavior. The later depends on farmers' opportunities to diversify their foods. Further work is needed to determine the impact of these different aspects on the risk of lathyrism and the economic and nutritional benefits of grass pea production. This will require the use of sustainable livelihood framework, which takes a more comprehensive view of rural livelihoods and livelihood strategies, rather than focusing on a single enterprise.

References


Asgelil Dibabe, Wolde Amlak Araia, Bekele Hundie, Regassa Ensermu, Wasie Haile, Yeshanew Ashagrie, Asmare Yalew and Wondimagen Seyoum
Grass pea production, consumption and processing


Legesse et al.


Indigenous Noug Production Practices, Constraints and Intervention Options in North and West Shewa Zones, Oromiya Region

Agajie Tesfaye1, Adefris Tekle Wold2 and Adugna Wakjira2

Introduction

Noug (Guizotia abyssinica) occupies 60% of the area allocated to oilseeds and accounts for more than 50% of the total oilseed production in Ethiopia (Miller and Hammond, 1992). It is the earliest crop in Ethiopia ever brought to domestication, perhaps around the third millennium B.C. (Dogget, 1986). It is cultivated by small-scale farmers primarily in the mid-altitude areas 1600-2200 m and rarely in the lower (500-1600 m) and higher (2200-3000 m) altitudes where the annual precipitation is between 500 and 1200 mm and temperature during the growing season is within the range of 15-23°C. The crop is a national priority for its edible oil, which is the major source of dietary fat for the majority of the population; its use as raw material for the oil-producing factories and mills operating at national and village levels; and for its use as source of foreign exchange earning that is estimated to be Birr 6,694,800 per annum. It is largely processed in small mills and the oil is mostly used for cooking. Only a small portion of the production reaches bigger oil factories (Getinet and Adefris, 1992).

Despite its long history of production and versatile uses, the average national seed yield of Noug is only 3.4 qt/ha. To overcome the problem of low productivity of Noug, research has been conducted for the last five decades in Ethiopia. Improved varieties of Noug and associated management practices have been generated and released. However, the production and productivity of Noug still remains low in Ethiopia in general and in north Shewa and west Shewa zones of Oromya Region in particular (Nigussie and Yeshanew, 1992). Hence, there is a need for a more coordinated, demand driven and agro-ecology based research to generate alternative technologies that are appropriate for smallholder farmers. This calls for the characterization of the indigenous knowledge of farmers in Noug production. Hence, this study was conducted to assess farmers’ indigenous Noug production systems; investigate the status of Noug production under on-farm conditions and identify and prioritize Noug production constraints.

Methodology

The Study Site

This study was conducted in Noug producing areas of Wera Jarso woreda (north Shewa zone, Oromiya Region) and Dendi woreda (west Shewa zone) in the

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1999/2000 cropping season. Wera Jarso is located on the highway from Addis Ababa to Gojam at about 180 - 200 km northwest of Addis Ababa. Wera Jarso woreda is characterized by tef and noug based farming systems at an altitude of about 2300 m. Even though there is no adequate meteorological data for Wera Jarso woreda, a large proportion of rain falls in the main rainy season (June - August).

Dendi woreda is located at about 85 - 95 km west of Addis Ababa on the highway from Addis Ababa to Nekemt. The mid-altitude of Dendi woreda is characterized by tef and noug based farming systems with an altitude of about 2200 meters above sea level (m) and an average annual rainfall ranging from 900 --1000 mm. A long-term rainfall data of the mid-altitude areas indicates that about 66% of the annual rain falls in the main rainy season (June - September) while 27% falls in the short rainy season (February - May) as indicated in Figure 1. The lowest amount of rainfalls in December and the highest in August. The annual average minimum temperature was 8.5°C ranging from 5.7°C - 9.9°C while the maximum was 24.1°C ranging from 21.2°C - 26.5°C (Ginchi Sub-center Meteorological report, unpublished).

**Sampling, Data Collection and Analysis**

Three-stage sampling technique was applied to select sample woredas, peasant associations (PAs) and farmers. The study areas were selected purposively to represent noug production systems in north and west Shewa zone. Sample PAs were selected randomly from the lists of noug growing PAs in the two woredas. Samples of farmers interviewed were selected from the population of the selected PAs using systematic sampling technique.

Three types of survey procedures were employed to collect the required data. First, secondary data was collected from different published and unpublished sources. This helped to acquire a general understanding of the farming systems of the study areas and used as a base to develop a checklist for the informal survey. In the second stage, some of the most important participatory rural appraisal (PRA) tools, such as semi-
Noug production, constraints and interventions

Structured interviews and matrix rankings were conducted using a checklist to collect mainly qualitative information on different aspects of noug production systems. Following the PRA, formal survey was also conducted in the third stage to collect quantitative data. Formal survey helped to quantify some of the most important parameters and verify the information collected during PRA survey. A structured questionnaire was developed, pre-tested and used as a tool in conducting the formal survey. Enumerators collected the quantitative data from farmers using a questionnaire with close supervision of researchers of Holetta Research Center supervisors and development agents of the Office of Agriculture. Enumerators who have completed grade 12 and speak the local language were recruited from the PAs selected for the study based on a priori set criteria. Training was also provided for enumerators on the methodology of recording data and objectives of the study, how to approach the farmers and cross check data. 434 sample farmers were selected and interviewed for this study (203 from Wera Jarso and 231 from Dendi woreda).

Results and Discussion

Landholding
As reported by 98% of the sample farmers, the decrease in land holding per household was one of the most important problems for farming. About 87% of the sample farmers have realized that the dominant factor that caused land shortage per household was increases in farming population. This problem has resulted in a limited opportunity to increase production by increasing cropped area. Hence, the results seem to suggest that research and other intervention options should focus in increasing productivity through intensification of farming using improved agricultural technologies and other practices.

Noug growers in the study areas allocated 14% of their cropped land to noug production (Figure 2). Noug growers on average allocated 0.67 ha of land ranging from 0.13 – 3.00 ha for noug production (Table 1). Even though most of the farmers seem to grow on black soils, noug was grown on different soil types.

Rape seed 10%  
Lentil 6%  
Chickpea 11%  
Wheat 15%  
Noug 14%  
Tef 44%

Figure 2. Proportion of cropped land allocated to different crops
A large proportion of sample farmers (91%) allocated 0.6 ha of land on average for grazing and 0.3 ha for hay making (Table 2). However, the proportion of farmers practicing fallowing was low (11%) and this might imply that most farmers are concentrating on other options, such as fertilizer application and crop rotation, for maintaining and improving the fertility of the soil. In general, 80% of the farmers’ landholding was allocated for crop production and 15% for feed (grazing and pasture making). The remaining proportion was allocated to tree planting and other uses.

**Table 2. Feed and tree area (ha) allocated by farmers, 1999/2000.**

<table>
<thead>
<tr>
<th>Landholding</th>
<th>Owners</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing</td>
<td>394</td>
<td>91</td>
<td>0.13</td>
<td>3.00</td>
</tr>
<tr>
<td>Hay</td>
<td>205</td>
<td>47</td>
<td>0.06</td>
<td>1.25</td>
</tr>
<tr>
<td>Fallow</td>
<td>48</td>
<td>11</td>
<td>0.13</td>
<td>1.50</td>
</tr>
<tr>
<td>Tree</td>
<td>112</td>
<td>26</td>
<td>0.03</td>
<td>0.50</td>
</tr>
</tbody>
</table>

*n represents the number of growers

**Table 1. Area (ha) of land allocated to noug production, 1999/2000.**

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Growers</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black soil</td>
<td>228</td>
<td>0.13</td>
<td>3.00</td>
<td>0.48</td>
</tr>
<tr>
<td>Red soil</td>
<td>17</td>
<td>0.25</td>
<td>1.75</td>
<td>0.56</td>
</tr>
<tr>
<td>Mixed soil</td>
<td>211</td>
<td>0.13</td>
<td>3.00</td>
<td>0.82</td>
</tr>
<tr>
<td>Total</td>
<td>434</td>
<td>0.13</td>
<td>3.00</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*n represents the number of growers

A mixture of red and black

**Purposes of Growing Noug**

As reported by 93% of the sample farmers, the main purpose of *noug* production was for marketing. Farmers perceive *noug* as a cash crop and it is an important source of on-farm income. This was confirmed by the fact that 74% of the total *noug* produced was sold at the time of the study. The second important purpose of producing *noug* was to use it as a break crop and planted in rotation with cereals to maintain and improve the fertility of the soil. This was an important factor, which farmers take into consideration while making decision to grow *noug*. Research findings have also confirmed that *noug* is a good precursor crop to cereals (Nigussie and Yeshanew, 1992; Adefris and Nigussie, 1996).

The third important purpose of *noug* production was as a source of food. In special occasions, roasted and processed *noug* seed was utilized as food in mixture with honey (locally known as “*Lilito*”) and roasted barley (locally known as “*Geb's kollo*”). “*Lilito*” was mostly consumed by nursing women immediately after delivery. Processed *noug* seed was also supplied to lean cattle and cows affected by dry season. In rare cases, farmers prepared home made cooking oil from *noug* (locally known as “*Kibanug*”).
Management Practices

Land Preparation
Farmers start land preparation for noug planting in April on mixed and red soils and in May on black soils if rain commences timely. Farmers commonly practiced twice land preparation of noug fields in all soil types, because they (56%) perceived that frequent land preparation results in water logging problem especially on black and mixed soils (Table 3). Some farmers (39%) also felt that frequent land preparation does not have an influence on yield. In general, land preparation for noug fields is less frequent as compared to other crops, such as cereals. However, this farmers’ perception was not verified by research findings. Hence, the effect of frequency of land preparation on the yield of noug need to be studied and optimal frequency of land preparation need to be determined through research.

Table 3. Reasons for less frequent land preparation of noug fields

<table>
<thead>
<tr>
<th>Reasons</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lodging problem</td>
<td>117</td>
<td>27</td>
</tr>
<tr>
<td>Water logging</td>
<td>243</td>
<td>56</td>
</tr>
<tr>
<td>No effect on yield</td>
<td>169</td>
<td>39</td>
</tr>
<tr>
<td>No weed problem</td>
<td>104</td>
<td>24</td>
</tr>
</tbody>
</table>

Planting Time
Farmers planted noug in May on mixed and red soils, and in June on black soils. An experiment conducted to study the effect of sowing date on seed yield indicates that optimum sowing time of noug varies with the rain of the particular location (Nigussie and Yeshanew, 1992). They suggested that planting noug during mid June to early July is recommended in the high altitudes (above 2000 m) and mid to late June in the lower altitude (below 2000 m) areas in the central zone. However, farmers of the study areas practice early planting as compared to the recommended one. This might have a negative effect on yield, because, there should be enough time, after the beginning of the steady rain, to satisfy the water requirement of the soils prior to planting. Farmers, therefore, need to be encouraged to follow the research recommendation.

Seed Rates and Seed Sources
Seed rates depend on soil type, quality of seed, plant population required and tillering ability of the crop. On black and mixed soil, farmers used less seed rates (12 kg/ha) for noug. This was due to more tillering and less weed population on these soils as compared to red soil. Farmers used a seed rate of about 20 kg/ha on red soils. However, experimental results have confirmed that seed rate has no major influence on seed yield due to compensatory effects of yield components of noug for seed yield at lower plant populations (Adefris and Negussie, 1996). These authors have also reported that seed rate is rather associated with planting date and suggested that a seed rate of 6 – 10 and 12 – 15 kg/ha were found to be optimum rates for early and late season sowings. According to a report by Negussie and Yeshanew (1992), a seed rate of 5 kg/ha is good enough while with delayed sowing a rate of 10-15 kg/ha is necessary.

The main source of noug seeds of farmers was mostly from previous harvest. Sometimes, farmers obtained noug seeds in exchange with tef, wheat and chickpea...
and through purchase from the market. During seed selection, farmers consider plumpness of seed and the quality that is not affected by frost.

**Fertilizer application**

Even though fertilizer application is one of the mechanisms to improve the fertility of the soil, not all the sample farmers applied it on **noug** fields. According to 68% of the sample farmers, **noug** is not responsive to fertilizer and it has rather the ability to improve and maintain the fertility of the soil. About 29% of the sample farmers also felt that since the price of fertilizer is becoming unaffordable, priority was given to other crops, such as cereals. The farmers' perception was confirmed by research findings and it was reported that **noug** is not responsive to NP applications (Balesh et al., 1992). Adefris and Nigussie (1996) have also proved that **noug** is less responsive to fertilizer. However, the same authors have suggested that since application of fertilizer hastens flowering and maturity, 23/23 kg/ha of N/P2O5 is recommended to be applied at planting. However, there is a need to investigate whether this recommendation is economical or not before it is disseminated to users.

**Weed Management**

Even though **Plantago lanceolata** (locally known as **Kortebe**), **Setaria verticillata** (locally known as **Asendabo**), and **Guizotia scabra** (locally known as **Mech**') are common weeds in **noug** fields, farmers have the perception that weed is not a problem on **noug** fields. As a result, not all of the sample farmers have ever weeded their **noug** fields. This was because, 55% of the sample farmers perceived that weeds do not affect **noug** yield, but rather, **noug** itself has the ability to suppress weeds. Farmers also reported that weeds from **noug** fields are important sources of livestock feed immediately after harvesting of **noug**. On the other hand, research findings have reported that **noug** is a poor competitor to weeds at its earlier growing stages (Rezene, 1992). The same author suggested that one hand weeding at its critical stages is adequate. No adequate research was conducted to screen and identify economically feasible herbicides to control **noug** weeds and to assess the economic loss caused because of weed infestation. Moreover, a research investigation should be initiated to determine whether removing weeds from **noug** fields early in the season or leaving the weeds in the field to be used, as animal feed is economical.

**Pests and Diseases**

Pest was reported to be one of the most important problems in **noug** production. The common pests on **noug** were **noug** fly and bollworm. Farmers noticed that **noug** fly occurs when little showers of rainfall at flowering stage followed by dry spell condition. Nevertheless, the occurrence of bollworm is reported to be occasional. It was observed that the larva of insect pest forms a ball like structure on the stem of the crop. This resulted in the stunted growth and infertile pods.

The occurrence of a disease was also observed on **noug** fields. Fungal types of diseases were observed on **noug** causing the crop to abort seed setting. Frost problem was also reported on **noug** grown in the low-lying depressed areas. However, farmers exercised no control measures to overcome pest, disease and frost problems. Farmers reported considerable yield losses due to pest, disease and frost incidences. Yield loss assessment studies need to be initiated to determine the extent and severity of pests and diseases. Biological characteristics of **noug** pests and diseases should also be studied to design appropriate and effective control strategies.
Harvesting
The common harvesting season of *noug* is reported to be mid November to early December, which seems a bit later than the recommended harvesting season. On top of this, farmers faced labor shortage problem during harvesting of *noug* since it overlaps with harvesting of *tef*, wheat and sorghum. As a result, farmers reported they faced serious yield losses due to shattering of *noug*, which is aggravated because of late harvesting. The farmers, of course, try to overcome seasonal labor shortage problem by efficiently utilizing their family labor and forming local labor sharing arrangements (locally known as “debo and wonfe”). Research findings have also confirmed that late harvesting is one of the factors that affects *noug* yield (Adefris and Nigussie, 1996). The same authors have suggested that harvesting *noug* when the bud moisture content is about 40% (which is expected to be three weeks after 50% petal drop) resulted in higher yield and minimum shattering without affecting the oil content.

The Role of Gender in *Noug* Production

*Noug* production practices seem to be gender sensitive like other crops. Men mainly performed plowing and planting activities of *noug*. Even though men also participate in harvesting of *noug*, women and adult boys do most of the harvesting and threshing activities. This was because; men are busy in harvesting other crops in the same season. It was reported that pregnant women did not participate in harvesting and threshing activities of *noug*. This was because, according to the farmers, the dusty pollen and other particles arising from *noug* plant (locally known as “Magde”) causes abortion when inhaled by pregnant women. Home processing of *noug* was reported to be a strenuous activity and women and girls mainly performed it. Sometimes, boys also participate in performing the arduous activities in home processing of *noug*. Women also participate in selling *noug* in small quantities while men sale in large lots. The results seem to imply that gender sensitiveness of *noug* production need to be taken into consideration when generating appropriate technologies to increase production and productivity of *noug*. Moreover, a research activity needs to be initiated to study why dusty particles inhaled by pregnant women because abortion and safe measures should be recommended to get rid of this problem.

Technology Adoption

Farmers reported that only one type of local *noug* variety was grown. According to farmers, the specific characteristics of this variety are: grown in the main rainy season (May/June – November/December), adaptable to highland areas, easily affected by moisture stress conditions, has good tillering capacity on fertile soils, has weed suppressing ability, shatters easily particularly when planted on red and black soils, and has poor yield potential (3-4 qt/ha). However, depending on single variety may be risky for farmers and limits their choice for consumption and marketing. Taking this problem into consideration, research on oilseeds started during Italian invasion and varietal development started in the early sixties (Getinet and Nigussie, 1992).
Four decades of research efforts have released five types of improved *noug* varieties (Sendafa, Fogera, Este, Kuyu and Shambu-1). The yields of these varieties under controlled on-station conditions ranged from 7.8 – 10.8 q/ha (Table 4).

<table>
<thead>
<tr>
<th>Improved varieties</th>
<th>On-station yield (q/ha)</th>
<th>Year of release</th>
<th>Year of on-farm testing</th>
<th>Type of on-farm trial</th>
<th>Average on-farm yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sendafa</td>
<td>7.8</td>
<td>1976</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>kuyu</td>
<td>10.8</td>
<td>1994</td>
<td>1995-1996</td>
<td>Verification</td>
<td>5.7</td>
</tr>
<tr>
<td>Shambu-1</td>
<td>9.5</td>
<td>2001</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Not conducted

Even though releasing improved varieties of *noug* for use started in the mid seventies, 92% of the overall sample farmers were not yet aware of the existence of these varieties at the time of the study. None of the sample farmers in Wera Jarso *woreda* and only 2% in Dendi *woreda* have ever planted improved *noug* varieties some time in the past. About 86% of those farmers who were aware of the existence of improved varieties of *noug* did not plant yet due to the inability to get improved seeds of *noug*. Other reasons included that the farmers were suspicious of the adaptability and productivity of improved *noug* varieties at their local conditions as compared to their local variety.

On-farm trials were also conducted to verify the performances of these varieties under the farmers’ conditions. However, it was observed that the released improved varieties performed poorly under on-farm conditions (with their yields reduced almost by half) than under on-station. The on-farm results, therefore, seem to support the farmers’ suspicion and that the performances of improved varieties under on-farm circumstances were not attractive.

Since *noug* is becoming an important source of cash for farmers in particular and an important source of foreign currency for the country in general, emphasis has to be given for this crop by both research and development institutions to improve its production and productivity.

### Relationship of Quantity of Noug Produced and Sold With Price

Quantity of *noug* produced and sold is influenced by several factors, among which price is one. In previous sections, it was explained that farmers produce *noug* mainly for marketing. It was assumed that price plays key role in affecting farmers’ decision and is positively associated with the quantity of *noug* produced and sold. This hypothesis was tested by taking five years data on the quantity of *noug* sold at the market and its price. As indicated in Figure 3, quantities of noug produced and sold are related with price. A correlation analysis between quantity of *noug* sold and its price showed highly significant and positive relationship in all the years considered in this analysis (Table 5).
About 33% of the sample farmers used noug chaff mainly as livestock feed, of which 61% ranked noug chaff second to fourth in preference for livestock feed among other crop residues. However, about 35% of the users reported that noug chaff is not a good feed for animals if fed without mixing it with other crop residues. Noug is also the most important source of a concentrate feed, nougcake. Nougcake is believed to be the best of all feeds and it is fed particularly to the milking cows and lean animals. However, only 7% of the sample farmers have reported using nougcake at the time of the study. Most of the farmers have reported the unavailability and high price of nougcakes as problems. Some farmers are even unaware of the uses of oilcakes.

**Production Constraints and Suggested Intervention Options**

This study has identified the following important constraints that limited the productivity of noug. Measures to be taken are also suggested to overcome these constraints.

**Low yielding Potential of Local Varieties**

The farmers reported that the poor productivity of noug (3 – 4 qt./ha) as compared to other crops is the most important constraint in noug production. Research has a key role to play in overcoming this problem. Even though there are improved noug varieties released for use so far, they were not found to be well performing under on-farm conditions. Hence, much effort and emphasis has to be given to research work to generate high yielding varieties under farmers' conditions.

**Shattering**

Grain loss due to shattering particularly on red and black soils was reported to be one of the major problems in noug production. This problem becomes serious when harvesting is delayed due to overlapping of farming activities. Research findings have also confirmed that noug yield could be reduced considerably if noug is not harvested timely. Hence, investigations are required to generate noug varieties that mature timely and uniformly. Growth regulator studies may be one of the research interventions to overcome such inherent problem of noug.

**Pest and Diseases**

Noug fly, bollworm and other pests were reported to be serious problems challenging noug productivity. Powdery mildew, stem and leaf blight were also observed on noug crop. Hence, loss assessment studies are suggested to be conducted to understand the severity of the problem. Moreover, detail studies are required to study the types and biological characteristics of pests and diseases. The researchers should also incorporate resistance of the varieties to pests and diseases as one of the traits when developing a high yielding noug variety. Studies are also required on improved cultural practices to control pests and diseases. Moreover, identification and evaluation of environmentally friendly chemicals and determination of cost-effective rate of application should be strengthened further.
It was also assumed that the quantity of noug produced in a particular year is positively associated with the price of the previous year. To test this hypothesis, four years data of quantity produced and prices were taken into account. As indicated in Table 6, quantity of noug produced was also positively related with the price of noug.

In general, the results of correlation analysis indicate that quantity of noug produced and sold is positively related with price. This implies that either increases or decreases of price leads to increases or decreases of quantity produced and sold.

**The Contribution of Noug to Livestock Production**

Noug has a role to play in livestock production as important source of feed. Noug chaff is one of the crop residues fed to livestock in mixture with rough pea straw.
Frost
Farmers reported frost problem in low-lying depressed areas. Agronomic studies should be conducted to adjust planting dates as one of the remedies to alleviate the problem. Developing frost tolerant varieties should also be taken into consideration by breeders.

Water logging
When prolonged rainfall occurs particularly on black and mixed soils, there may be water logging problem on noug fields. This may result in stunted growth of the crop. Farmers open furrows on the borders of fields to drain excess water. However, this may not adequately help if the problem is on a large area of fields. Hence, appropriate water draining technologies should be sorted out. The breeders should also consider the problem and develop water logging tolerant varieties.

Conclusions and Recommendations

Noug is an important cash crop in the study areas. It is one of the exportable oilseeds and contributes in fetching foreign currency to the country. However, its contribution to the national economy was limited due to its low production and productivity. Low productivity was attributed to the use of traditional production technologies. Previous research efforts have generated and released improved varieties and associated packages since mid seventies. As confirmed through on-farm evaluation the performance of the improved varieties was not encouraging. This suggests that more research work has to be conducted on this crop taking into consideration farmers' circumstances, priorities and needs. Especially, the participation of farmers in problem identification, planning, implementation and evaluation of the technology generation process is not only important but makes the process demand driven and client oriented.

Price was observed to be the most important factor related with noug production. Reasonable price is an incentive for producers and encourages them to use more input and produce more. Hence, the policy intervention, such as adequate transportation and communication facilities to rural markets, is required to create enabling environment for the price to be reasonable.

In general, much emphasis needs to be taken to improve the contribution of noug to the household and national economy. Relevant stakeholders should join hands and work closely to address the constraints from different directions and, improve the production and productivity of noug.

References


Gender Analysis in Bean Production in Bosset Area

Dawit Alemu and Yeshi Chiche

Introduction

There is a growing recognition of gender-differentiated interaction among welfare, efficiency and the success of technology transfers. A number of studies have documented the existence of productivity differences between female and male-headed households (Udry et al., 1995; Quisumbing, 1996; Sahn and Haddad, 1991). Other studies have shown gender difference in the adoption of improved technologies (Addis et al., 2000; Mwangi et al., 2000). These findings have showed the need to creating gender-disaggregated framework for targeting policy and interventions.

Most of these studies have focused on households based on the gender of the household head and implicitly viewed the household as having only one set of preference (unitary model of household). This assumption has been a powerful tool for understanding household behavior, such as the distribution of tasks. Moving further, Alderman et al. (1995) argue that more effective policy instruments can emerge from analyzing the processes by which households balance the diverse interests of their members (collective model).

This study looks at the gender differentials in bean production among household types that are categorized based on the gender of the household head, type of family (monogamy or polygamy) and land ownership. In addition, it attempts to look at the involvement of household members in the production and decision-making processes. It assists in understanding the task of specialization within the household and identifying the division of labor by gender. The objectives of this study were to assess the gender differentials in bean production among household types that are categorized based on the gender of household head, type of family (monogamy or polygamy) and land ownership.

Methodology

The Study Area

The study was conducted in Bosset wereda, which is the major bean growing area in the central rift valley of Ethiopia. The area is semi-arid with rainfall ranging between 600 and 800 mm per year and altitude between 1500 and 1880 m. The major crops grown are maize, tef, haricot bean and sorghum. In the eastern Shewa Zone where Bosset is located, 6.45% of the cropland was allocated for haricot bean in 1998/99 cropping season as compared to a 1.6% of national average (CSA, 1999). The cropland allocated for maize was 30% and similarly for tef 30%.

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1 Nazareth Agricultural Research Center P.O.Box 436, Nazareth: narc@telecom.net.et
2 Wereda is the third level administrative unit under regional state in Ethiopia
3 Tef (Eragrostis tef) is the major cereal crop in Ethiopia
**Sampling Procedure**

A multi-stage sampling was used to select farmers. First, based on the level of haricot bean production Boffa wereda was purposively selected. Four peasant associations in Boffa, namely Ararso-Bero, Sara-Areda, Kechachule-Guji, and Dire-Degaga, were selected. About 52% of the total production of the wereda was from this area in the 1999-cropping season. Households in each PA were categorized based on the following household types:

- Male headed with one wife (MHoW)
- Male headed with more than one wife (MHmW)
- Female headed (FH)
- Male headed Landless households (ML)

The list prepared for the purpose of land tax collection was used for male and female-headed household’s selection. For landless households, the list was prepared using key informants and development agents (DAs) of the Bureau of Agriculture. Key informants and DAs have also identified male headed with more than one-wife households from the list. From each PA, 10 households for each household type were randomly selected, making the total sample size of 160 households. Well-trained enumerators using structured questionnaire under strict supervision of the researcher collected the data.

**Analytical Framework**

Descriptive approach is employed to compare the socio-economic characteristics and gender differentials among household types. The productivity difference is assessed using a simple multiple-regression model represented as follows:

\[
Y = \alpha + \beta_{\text{Area}} X_{\text{Area}} + \beta_{\text{Age}} X_{\text{Age}} + \beta_{\text{Ox}} X_{\text{Ox}} + \beta_{\text{Off-farm}} X_{\text{Off-farm}} + \\
+ \beta_{\text{MHmW}} X_{\text{MHmW}} + \beta_{\text{FH}} X_{\text{FH}} + \beta_{\text{ML}} X_{\text{ML}} + \varepsilon
\]

Where:
- \( Y \) = Yield in quintals 4 per hectare,
- \( X_{\text{Area}} \) = Area size allocated for haricot bean in hectare,
- \( X_{\text{Age}} \) = Age of the household head (in years),
- \( X_{\text{Ox}} \) = 1 if the household owns ox or oxen, 0 otherwise,
- \( X_{\text{Off-farm}} \) = 1 if the household has off farm activity, 0 otherwise,
- \( X_{\text{MHmW}} \) = 1 if MHoW, 0 otherwise
- \( X_{\text{FH}} \) = 1 if FH, 0 otherwise
- \( X_{\text{ML}} \) = 1 if ML, 0 otherwise
- \( \alpha \) = Constant to be estimated
- \( \beta_i \) = parameters to be estimated
- \( \varepsilon \) = Disturbance term with \( \varepsilon \sim \text{IID} \)

This relation, of course, is not a production function that can map inputs to outputs and thus is determined by biology and technical efficiency with which inputs are used.

\* Quintal is equivalent to 100 kilograms
Instead, it is a reduced form, which provides a test of the efficiency of the allocation of inputs. The following assumptions were hypothesized:

- The size of the area allocated to haricot bean will either affect positively or negatively yield level.
- Ox ownership will have a positive effect on yield level of haricot bean because farmers who own oxen can undertake their farm activities timely as compared to those who do not own.
- Age of the household head will have a positive effect on yield as experience in production is positively correlated with age.
- There will be yield difference among household types as they have different resource endowments and use pattern, and production constraints.

**Socio-Economic Characteristics**

In the study area, 78.28% of households were found to be male headed with one wife, 2.4% male headed with more than one wife, 7.68% female headed and 11.66% landless households. The sampled households have become female headed either due to divorce or are widows. Landless households are those, which do not own their own land, and all the sampled landless households were found to be male headed and are not registered as members of the peasant associations (PAs).

**Household Characteristics**

Household heads are characterized in terms of age, religion, level of education and off-farm income as presented in Table 1. The average age of female and male head households is similar, about 50 years, whereas, landless household heads are 29 years old on average. About 95% of the households belong to Christian religion and the remaining to Islam. All household heads with more than one wife are illiterate. About 98 and 75% of the female household heads and landless household heads are illiterate respectively.

Farmers’ involvement in generating off-farm income varies among household types. Thirty five per cent of male headed with one wife, 7.5% of male headed with more than one wife, and 25% of female headed, and 20% of landless households have off-farm income. The type of activities for generating off-farm income varies. The major source of off-farm income for the male headed with on wife households is firewood selling and for female-headed households local alcohol selling (Table 1). Male headed households with more than one wife have the highest family size (9.45 persons), followed by male headed households with one wife (6.25 persons) (Table 2). Female-headed households have the smallest family size (3.49 persons). The test for mean family size differences shows that there is statistically significant difference in size among household types except between female-headed and landless households.
Table 1. Household head characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>MHoW</th>
<th>MHmW</th>
<th>FM</th>
<th>ML</th>
<th>Total sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of household head(years)</td>
<td>49.35 (11.90)</td>
<td>50.90 (10.37)</td>
<td>51.20 (13.54)</td>
<td>28.57 (4.86)</td>
<td>45.01 (14.25)</td>
</tr>
<tr>
<td>Religion (in %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Islam</td>
<td>5.00</td>
<td>5.00</td>
<td>2.50</td>
<td>7.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Christian</td>
<td>95.00</td>
<td>95.00</td>
<td>97.50</td>
<td>92.50</td>
<td>95.00</td>
</tr>
<tr>
<td>Education (in %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>90.00</td>
<td>100.00</td>
<td>97.50</td>
<td>75.00</td>
<td>90.06</td>
</tr>
<tr>
<td>Off-farm income (in %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of farmers with off-farm income</td>
<td>35.00</td>
<td>7.50</td>
<td>20.00</td>
<td>20.00</td>
<td>21.88</td>
</tr>
<tr>
<td>Types of off-farm activities (% of farmers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laborer</td>
<td>10.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.50</td>
</tr>
<tr>
<td>Trading</td>
<td>5.00</td>
<td>-</td>
<td>5.00</td>
<td>10.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Firewood selling</td>
<td>17.50</td>
<td>5.00</td>
<td>2.50</td>
<td>7.50</td>
<td>8.23</td>
</tr>
<tr>
<td>Land leasing</td>
<td>2.50</td>
<td>2.50</td>
<td>-</td>
<td>-</td>
<td>1.25</td>
</tr>
<tr>
<td>Local alcohol seller</td>
<td>-</td>
<td>-</td>
<td>17.50</td>
<td>2.50</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Resource Ownership

Table 3 summarizes the difference among household types in resource ownership, i.e., type of house owned, number of oxen, and land size owned. In areas where there is erratic rainfall pattern, timely undertaking of all farm activities is very important. One of the limiting factors to undertake these activities on time is the availability of oxen. As shown in Table 3, there is a difference in number of oxen owned among household types. About 68% of female-headed households do not own oxen.

Type of house owned can be seen as indicators of household wealth in that iron roofed house owners are richer than grass roofed house owners. Male headed with one wife and landless households are the one who live in grass-roofed houses, whereas, about 13% of male-headed households with more than one wife and female headed households live in iron sheet-roofed houses.

Table 2. Average labor availability per household

<table>
<thead>
<tr>
<th>Household members</th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
<th>ML</th>
<th>Sample mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households size</td>
<td>6.25 (2.05)</td>
<td>9.45 (3.19)</td>
<td>3.98 (1.73)</td>
<td>4.18 (1.34)</td>
<td>5.96 (3.10)</td>
</tr>
<tr>
<td>Male adult</td>
<td>1.93 (1.00)</td>
<td>1.83 (1.03)</td>
<td>1.00 (0.88)</td>
<td>1.10 (0.30)</td>
<td>1.46 (0.94)</td>
</tr>
<tr>
<td>Female adult</td>
<td>1.45 (1.01)</td>
<td>2.63 (1.23)</td>
<td>1.15 (0.48)</td>
<td>1.03 (0.16)</td>
<td>1.56 (1.04)</td>
</tr>
<tr>
<td>Children</td>
<td>2.88 (1.45)</td>
<td>5.00 (2.45)</td>
<td>1.83 (1.60)</td>
<td>2.05 (1.15)</td>
<td>2.94 (2.13)</td>
</tr>
<tr>
<td>Pair wise test for average household size differences between household types²</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHoW</td>
<td>-</td>
<td>5.334 (0.01)*</td>
<td>5.365 (0.01)*</td>
<td>5.365 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>MHmW</td>
<td>5.334 (0.01)*</td>
<td>-</td>
<td>9.530 (0.01)*</td>
<td>9.634 (0.01)*</td>
<td></td>
</tr>
<tr>
<td>FH</td>
<td>5.365 (0.01)*</td>
<td>9.530 (0.01)*</td>
<td>-</td>
<td>0.578 (0.10)</td>
<td></td>
</tr>
</tbody>
</table>

Note: in parentheses are standard deviations;
1 - Entries are mean values and in parenthesis are standard deviations
2 - Computed t-values and in parentheses are significance levels.
* shows statistically significant difference

The average farm size ranges from 1.33 ha for female headed to 2.52 ha for male-headed households with more than one wife households do. Statistically significant difference in farm size is observed between male headed and female-headed
households. The Female headed households have smaller farm size, 1.33 ha of land, as compared to other types of households.

**Gender Differentials in Haricot Bean Production**

In this section, the gender differentials are analyzed in terms of the importance of bean growing, cropland allocation, variety preference, family members' involvement in agronomic practices, and productivity difference among household types.

### Table 3. Resource ownership

<table>
<thead>
<tr>
<th>Oxen ownership (in % of households)</th>
<th>Household type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number owned of oxen</td>
<td>Sample mean</td>
</tr>
<tr>
<td>0</td>
<td>MHoW</td>
</tr>
<tr>
<td>0</td>
<td>50.00</td>
</tr>
<tr>
<td>1</td>
<td>22.50</td>
</tr>
<tr>
<td>2</td>
<td>20.00</td>
</tr>
<tr>
<td>&gt;2</td>
<td>7.50</td>
</tr>
<tr>
<td>Type of house owned (in % of households)</td>
<td></td>
</tr>
<tr>
<td>Grass roofed</td>
<td>100.00</td>
</tr>
<tr>
<td>Iron roofed</td>
<td>0.00</td>
</tr>
<tr>
<td>Land ownership1 (in ha)</td>
<td>2.05 (1.07)</td>
</tr>
</tbody>
</table>

**Pair wise test for mean farm size difference between household types**

<table>
<thead>
<tr>
<th></th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
<th>ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHoW</td>
<td>-</td>
<td>1.7417 (0.05)</td>
<td>3.4581 (0.01)*</td>
<td>1.7015 (0.05)</td>
</tr>
<tr>
<td>MHmW</td>
<td>-</td>
<td>-</td>
<td>4.8718 (0.01)*</td>
<td>3.2785 (0.01)*</td>
</tr>
<tr>
<td>FH</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.6545 (0.1)</td>
</tr>
</tbody>
</table>

*Note: * indicates statistically significant difference at significance level given in parenthesis. Entries are t-values.

1- size of land under cultivation

### Importance of Growing Haricot Bean

As is presented in Table 4, the percentage of haricot bean growers are higher for male-headed households as compared to the female-headed households and it ranges from 57.5% of female-headed to 85% of male headed with more than one wife households. The main reason for producing haricot bean is to sell in the market for better price and to a lesser extent for home consumption. This shows that in the study area beans are considered as cash crop. All female-headed households responded that they grow haricot beans because of its better price as compared to other crops. The male-headed household with one wife responded that beans are important for home consumption and can be sold for better price (Table 4).

### Table 4. Haricot bean growers and their reasoning (in percentage of haricot bean growing households)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Household type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MHoW</td>
</tr>
<tr>
<td>Growers</td>
<td>75.00</td>
</tr>
<tr>
<td>Beans are important for home consumption</td>
<td>90.00</td>
</tr>
<tr>
<td>Beans can be sold for better price</td>
<td>96.00</td>
</tr>
<tr>
<td>Beans do not require much labor</td>
<td>6.67</td>
</tr>
</tbody>
</table>
Land Allocation

The size and proportion of cropland allocated for haricot beans is presented in Table 5. The proportion of total cropland allocated to haricot bean ranges from 30 to 40%. This shows that haricot bean is a major crop in the area in line with tef, maize and sorghum. There is statistically significant difference in mean land size allocated for haricot bean among household types. The male-headed households with more than one wife allocate larger cropland for haricot beans (0.74 ha) as compared to the other household types. The statistical tests for mean difference in the proportion of cropland allocated for haricot bean also show that there is a difference among household types. In this case, female-headed followed by landless households allocate higher proportion of their cropland to haricot bean as compared to other households.

Variety Preference

In the study area, the decision for haricot bean variety to plant is heavily influenced by the local market demand. Almost all interviewed farmers (95.75%) responded that they prefer to plant the variety called Mexican 142, locally called “Lemat” due to the higher price at the local market attributed by its white color. Only 4.25% of the farmers grow local varieties.

There are two major sources of seed for haricot bean. One is own stock and the other purchase from local market. About 40% of male-headed households with one wife, 70.58% of male-headed households with more than one wife, 30.43% of female headed and 58.06% of landless households retain their own seed from own production. The rest bought from the local market at time of planting at higher price and commonly of low quality seed.

Table 5. Cropland allocation for haricot bean in Boffa area in 1998/99-crop season (percentage of respondents)

<table>
<thead>
<tr>
<th>Household type</th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
<th>ML</th>
<th>Total sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growers (in % of households)</td>
<td>75.00</td>
<td>85.00</td>
<td>57.50</td>
<td>77.50</td>
<td>73.75</td>
</tr>
<tr>
<td>Mean area allocated for haricot beans (ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 0.25 ha</td>
<td>16.67</td>
<td>23.53</td>
<td>26.08</td>
<td>25.80</td>
<td>22.88</td>
</tr>
<tr>
<td>0.25 &lt; x ≤ 0.5 ha</td>
<td>46.66</td>
<td>26.47</td>
<td>39.14</td>
<td>29.03</td>
<td>34.75</td>
</tr>
<tr>
<td>0.5 &lt; x ≤ 1 ha</td>
<td>36.67</td>
<td>32.35</td>
<td>34.78</td>
<td>29.03</td>
<td>19.49</td>
</tr>
<tr>
<td>&gt; 1 ha</td>
<td>-</td>
<td>17.65</td>
<td>-</td>
<td>16.14</td>
<td>5.85</td>
</tr>
<tr>
<td>Average size in ha (SD)</td>
<td>0.57(0.21)</td>
<td>0.74(0.48)</td>
<td>0.54</td>
<td>0.69</td>
<td>0.64</td>
</tr>
<tr>
<td>Average share of cropland (SD)</td>
<td>0.33</td>
<td>0.30</td>
<td>0.40</td>
<td>0.39</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Pair wise tests for mean difference in land allocation for Haricot bean

<table>
<thead>
<tr>
<th></th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHoW</td>
<td>1.8903* (0.5281)</td>
<td>0.4351 (1.3926)</td>
<td>1.2941 (1.3904)</td>
</tr>
<tr>
<td>MHmW</td>
<td>-</td>
<td>1.9124* (2.2147)**</td>
<td>0.4707 (2.3127)**</td>
</tr>
<tr>
<td>FH</td>
<td>-</td>
<td>-</td>
<td>1.3868 (0.2143)</td>
</tr>
</tbody>
</table>

- entries are t-values for mean difference test in land size allocated for haricot bean
* entries are t-values for mean difference test in cropland proportion allocated for haricot bean
** Statistically significant difference at 0.05 level of significance and * at 0.1
With respect to consumption preference, majority of the farmers consume beans bought from warehouses locally called "megazene" that are of low quality and mixed in color. This is due to the price that they can buy more in terms of quantity for home consumption by selling small amount of their own quality beans. The price of "megazene" ranges from 50 to 62 birr/quintal.

Gender Differentials in Agronomic Practices
Yeshi (1997) has identified in Nazareth area that there is specialization among household members to undertake farm activities with men handling ploughing, planting and applying fertilizer, while women handle domestic activities like fetching water, collecting firewood and childcare. To compare family members' involvement among household types in different agronomic practices, family members were grouped into adult male, adult female, children and their combination. A person with an age of 15 years or greater is considered as an adult. Chi-square tests were then performed to see whether there is a difference in the involvement of family member groups in each agronomic practice among household types. The test results show that there is a significant difference in the involvement of family member groups in each agronomic activity among household types.

Seed sorting
The majority (more than 50%) of bean-growing households, except landless, do not clean and sort haricot bean seeds. This implies that seed sorting is not a major activity. The involvement of households in the activity is 45, 23, 13 and 12% for male-headed landless households, male-headed households with one wife, and female-headed and male-headed household with more than one wife, respectively. Across households, adult females do seed sorting.

Plowing
In most of the households (over 52%), adult male family members do plowing. Children are also involved in male-headed households. In 38% of male-headed household with one wife and male-headed households with more than one wife, children are involved in plowing with adult male family members. The majority of landless households (61%) and 35% of the female-headed households do not undertake second plowing. Plowing is done by either adult male family members in male headed or by non-family labor (hired or relative) in female-headed households. 22% of female-headed households practice sharecropping (commonly 50% share) and about 13% of them get labor from relatives without payment.

Sowing
Adult male members of the households do this activity. In about 35% of the female-headed households, sowing is done by non-family labor.

Fertilizing
Majority of the households do not fertilize their haricot bean fields. Seventy six percent of male-headed households with one and more than one wives, 91% of female-headed and about 58% of the landless households do not fertilize their haricot

5 meaning warehouse in local language but here it refers a mixed and low quality haricot bean coming out from warehouse after cleaning and grading
6 This is an arrangement where the landowner gets commonly half of the production for providing the land for cultivation to other farmer. The farmer who takes usually covers all the production costs.
bean fields. This shows that haricot bean is not fertilized. In those households where beans are fertilized, the activity is conducted dominantly by adult male family members and in few cases by both adult female and male members.

**Weeding**
Except for female-headed households, haricot bean fields are commonly weeded. In majority of male-headed households (73.9%) all family members and in landless households both adult female and male members of the family participate in weeding haricot bean.

**Harvesting**
All family members participate in bean harvesting except in female-headed households where adult female and male family members and non-family labor undertake the activity. All family members participate in harvesting beans in about 47% of male headed with one wife and 65% of male-headed households with more than one-wife. In about 84% of the landless households, both adult female and male members of the family do harvesting. In about 35% of the female-headed households, the activity is undertaken by non-family labor. This is because in about 35% of female-headed households the labor source for bean production comes from production share arrangement for labor and oxen service and from unpaid relatives’ labor.

**Transporting**
All family members in all types of households participate in transporting harvested beans for threshing except in landless households where adult female and male members of the households take the responsibility. In female-headed households, non-family labor participates in this activity as in other activities.

**Piling**
Piling is an activity dominantly done by adult male members in all household types. Hired labor is involved in about 22% of the female-headed households to undertake the activity.

**Threshing and Winnowing**
There is a significant variation among households even with in each household type in the participation of household members in harvesting. All household members dominantly undertake the activity in male head households. In female-headed and landless households, adult female and male members of the households usually take the responsibility of heading the family. Adult males in all household types dominantly do winnowing. Children in male-headed households participate in the activity with adults.

**Storing**
Adult family members with more participation of male adults do the storing. The activity is not undertaken by about 3% of male-headed households with one wife and by about 6% of male-headed households with more than one wives.

**Productivity Difference**
The average yield achieved in the area was 4.5 q/ha with considerable variability in yield even with in each household type (Table 6). The values of the coefficient of
variation ranges from 125% for female-headed households to 52% for male-headed households with more than one wives. The yield level achieved in the area is far below the level achieved in the Zone and even at the national level. The reason for the low level of yield in the area and the considerable yield variation even within each household type needs further investigation.

Table 6. Average yield of haricot bean by household type

<table>
<thead>
<tr>
<th>Household type</th>
<th>Average yield (in quintals/ hectare)</th>
<th>Coefficient of variation (CV in %)</th>
<th>Average yield, all households(CV)</th>
<th>National average yield (quintals/ ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHoW</td>
<td>3.50</td>
<td>104.05</td>
<td>4.5 (70.55)</td>
<td>7.92</td>
</tr>
<tr>
<td>MHmW</td>
<td>4.20</td>
<td>52.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FH</td>
<td>3.40</td>
<td>124.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td>4.50</td>
<td>58.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Source: CSA 1999

The variables used to estimate the productivity difference are described in terms of their mean values and standard deviations (Table 7).

Table 7 Description of yield determinant variables in bean production

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield in quintals per hectare</td>
<td>3.8276</td>
<td>3.2187</td>
</tr>
<tr>
<td>Explanatory variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area allocated for haricot bean in hectare</td>
<td>0.6429</td>
<td>0.3871</td>
</tr>
<tr>
<td>Age of household head</td>
<td>44.7288</td>
<td>14.3828</td>
</tr>
<tr>
<td>Ox ownership dummy = 1 if own ox, 0 otherwise</td>
<td>0.5847</td>
<td>0.4948</td>
</tr>
<tr>
<td>Off farm income dummy = 1 if has off farm income, 0 otherwise</td>
<td>0.1864</td>
<td>0.3911</td>
</tr>
<tr>
<td>Household type dummy (MHoW is reference)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHmW = 1 if belongs to male headed household with more than one wife, 0 otherwise</td>
<td>0.2881</td>
<td>0.4548</td>
</tr>
<tr>
<td>FH = 1 if belongs to female headed household, 0 otherwise</td>
<td>0.1949</td>
<td>0.3948</td>
</tr>
<tr>
<td>ML = 1 if belongs to landless household, 0 otherwise</td>
<td>0.2627</td>
<td>0.4419</td>
</tr>
</tbody>
</table>

The data from bean growing households were fit to the model specified. The regression estimates are presented in Table 8 and 9. The multicollinearity issue was checked earlier following the rule that it is regarded as a problem only if the $R_y^2$ is less than $R_f^2$, where $R_y^2$ = the dependent variable’s multiple correlation with the whole set of explanatory variables and $R_f^2$ = the multiple correlation of $X_i$ with other members of the independent variables set (Maddala 1977). The restriction of the constant term in the model was due to its collinearity with other explanatory variables.

The regression estimates show that plot size allocated for beans, ox ownership, off farm activity and the dummy variable for landless households are statistically significant (Table 8). The plot size allocated for haricot bean, off farm activity, and ox ownership has a positive effect on the yield achieved per unit area. Households who allocated larger plot for haricot bean production achieved higher yield per unit area. Farmers who own an ox or oxen achieved higher yield per unit area as compared to those without oxen. This is in line with farmers’ assessment of major production constraint such as lack of oxen.

Farmers involved in off farm activities achieved higher yield as compared to those who do not have. This can be justified by the higher ability of those who have off farm income to purchase inputs. There is no statistically significant productivity difference among male-headed households with one wife, male-headed household with more
than one wife and female-headed households. Landless households achieved higher productivity as compared to the others.

The higher productivity achieved by landless households has an implication to the existing land ownership policy. Under the existing policy, land cannot be sold or exchanged, which is limiting its transfer to efficient producers. In addition, it causes a further reduction of farm size, as the only way of acquiring land remains inheritance from parents. The fragmentation of farms will have a negative impact on productivity as plot size has a positive effect on productivity.

### Table 8. Determinants of yield in bean production

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
</tr>
<tr>
<td>Area allocated for bean (in hectare)</td>
<td>1.5873**</td>
</tr>
<tr>
<td>Age of the household head</td>
<td>0.0148</td>
</tr>
<tr>
<td>Ox ownership</td>
<td>1.3833**</td>
</tr>
<tr>
<td>Off farm income</td>
<td>1.8595**</td>
</tr>
<tr>
<td>Household type dummies:</td>
<td></td>
</tr>
<tr>
<td>If MHoW</td>
<td>1.0575</td>
</tr>
<tr>
<td>If FH</td>
<td>0.9576</td>
</tr>
<tr>
<td>If ML</td>
<td>1.5541**</td>
</tr>
<tr>
<td>( R^2 )</td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson statistic</td>
<td></td>
</tr>
<tr>
<td>Sample size (n)</td>
<td></td>
</tr>
</tbody>
</table>

1. MHoW is the reference for the household dummies

\* - Significant at \( \alpha \leq 0.10 \)

\* - Significant at \( \alpha \leq 0.05 \)

\* - Significant at \( \alpha \leq 0.01 \)

\( R^2 \) - Coefficient of determination adjusted for degrees of freedom

### Markets

All household types sell their beans in local market. This is because the farmers are aware of the transportation cost that is similar to the price difference between the local and the nearby town markets. Household heads sell beans in the majority of the household types except in the landless households where selling is done by both female and male adult members of the family. Few households do not sell beans. The chi-square test shows that there is a significant difference in the involvement of family members among household types in selling beans (Table 9). Almost all the sampled farmers responded that they sell beans either immediately after harvest mainly to generate cash to purchase food items or for loan settlement. Only few responded to sell their haricot bean immediately after harvest to avoid storage loss.

### Table 9. Involvement of family and non-family member groups in selling beans

<table>
<thead>
<tr>
<th>Household type</th>
<th>MHoW % (n)</th>
<th>MHmW % (n)</th>
<th>FH % (n)</th>
<th>ML % (n)</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult male</td>
<td>70.00 (21)</td>
<td>61.74 (21)</td>
<td>4.35 (1)</td>
<td>29.03 (9)</td>
<td></td>
</tr>
<tr>
<td>Adult female</td>
<td>3.33 (1)</td>
<td>2.94 (1)</td>
<td>91.30 (21)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Adult female and male</td>
<td>20.00 (5)</td>
<td>20.59 (7)</td>
<td>-</td>
<td>64.52 (20)</td>
<td>122.10**</td>
</tr>
<tr>
<td>Adult female and children</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Adult male and children</td>
<td>-</td>
<td>5.89 (2)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>All family members</td>
<td>3.33 (1)</td>
<td>2.94 (1)</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Do not undertake the activity</td>
<td>3.34 (1)</td>
<td>5.89 (2)</td>
<td>4.35 (1)</td>
<td>6.45 (2)</td>
<td></td>
</tr>
</tbody>
</table>
Gender analysis in bean production

Selling Price Variations
Since almost all farmers sell beans, immediately after harvest it was not possible to assess price variations over time. Nevertheless, it is found from a 3-month data that there is price difference among household types. Female-headed households sell at higher price as compared to other household types (Table 10). Statistical tests for mean price difference between household type show that there is a significant price difference between households except between male headed households with one wife and male headed households with more than one wife and between male headed households with more than one wife and female headed households. The 3-month average sale price ranged from 163.26 for landless households to 180.00 birr/quintal for female-headed households. The reason why female headed households sell at better price is that females sell in a retail manner, whereas, males sell in bulk. In addition, females have higher bargaining ability and are capable of predicting the price variation even within a single market day.

Table 10. Difference in haricot bean price among household types

<table>
<thead>
<tr>
<th>Household type</th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
<th>ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of sale</td>
<td>X</td>
<td>SD</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>October</td>
<td>166.00</td>
<td>18.97</td>
<td>166.43</td>
<td>22.12</td>
</tr>
<tr>
<td>November</td>
<td>175.83</td>
<td>14.43</td>
<td>175.24</td>
<td>15.29</td>
</tr>
<tr>
<td>December</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total average</td>
<td>171.36</td>
<td>16.99</td>
<td>173.04</td>
<td>17.23</td>
</tr>
</tbody>
</table>

Tests for average haricot bean price difference between household types
(Ho: mean difference = 0)

<table>
<thead>
<tr>
<th></th>
<th>MHoW</th>
<th>MHmW</th>
<th>FH</th>
<th>ML</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHmW</td>
<td>0.3427</td>
<td>1.8838 *</td>
<td>1.7894 *</td>
<td></td>
</tr>
<tr>
<td>FH</td>
<td>-</td>
<td>1.5615 **</td>
<td>2.2106 ***</td>
<td></td>
</tr>
</tbody>
</table>

Statistically significant mean difference * at $\alpha = 0.1$, ** at $\alpha = 0.05$ and *** at $\alpha = 0.01$

$\bar{X}$ - Average price in ETB/quintal, SD – standard deviations

Decision-Making
All decisions in haricot bean production are made by the household head (HHD) either alone or by HHD consulting with his wife or wives (Table 11). In the majority of male headed households with one wife (over 51%) decisions are made by HHD in consultation with his wife, whereas, in male headed households with more than one wife decisions are dominantly done by the HHD. In female-headed households, decisions are made by the HHD, except few cases where either adult family members or relatives are consulted. In households where production is undertaken using output share arrangement, decisions are de facto made through negotiation even though the household head de jure claims that decisions are made by her/him. This type of production arrangement is common in female-headed households. In landless households, decisions are dominantly made by HHD in consultation with his wife.
Table 11. Decision-making among household types in bean production (percentage of households)

<table>
<thead>
<tr>
<th>Decisions</th>
<th>Household type</th>
<th>HHD</th>
<th>HHD Wife</th>
<th>HHD</th>
<th>HHD Wife</th>
<th>HHD</th>
<th>Both*</th>
<th>HHD</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which variety to plant</td>
<td>MHoW</td>
<td>46.15</td>
<td>53.85</td>
<td>78.38</td>
<td>21.62</td>
<td>92.50</td>
<td>7.50</td>
<td>44.74</td>
<td>55.26</td>
</tr>
<tr>
<td>Accepting a new variety</td>
<td>MHoW</td>
<td>46.15</td>
<td>53.85</td>
<td>81.08</td>
<td>18.92</td>
<td>92.50</td>
<td>7.50</td>
<td>44.74</td>
<td>55.26</td>
</tr>
<tr>
<td>How much to plant</td>
<td>MHoW</td>
<td>48.72</td>
<td>51.28</td>
<td>83.78</td>
<td>16.22</td>
<td>92.50</td>
<td>7.50</td>
<td>47.37</td>
<td>52.63</td>
</tr>
<tr>
<td>Which plot to use for each crop</td>
<td>MHoW</td>
<td>48.72</td>
<td>51.28</td>
<td>83.78</td>
<td>16.22</td>
<td>92.50</td>
<td>7.50</td>
<td>47.37</td>
<td>52.63</td>
</tr>
<tr>
<td>Whether to use fertilizer</td>
<td>MHoW</td>
<td>41.03</td>
<td>58.97</td>
<td>70.27</td>
<td>29.73</td>
<td>92.50</td>
<td>7.50</td>
<td>44.74</td>
<td>55.26</td>
</tr>
<tr>
<td>When to sell</td>
<td>MHoW</td>
<td>28.21</td>
<td>71.79</td>
<td>56.76</td>
<td>43.24</td>
<td>92.50</td>
<td>7.50</td>
<td>28.95</td>
<td>71.05</td>
</tr>
<tr>
<td>How much to sell</td>
<td>MHoW</td>
<td>28.21</td>
<td>71.79</td>
<td>56.76</td>
<td>43.24</td>
<td>92.50</td>
<td>7.50</td>
<td>28.95</td>
<td>71.05</td>
</tr>
<tr>
<td>For what purpose to use income from sale</td>
<td>MHoW</td>
<td>28.21</td>
<td>71.79</td>
<td>59.46</td>
<td>40.54</td>
<td>92.50</td>
<td>7.50</td>
<td>34.21</td>
<td>65.79</td>
</tr>
</tbody>
</table>

Note: HHD indicates that decision is made household head only, “Both” indicates that both HHD and wife or wives make decision. * Indicates that HHD and adult family either members or relatives make decisions.

The implication of these findings is that in addressing the issue of transferring improved technologies efficiently one can see which family members in each household type should be first consulted and be convinced. In case of male headed with one wife and landless households both the HHD and the wife should be involved in any extension activity concerning haricot bean, whereas, in female headed and male headed with more than one wife households the HHD is the one who should be consulted.

Production Constraints

Farmers were given the list of production constraints and were asked to identify and prioritize them taking into consideration their own situation. The result is presented in Table 12. The result shows that for all household types the main production constraint is lack of oxen followed by lack of improved haricot bean seed. The second main constraint for male-headed households with one wife is lack of improved haricot bean seed as the highest percentage of the households ranked the constraint as second. Blank entries imply that the constraint under question was not identified as production constraint.

Labor shortage, disease and pest problem and price variability were not identified as constraint. Female headed and landless households have land shortage problem.

The erratic nature of rainfall in the area makes timely undertaking of agronomic practices more difficult. At the same time, when the rain falls there is also competitive demand for oxen service for land preparation and/or planting of almost all crops in the area. Therefore, those farmers without oxen will not be able to undertake farm activities timely that may result in total loss of crop harvest.

Due to the nature of subsistence farming and the fear from storage loss, majority of the farmers are obliged to buy seeds at higher price and/or low quality seeds during planting. The Ministry of Agriculture (MOA) through the woreda Bureau of Agriculture (WBOA) has tried to address this problem by providing improved bean
seed for selected farmers just for seed multiplication purpose. The intention was to buy the seed back from these farmers and sell to other farmers at fair price. The arrangement with these farmers was to keep the seed until planting and sell back to the WBOA at the price set immediately after harvest. The price arrangement and the cost incurred due to storage obviously caused disincentive for these farmers and the intended farmer-to-farmer seed distribution did not work.

Table 12. Production constraints ranked according to priority among household types

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Household type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MHoW</td>
</tr>
<tr>
<td>Lack of improved seed</td>
<td>2</td>
</tr>
<tr>
<td>Shortage of land</td>
<td>-</td>
</tr>
<tr>
<td>Shortage of oxen</td>
<td>1</td>
</tr>
<tr>
<td>Shortage of labor</td>
<td>-</td>
</tr>
<tr>
<td>Lack of fertilizer</td>
<td>4</td>
</tr>
<tr>
<td>Shortage of rainfall</td>
<td>3</td>
</tr>
<tr>
<td>Disease problem</td>
<td>-</td>
</tr>
<tr>
<td>Pest problem</td>
<td>-</td>
</tr>
<tr>
<td>Price variability</td>
<td>-</td>
</tr>
</tbody>
</table>

Conclusions and Recommendations

This study looked at the gender differentials in bean production among household types that are categorized based on the gender of the household head, type of family (monogamy or polygamy) and land ownership. In addition, it attempted to look at the involvement of household members in the production and decision making processes.

The data for the study were obtained through individual farmer interview using structured questionnaire. Descriptive and regression analysis was employed to analyze the data. The analysis shows that the percentage of haricot bean growers is higher for male-headed households as compared to the female-headed households and it ranges from 57.5 % of female-headed to 85 % of the male-headed households with more than one wife. The proportion of total cropland allocated to haricot bean ranges from 30 to 40%. This shows that haricot bean is a major crop in the area in line with tef, maize and sorghum. More than 90 % of the households in all household types responded that they grow beans because it can be sold for better price. This shows that in the study area beans are considered as cash crop.

In the study area the decision on which type of haricot bean variety to plant is heavily influenced by the local market demand. Almost all the interviewed farmers (95.75%) responded that they prefer to plant the variety called Mexican 142, locally called "Lemat" due to the higher price at the local market that is attributed by its white color.

The chi-square tests performed show there a significant difference in the involvement of family member groups in each agronomic activity among household types. This difference comes from the labor availability within each household type. In general, plowing, planting, piling and winnowing are activities undertaken by adult male family members. Whereas, weeding, all family members including children commonly do harvesting, transporting, threshing and storing. Adult female family members do only seed cleaning, even though only few households undertake the activity.
All household types sell their beans at local market, as the farmers are aware of the transportation cost that equalizes the price difference at the local and nearby town markets. Almost all the sampled farmers responded that they sell beans either immediately after harvest mainly to generate cash to purchase food items or for loan repayments. Only few responded sell immediately after harvest to avoid storage losses. It is found that there is price difference among household types at which haricot bean is sold beans. Female-headed households sell at higher price as compared to other household types (significant at $\alpha \leq 0.1$). The reason why female headed households sell for better price is that females sell in a retail manner, whereas, males sell in bulk. In addition, females have higher bargaining ability and are capable of predicting the price variation even within a single market day. The average sale price ranged from 163.26 for landless households to 180.00 birr/quintal for female-headed households.

All decisions from on which variety to plant to for which purpose to use income from haricot bean sale are made either by the household head (HHD) alone or in consultation with his wife or wives. In the majority of male headed households with one wife (>51%) decisions are made by HHD in consultation with his wife, whereas, in male headed households with more than one wife decisions are dominantly made by the HHD. In female-headed households, decisions are made by the HHD, except for few cases where either adult family members or relatives are consulted. This implies that in addressing the issue of transferring improved technologies efficiently one can see which family members in each household type should be first consulted and be convinced. In case of male headed households with one wife and landless households both the HHD and the wife should be involved in any extension activity concerning haricot bean, whereas, in female headed and male headed households with more than one wife households the HHD is the one who should be consulted.

The main production constraint in the area is identified to be lack of oxen followed by lack of improved haricot bean seed. Labor shortage, disease and pest problem and price variability were not identified as constraint. Female headed and landless households have land shortage problem, whereas; male-headed households with one or more wives do not have the problem.

The simple multiple regression analysis showed that there is a difference in productivity only between landless and other household types, with higher productivity achieved by landless households. The plot size allocated for haricot bean, off farm activity and ox ownership has a positive effect on yield. The higher productivity achieved by landless households has an implication to the existing land ownership policy. Under the existing policy, land is not for sale or exchange, which is limiting the transfer of land to efficient producers. In addition, it causes further reduction of farm size due to the population dynamics within a family, as the only way of acquiring land remains inheritance from parents. This fragmentation of farms will have again a negative impact on productivity as plot size has a positive effect on productivity.

Most studies on gender differentials are meant to generate information that can assist the formulation of more effective policy instruments to address the existing production problems. In this study, female-headed households are found to be the one with limited resource ownership (landholding and oxen) as compared to the male-headed households. There is no statistically significant productivity difference among female-headed, male-headed households with one wife and male-headed households with
more than one wife. Landless households achieved higher productivity as compared to the other household types.

Any extension activity regarding agronomic practices in bean production should consider household types, as there is a difference in the involvement of households’ members in undertaking different agronomic activities among household types. The significant positive effect of plot size on productivity and the higher productivity achieved by the landless households implies a need for further study on the current land ownership policy and its effect on productivity by incorporating all crops and livestock.

Lack of oxen is the major production constraint with significant positive effect on productivity, has to be addressed through better animal production practices especially through minimizing the death of animals during drought. The formal and informal credit systems should also be encouraged to alleviate the problem.

Even though many improved haricot bean varieties that are appropriate to the area were released, farmers plant dominantly Mexican 142. They also stated that other varieties are not available except the local ones. With this regard, rigorous effort should be made to provide farmers with choice of improved varieties. The MOA’s effort through the wereda Bureau of Agriculture to provide farmers with improved varieties should be strengthened and the pros and cons of the current seed dissemination strategy should be analyzed. A strategy that can provide sustainable economic incentive for seed multipliers should be designed.

References


Grass Pea Consumption and Lathyrysm in Ethiopia

Legesse Dadi¹, Hailemariam Teklewold², Aden Aw Hassan³, Aali Abdel Moniem³ and Geletu Bejiga¹

Introduction

Grass pea is one of the important legumes cultivated by small-scale farmers for human consumption. Grass pea grows in areas with adverse environmental conditions such as moisture stress, poor soil fertility and water logging (Asfaw, 2000 unpublished report Comment: not in the reference list; Response: It is unpublished and this was the reason for not including ref. list). Despite its nutritional value and good yield under adverse environmental conditions, it contains neurotoxin element, which causes health hazard if excess amount is consumed. The health risk of grass pea consumption is greatest when people face serious limitations on access to food and thus they consume grass pea for longer period. This poses problems regarding its production, processing, preparation and consumption. Over-consumption of grass pea (usually more than 30% of the diet) for a prolonged period, 3-4 months, causes a disease known as lathyrysm (Redda et al., 1994; Wuletaw et al., 1997). Lathyrysm is a crippling disorder resulting in an irreversible paralysis of both legs, particularly in young males. The neurotoxin element that causes lathyrysm has been identified as a water-soluble non-protein amino acid known as β-N-Oxalyl-β-diaminopropionic (β-ODAP) (Berhanu et al., 1997; Ghirma et al., 1997).

In the late 1980s in Ethiopia, some studies have been done to assess the production and consumption of grass pea and prevalence rates of lathyrysm. With the exception of few studies including nutritional and epidemiological surveys in the Dembia and Fogera districts (Redda et al., 1993), other studies based on secondary data and comprehensive studies on grass pea production, processing and consumption have not been conducted. At present, with the exception of research aimed at developing varieties with acceptable β-ODAP and yield, the research on grass pea and lathyrysm (chemistry, neurological, nutrition, epidemiology, processing etc.) is limited. Therefore, there exist information gaps regarding grass pea production, processing and consumption.

Recent developments in the incidences and distribution of lathyrysm have not received adequate attention. Moreover, the social and economic impact of lathyrysm on the victims, their households and community at large has received

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² Ethiopian Agricultural Research Organization, Debre Zeit Research Center, P.O Box 32, Debre Zeit, Ethiopia
³ ICARD, P.O Box, 5466, Aleppo Syria
little attention. Farmers' indigenous knowledge about grass pea toxicity and their related attitude towards its consumption have not been adequately assessed. Indigenous mitigation measures to minimize the risks of lathyrism hazards were not examined and evaluated.

Adequate information on the health risks of grass pea consumption as well as effective and feasible methods to reduce the toxic substance down to safe levels is crucial for increasing the benefits of grass pea production and reducing its health risks. In this regard, indigenous knowledge is very important in seeking solution to the problem. However, indigenous knowledge of communities about grass pea toxicity and their strategies to reduce it are not well known. This study, therefore, aims to document indigenous community knowledge and farmers' perceptions of toxic compound and their strategy to reduce it. The study also assesses distribution of lathyrism in the study areas.

**Methodology**

**Study Areas, Sampling and Interviews**

The study was conducted in Fogera wereda in South Gonder, Jama wereda in South Welo, Bichana wereda in East Gojam and Ada-Liben, Gimbichu and Akaki weredas in East Shewa Zones from March 2000 to July 2000. The study weredas were selected purposively based on status of grass pea production and their accessibility during dry season. From each selected weredas, two Peasant Associations (PAs) were randomly selected. Sample farmers were selected using a systematic random sampling technique. A sample size of 302 farmers, 100 farmers from each zone, were selected and interviewed.

Past studies have shown that lathyrism prevalence rate in Ethiopia ranges from 1 to 7 persons per 1000 persons. Given this information, the chance of selecting sufficient number of lathyrism patient would be slim if random sampling method is employed. Therefore, all lathyrism patients (88) mentioned by sample farmers have been listed and interviewed.

Initially a rapid rural appraisal method was used to assess grass pea production and consumption. A semi-structured interview of individuals and key informants, and focus group discussions were held to understand the different farming systems and identify target areas. This method was also used to identify household members to be interviewed with respect to different activities, and formulate targeted questionnaire for different gender groups.

The information was collected from both men and women. The formal interviews were planned and implemented in such a way that female enumerators administer the interviews to women and male enumerator to men. The data were collected using a standard questionnaire initially prepared in English and later on translated into local languages. The questionnaire was pre-tested and modified accordingly. Female and male enumerators were recruited from secondary school graduates. The researchers have trained enumerators on the purpose of the survey and techniques of interviewing. In addition to primary data, secondary data have been gathered from different sources.
Consumption

Grass pea is consumed in the forms of *Shiro-wot*, sauce made of spiced powder; *Kik-wot*, sauce made of dehulled split; *Nifro*, boiled grain; *Kollo*, roasted grain; and as *kitta*, bread made of grass pea mixed with other grains. Poor households also consume it as *kitta* during acute food shortage period. Among these forms, grass pea is widely consumed in the form of *shiro-wot* across the study areas.

There exists spatial variation in quantity and forms in which grass pea is consumed. In the study areas, per capita grass pea consumption is the highest in east Gojam zone followed by South Gonder. With the exception of *shiro wot*, there is variation in terms of forms in which grass pea is consumed. Consumption of grass pea as *nifro* and *kollo* is more prevalent in South Welo and South Gonder. Grass pea is more widely consumed by low-income groups in rural and urban areas. The low-income groups in rural areas commonly consume *kitta*, *kollo* and *nifro* made from grass pea alone, or its mixture with other crops.

In the study areas, and elsewhere in the country, grass pea is the least preferred legume for human consumption, compared to other legumes. Despite this, most households in rural areas and low-income urban dwellers consume grass pea at least in *shiro* form. As pointed out by many farmers, the preferred legumes are not produced in sufficient amount due to insects and disease problems and most households cannot afford buying the preferred legumes due to relatively higher prices. Grass pea is, however, the cheapest legume, which makes it to be widely consumption.

Farmers' Knowledge of Lathyrism

Cause of Lathyrism

Sample farmers, as well as patients, were asked about the relation between grass pea and lathyrism. Most of them know that lathyrism is caused by grass pea. All farmers in South Welo and most of them in South Gonder (97%) and in East Gojam (89%) know that grass pea contains a toxic compound, which affects human health. It is only in east Shewa zone where the majority (91%) of women reported that they are not aware about the effect of grass pea on human health.

Although many farmers know the effect of grass pea on human health, many of them (women who were interviewed) do not know whether the onset and severity of lathyrism had a direct relationship with the amount and length of period of grass pea consumption. The perceptions of the communities about the cause of lathyrism vary in different areas. Some of the local perceptions are:

- In Fogera wereda, farmers think that lathyrism is caused by exposure to vapor coming out during grass pea cooking. Stepping on ground exposed to water used for cooking grass pea is considered dangerous; and
- In South Welo, most of the farmers believe that consuming grass pea with milk and meat causes lathyrism.
Walking in grass pea field and exposure to vapor coming from wetted grass pea straw and sleeping on grass pea straw (using grass pea straw as bedding material) particularly when it gets wet is thought to be dangerous. Across the study, area farmers believe that consumption of grass pea in raw form with milk is considered more toxic and dangerous for health.

Farmers know the association of lathyrus and grass pea consumption. However, most of them consume grass pea because of economic reasons. Most households in rural areas are poor and cannot afford buying other preferred legumes. Therefore, they have no other option than consuming grass pea produced on their farm. Grass pea performs better than chickpea and lentils under adverse environmental conditions (i.e., moisture stress and diseases). Thus, consumption of grass pea was sustained due to its availability and relatively lower price compared to other legumes.

Farmers’ Strategies for Reducing the Toxic Effects of Grass Pea

Farmers apply the following strategies to reduce the toxic β-ODAP contents of grass pea, and thereby to minimize the health hazard that could occur when consumed.

Avoiding consumption
Some farmers wish to refrain from consuming grass pea. However, this is not a viable option for most of the households in view of widespread poverty in rural areas. Only 2-5% of the farmers, who can afford to purchase preferred legumes, refrained from consuming grass pea in any form.

Blending
Some farmers believe that blending grass pea with other legumes or cereals and limiting quantity of grass pea consumed reduces the health risk that could occur following excessive consumption of grass pea. Mixing is also done to have better taste (Table 1). Farmers mix grass pea with other legumes at an approximate one to one ratio, to reduce the toxic compound and consequently the health risk associated with grass pea consumption. Processing and preparation methods: Farmers apply different processing and preparation methods to reduce the β-ODAP content of grass pea and thereby to reduce the risks of lathyrism.
Table 1. Proportion of farmers who make shiro from grass pea alone and grass pea mixture with chickpea, faba bean and field pea by Zone

<table>
<thead>
<tr>
<th>Type of legume mixed with grass pea</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass pea alone</td>
<td>22.9</td>
<td>75.2</td>
<td>90.4</td>
<td>41.4</td>
<td>55.6</td>
</tr>
<tr>
<td>Other legumes</td>
<td>1.9</td>
<td>0</td>
<td>1.0</td>
<td>9.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Grass pea and Fababean mix</td>
<td>69.5</td>
<td>0</td>
<td>3.8</td>
<td>19.7</td>
<td>23.2</td>
</tr>
<tr>
<td>Grass pea and field pea mix</td>
<td>3.8</td>
<td>0</td>
<td>1.9</td>
<td>14.5</td>
<td>6.1</td>
</tr>
<tr>
<td>Grass pea and chickpea mix</td>
<td>1.9</td>
<td>24.8</td>
<td>2.9</td>
<td>14.5</td>
<td>11.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reason</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>East Shewa</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce toxicity</td>
<td>67.5</td>
<td>22.2</td>
<td>0</td>
<td>2.1</td>
<td>37.9</td>
</tr>
<tr>
<td>Better taste</td>
<td>23.8</td>
<td>77.8</td>
<td>100.0</td>
<td>55.3</td>
<td>45.3</td>
</tr>
<tr>
<td>Consume more of cheap legume</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27.7</td>
<td>8.1</td>
</tr>
</tbody>
</table>

The conventional processing methods are more rigorously applied in case of grass pea. Consumers frequently wash grass pea grain and splits to reduce its toxic compound and to make it safe for consumption. Substantial proportion of households who consume grass pea as kollo, nifro, kik and kita do soaking to reduce the toxic compound. Roasting and cooking (boiling) are also reported by few farmers as means of reducing toxic compound. Empirical findings confirmed that the β-ODAP in grass pea is volatile and water-soluble (Srivastav and Khokhar, 1996; Girma et al., 1997) and this indicates that treating with water and heat reduces the toxic content.

In South Welo, farmers perceive that the toxic compound in grass pea is volatile. Therefore, they thinly and evenly drop water by hand on lightly toasted grass pea grain to let the toxic compound evaporate in forms of vapor. In doing so, they do not expose themselves to vapor coming out of the toasted grain. In South Gonder, women tend to avoid exposure to vapors coming out of a pot at time of nifro cooking. In addition, after draining boiling water, they dispose drained water in a place where people would not step on.

Variety selection: Farmers wish to have varieties with zero or safe levels of β-ODAP, but there are no such varieties at present. Researchers are working to develop grass pea varieties with acceptable β-ODAP content. Some promising lines have already been identified and are being tested for their performance and level of β-ODAP under different environments. Yet the promising lines are not officially released and tested under different environments on farmers’ fields.

The development of grass pea varieties with acceptable levels of β-ODAP and yield would have positive impact in reducing costs of food processing and preparation by reducing the time of soaking and cooking. This would also reduce protein, vitamins and other nutrients loss due to rigorous processing usually done for reducing toxic effect of grass pea. In addition, this would also reduce the incidence of lathyrism and its economic and social costs.
Incidences and Distribution of Lathyrism

Spatial Distribution
Table 2 shows the prevalence rate of lathyrism in the peasant association randomly sampled from among PAs known for their production and consumption of grass pea. The highest prevalence rate of 8.7 persons per 1000 persons was observed at Shina, followed by 5.9 persons per 1000 persons at Sifatira. These two PAs are both found in Fogera wereda of South Gonder. At Shina, the prevalence rate of lathyrism is higher than what Redda et al. (1993) documented for the same locality. In the two remaining zones, the prevalence rates were 5.28 persons at Ejerti PA in Jama wereda of South Welo and 4.56 persons per 1000 persons at Yetenbina Weyna in Bichana wereda of east Gojam zone. In east Shewa the prevalence rate of lathyrism was zero.

Other studies on the distribution of lathyrism emphasized that lathyrism is a potential health hazard in grass pea producing areas of Ethiopia. As notes by Redda et al. (1994), lathyrism reached epidemic proportions in times of famines caused by drought. The distribution of lathyrism is widespread. The prevalence rates of lathyrism in east Gojam and west Gojam, Gonder and west Shewa were estimated at 0.9, 3.4, 4.7 and 2.3 persons per 1000 persons respectively (Brehanu, 1991). Getahun and Redda (1997) reported prevalence rates ranging from 0.6 to 2.9 persons per 1000 persons in the northern part of Ethiopia. In another study, Redda et al. (1994) documented the highest prevalence rate in Yilmana-Densa (7.5 persons/1000 persons), a wereda of west Gojam followed by Fogera (6.2 persons/1000 persons) and Dambia (6.2 persons/1000 persons), which are weredas of South Gonder and north Gonder, respectively. They associated the distribution or the occurrences of lathyrism in different parts of the country with the distribution of grass pea production.

Table 2. Grass pea production and prevalence rate of lathyrism

<table>
<thead>
<tr>
<th>Zone/wereda/PA</th>
<th>Area ('000 ha)</th>
<th>Production ('000 ton)</th>
<th>Prevalence (per 1000 persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Gonder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fogera wereda</td>
<td>4.20</td>
<td>3.710</td>
<td>8.70</td>
</tr>
<tr>
<td>Shina</td>
<td></td>
<td></td>
<td>5.90</td>
</tr>
<tr>
<td>Sifatira</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Welo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jama wereda</td>
<td>2.10</td>
<td></td>
<td>4.10</td>
</tr>
<tr>
<td>Yedo</td>
<td></td>
<td></td>
<td>5.28</td>
</tr>
<tr>
<td>Ejerti</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Gojam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bichana wereda</td>
<td>4.80</td>
<td>8.680</td>
<td>3.03</td>
</tr>
<tr>
<td>Felegeslam</td>
<td></td>
<td></td>
<td>4.56</td>
</tr>
<tr>
<td>Yetenbina weyna</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Shewa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ada wereda</td>
<td>0.60</td>
<td>0.670</td>
<td>0.00</td>
</tr>
<tr>
<td>Yerar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bechako</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Prevalence rates are estimated from survey data; Area and production figures are from respective zonal agricultural departments.
Grass pea consumption and lathyism

**Longitudinal Distribution**

Longitudinal analysis of occurrence of lathyism showed that the occurrence of the disease is distributed over the years, with the highest frequency of incidence reported in 1985. In 1984/85, there was shortage of food and famine due to severe drought and many people have died due to food shortage and famine. Our results are in agreement with past research findings. Since grass pea is drought tolerant crop, many people depend on it as their basic food during times of famine, and large quantities of grass pea are eaten when main crops are destroyed by drought (Redda et al., 1993). After the 1985 drought, the disease still sporadically occurred in the study areas and affected 3-6 persons per year from 1988 to 1997. In South Welo, the rate of occurrence of lathyism was high after the 1995 drought, the highest in 1997 (Table 3). Thus, the threat of lathyism on human health still exists.

<table>
<thead>
<tr>
<th>Year</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948 or before</td>
<td>6.6% 2</td>
<td>6.6% 2</td>
<td>0 0</td>
<td>4.8% 4</td>
</tr>
<tr>
<td>1949</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1950</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1960</td>
<td>0 0</td>
<td>0 0</td>
<td>4.5% 1</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1965</td>
<td>3.3% 1</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1966</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1970</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>4.5% 1</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1971</td>
<td>0 0</td>
<td>0 0</td>
<td>4.5% 1</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1972</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1973</td>
<td>0 0</td>
<td>9.7% 3</td>
<td>0 0</td>
<td>3.6% 3</td>
</tr>
<tr>
<td>1974</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1975</td>
<td>0 0</td>
<td>6.5% 2</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1976</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>4.5% 1</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1977</td>
<td>3.3% 1</td>
<td>0 0</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1978</td>
<td>0 0</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1980</td>
<td>0 0</td>
<td>0 0</td>
<td>13.8% 3</td>
<td>3.6% 3</td>
</tr>
<tr>
<td>1981</td>
<td>0 0</td>
<td>6.5% 2</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1982</td>
<td>3.3% 1</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1985</td>
<td>10.0% 3</td>
<td>16.1% 5</td>
<td>22.7% 5</td>
<td>15.7% 13</td>
</tr>
<tr>
<td>1986</td>
<td>3.3% 1</td>
<td>3.2% 1</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>1987</td>
<td>3.3% 1</td>
<td>0 0</td>
<td>0 0</td>
<td>1.2% 1</td>
</tr>
<tr>
<td>1988</td>
<td>6.7% 2</td>
<td>0 0</td>
<td>13.8% 3</td>
<td>6.0% 5</td>
</tr>
<tr>
<td>1990</td>
<td>6.7% 2</td>
<td>3.2% 1</td>
<td>9.1% 2</td>
<td>6.0% 5</td>
</tr>
<tr>
<td>1992</td>
<td>6.7% 2</td>
<td>3.2% 1</td>
<td>4.5% 1</td>
<td>4.8% 4</td>
</tr>
<tr>
<td>1993</td>
<td>6.7% 2</td>
<td>5.5% 2</td>
<td>0 0</td>
<td>4.8% 4</td>
</tr>
<tr>
<td>1994</td>
<td>10.0% 3</td>
<td>0 0</td>
<td>4.5% 1</td>
<td>4.8% 4</td>
</tr>
<tr>
<td>1995</td>
<td>0 0</td>
<td>6.5% 2</td>
<td>4.5% 1</td>
<td>3.6% 3</td>
</tr>
<tr>
<td>1996</td>
<td>10.0% 3</td>
<td>0 0</td>
<td>0 0</td>
<td>3.6% 3</td>
</tr>
<tr>
<td>1997</td>
<td>13.3% 4</td>
<td>0 0</td>
<td>9.1% 2</td>
<td>7.2% 6</td>
</tr>
<tr>
<td>1998</td>
<td>6.7% 2</td>
<td>0 0</td>
<td>0 0</td>
<td>2.4% 2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0% 30</td>
<td>100.0% 31</td>
<td>100.0% 22</td>
<td>100.0% 83</td>
</tr>
</tbody>
</table>
Distribution of Occurrences by Sex and Age
Out of 302 households interviewed in South Gonder, South Welo and east Gojam, 88 households were affected by lathyrism. This group was asked additional information about the age at onset of the disease and information on other social and economic indicators to assess the social and economic impact of lathyrism. Table 4 shows the sex of lathyrism patients and their age at the onset of the disease. The results from three zones indicate that the disease affected male more than female. The proportions of male affected by the disease in South Welo, South Gonder and east Gojam range from 70% to 91% of the total affected. The average age of the patients at the time of the onset of the lathyrism was 8, 15 and 10 for male in South Welo, South Gonder and east Gojam, respectively. The average age of female patients at the time of onset of the disease ranges from 12 years in east Gojam to 23 years in South Gonder. These findings are in agreement with the results of Getahun and Redda (1997) for Estie wereda in South Gonder. Lathyrism affected young persons, such age groups of people are economically active, have a long planning horizon, and the disease causes a permanent loss of critical work force for farm households in the rural areas.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Sex (%)</th>
<th>Age at the onset of the disease</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Welo</td>
<td>Male</td>
<td>11.10</td>
<td>7.90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>17.22</td>
<td>24.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12.93</td>
<td>14.75</td>
<td></td>
</tr>
<tr>
<td>South Gonder</td>
<td>Male</td>
<td>23.86</td>
<td>15.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>22.67</td>
<td>14.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>23.74</td>
<td>14.84</td>
<td></td>
</tr>
<tr>
<td>East Gojam</td>
<td>Male</td>
<td>15.80</td>
<td>9.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>11.50</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>15.41</td>
<td>9.24</td>
<td></td>
</tr>
<tr>
<td>All locations</td>
<td>Male</td>
<td>17.22</td>
<td>12.63</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>16.74</td>
<td>17.72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>17.12</td>
<td>13.73</td>
<td></td>
</tr>
</tbody>
</table>

Economic Profile of Lathyrism Affected and Unaffected Households
Most of the lathyrism patients are involved in farming for living and few of them are dependent and supported by their families (Table 5). However, lathyrism-affected households own significantly smaller farm size as compared to unaffected households (Table 6). They usually share out their land because of their physical disability to work on their farm and/or insufficient income to hire in labor. This partly explains poverty status of affected households and their susceptibility to lathyrism.
Grass pea consumption and lathyrism

Table 5. Sources of livelihood for lathyrism-affected households

<table>
<thead>
<tr>
<th>Activity</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Farming</td>
<td>26.7</td>
<td>8</td>
<td>64.7</td>
<td>22</td>
</tr>
<tr>
<td>Dependent</td>
<td>73.3</td>
<td>22</td>
<td>29.4</td>
<td>10</td>
</tr>
<tr>
<td>Begging</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>Priest</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>Weaving</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

As depicted in Table 7, the lathyrism-affected households earn substantially less income than the unaffected households in all the study Zones. The difference in gross income between the two groups ranges from 700 birr per household in South Welo to over 900 birr per household in South Gonder. This confirms that households belonging to low-income groups are more affected by lathyrism than households from high-income group in the three Zones.

The two groups also differ in terms of livestock owned. Lathyrism affected household on average owned 1.75 tropical livestock unit (TLU) while unaffected households on average owned 3.33 TLU and this variation is highly significant (p < 0.01). The two groups also differ in average number of cows and oxen owned (Table 8). This difference has deeper economic implications, since oxen are used for traction in crop production activities. Thus, affected households do not have sufficient number of oxen for crop cultivation, consequently produce, and earn less than unaffected households earn.

Table 6. Average farm size (ha) and tenure arrangement for lathyrism affected and unaffected households

<table>
<thead>
<tr>
<th>Description</th>
<th>Household</th>
<th>South Welo Mean (t-value)</th>
<th>South Gonder Mean (t-value)</th>
<th>East Gojam Mean (t-value)</th>
<th>All locations Mean (t-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>t-value</td>
<td>n</td>
<td>t-value</td>
</tr>
<tr>
<td>Total farm size</td>
<td>Affected</td>
<td>1.20</td>
<td>30</td>
<td>1.21</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>1.33</td>
<td>69</td>
<td>1.43</td>
<td>67</td>
</tr>
<tr>
<td>Cultivated area</td>
<td>Affected</td>
<td>1.12</td>
<td>30</td>
<td>1.09</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>1.23</td>
<td>69</td>
<td>1.37</td>
<td>67</td>
</tr>
<tr>
<td>Grass pea area</td>
<td>Affected</td>
<td>0.32</td>
<td>18</td>
<td>0.97</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>0.27</td>
<td>50</td>
<td>0.43</td>
<td>65</td>
</tr>
<tr>
<td>Share and rent in</td>
<td>Affected</td>
<td>0.75</td>
<td>1</td>
<td>0.63</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>0.58</td>
<td>18</td>
<td>0.62</td>
<td>32</td>
</tr>
<tr>
<td>Share and rent out</td>
<td>Affected</td>
<td>0.85</td>
<td>12</td>
<td>0.65</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>0.75</td>
<td>14</td>
<td>0.73</td>
<td>9</td>
</tr>
</tbody>
</table>

*** and * indicate statistical difference at 1% and 10% significance levels

Table 7. Gross Income of lathyrism affected and unaffected households by zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Affected Mean (S. D.) n</th>
<th>Unaffected Mean (S. D.) n</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Welo</td>
<td>2178 (1750) 28 2878 2283 68</td>
<td>2.15 **</td>
<td></td>
</tr>
<tr>
<td>South Gonder</td>
<td>2230 (2526) 23 3165 2078 67</td>
<td>1.97 **</td>
<td></td>
</tr>
<tr>
<td>East Gojam</td>
<td>3581 (1515) 25 4420 1936 77</td>
<td>1.98 **</td>
<td></td>
</tr>
<tr>
<td>All location</td>
<td>2606 (2102) 86 3629 2197 212 3.33***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** and *** indicate statistical difference at 5% and 1% significance level; S. D. indicates standard deviation. S.D - Standard Deviation
Table 8. Number of livestock kept on the farm by affected and unaffected households

<table>
<thead>
<tr>
<th>Type</th>
<th>Group</th>
<th>South Welo</th>
<th></th>
<th>South Gonder</th>
<th></th>
<th>East Gojam</th>
<th></th>
<th>All locations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean n</td>
<td>t-value</td>
<td>Mean n</td>
<td>t-value</td>
<td>Mean n</td>
<td>t-value</td>
<td>Mean n</td>
<td>t-value</td>
</tr>
<tr>
<td>Cows</td>
<td>Affected</td>
<td>1.00</td>
<td>14</td>
<td>1.21</td>
<td>14</td>
<td>1.22</td>
<td>9</td>
<td>1.14</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>1.10</td>
<td>41</td>
<td>1.78</td>
<td>45</td>
<td>1.29</td>
<td>55</td>
<td>1.39</td>
<td>141</td>
</tr>
<tr>
<td>Oxen</td>
<td>Affected</td>
<td>1.33</td>
<td>12</td>
<td>1.24</td>
<td>17</td>
<td>1.42</td>
<td>19</td>
<td>1.33</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>1.45</td>
<td>49</td>
<td>1.81</td>
<td>59</td>
<td>1.66</td>
<td>67</td>
<td>1.65</td>
<td>175</td>
</tr>
<tr>
<td>Poultry</td>
<td>Affected</td>
<td>2.50</td>
<td>14</td>
<td>5.24</td>
<td>21</td>
<td>2.50</td>
<td>2</td>
<td>4.05</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>2.62</td>
<td>50</td>
<td>5.63</td>
<td>51</td>
<td>2.10</td>
<td>10</td>
<td>3.95</td>
<td>111</td>
</tr>
<tr>
<td>TLU</td>
<td>Affected</td>
<td>1.79</td>
<td>30</td>
<td>1.52</td>
<td>33</td>
<td>1.99</td>
<td>25</td>
<td>1.75</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Unaffected</td>
<td>2.97</td>
<td>69</td>
<td>3.75</td>
<td>67</td>
<td>3.28</td>
<td>77</td>
<td>3.33</td>
<td>213</td>
</tr>
</tbody>
</table>

* and *** indicate statistical difference at 5% and 1% significance level.

As noted by one patient, they have no access to credit because of their poverty and lack of resources for collateral. Credit suppliers do consider lathyrism patients as non-credit worthy as the patients lack physical capability to engage in physical work and generate income and payback the principal and interest. Non-agriculture related credits are rarely available in the study areas. Even if it is made available, the credit is not destined to lathyrism patients and other disabled persons. Occupation wise, some of the lathyrism patients had engaged in farming before the onset of the disease, few of them shifted into less physically demanding duties like church service (1 person), begging (1 person), handcraft (2 persons) and herding after the onset of the disease.

In rural areas the size, quality and type of accommodations and the ability of a household to feed its members throughout the year could also be used as indicators of wealth status or poverty of a household. The lathyrism-affected households are worse off than unaffected ones based on these indicators. Unaffected households are by far better than affected households in terms of food-security are. For instance, in east Gojam only 29% of lathyrism-affected household have sufficient food supply for the whole year while this figure was 58% for unaffected households in the same region and the difference is highly significant (p < 0.01). In terms of the type of shelter, the proportions of households who have tin-roofed houses were more for the unaffected households than the affected households (Table 9).

Table 9. Proportion of lathyrism affected and unaffected households who have tin-roofed house and can supply food throughout the year

<table>
<thead>
<tr>
<th>Zone</th>
<th>Affected</th>
<th>Unaffected</th>
<th>Total sample</th>
<th>Chisquare</th>
<th>Contingency Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tin roofed house</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Welo</td>
<td>3.6</td>
<td>23.8</td>
<td>17.6</td>
<td>5.48***</td>
<td>0.24</td>
</tr>
<tr>
<td>South Gonder</td>
<td>0.0</td>
<td>1.5</td>
<td>1.1</td>
<td>0.466</td>
<td>0.04</td>
</tr>
<tr>
<td>East Gojam</td>
<td>52.0</td>
<td>74.0</td>
<td>68.6</td>
<td>4.25**</td>
<td>0.10</td>
</tr>
<tr>
<td>Self-sufficient in food supply</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Welo</td>
<td>3.3</td>
<td>16.7</td>
<td>12.5</td>
<td>3.36**</td>
<td>0.18</td>
</tr>
<tr>
<td>South Gonder</td>
<td>30.8</td>
<td>46.0</td>
<td>41.6</td>
<td>1.77</td>
<td>0.14</td>
</tr>
<tr>
<td>East Gojam</td>
<td>29.2</td>
<td>57.9</td>
<td>51.0</td>
<td>6.02***</td>
<td>0.24</td>
</tr>
</tbody>
</table>

** and *** indicate statistical difference at 5% and 1% significance level.

Some of the economic and social indicators discussed above clearly indicated variation between lathyrism-affected and unaffected households. Consequently, the two groups differ in the quantity of grass pea and other legumes consumed.
The amount of grass pea consumed by lathyrism-affected household was albeit higher than the quantity of grass pea consumed by unaffected households. The quantities of chickpea, lentils and faba bean consumed by the two groups are different and the differences are statistically significant in six out of seven comparisons made (Table 10). This result indicates that household affected by lathyrism depend more on grass pea than unaffected households. The unaffected households have a capacity to purchase other legumes to blend with grass pea for consumption. Most of the unaffected households do not consume grass pea alone, whereas this is common for the lathyrism-affected households.

The two groups also differ, particularly in South Welo, in terms of how they consume grass pea. The proportion of lathyrism-affected households who consume grass pea as kollo and nifro is more than the proportion of unaffected household who consume grass pea in the two specified forms. However, there is no significant variation between the two groups in South Gonder and east Gojam zones in terms of proportions of farmers consuming grass pea as Kollo. In South Gonder Zone, the proportions of lathyrism affected and unaffected households who consume grass pea as nifro do not significantly differ (Table 11).

Social Impacts of Lathyrism on Patients

Lathyrism patients, as any other citizen, have the right to serve in a leadership positions in any grass-root administrative structures (e.g. peasant association) and community based organizations (iddir, mehber and service cooperative). In practice, very few of them assumed leadership positions in these institutions because of their physical disability (Table 12). Although rate of divorce for lathyrism patients is not established yet, cases of divorce were reported both by men and women patients in South Gonder indicating that Lathyrism patients are socially disadvantaged in that respect. Thus, the social and economic effect of lathyrism on the individuals affected by the disease, their households, the community and the whole economy appears to be great.

Econometric Analysis of Factors Associated with Incidence of Lathyrism

Attempt has been made to identify factors associated with incidence of lathyrism. The factors assumed to have relation with lathyrism include: extent of grass pea consumption, state of processing and preparation of food from grass pea, consumers awareness about the negative effect of grass pea consumption, economic status and other household characteristics.

1 Iddir is an informal organization formed by volantry members mainly to support each other during death of family members. Mehber is an informal religious organization formed by volantry member to pray and celibrate a certain saint's day together.
Studies done in Ethiopia and elsewhere confirmed that lathyrism occurs when food constituting at least 30% of grass pea is continuously consumed for three to four months and the level of \( \beta \)-ODAP in a human body exceeds certain tolerable level. The tolerable level of \( \beta \)-ODAP may vary from individual to individual. When excessive amount of grass pea is consumed, the toxic compound is accumulated in the body. Subsequently it weakens the muscles, and results in irreversible paralysis of lower limbs. The threshold levels, at which the subject catches the disease, may vary from individual to individual. The incidence of lathyrism also varies among different age and sex groups. Younger persons are affected more than older persons are. Male are affected more than female. Among others, Getahun and Redda (1997) and Redda et al. (1997) reported variation in the incidence of the disease among age and sex groups. The disease results in varying degree of disability and this may arose from the individuals' tolerance threshold level against a given amount of \( \beta \)-ODAP present in the body during a given period. On the other hand, factors that enhance and factors that reduce the effects of the toxic compound in the human body may work for and against the incidence of the disease. Wealth status and different processing and preparation method reduce the amount of \( \beta \)-ODAP that could be taken-in during grass pea consumption. Economically better-off households can afford buying other legumes and may not consume grass pea alone and consume it in nifro and kollo forms. In relative terms, they consume limited amounts of grass pea as opposed to poverty-stricken households. Therefore, they are less likely to be affected by lathyrism. Similarly, different processing and preparation methods (detoxification) greatly reduce the amount of \( \beta \)-ODAP found in grass pea. Hence, the likely occurrence of lathyrism declines with the application of different processing and food preparation methods. The relation between incidences of lathyrism and consumption behavior, wealth status, the way food processing and preparation and other social and economic characteristics of consumer households were modeled using the probit regression model.

<table>
<thead>
<tr>
<th>Crops/household</th>
<th>South Welo</th>
<th>South Gonder</th>
<th>East Gojam</th>
<th>All locations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean n t-value</td>
<td>Mean n t-value</td>
<td>Mean n t-value</td>
<td>Mean n t-value</td>
</tr>
<tr>
<td>Faba Bean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>5.63 30 3.05**</td>
<td>0 33 -</td>
<td>1.84 25 3.06**</td>
<td>2.39 88 3.55**</td>
</tr>
<tr>
<td>Unaffected</td>
<td>12.22 69 -</td>
<td>0 67 -</td>
<td>4.22 77 5.48</td>
<td>5.48 213</td>
</tr>
<tr>
<td>Chick Pea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>.08 30 1.57*</td>
<td>1.40 33 3.19**</td>
<td>18.45 25 .25</td>
<td>5.80 88 1.91**</td>
</tr>
<tr>
<td>Unaffected</td>
<td>.81 69 7.66 67</td>
<td>19.90 77 9.87</td>
<td>9.87 213</td>
<td></td>
</tr>
<tr>
<td>Grass pea</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>17.40 30 .47</td>
<td>30.23 33 1.18</td>
<td>29.08 88 1.83</td>
<td>29.08 213</td>
</tr>
<tr>
<td>Unaffected</td>
<td>18.84 69 25.01 67</td>
<td>35.46 77 26.79</td>
<td>26.79 213</td>
<td></td>
</tr>
<tr>
<td>Lentil</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>0 30 1.91**</td>
<td>42 33 2.88**</td>
<td>0 25 1.55*</td>
<td>1.86 88 3.16**</td>
</tr>
<tr>
<td>Unaffected</td>
<td>.40 69 3.74 67</td>
<td>24 77 1.39</td>
<td>1.39 213</td>
<td></td>
</tr>
</tbody>
</table>

* , ** and *** indicate statistical difference at 10%, 5% and 1% significance level.
Grass pea consumption and lathyrism

Table 11. Distribution of affected and unaffected households in terms of grass pea consumption in forms of kollo and nifro

<table>
<thead>
<tr>
<th>Zone</th>
<th>Affected</th>
<th>Unaffected</th>
<th>Total sample</th>
<th>$\chi^2$</th>
<th>Contingency Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Welo</td>
<td>83.0</td>
<td>47.8</td>
<td>57.6</td>
<td>8.68**</td>
<td>0.29</td>
</tr>
<tr>
<td>South Gonder</td>
<td>87.9</td>
<td>88.1</td>
<td>88.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>East Gojam</td>
<td>44.0</td>
<td>41.6</td>
<td>42.2</td>
<td>0.05</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Proportion consuming in form of nifro

<table>
<thead>
<tr>
<th>Zone</th>
<th>Affected</th>
<th>Unaffected</th>
<th>Total sample</th>
<th>$\chi^2$</th>
<th>Contingency Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Welo</td>
<td>66.7</td>
<td>31.9</td>
<td>42.4</td>
<td>10.36***</td>
<td>0.31</td>
</tr>
<tr>
<td>South Gonder</td>
<td>21.2</td>
<td>14.9</td>
<td>17.0</td>
<td>0.62</td>
<td>0.08</td>
</tr>
<tr>
<td>East Gojam</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

*** indicates statistical difference at 1% significance level

Table 12. Participation of patients in leadership positions in community based social institutions (percentage)

<table>
<thead>
<tr>
<th>Institutions</th>
<th>South Welo (n = 30)</th>
<th>South Gonder (n = 31)</th>
<th>East Gojam (n = 22)</th>
<th>All locations (n = 83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peasant Association</td>
<td>10.0</td>
<td>16</td>
<td>86</td>
<td>34</td>
</tr>
<tr>
<td>Service Cooperative</td>
<td>7</td>
<td>0</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>Iddir</td>
<td>10.0</td>
<td>13</td>
<td>68</td>
<td>27.5</td>
</tr>
<tr>
<td>Mahber</td>
<td>7</td>
<td>8.5</td>
<td>50</td>
<td>18.7</td>
</tr>
</tbody>
</table>

The probit model assumes that there is a threshold level beyond, which the stimuli (the subject) cannot stand the effects of stimulus (dependant factors). This threshold may vary from individual to individual. Individuals having high threshold (index) is said to be resistant to a disease or medicinal doses or resistant to change from one state to the other. In the probit model, threshold is expressed in terms of latent (index) variable. To describe the probit model, let I be an index or unobserved variable defined as,

$$y = 1 \quad \text{if } \beta x_i + e_i > I^*$$

$$y = 0 \quad \text{if } \beta x_i + e_i < I^*$$

Where $I^*$ is a critical value of index I. In this model the probability of observing a response, i.e. whether an individual catches lathyrism or not, is defined in terms of the level of the unobserved index I and the standard cumulative normal distribution is used to transform the index I into a probability value. The index I is a linear combination of explanatory variables, and may take any value between $-\infty$ and $\infty$, while its transformation ensures that all corresponding probability values lie between 0 and 1. This model has many plausible characteristics: in particular, it determines the decision variable y by $y = 1$ if $I < I^*$, and by $y = 0$ if $I > I^*$. Here I can be defined as a potential lathyrism tolerance index. If this calculated potential tolerance index for an individual exceeds that individual's personal critical value of the index ($I^*$), the individual is more likely to catch the disease. Thus one can interpret a low $I^*$ as a high underlying likelihood that an individual will catch lathyrism, and high $I^*$ as a low underlying likelihood that an individual will not be affected by lathyrism. In the probit model, the critical values are assumed to be distributed normally among individuals (Finney, 1971; Kennedy, 1979).

The empirical model was specified as function of explanatory variables thought to affect incidence of lathyrism. Description and measurement of the
explanatory variables used in the probit model are given in Table 13. The summary of the variable and their expected signs are also indicated in the same table. A maximum likelihood method was used to estimate the probit model. LIMDEP version 7 (Greene, 1997) was used to estimate the model. The probit model as a whole is significant in explaining incidence of lathyrism. The log likelihood ratio test\(^2\) shows that the explanatory variables taken together influence incidences of lathyrism.

Table 14 presents the coefficients of the probit model for incidences of lathyrism. All the explanatory variables have the expected signs. Out of the 14 explanatory variables, five are found to significantly affect the incidence of lathyrism. Tropical livestock units and a dummy variable as a proxy for self-sufficiency in food supply throughout the year are highly significant. These variables are indicators of wealth and their coefficients imply that better-off consumers are less likely affected by lathyrism. Economically better-off group can afford to purchase other legumes and in most cases, such group does not consume grass pea alone and consume lower amounts of grass pea as compared to low-income consumers.

The coefficient attached to the variable family size is positive and significant at 5\% level. This implies that, given the other explanatory variables held constant, increase in consumption of grass pea driven by food demand of family size creates favorable condition for the incidence of lathyrism. In the model, family size was assumed to represent consumption pressure of the household. With increase in family size consumption pressure will increase. This will force particularly the poor households to consume crops that have low market value. Such consumers sell high value crop either to purchase low value crop or to earn cash for various financial needs. For example, in Kalu wereda, South Welo zone, farmers who participated in employment generation schemes and received wheat as payment sold wheat and purchased maize for consumption (Addis Anteneh consult, 2001, unpublished report. At time of transaction, price of maize was lower than price of wheat. Grass pea, being the cheapest legumes, is more consumed by low-income consumers than well to do consumers. Well to do farmers who produce grass pea either sells it or consume it in a mixture with other legumes only in form of shiro. Consequently, it is more likely that low-income consumers, who consume more amount of grass pea, are affected by lathyrism. It is important to note that, depending on the balance between variables that stimulate and deter incidence of lathyrism, lathyrism may or may not occur.

\(^2\) Calculated chi-square (53) is greater than critical value (with degree of freedom of 14) of chi-square at 1\% level.
Table 13. Definition, measurement and summary of explanatory variables

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Description</th>
<th>Unit of measurement</th>
<th>Expected Sign</th>
<th>Mean (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location-1 Dummy</td>
<td></td>
<td>1, if South Welo, 0 otherwise</td>
<td>-/+</td>
<td>(33)</td>
</tr>
<tr>
<td>Location-2 Dummy</td>
<td></td>
<td>1, if South Gonder, 0 otherwise</td>
<td>-/+</td>
<td>(33)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td>Sex of household head 1, if male, 0 otherwise</td>
<td>-/+</td>
<td>(92)</td>
</tr>
<tr>
<td>Tropical Livestock Unit</td>
<td></td>
<td>Tropical Livestock unit owned per household</td>
<td>-</td>
<td>2.86</td>
</tr>
<tr>
<td>Self Sufficiency Dummy</td>
<td></td>
<td>1, if self-sufficient, 0 otherwise</td>
<td>-</td>
<td>(36)</td>
</tr>
<tr>
<td>Duration of Consumption</td>
<td></td>
<td>Length of time (days) for which grass pea consumed</td>
<td>+</td>
<td>265</td>
</tr>
<tr>
<td>Extent of Consumption</td>
<td></td>
<td>Quantity of grass pea consumed kg/head</td>
<td>+</td>
<td>29</td>
</tr>
<tr>
<td>Forms of Consumption</td>
<td></td>
<td>Dummy: 1, if <em>nifro</em> and <em>kollo</em>, 0 otherwise</td>
<td>+</td>
<td>(64)</td>
</tr>
<tr>
<td>Processing method</td>
<td></td>
<td>Frequency of grass pea washing</td>
<td>-</td>
<td>2.87</td>
</tr>
<tr>
<td>Blending/mixing</td>
<td></td>
<td>Ratio of other legumes to grass pea</td>
<td>-</td>
<td>0.39</td>
</tr>
<tr>
<td>Awareness</td>
<td></td>
<td>Dummy: 1, if aware of toxicity of grass pea, 0 otherwise</td>
<td>-</td>
<td>(84)</td>
</tr>
</tbody>
</table>

Note: - and + stands for negative and positive, respectively.

The variable representing extent of consumption of grass pea has a positive coefficient, significantly different from zero. This implies that the extent of consumption of grass pea does positively influence incidence of lathyrism. This variable is directly related to the amount of grass pea consumed per head. Thus, with increase in quantity of grass pea consumption, other things being equal, the likelihood of catching lathyrism increases. It is important to note that per capita consumption of grass pea tends to be higher for resource poor and poverty-threatened rural consumers. Thus, this group is more liable for lathyrism threat. The variable representing forms of consumption bears positive coefficient. The coefficient is significantly different from zero and this implies that consuming grass pea as *nifro* and/or *kollo* increases the probability of occurrence of lathyrism more than consuming it as *shiro*. Since most of the sample households consume grass pea as *shiro*, additional consumption as *nifro* and/or *kollo* increases intake (consumption) or dose of the toxic compound that causes lathyrism.

Table 14. Probit regression coefficients of variables affecting lathyrism incidence

<table>
<thead>
<tr>
<th>Explanatory variables</th>
<th>Parameter estimate (β)</th>
<th>T-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.2147</td>
<td>-0.421</td>
</tr>
<tr>
<td>Location-1 (1= if South Welo)</td>
<td>0.0882</td>
<td>0.324</td>
</tr>
<tr>
<td>Location-2 (1= if East Gojam)</td>
<td>0.2139</td>
<td>0.940</td>
</tr>
<tr>
<td>Sex of household head (1= if male)</td>
<td>-0.0118</td>
<td>-0.039</td>
</tr>
<tr>
<td>Tropical livestock unit</td>
<td>-0.1985</td>
<td>-4.249***</td>
</tr>
<tr>
<td>Self sufficiency in food (1= if yes)</td>
<td>-0.4008</td>
<td>-2.057**</td>
</tr>
<tr>
<td>Duration of consumption</td>
<td>0.0007</td>
<td>0.825</td>
</tr>
<tr>
<td>Extent of consumption</td>
<td>0.0052</td>
<td>1.182</td>
</tr>
<tr>
<td>Forms of consumption</td>
<td>0.2966</td>
<td>1.571*</td>
</tr>
<tr>
<td>Processing method</td>
<td>-0.0776</td>
<td>-0.665</td>
</tr>
<tr>
<td>Blending/mixing</td>
<td>-0.1217</td>
<td>-0.792</td>
</tr>
<tr>
<td>Awareness about effect on health (1= if yes)</td>
<td>-0.0734</td>
<td>-0.309</td>
</tr>
<tr>
<td>Number of observation</td>
<td>302</td>
<td></td>
</tr>
<tr>
<td>Log-likelihood function</td>
<td>-159.535</td>
<td></td>
</tr>
<tr>
<td>Model chi-square</td>
<td>45.379</td>
<td></td>
</tr>
<tr>
<td>Proportion correctly predicted</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>

* *, ** and *** indicate statistical difference at 10%, 5% and 1% significance level

The indigenous processing method employed by consumers tends to reduce the incidence of lathyrism. The coefficient of the variable representing the
processing method is negative although not significant. Although this level of significance is higher than the normally accepted significance levels of 1%, 5% and 10%, one needs to appreciate the contribution of this variable in terms of reducing the incidence of lathyrism with consumption of grass pea.

Conclusions and Recommendations

Despite being the least preferred legume for human consumption, grass pea is widely consumed by low-income farmers in several local preparations such as shiro, nifro, kollo and kita while middle-income farmers consume it only as shiro. There are two main reasons for the consumption of grass pea. First, farmers cannot produce the preferred legumes, chickpea and lentils, in sufficient amounts due to insects and disease problems. Grass pea is more readily available because of its better tolerance to insects and diseases. Second, low-income farmers cannot afford to buy preferred legumes because of their relatively high prices.

The health hazard associated with the consumption of grass pea still exists in the rural areas. It is highly associated with drought periods when food security situation of the rural population deteriorates. Although perceptions of communities about the cause of lathyrism vary from one area to another, many farmers in the study area know the effect of grass pea consumption on human health. However, most of them do not relate the onset and severity of lathyrism to the amount and the length of the period that grass pea is consumed. Further, most respondent women have wrong impression regarding concentration of toxic compound found in different parts of grass pea seeds. They feel that the toxic compound of grass pea is concentrated in husk and they try to remove and discard the husk as a means to avoid risk.

Lathyrism mainly affected poorer households who have greater household food insecurity, own fewer assets such as land and livestock, and had lower income than unaffected households had. Poor households will continue to depend on grass peas as source of protein for years to come. Therefore, effective educational and public awareness programs are required to inform rural people about the health hazards associated with different consumption patterns of grass pea. There is need for the development of simple and standardized detoxification techniques and their popularization as part of agricultural extension program. Simple guidelines for the use of such techniques that can reduce the neurotoxin substance in local preparations of grass pea down to save levels are badly needed.

Current efforts in developing new varieties with low and acceptable level of β-ODAP content should continue. Some promising lines have already been identified and at present being tested for their performance and level of β-ODAP under different environments. Such varieties would have positive impact in reducing costs of food processing and preparation by reducing the time of soaking and cooking. This would also save protein, vitamins and other nutrient losses due to rigorous processing usually done for reducing the neurotoxin substance of grass pea. Above all the development of varieties with low level of
Grass pea consumption and lathyrism

β-ODAP will reduce the incidence of lathyrism and social and economic costs to poor rural households. Grass pea lines found to be β-ODAP free or with acceptable β-ODAP content should be evaluated under different environment and farmers’ conditions prior to their official releases and promotion for wider use. Some findings are available on β-ODAP contents of grass pea grown by farmers in different parts of the country. The determination of β-ODAP contents of landraces should continue.

Finally, it should be noted that there is little effort to support and rehabilitate lathyrism affected patients and their households. The lathyrism-affected persons are overlooked, lose their social status and become even more vulnerable. Therefore, NGOs and concerned governmental organization should give due attention to this section of the community and develop suitable income generating schemes for lathyrism affected households.

References


Barley-based Farming System in Gassera Area of Bale Highlands

Bekele Hundie Kotu¹, Paulos Asrat¹ and Aseffa Seyoum¹

Introduction

Many research and extension activities are regularly carried out in developing countries. A major proportion of these activities did not achieve the desired results. This could be mainly because of the wrong research strategies and approaches followed by research institutions and development organizations in the past. That is, in conventional approaches, research activities were done only at stations, where conditions are different from the farmers' conditions. Moreover, research was conducted without considering the natural and socioeconomic problems/constraints of the smallholder farmers. This resulted in research outputs, which are incompatible with most farming systems.

To correct the limitations of the conventional approach, farming system research (FSR) has been operational since more than a decade by every research center of Ethiopia. FSR is a form of site specific, target-group-oriented and multidisciplinary approach through which a set of farmers' production constraints and possible solutions are identified (Alelign, 1988; Kassahun et al., 1988). It is aimed at designing agricultural improvements for specific ecological zones and groups of farmers having similar farming circumstances. This study also used FSR approach to identify barley production constraints. An informal survey was already undertaken in the study area and this study was a follow-up study mainly targeted to verify the information obtained during the informal survey and to get additional information about the priority problems related to barley production.

Production Trends

Barley is one of the most important cereal crops grown in Bale highlands. In Ethiopia, Bale Zone is the second both in barley area and production next to Arsi. In Bale itself, barley ranks second in total crop area and production. It covers about 30% of the total area under private peasant holdings, and contributes nearly 30% of the total cereal production in Bale Zone.

The trend of area under barley for private peasant holdings (small-scale farmers) was irregular since 1988. In 1988 and 1989, the area under barley was almost constant and the average was 41,780 ha. The barley production area increased had by 24% in 1990 as compared to the two preceding years. In 1994, the total area under barley was greater by 6,650 ha than that in 1990. However, it decreased by 9.3% (5,430 ha) in the following year (1995). In 1998, the area under barley for private peasant holdings in Bale zone was 85,950 ha. It

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accounted for about 10% of the total area allocated to barley in Ethiopia (CSA, 1989; CSA 1990; CSA 1994; CSA 1995; and CSA 1998).

On the other hand, the general trend of area under barley was declining for state farms. The decline in area planted to barley was, however, very high in 1989, 1991 and 1995. In 1989, the area under barley declined by 43% from the previous year i.e. from 17,271 ha to 9,820 ha (CSA, 1990). In 1991 and 1995, the area planted to barley decreased by 67% and 81% from their preceding years respectively (CSA, 1992; CSA, 1995). In 1997, the total area allocated for barley by state farms was only 393 ha (CSA, 1997). The main reason for the general decline in the area allocated to barley in Bale zone is the expansion of wheat production because of better availability of improved varieties. Absence of improved varieties that tolerate barley shoot fly damage forced farmers to reduce the area they allocate to barley in addition to other reasons such as shift in dietary habit.

Producers' cooperatives were also one of the barley producers in Bale up to 1990. They planted barley on average on 2,850 ha of land per year (CSA, 1990). Nevertheless, producers' cooperatives are not functional after 1991.

Similar to that of area under barley, the production trend of barley in Bale was not smooth since 1988. In 1988, small-scale farmers of Bale produced 52,996 tones of barley (CSA, 1989). After five years, in 1994, however, the total barley production was very low (43,612 tones) (CSA, 1995). This is perhaps because of unfavorable climatic conditions in that year which reduced the yield of barley by about 36% as compared to the yield obtained three years back (in 1990). In 1995, the total production was almost the same (49,226 tones) but the yield improved from 0.75 t/ha in 1994 to 0.93 t/ha. Since the area planted to barley by state farms has declined progressively from 1988, the total barley produced has declined alarmingly since then. In 1988, the total barley produced by state farms reached 16,519 tones, which has declined to 394.4 tones in 1997 (CSA, 1989; CSA, 1997; and CSA, 1998).

The objective of the study is to identify barley production constraints and suggest possible opportunities as perceived by farmers.

Methodology

A multi-stage sampling procedure was used to identify the sample units (farmers). First, peasant associations (PAs) were listed and a simple random sampling was applied to select thirteen PAs. Thereafter, a systematic random sampling technique was applied to get a sample of 104 household heads consisting of 102 males and 2 females. However, the analyses were based on the responses of 99 farmers because five of the sample farmers were not around during the survey. Primary data were obtained from farmers using a structured questionnaire. An informal survey of farmers was used to obtain qualitative data on their farming practices and circumstances that were used to develop the questionnaire for the formal survey. The formal survey was supplemented by secondary data from Gassera District Agricultural Development Office (GDADO) and informal interaction with extension staff. The data was collected using trained enumerators. Descriptive statistics was used to analyze the data.
The Target Area

The study area is located in Bale zone of Oromiya National Regional State and it covers about 96,600 hectare of land. The town of Gassera, which is located at about the center of the target area, is 60 km away from the Zone Capital (Robe) in the northeast direction. The elevations of most locations of the target area are above 2,000 m. Most parts of the area are plain with nearly flat topography. Areas ranging from gentle to steep slopes are commonly observed in the northern part bordering the gorge of Wabe.

Two main target-groups, Target-group-I and target-group-II, were identified. Target-group-I is mainly characterized by moisture stress or drought. Crop failures are reported to exist repeatedly because of low rain during the cropping seasons. In this area, Genna/belg (March to July) is the dominant season in which most of the crops are produced. In Target-group-II domain, the rainfall distribution is usually favorable for normal crop production. However, in the eastern part of this domain high rain and water logging are the main production problems.

Soils of the area have high clay contents varying from light grayish to dark black in color. Soils varying in depth from shallow Regosols to deep Vertisols are observed. The dominant soil types are the dark black clay soils (Vertisols), light brown colored soils known by local vernaculars as 'abole', 'gali', and 'daro', and the red soils called 'dimile'.

According to farmers, the 'daro' soils are the most productive with a little or almost no fertilizer requirement followed by dark black clay Vertisol, and the least productive soils are the 'dimile' soils to which application of chemical fertilizers is necessary. The farmers believe that the dark black clay soils have high inherent chemical fertility; the major problem being the extremely poor physical conditions they exhibit which is often manifested by their poor internal drainage characteristics. The dark black clay soil (Vertisols), being the most dominant soils in the study area, has got a specific morphology and their physical and chemical characteristics vary within a narrow range. These soils are believed to have more than 50% clay. Farmers often face serious problem in managing these soils especially during land preparation (plowing). They become very sticky when there is excess rainfall and hard when the rainfall tends to cease. Water logging is a severe problem in these soils.

Socioeconomic Characteristics

Demography

Demographic characteristics of sample farmers in the two target groups are shown in Table 1. Almost all (98%) of the farmers were married. Literacy rate of the farmers was also high i.e. about 75% of the farmers were literate who received either religion-based or modern education. Only 2% of the sample households were female-headed. The mean age was 46 years whereas the minimum and the maximum age were 20 and 80 years, respectively. The range for family size was large i.e. the minimum family size was two and the
maximum was 22. Members in the active age group (14-60 years) constituted about half of the family size. The sample included farmers having different levels of experience in farming. About 25% were young farmers who had less than 10 years of experience and 23.3% were farmers who stayed in farming for more than 30 years. The rest had between 10 and 30 years of experience.

Almost all of the farmers used communal labor for crop production; and only 25.5% of the farmers hired labor. Female household members were involved mostly in weeding, maize ‘kutkuato’\(^2\), and harvesting, grain storing. Mostly they were involved in weeding of maize and tef. Children (<14 years) were also involved in crop and livestock production in about 57% of the households (their main activities being cattle herding and weeding). The majority (69.2%) of farmers hired casual laborers. The average wage rate was about 7.1 Birr per day including lunch and/or diner. Farmers used hired labor for wheat (88.2%), barley (76.5%), linseed (58.8%), tef (47.1%), and maize (17.6%) production. Harvesting was the major activity for which most of the farmers (94.4%) used hired labor. About 52% of the respondents reported that, there was labor shortage.

Cash is necessary to cover several types of expenses a farm household need to settle. Two broad categories of income sources existed for the farmers, farm and off-farm income sources. Farm produces were the most important income sources on which more than 95% of the farmers were dependent. Crops were the dependable sources of income for 96% of the households followed by livestock, which covered some or all of the cash needs of about 82% of farmers. Moreover, crop production was ranked first by about 94% of the respondents while only 6% of the farmers put livestock or off-farm activities on the first rank as far as importance in cash generation is concerned. The proportion of farmers dependent on off-farm activities was relatively small (32.3%). Linseed was the main crop from which 87.4% of the farmers got cash. It was the first cash crop for about 74% of the respondents. The other two crops used as income sources were wheat (69.5%) and tef (58.9%). Maize and barley got the next successive ranks by generating income for 38.9% and 33.7% of the farm households. From livestock, cattle got the leading rank based on the percent of respondents (97.5%) followed by sheep (12.3%) and goat (4.9%). Most farmers (90.1%) sold crops to cover their livelihood expenses, to purchase inputs and pay land tax.

According to some sample farmers who had average family size of 8.4 people, the annual barley consumption was about 300 kg. Most of them supplemented it by 284 kg of wheat. Forty-three percent of the sampled farm households consumed on average about 144 kg of tef per annum. This result excludes the annual consumption of other crops and edible items.

<table>
<thead>
<tr>
<th>Table 1. Demographic characteristics of sample farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>[</td>
</tr>
<tr>
<td>%</td>
</tr>
</tbody>
</table>

---

\(^2\) Method of weed control in maize by hoeing under the young plant
Barley-based farming systems in Gassera

<table>
<thead>
<tr>
<th>Education</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>22.9 8 26.6 17</td>
<td>25.3</td>
<td></td>
</tr>
<tr>
<td>Basic education</td>
<td>48.6 17 28.1 18</td>
<td>35.4</td>
<td></td>
</tr>
<tr>
<td>Primary education</td>
<td>20 7 32.8 21</td>
<td>28.3</td>
<td></td>
</tr>
<tr>
<td>Secondary education</td>
<td>8.6 3 12.5 8</td>
<td>11.1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>2.9 1 1.6 1 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>97.1 34 98.4 63 98.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marital status</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>94.3 33 100 63 98.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>2.9 1 0 0 1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>2.9 1 0 0 1.0</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Hired labor</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>17.1 6 30.2 19 25.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>82.9 29 69.8 44 74.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communal labor</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>100 35 98.4 62 99.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0 0 1.6 1 1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income source</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale of crops</td>
<td>97.1 34 95.3 61 96.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sale of livestock</td>
<td>88.6 31 78.1 50 81.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-farm income</td>
<td>37.1 13 29.7 19 32.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>0 0 1.6 1 1.0</td>
<td></td>
<td></td>
</tr>
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</table>

**Mean SD Mean SD**

<table>
<thead>
<tr>
<th>Age</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.6 13</td>
<td>46.6 14</td>
<td>46.4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Family size (total)</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.7 2.6 8.4 3.9 8.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>&lt; 14 years</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 2.0 3.9 2.2 3.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>&gt; 60 years</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3 0.8 1.3 0.5 1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Land Resource and Allocation Pattern**

According to the 1996 land-use data of GDADO, the total cultivated land of the target area was 96,600 ha. However, 14% of the total land was non-utilized land for agriculture and about 11% was a non-useable land.

Table 2. Land ownership of sample farmers in 1997

<table>
<thead>
<tr>
<th>Season</th>
<th>Area (ha)</th>
<th>Target group-I</th>
<th>Target group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own land</td>
<td>Genna</td>
<td>2.14</td>
<td>1.38</td>
<td>3.51***</td>
</tr>
<tr>
<td></td>
<td>Bone</td>
<td>1.46</td>
<td>1.64</td>
<td>0.69</td>
</tr>
<tr>
<td>Shared-in</td>
<td>Genna</td>
<td>1.55</td>
<td>0.53</td>
<td>2.86**</td>
</tr>
<tr>
<td></td>
<td>Bone</td>
<td>0.71</td>
<td>0.67</td>
<td>0.23</td>
</tr>
<tr>
<td>Fallow land</td>
<td>Genna</td>
<td>0.65</td>
<td>0.67</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Bone</td>
<td>0.44</td>
<td>0.68</td>
<td>1.63</td>
</tr>
</tbody>
</table>

**Significant at 5% probability level, *** = Significant at 1% Probability level**

The rest 75% of the total area was allocated for crop production (33%), pasture (28%), forest (13%), villages (0.7%) and small-scale irrigation (0.6%).

The average farm size of the sample farmers was 3.23 ha in 1997. In addition, 33% of farmers in Genna season and 24% of farmers in bona season had fallow plots, which were usually kept for pasture. The average area of fallow land
were 0.67 ha and 0.62 ha in Genna and bona seasons respectively. About 41% of the farmers reported that their land was not adequate in producing sufficient grain that sustains their family throughout the year. Consequently, 29.2% of them cultivated farm lands of other farmers through sharecropping agreements and some few (4.2%) reported that they made their farms input intensive to increase yield.

Farmers in Target-group-I were more dependent on genna season. This was manifested partly by the proportion of land they allocated for genna crops. The farmers in this target group allocated about 60% of their farmland for genna crops (Table 2). The average area of own-land allocated to genna crops in Target-group-I was significantly larger than Target-group-II (P < 0.01).

Table 3. Crops grown by the sample farmers

<table>
<thead>
<tr>
<th>Crop</th>
<th>Season</th>
<th>Target-group-I</th>
<th>Target-group-II</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Barley</td>
<td>Genna</td>
<td>100</td>
<td>35</td>
<td>87.5</td>
</tr>
<tr>
<td></td>
<td>bona</td>
<td>65.7</td>
<td>23</td>
<td>75</td>
</tr>
<tr>
<td>Wheat</td>
<td>Genna</td>
<td>85.7</td>
<td>30</td>
<td>51.6</td>
</tr>
<tr>
<td></td>
<td>bona</td>
<td>65.7</td>
<td>23</td>
<td>90.6</td>
</tr>
<tr>
<td>Linseed</td>
<td>Genna</td>
<td>45.7</td>
<td>16</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>bona</td>
<td>42.9</td>
<td>15</td>
<td>73.4</td>
</tr>
<tr>
<td>Tef</td>
<td>Genna</td>
<td>28.6</td>
<td>10</td>
<td>71.9</td>
</tr>
<tr>
<td></td>
<td>bona</td>
<td>2.9</td>
<td>1</td>
<td>3.1</td>
</tr>
<tr>
<td>Maize</td>
<td>Genna</td>
<td>82.9</td>
<td>29</td>
<td>75</td>
</tr>
<tr>
<td>Field pea</td>
<td>Genna</td>
<td>28.6</td>
<td>10</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>bona</td>
<td>17.1</td>
<td>6</td>
<td>46.9</td>
</tr>
<tr>
<td>Emmer</td>
<td>Genna</td>
<td>31.4</td>
<td>11</td>
<td>20.3</td>
</tr>
<tr>
<td>wheat</td>
<td>bona</td>
<td>17.1</td>
<td>6</td>
<td>48.4</td>
</tr>
</tbody>
</table>

** = Significant at 5% probability level, *** = Significant at 1% probability level.

However, the two target groups were not significantly different in area of land allotted to bona crops. On the contrary, in Target-group-II, the two seasons got almost equal share in area of land allocated to crops. About 54% of the land (1.64 ha) was cultivated in the bona season and the rest was cultivated in the other season. Similarly, the two groups were significantly different in area of land allocated to barley in the genna season (P < 0.01). That is, farmers in Target-group-I planted barley on larger area (0.92 ha) than those in Target-group-II (0.5 ha) in genna season (Table 4). Moreover, average area of land allocated to wheat in Target-group-I (0.75 ha) was significantly greater than that planted to the same crop in Target-group-II (0.51 ha) in the genna season.
Livestock Ownership

The target area is known for its livestock resource. Livestock are kept not only for economic purposes but also for their social values. Farmers rear a number of livestock namely cattle, equine (donkeys, horses and mules), and small ruminants (sheep and goats). The livestock ownership of the sample households is shown in Table 5. In 1996, there were about 163,127 cattle, 3,742 sheep, 8,471 goats, 5,515 donkeys, 5,302 horses, and 1,791 mules in Gassera areas.

The two target groups were significantly different in average number of cattle owned. The t-test showed that Target-group-I was significantly different from its counter part in cattle ownership at 1% level (Table 5). This difference was brought because of significantly larger number of cows, heifers, calves, and oxen owned by farmers in Target-group-II, as there is better livestock feed and water availability as compared to Target Group-I.

Table 5. Livestock ownership of the sample farmers

<table>
<thead>
<tr>
<th></th>
<th>Target-group-I</th>
<th>Target-group-II</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Cattle</td>
<td>6.3</td>
<td>3.9</td>
<td>10.5</td>
</tr>
<tr>
<td>Ox</td>
<td>2.3</td>
<td>1.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Cow</td>
<td>2.6</td>
<td>1.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Heifer</td>
<td>1.7</td>
<td>0.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Bull</td>
<td>1.8</td>
<td>0.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Calf</td>
<td>1.4</td>
<td>0.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Equine</td>
<td>2.1</td>
<td>1.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Donkey</td>
<td>1.5</td>
<td>0.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Horse</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Mule</td>
<td>1.0</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>Small ruminants</td>
<td>2.0</td>
<td>-</td>
<td>4.5</td>
</tr>
<tr>
<td>Sheep</td>
<td>-</td>
<td>-</td>
<td>4.2</td>
</tr>
<tr>
<td>Goat</td>
<td>2.0</td>
<td>-</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**= Significant at 10% probability level, ***= Significant at 5% probability level, ****= Significant at 1% probability level.
Access to Credit and Information
Farmers got formal credit through Agricultural Development Office in the form of farm inputs (fertilizer, improved seeds- mostly wheat, and herbicides). Agri-Service Ethiopia Bale Project Coordination Office also provided improved seeds of wheat through credit. About half of the respondents had access to formal credit, out of which 81.4% received it in the form of fertilizer. Farmers got information on new technologies from three main sources. These were extension or development agents (DAs), farmers’ training courses, and radio. The majority (94.9%) got information through DAs (Table 6). Meetings called by PAs were the major forums for the DAs to advise farmers. Moreover, DAs advise farmers in general and contact farmers in particular, individually by being on farmers’ field during different farm operations.

<p>| Table 6. Sources of information for farmers on improved technologies |
|----------------|----------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Target-group-I</th>
<th>Target-group-II</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension (DA)</td>
<td>yes</td>
<td>91.4</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>8.6</td>
</tr>
<tr>
<td>Radio</td>
<td>yes</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>91.4</td>
</tr>
<tr>
<td>Training course</td>
<td>yes</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>no</td>
<td>94.3</td>
</tr>
</tbody>
</table>

Barley Production

Barley Varieties
Farmers produced only local barley varieties. No improved barley variety existed in the hands of sample farmers. Improved barley varieties released so far did not perform well in this area due to the presence of barley shoot fly (Delia arambourgi). Diversification of barley varieties was minimal among the sample farmers. Almost all of the farmers grew a single barley variety, which was dominantly Aruso. Other barley varieties such as Burtuji, Kinticho, Bahir-Seded, and Cheneka were also reported to exist.

Barley Management Practices

Seedbed preparation, planting time and seed rate
Land preparation was totally done by an oxen-drawn plow called ‘maresha’. No one from the sample farmers prepared his land using tractors. The starting time for land preparation is influenced by a number of factors. These include easiness of the land for plowing, type of the preceding or the following crop, rainfall pattern, soil moisture status, and availability of oxen and human labor. About 70% of the farmers started seedbed preparation either in September or in October for genna crops. For bona crops, most of the farmers (83.9%) started land preparation in April or in May after planting of genna crops. This result is consistent with the initial result of informal survey conducted a year before this survey. The variation of the two seasons with respect to plowing frequency for
barley was minimal. In both seasons, more than 85% of the farmers plow their barley field 4-6 times the mode being five times.

Planting time of barley varies from place to place and from year to year. The two target groups were significantly different in planting period of barley in genna season ($\chi^2 = 28.8; d.f. = 11; P < 0.01$). Most of the farmers planted barley before the end of April in Target-group-I whilst farmers in Target-group-II extended planting time of barley up to mid-May (Table 7). Similarly farmers in Target-group-I were significantly different from farmers in Target-group-II in planting time of barley in bona season ($\chi^2 = 22.4; d.f. = 9; P < 0.01$). That is, about 97% of the responses indicated that farmers in Target-group-I planted barley between mid-July and mid-September and about 94% of the responses indicated that farmers in Target-group-II planted barley between early August and end of September (Table 7).

The average seed rate for barley was 195 kg/ha for 88% of the sample farmers. This is quite greater than the seed rates usually recommended for barley (100-125 kg/ha).

**Soil fertility management**

The sample farmers had history of less than 15 years in using chemical fertilizers. More than 70% of the farmers started using fertilizer after market liberalization. All of the farmers used DAP at the beginning. Even in 1997, about 91% of the respondents used DAP on their crops and only 27.8% applied Urea. Similarly, more than 80% of the farmers who used fertilizer on barley applied DAP in 1997. The proportion of farmers using fertilizers, not only on barley but also on other crops, was low. For example, in 1997 bona season, only 56.3% of the farmers used fertilizer on any crop. Likewise, the percent of farmers who applied fertilizer on barley was only 34.3%. About 56% of the farmers in Target-group-II applied DAP on some of their crops and about 37% of the farmers in Target-group-I. This difference is significant at 10% level (Table 9). Moreover, the percent of farmers applying urea in Target-group-I was also significantly greater than that in Target-group-II ($\chi^2 = 3.75; d.f. = 1; P < 0.1$). The reasons given by farmers for not using fertilizer were lack of money, late delivery, and other personal problems. Lack of money was the major bottleneck hindering fertilizer use as reported by 74.4% of the farmers. Barley and wheat were the priority crops as far as fertilizer application are concerned being fertilized by 63% and 83.3% of fertilizer-users respectively. Fertilizer was
also applied on other crops such as, tef, emmer wheat and maize. The average rate of DAP applied on barley was 57.3 kg/ha. The average annual consumption of DAP per household was constant between 1995 and 1997 i.e. 91 kg per year (Table 8). However, the percent of farmers who used fertilizer (DAP) increased consistently from 29 in 1995 to 50 in 1997.

Farmers reported several institutional and economic problems, which they faced in using fertilizer. The main ones were lack of money and high price of fertilizer (Table 10). There were two major sources of fertilizer for farmers. These were Gassera District Agricultural Development Office, which supplied 57.5% of fertilizer users and market (46.9%).

The other soil fertility enhancing methods were crop rotation and manure. More than 90% of the farmers used crop rotation to increase the productivity of their land. The crops used in rotation were wheat, barley, maize, tef, pulses, linseed, and emmer wheat. However, about 74% of the respondents rotated cereals after cereals, which is not recommended. Animal manure was not widely used. Only 29.3% of the farmers used it to improve the fertility of the soil.

Table 8. Yearly fertilizer consumption of the sample farmers (1995-1997)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>genna</td>
<td>bona</td>
<td>total</td>
</tr>
<tr>
<td>DAP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>amount bought (kg)</td>
<td>51</td>
<td>62</td>
<td>91</td>
</tr>
<tr>
<td>percent of farmers</td>
<td>21</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Urea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>amount bought (kg)</td>
<td>50</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>percent of farmers</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 9. Proportion of sample farmers who used fertilizer in 1997

<table>
<thead>
<tr>
<th></th>
<th>Target-group-I</th>
<th>Target-group-II</th>
<th>( \chi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>% n</td>
<td>% n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applied fertilizer</td>
<td>45.7</td>
<td>16</td>
<td>60.3</td>
</tr>
<tr>
<td>Applied DAP</td>
<td>37.1</td>
<td>13</td>
<td>56.3</td>
</tr>
<tr>
<td>Applied urea</td>
<td>5.7</td>
<td>2</td>
<td>20.3</td>
</tr>
</tbody>
</table>

* = Significant at 10% probability level.

Table 10. Problems encountered by sample farmers in using fertilizer

<table>
<thead>
<tr>
<th></th>
<th>%</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>late delivery</td>
<td>13.6</td>
<td>6</td>
</tr>
<tr>
<td>inadequate supply</td>
<td>3.4</td>
<td>2</td>
</tr>
<tr>
<td>high price</td>
<td>66.1</td>
<td>39</td>
</tr>
<tr>
<td>lack of money</td>
<td>86.4</td>
<td>51</td>
</tr>
<tr>
<td>inadequate credit</td>
<td>6.8</td>
<td>4</td>
</tr>
<tr>
<td>others</td>
<td>20.3</td>
<td>12</td>
</tr>
</tbody>
</table>

Weed management

Ninety seven percent of the farmers reported that weeds were important problems in crop production. The major weed flora of the survey zone include Guizotia scabra, Galinsoga purviflora, Amaranthus hybridus, Digitaria abyssinica, Digitaria sclarum, Tagetes minuta L., Ocium canam, Polygonum nepalenses, Bracica spp, Rumex spp, and Cuscuta spp, Flaria frinervia, Galium spuriun, Plantago lanceolata, Bidens pachyloca, Bidens plosa, Raphanus raphanistrum, Z-weed (not identified), Chenopodium spp, Solanum nigrum, Comolina bengalensis, Erucastru spp, and Cyperus blysmoides. Among these
weed species, *Guizotia scabra*, *Galinsoga purviflora*, *Amaranthus hybridus*, and *Digitaria abyssinica* are economically important in the study area.

Both hand weeding and herbicides were used to control weeds (Table 11). The majority (96.6%) of the farmers weeded barley once. 2-4D was the only herbicide used. More than 85% of herbicide-users started using 2-4D in 1995 and thereafter. There were two sources of herbicide for farmers GAADO and market. Forty eight percent purchased 2-4D from market whereas 44% got it from GAADO. The average rate of 2-4D was 0.56 l/ha. Farmers indicated several constraints related to the use of 2-4D. The main ones were high price, lack of sprayer and lack of money to purchase herbicide (Table 11).

<table>
<thead>
<tr>
<th>Weed control methods</th>
<th>%</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand weeding</td>
<td>38</td>
<td>27</td>
</tr>
<tr>
<td>Partial hand weeding*</td>
<td>22.5</td>
<td>16</td>
</tr>
<tr>
<td>Herbicide</td>
<td>36.6</td>
<td>28</td>
</tr>
<tr>
<td>Herbicide + partial hand weeding</td>
<td>1.4</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Constraints to herbicide use</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Late delivery</td>
<td>20.5</td>
<td>8</td>
</tr>
<tr>
<td>Inadequate supply</td>
<td>10.3</td>
<td>4</td>
</tr>
<tr>
<td>High price</td>
<td>59.0</td>
<td>23</td>
</tr>
<tr>
<td>Lack of money</td>
<td>48.7</td>
<td>19</td>
</tr>
<tr>
<td>Lack of sprayer</td>
<td>53.8</td>
<td>21</td>
</tr>
<tr>
<td>High rent of sprayer</td>
<td>30.8</td>
<td>12</td>
</tr>
<tr>
<td>Inadequate credit</td>
<td>2.6</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>7.7</td>
<td>3</td>
</tr>
</tbody>
</table>

* = Random pulling out of larger weeds.

**Harvesting and post-harvest management**

All of the farmers harvested barley manually using sickles. No farmer used combine harvester to harvest any crop though the terrain characteristics of the area favors mechanization. About 63% of the farmers indicated that combine harvesters were not available and 56.6% reported they did not have money to hire combine harvesters (Table 12). Since harvesting time of crops depends up on planting time, the two groups were different in time of harvesting of barley in both seasons.

<table>
<thead>
<tr>
<th>Limiting factors for farm mechanization</th>
<th>%</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of knowledge</td>
<td>9.1</td>
<td>9</td>
</tr>
<tr>
<td>Lack of money</td>
<td>56.6</td>
<td>56</td>
</tr>
<tr>
<td>Land not suitable</td>
<td>22.2</td>
<td>22</td>
</tr>
<tr>
<td>Fragmented farm plots</td>
<td>20.2</td>
<td>20</td>
</tr>
<tr>
<td>Not available</td>
<td>62.6</td>
<td>62</td>
</tr>
<tr>
<td>Others</td>
<td>3.0</td>
<td>3</td>
</tr>
</tbody>
</table>

About 78% of the responses indicated that farmers in Target-group-I harvested barley between early July and end of July. Only 12.1% of the farmers extended harvesting up to end of August in this domain. However, the statistical analysis showed that about 55% of the farmers in Target-group-II extended harvesting up to the end of August in *genna* season (Table 13). Similarly, harvesting time
of barley in *bona* season was earlier in Target-group-I than in Target-group-II. In Target-group-I, about 88% of the responses showed that farmers undertook harvesting before end of December whilst in Target-group-II more than 80% of the responses showed that farmers harvested barley between mid-November and mid January (Table 13).

Farmers piled barley in fields after harvesting. During dry period, when they got time, they transported it to a threshing site, which is usually kept fallow for this purpose. Most of the interviewed farmers (91.8%) used local transporting implement made of wood, locally termed as ‘mezgie’ or ‘gurto’. It is supported and pulled by two oxen. The other 25.8% also used donkeys to transport their non-threshed barley from farm sites to threshing sites.

Table 13. Harvesting time of barley in *genna* and *bona* seasons

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Time of harvesting</th>
<th>Target-group-I</th>
<th>Target-group-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td><em>Genna</em></td>
<td>Early July to end of July</td>
<td>84.8</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Mid July to mid August</td>
<td>9.0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Early August to end of August</td>
<td>12.1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Mid August to mid September</td>
<td>3.1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Early September to end of September</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Bona</em></td>
<td>Early November to end of November</td>
<td>40.9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Mid November to mid December</td>
<td>22.7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Early December to end of December</td>
<td>36.8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Mid December to mid January</td>
<td>4.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Early January to end of January</td>
<td>9.1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Mid January to mid February</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

All of the sample farmers used oxen trampling method to thresh barley. About 46% of the farmer’s threshed *genna* crops, including barley, immediately after harvesting and 31.3% kept them piled until *bona* crops were threshed. In *bona* season, 96.4% of the respondents undertook threshing just after harvesting (Table 14).

The grain yield of barley varies from year to year depending up on rainfall distribution and other natural occurrences (disease, insect pest, weed infestation, flood, etc.), soil fertility, frequency and depth of tillage, varieties, crop rotation, rate of fertilizer used, planting time, etc. In a nutshell, a certain level of grain yield is a result of interaction between natural circumstances, farmers’ crop management levels, and crop varieties. Keeping this fact in mind, the average grain yields of barley, wheat, tef, and emmer wheat are presented in Table 15.
Barley-based farming systems in Gassera

Table 14. Time for threshing crops in genna and bona season

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Time of threshing</th>
<th>Target-group-I</th>
<th>Target-group-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%  n</td>
<td>%  n</td>
</tr>
<tr>
<td>Genna</td>
<td>Early October to end of October</td>
<td>26.7 8</td>
<td>28.0 14</td>
</tr>
<tr>
<td></td>
<td>Mid October to mid November</td>
<td>- -</td>
<td>6.0 3</td>
</tr>
<tr>
<td></td>
<td>Early November to end of November</td>
<td>6.7 2</td>
<td>22.0 11</td>
</tr>
<tr>
<td></td>
<td>When bona crops are threshed (January to February)</td>
<td>36.7 11</td>
<td>28.0 14</td>
</tr>
<tr>
<td></td>
<td>Just after harvesting (Late July to Late August)</td>
<td>46.7 14</td>
<td>46.0 23</td>
</tr>
<tr>
<td>Bona</td>
<td>Mid January to mid February</td>
<td>- -</td>
<td>16.4 9</td>
</tr>
<tr>
<td></td>
<td>Early February to end of February</td>
<td>8.3 3</td>
<td>17.8 13</td>
</tr>
<tr>
<td></td>
<td>Mid February to mid March</td>
<td>- -</td>
<td>2.7 2</td>
</tr>
<tr>
<td></td>
<td>Early March to end of March</td>
<td>- -</td>
<td>2.7 2</td>
</tr>
<tr>
<td></td>
<td>Just after harvesting (early to end of January)</td>
<td>91.3 33</td>
<td>64.3 47</td>
</tr>
</tbody>
</table>

The grain yield of barley was lower in 1997 than the preceding two years. In bona season of 1997, the average grain yield declined by about 32% and 21% as compared to the grain yield levels of the similar season in 1995 and 1996 respectively. Similarly, the grain yield of barley in genna season of 1997 was lower by 4% and 11% than those in genna season of the respective preceding two years. Unfavorable rainfall pattern was the major problem contributed for yield reduction in barley according to 92.3% of the farmers followed by disease (34.6%). The sample farmers used three types of grain storing equipment namely ‘gota’, sacks/fertilizer bags, and pots (Table 16). The important storage problems were rats, weevils and moisture/moulds. About 96% of the respondents indicated rats were important storage pests.

Table 15. Average grain yield of small cereals (in kg/ha) in 1997

<table>
<thead>
<tr>
<th></th>
<th>Target-group-I</th>
<th>Target-group-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>genna  bona</td>
<td>genna  bona</td>
</tr>
<tr>
<td>Barley</td>
<td>556 444</td>
<td>834 743</td>
</tr>
<tr>
<td>Improved wheat</td>
<td>741 696</td>
<td>1191 1095</td>
</tr>
<tr>
<td>Local wheat</td>
<td>426 411</td>
<td>707 559</td>
</tr>
<tr>
<td>Average (wheat)</td>
<td>505 460</td>
<td>821 692</td>
</tr>
<tr>
<td>Emmer wheat</td>
<td>2926* 1050*</td>
<td>659 640</td>
</tr>
<tr>
<td>Tef</td>
<td>416 -</td>
<td>384 -</td>
</tr>
</tbody>
</table>

*The observed values were highly dispersed; hence, the mean grain yield of emmer wheat is not reliable in Target-group-I.

Table 16. Grain storage places and storage problems

<table>
<thead>
<tr>
<th></th>
<th>Target-group-I</th>
<th>Target-group-II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%  n</td>
<td>%  n</td>
</tr>
<tr>
<td>Storage places</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gotera</td>
<td>97.1 34</td>
<td>90.6 58</td>
</tr>
<tr>
<td>Sacks/fertilizer bags</td>
<td>74.3 26</td>
<td>84.4 54</td>
</tr>
<tr>
<td>Pots</td>
<td>31.4 11</td>
<td>32.8 21</td>
</tr>
<tr>
<td>Storage problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weevil</td>
<td>79.4 27</td>
<td>69.8 44</td>
</tr>
<tr>
<td>Rat</td>
<td>94.1 32</td>
<td>96.8 61</td>
</tr>
<tr>
<td>Moisture/moulds</td>
<td>5.9 2</td>
<td>1.6 1</td>
</tr>
</tbody>
</table>

3 Large container of grains made of usually bamboo trees and plastered by mud.
Production Constraints and Solutions

The principal problems of the farming community vary from one PA to another and, even, from one site to another. Keeping these differences of problems across location in mind, socio-economic problems and constraints directly related to crop production are summarized in table 17 based on the responses from the sample farmers.

Crop diseases and insect pests were reported as major constraints by major proportion of the farm households in both target groups. Among crop diseases, net blotch on barley and septoria and tan spot on wheat are important diseases during genna/belg season whereas leaf rust and net blotch on barley and strip rust and stem rust on wheat were found to be important during bona/meher season.

Table 17. Socio-economic problems and constraints directly related to crop production (% of respondents)

<table>
<thead>
<tr>
<th>Crop production problems</th>
<th>Target-group-I</th>
<th>Target-group-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases</td>
<td>69.7*</td>
<td>85.9</td>
</tr>
<tr>
<td>Insect pests</td>
<td>27.3</td>
<td>29.7</td>
</tr>
<tr>
<td>Water logging</td>
<td>9.1</td>
<td>10.9</td>
</tr>
<tr>
<td>Low moisture stress</td>
<td>51.5</td>
<td>15.4</td>
</tr>
<tr>
<td>Socio-economic problems</td>
<td>67.7</td>
<td>66.7</td>
</tr>
<tr>
<td>Shortage of human clinic</td>
<td>16.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Abundance of clean water for drinking</td>
<td>9.7</td>
<td>48.9</td>
</tr>
<tr>
<td>Shortage of fuel wood</td>
<td>51.6</td>
<td>33.3</td>
</tr>
<tr>
<td>Shortage of schools</td>
<td>45.2</td>
<td>15.6</td>
</tr>
</tbody>
</table>
*Figures indicate percentage of farmers ranked a problem as major or minor.

With regard to insect pests, barley shoot fly and aphid on barley and wheat; bollworm on linseed and green pea aphid and pod borer on field pea were the most important ones. As far as the possible suggestions, concerning diseases and pests the foremost important issues is to give emphases to screening resistant varieties that withstand this diseases and pests. Studying the nature of pests and screening effective insecticide is also important. Farmers' indicated that weeds sometimes cause complete crop failure. The suggestion regarding this problem is to advice farmers to prepare their land well, to use clean seeds, to weed their crops early and to use the recommended level of herbicides. Researchers have to come up with alternative herbicide other that 2-4D.

Water logging was a major crop production problem in the eastern part of target group II. To overcome this problem it is very important to advise farmers to properly drain their farmland with their available technology at hand. In addition introducing broad bed maker plough can be an alternative solution to the problem. Low moisture stress was also one of the major crop production problems identified by farm households in Target Group I. Hence, researchers should concentrate their efforts to develop early maturing varieties.
Conclusions and Recommendations

A diagnostic farming system survey was conducted in Gassera area. Ninety-nine farm households were interviewed using a structured questionnaire. Two main target groups: Target Group I and Target Group II, were identified. In Target Group I crop failures are reported to exist repeatedly because of low rain during the cropping seasons. In Target Group II the distribution of rainfall is mostly favorable for crop production except in the eastern part of the target group where water logging is the main crop production problem.

Farmers in Target Group I was more dependent on \textit{genna/belg} season for crop production because of better rainfall distribution. This was partly manifested by the proportion farmland allocated (60\%) to crops in this season. On the contrary, Target Group II, the two seasons got almost equal share in area of farmland located for crops (54\% in \textit{bona/meher} season and 46\% in \textit{genna/belg} season). In \textit{bona/meher} season of 1997 barley was the second crop next to wheat in area coverage in both target groups (36\% in Target Group I and 31\% in Target Group II). In \textit{genna/belg} season of the same year, barley was the first crop in Target Group I (43\%) and it was the second crop in Target Group II (36\%).

The study area is known for its livestock resource. Livestock has both economic and social values. Cattle, equine, and small ruminants are the most important livestock type kept by farm households. The two target groups were significantly different in terms of cattle ownership. This is attributable to the fact that in Target Group II the rainfall distribution is favorable throughout the year, which in turn result in availability of livestock feed and water.

Crops were dependable sources of income for 96\% of farm households followed by livestock, which covered some or all of the cash needs for about 82\% of the farmers. Barley took the fourth rank as a source of income, and it was the major source of income for about 34\% of the farm households. However, it took the first rank with in the level of household consumption. Despite its importance barley production in the study area was constrained by lack of resistant varieties to insect pests (particularly barley shoot fly) and disease.

Barley shoot fly impaired barley production in Bale highlands in general and in the study area in particular. This problem causes a decline in area allocated to barley. Improved barley varieties so far released by the agricultural research system could not able to withstand insect pest. Therefore, much emphasis should be given to come up with better resistant barley varieties. Screening effective insecticide is also another area that should get emphasis so that farmers can produce the available improved barley varieties. In addition to barley shoot fly, diseases and weeds are also important bottlenecks to barley production. Research has to come up with resistant barley varieties to diseases and with alternative herbicides to control weed. The extension system should advise farmers to prepare their land well, to use clean seeds and recommended rate of herbicide.
References

Analysis of Tef Production Systems and Constraints in Ejere and Ada Berga Weredas, West Shewa Zone

Agajie Tesfaye1, Getachew Agegnehu2, Abraham Gebeyehu3, and Mesfin Haile1

Introduction

Agriculture is the mainstay of Ethiopian economy, more than 50% of the GDP and around 85% of the job opportunities are contributed by the agricultural sector (MoWR, 1997). In spite of the leading position of the sector in the national economy, the efficiency and growth of the agricultural sector is still insufficient (MoWR, 1997).

Tef occupies 2.8% of the cultivated land under cereals while sorghum occupies 20%, barley 17%, maize 16%, wheat 13%, millet 5%, and oats 1%. Presently, it is cultivated under diverse agro-climatic conditions. It can be grown from sea level up to 2800 meters altitudes, under various rainfall, temperature, and soil regimes. However, according to experiences gained from national yield trials conducted at different locations, tef performs excellent at an altitude of 1800-2100 meters above sea level (masl), growing season rainfall of 450-550 mm, and a temperature range of 10°c – 27°c.

Since tef is economically the most important crop at national level in general and in west Shewa zone in particular, great efforts in research and extension activities have been made to improve the productivity of the crop. A number of improved tef varieties with their associated packages have been generated and disseminated to the farmers. However, the production of tef is still below expectation. Hence, there is a need to give more emphasis on research, extension, development, and policy interventions to improve the production and productivity of tef. This study was conducted with the following specific objectives to: analyse and characterize farmers' tef production practices; identify and prioritise constraints that limit the productivity of tef; to assess the status of tef production technologies in the farming systems.

Methodology

The Study Sites

The survey focused on the major tef growing areas of Ejere, Dendi and Ada Berga weredas, west Shewa zone. However, since tef production practices in Dendi and Ejere weredas are similar, representative peasant associations (PAs) were selected from Ejere and the findings of Ejere wereda were assumed to represent tef production systems in Dendi wereda and other similar agro-ecologies. The total annual rainfall in the highland areas of the two weredas was above 1000 mm. The major agricultural activity of the area depends on rain-fed crop production. Since most of the weredas are found in the highland part of the region, they are densely populated and most of the

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1 Socio-economist, 2Agronomist, 3Forage and Pasture, Holetta Research Center, P.O.Box 2003, Addis Ababa.
lands are under cultivation. Ejere wereda is located along the highway from Addis Ababa to Nekemet at a distance of 55 km west of Addis Ababa. Ada Berga wereda is located on the main road from Addis Ababa to Muger at a distance of 80 km west of Addis Ababa. About 97% of both Ejere and Ada Berga weredas is located in M2-5 (Tepid to cool moist mountains and plateau) sub-agroecological zone.

Sampling Procedures, Data Collection and Analytical Techniques
Purposive sampling technique was used to select tef-growing weredas based on their production potential. Three-stage sampling procedure was used to select weredas, peasant associations (PAs) and farmer households. Samples of peasant associations were selected using simple random sampling technique from the lists of all major tef growing PAs in the selected weredas. Farmers to be interviewed were selected using systematic sampling technique.

Three types of survey procedures were employed to collect the required data. First, secondary data was collected to acquire a general understanding of the farming systems. Secondly, some of the participatory rural appraisal (PRA) techniques such as, matrix rankings and semi-structured interviews (individual, group, and key-informant interviews), were used to collect wide ranges of qualitative data. Third, focused formal survey was conducted to quantify some of the important parameters (such as family size, land ownership, livestock holdings, etc.) using a structured and pre-tested questionnaire. Enumerators were recruited and trained to fill the questionnaire by interviewing farmers with close supervision of researchers and the staffs of wereda Office of Agriculture. A total sample size of 472 farmers was selected from the study areas, of which 242 were from Ejere and 230 from Ada Berga. Out of the total sample, 88% of them in both study areas were male-headed while the remaining were female-headed households (Table 1). The quantitative data were analyzed with descriptive statistics using SPSS statistical software.

<table>
<thead>
<tr>
<th>Household type</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male headed</td>
<td>214</td>
<td>203</td>
<td>417</td>
</tr>
<tr>
<td>Female headed</td>
<td>28</td>
<td>27</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>230</td>
<td>472</td>
</tr>
</tbody>
</table>

Results and Discussion

Socio-economic Circumstances

Land holding
Farmers of Ejere wereda owned significantly higher cropped area (3.3 ha) than the farmers of Ada Berga wereda who owned 2.8 ha (P < 0.01) (Table 2). Tesfaye (2002) in his studies has reported that increased size of land holding has a positive association with adoption level of a technology. About 85% of the farmers in both study areas indicated that their land holding is not sufficient to cover food and other requirements for themselves and their families. This might be because of the declining productivity of land due to low soil fertility, minimum use of inputs and other traditional management practices. As a strategy to overcome this problem, the farmers believe
Tef production systems and constraints

that getting more land is a solution. As a result, 42% of the farmers in Ejere and 44% in Ada Berga weredas have leased-in some land from other farmers. The farmers who leased in land from others were those who owned enough oxen and human labor. As reported by about 36% of the farmers who leased-in land, the share arrangement of produce was on equal basis with the landowner. About 21% of the farmers in both study areas also leased-out part of their land holding to other farmers due to shortage of oxen (16% in Ejere and 9% in Ada Berga weredas) and cash to purchase the required external inputs (12% in Ejere and 6% in Ada Berga). Some farmers who did not own enough seed (12% in Ejere and 5% in Ada Berga) also leased-out part of their land to others. However, the farmers' perception of increasing cropped area to increase production may not be a stable solution for food shortage problem and it is not possible to increase area any time when required. Hence, the focal point of consideration should be in increasing the productivity through various appropriate means, of which research intervention is one.

Table 2. Farmer's allocation of land owned (ha) to different uses, 2001

<table>
<thead>
<tr>
<th>Landholding</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>n</td>
</tr>
<tr>
<td>Crop</td>
<td>236</td>
<td>3.3</td>
<td>230</td>
</tr>
<tr>
<td>Grazing</td>
<td>202</td>
<td>0.4</td>
<td>208</td>
</tr>
<tr>
<td>Pasture</td>
<td>30</td>
<td>0.2</td>
<td>78</td>
</tr>
<tr>
<td>Tree</td>
<td>42</td>
<td>0.01</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>238</td>
<td>3.6</td>
<td>230</td>
</tr>
</tbody>
</table>

*F-test value for mean difference

Family particulars

Previous studies also indicate that family size is one of the factors that affect the level of adoption of agricultural technologies (Mwangi et al., 2000). It is assumed that the larger the family size, the more likely that households will adopt new technology. This was because; the farmers could have adequate labor to perform farming activities timely. When the overall sample is considered, the average age of the household heads was 49 years with an average farming experience of 28 years. The average family size of farmers in both study areas was six ranging from 2 - 13 (Table 3).

When the overall household of the sample is considered, the proportion of population at young age (< 15 years) accounted for 48% while the proportion of the population in the working age (15 - 64 years) accounted for 47%. The proportion of old age population (> 64 years) accounted for about 5%. Hence, as the results indicate, out of the total members of a household, 53% depend on the remaining 47% for their livelihoods. Analysis of population dependency burden indicates that the overall dependency ratio was 111 (101 young dependency ratio and 10 old dependency ratio) implying that for 100 persons in the working age, there are 111 dependents. In general, the results imply that the dependency burden of the population is high and increasing the productivity of tef contributes in ensuring food security for the growing population.

Table 3. Family particulars of the sample households in the study areas

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>S.E</td>
</tr>
<tr>
<td>Age of HH</td>
<td>242</td>
<td>47</td>
<td>0.8886</td>
</tr>
<tr>
<td>Experience of HH</td>
<td>242</td>
<td>27</td>
<td>0.8736</td>
</tr>
<tr>
<td>Age of wife</td>
<td>194</td>
<td>35</td>
<td>0.7904</td>
</tr>
<tr>
<td>Total family size</td>
<td>235</td>
<td>6</td>
<td>0.1549</td>
</tr>
</tbody>
</table>

HH = Household head, SE = Standard error
Education

When the overall sample is considered, 60% of the household heads were not able to read and write (Table 4). About 23% of the farmers were able to read and write through informal sources of education, such as adult education programs and informal/traditional church schools. Only 17% of the farmers in both study areas have attended formal education ranging from elementary to high school levels.

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not read and write</td>
<td>124</td>
<td>51</td>
<td>159</td>
</tr>
<tr>
<td>Read and write*</td>
<td>77</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Elementary</td>
<td>32</td>
<td>13</td>
<td>35</td>
</tr>
<tr>
<td>Junior</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>High school</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*Able to read and write through informal sources of education

Extension

In the study areas, Regional Extension Package Program and different types of farmer training programs were the most important pathways for technology transfer. When the overall sample is considered, 38% of the farmers have participated in extension package programs at the time of the study. Moreover, 13% of the farmers have participated in different types of agricultural training programs. 81% of the overall sample farmers got information about technologies from Development Agents (Table 5). Farmer-to-farmer information exchange also plays considerable role as reported by 28% of the sample farmers. Some farmers (11%) owned radio and used it as important source of information about agricultural technologies. Hence, the results seem to suggest that extension contact, favorable training and other conditions that expose farmers to technologies need to be strengthened.

<table>
<thead>
<tr>
<th>Sources of information</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio</td>
<td>34</td>
<td>14</td>
<td>54</td>
</tr>
<tr>
<td>Friends</td>
<td>89</td>
<td>37</td>
<td>131</td>
</tr>
<tr>
<td>Contact farmers</td>
<td>78</td>
<td>32</td>
<td>127</td>
</tr>
<tr>
<td>DAs</td>
<td>201</td>
<td>83</td>
<td>380</td>
</tr>
</tbody>
</table>

The Research Extension Farmer Linkage Division of EARO has also made considerable contribution in technology dissemination. It demonstrated technologies to users under their own environmental and socio-economic conditions. As indicated in Table 6, some of the most important improved tef varieties released for use were demonstrated to farmers to test the performances of the varieties. This practice also contributes to farmers as source of improved seeds.

<table>
<thead>
<tr>
<th>Implementing institute</th>
<th>Improved varieties</th>
<th>Year of release</th>
<th>Years of demonstration</th>
</tr>
</thead>
<tbody>
<tr>
<td>and Farmer Linkage</td>
<td>DZ-Cr-44</td>
<td>1982</td>
<td>1986</td>
</tr>
<tr>
<td>Division of EARO</td>
<td>DZ-Cr-358 (Ziquala)</td>
<td>1995</td>
<td>1998</td>
</tr>
<tr>
<td></td>
<td>DZ-01-974 (Dukem)</td>
<td>1995</td>
<td>1998</td>
</tr>
<tr>
<td>National Extension</td>
<td>DZ-Cr-37 (Tseday)</td>
<td>1984</td>
<td>1995</td>
</tr>
<tr>
<td>Package Program</td>
<td>DZ-01-354</td>
<td>1970</td>
<td>2000</td>
</tr>
</tbody>
</table>

Labor use
As indicated in the previous sections, half of the household members were not in the age range of active labor force. As a result, farmers faced labor shortages during peak seasons of *tef* production. The most labor demanding activity in *tef* production was harvesting as reported by 91% of the farmers in Ejere and 80% in Ada Berga (Table 7). The differences in proportions were statistically significant (P<0.01) implying that seasonal labor shortage is acute in Ejere than Ada Berga. Except for threshing, there is statistically significant difference between the two weredas in terms of seasonal labor demands. This condition might create seasonal migration of labor from low demand to high demand areas in search of work and this helps to stabilize seasonal labor shortage problems especially for those who are able to hire additional labor. To minimize seasonal labor shortages, farmers used different local labor arrangement mechanisms, such as "Debo"², "Wonfel"³, and hiring casual laborers. The results seem to suggest that in generating technologies, attention should be given to consideration of the labor demands of the technologies. Farmers may not be willing to adopt a technology that requires more labor during peak seasons of labor demand.

### Table 7. Farming activities on which farmers faced seasonal labor shortages in *tef* production

<table>
<thead>
<tr>
<th>Farming activities</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Land preparation</td>
<td>40</td>
<td>17</td>
<td>37</td>
<td>27</td>
</tr>
<tr>
<td>Planting</td>
<td>102</td>
<td>42</td>
<td>54</td>
<td>48</td>
</tr>
<tr>
<td>Weeding</td>
<td>27</td>
<td>11</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Harvesting</td>
<td>220</td>
<td>91</td>
<td>80</td>
<td>66</td>
</tr>
<tr>
<td>Threshing</td>
<td>94</td>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>

**Credit**

Credit service is one of the subsidiary activities that influence the level of technology use by farmers. In most of the cases, improved agricultural technologies require the use of external inputs, such as fertilizer, herbicides, fungicides, etc and this requires for credit. In this study, about 31% of the farmers in Ejere and 51% in Ada Berga have taken credit for different farming activities and this difference was statistically significant (P<0.01). The credit service was mainly in the form of fertilizer and herbicides, which is accessed through wereda Office of Agriculture. There are also informal commercial sources of credit, such as village moneylenders, who lend money on short-term basis and charge high rates of interest (about 120% per annum). Informal non-commercial sources of credit, such as friends, relatives and neighbors, are also important means of alleviating acute cash shortages in the study areas. These sources of credit do not charge interest rates mainly for sake of maintaining friendship and relations.

**Cultural Practices**

### Seedbed Preparation

In the study areas, seedbed preparation for *tef* starts in March if the rain commences timely and extends up to July. Farmers perceived that among the cereals, *tef* requires fine seedbed for evenly germination of seeds and suppression of weed growth.

² Is a means of labor arrangement to assist those who are in demand of labor at peak periods of labor shortage. The beneficiary prepares food and local drinks for those who came to assist. It is a reciprocal labor arrangement and the one who came to participate expects the same willingness from the beneficiary.

³ Is a means of labor arrangement mostly among close relatives and friends. No food and drinks are served by the beneficiary and it is not necessarily reciprocal.
Accordingly, they practiced 5 - 6 passes before planting. This might be the reason why seedbed preparation was reported as one of the labor demanding activities in tef production (Table 7). In an experiment conducted to evaluate effect of tillage, weed control practices on yield, and yield components of tef, it was reported that plowing more than once might not be necessary if non-selective herbicides are applied to control weed flush before plowing (Aberra, 1992). The same study also reported that no tillage produced the lowest yield while there were no significant differences between 2, 3, 4 and 5 times tilling. Hence, research results seem to suggest that tef can be produced under reduced tillage and the farmers need to minimize extra tillage.

**Planting and Seed Rates**

Under normal conditions, it was observed that tef planting is based on the type of variety. The local variety red tef (*Bunign*) was planted earlier than white tef (*Magna*). Farmers have also noticed, tef planting varies by soil type. Tef planting extends from July - August, planting earlier on Andosols and later on Vertisols. On the other hand, research recommendation suggests that sowing date for most regions is 15 - 21 July on Andosols and 21 - 31 July on Vertisols. This ensures higher yields by avoiding some of the problems associated with early and late sowings (Seyfu, 1993). Farmers' practices of planting seem closely similar with research recommendations. Farmers used a seed rate of 30 - 35 kg/ha for tef. This is closely similar with the recommended rate of 25 - 30 kg/ha for broadcasting (Seyfu, 1993). Similar study also reported that if tef is planted using manually or motor-driven broadcaster or drill is available, lower seed rates, about 15 kg/ha, are preferable. However, farmers did not use this practice. The results seem to indicate that farmers' seed rates for broadcasting are closely in line with the research recommendations.

**Weed Management**

The most common weeds on tef were *Guzotia* spp., *Bidens* spp., *Cynodon dactylon*, *Digitaria* spp., *Amaranthus* spp., *Plantago* spp., and other species. It was observed that poor land preparation, use of low quality seeds and inefficient weed control practices were among the various causes of weed infestation. About 95% of the farmers in Ejere and 91% in Ada Berga perceived that tef is the most affected crop with weeds than other crops (Table 8). The most important weed control strategy was hand weeding as reported by 94% of the farmers in Ada Berga wereeda and 76% in Ejere and these proportions were statistically significant (P<0.01) as indicated on Table 9. When the overall sample is taken into consideration, about 76% of the farmers practiced once hand weeding of tef 4 - 6 weeks after planting. The results of previous experimental studies suggest that it is best to start with, a weed freed and clean field that has been plowed in the appropriate season (Seyfu, 1993). For hand weeding, similar study recommended that once hand weeding at early tillering stage (25 - 30 days after emergence) is adequate if weed infestation is low. If weed infestation is high, a second weeding should be done at the stem elongation stage. In general, the results of this study seem to indicate that most of the farmers practice closely similar weeding practices with research recommendations. This might be because, the farmers felt that tef is very sensitive and cannot compete with weeds. Research findings have also confirmed that yield losses to weed competing account for about 52% (Berhanu, 1986).

In addition to hand weeding, the application of post-emergence herbicide was another weed control strategy practiced by the farmers. It was reported that herbicide was
applied only on *tef* and wheat fields. This was because, farmers feel that these crops are more sensitive to weeds than others (Table 8).

<table>
<thead>
<tr>
<th>Crops</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tef</td>
<td>229</td>
<td>95</td>
<td>439</td>
<td>0.15</td>
</tr>
<tr>
<td>Wheat</td>
<td>52</td>
<td>22</td>
<td>129</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Maize</td>
<td>37</td>
<td>15</td>
<td>126</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sorghum</td>
<td>20</td>
<td>8</td>
<td>37</td>
<td>0.72</td>
</tr>
</tbody>
</table>

One liter of 2, 4-D ha⁻¹ was applied for *tef* field 40 days after planting to control broad-leaved weeds. Farmers' application rate and time of application was closely similar with the research recommendation of 2, 4-D at a rate of 0.8 - 1.3 kg a.i. / ha to be applied at 4 - 5 weeks after planting (Berhanu, 1986).

<table>
<thead>
<tr>
<th>Crops</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tef</td>
<td>185</td>
<td>76</td>
<td>401</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Wheat</td>
<td>34</td>
<td>14</td>
<td>112</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sorghum</td>
<td>48</td>
<td>20</td>
<td>79</td>
<td>0.05</td>
</tr>
<tr>
<td>Maize</td>
<td>72</td>
<td>30</td>
<td>208</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Barley</td>
<td>6</td>
<td>3</td>
<td>32</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

**Significant at 1% level of significance**

**Seed Source**

There are different sources of seed for *tef*, among which 96% of the farmers reserved part of the produce as seed from their previous harvests (Table 10). Exchange of *tef* with seeds of other crops, such as wheat, was also important source of farmers' seed. Wereda Offices of Agriculture supplied improved seeds through demonstration and extension package programs.

<table>
<thead>
<tr>
<th>Seed sources</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous harvest</td>
<td>232</td>
<td>96</td>
<td>455</td>
<td>0.52</td>
</tr>
<tr>
<td>Purchase from market</td>
<td>26</td>
<td>11</td>
<td>37</td>
<td>0.01</td>
</tr>
<tr>
<td>Exchange with seeds of other crops in the village</td>
<td>88</td>
<td>36</td>
<td>162</td>
<td>0.33</td>
</tr>
<tr>
<td>Borrowing</td>
<td>16</td>
<td>7</td>
<td>59</td>
<td>0.01</td>
</tr>
<tr>
<td>Wereda Offices of Agriculture</td>
<td>20</td>
<td>8</td>
<td>38</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Since improved varieties of *tef* are not supplied each year farmers have their own mechanism of maintaining seeds for the upcoming planting season. After harvesting, crops selected for seeds are threshed on a clean ground and kept separately in sacks or in locally constructed container known as *Gotha*. Knowledge of farmers' seed sources helps to understand the sustainable use of a technology that is released for use.

**Diversification of Varieties**

Diversification of *tef* varieties was a common practice in the study areas. When the overall sample is considered, a large proportion of the farmers (68%) planted more than one *tef* variety at a time (Table 11).
Table 11. Proportion of farmers growing different varieties of tef

<table>
<thead>
<tr>
<th>Number of improved varieties of tef</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>One</td>
<td>29</td>
<td>12</td>
<td>66</td>
</tr>
<tr>
<td>Two</td>
<td>145</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Three</td>
<td>59</td>
<td>24</td>
<td>48</td>
</tr>
<tr>
<td>Four</td>
<td>6</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Farmers have their own reasons for diversifying tef varieties. One of the most important factors for diversification was that farmers plant different varieties for food and market as reported by 50% of the overall sample (Table 12). The second most important reason was that depending on only one variety is risky and diversification is one of the risk aversion strategies as reported by 37% of the overall sample. Of course, availability of different environmental and natural factors, such as soil types, have contributed to enable farmers grow different tef varieties.

Table 12. Reasons for diversifying different varieties of improved tef

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different varieties are required for food and market</td>
<td>171</td>
<td>71</td>
<td>63</td>
<td>27</td>
</tr>
<tr>
<td>To aver risk</td>
<td>92</td>
<td>38</td>
<td>84</td>
<td>37</td>
</tr>
</tbody>
</table>

White seeded tef varieties were mainly planted for market since they are highly demanded by consumers due to their color. Red seeded tef varieties are mainly planted for consumption even though they are also sold at the market. For instance, white seeded tef (Magna) was mainly planted for sale as reported by 24% of the farmers in Ejere and 15% in Ada Berga. Moreover, the farmers of Ejere (29%) grow mixed color tef (Sergegna) mainly for sale.

Each variety has its own characteristics with regard to certain important parameters, such as adaptability to different climatic and soil conditions, resistance to waterlogging and moisture stresses, yield potential, straw quality as animal feed, height, taste preference for consumption and maturity status (Table 13). According to farmers' perception, the local varieties were low to medium yielder.

Table 13. Specific characteristics of some of the important tef varieties

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Bunign</th>
<th>Enat (Hado)</th>
<th>Sergenaga</th>
<th>Magna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptablety to different soil</td>
<td>Red and brown soils</td>
<td>Brown, red and black soils</td>
<td>Brown and black soils</td>
<td>Black and brown soils</td>
</tr>
<tr>
<td>Yield potential</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Straw quality as animal feed</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Height</td>
<td>Short</td>
<td>Long</td>
<td>Long</td>
<td>High</td>
</tr>
<tr>
<td>Taste preference for consumption</td>
<td>Satisfactory</td>
<td>Good</td>
<td>Good</td>
<td>Very good</td>
</tr>
<tr>
<td>Maturity length (days)</td>
<td>90</td>
<td>130-150</td>
<td>130-150</td>
<td>130-150</td>
</tr>
</tbody>
</table>

However, they noticed that improved varieties of tef grown with the recommended rate of fertilizer gave higher grain and straw yields than the local ones. Description of specific characteristics of varieties may help breeders to get a general understanding of the characteristics of local varieties for their future breeding programs.
Adoption of Production Technologies

Varieties
About 12 types of improved tef varieties released by Ethiopian Agricultural Research Organization were under production until the year 2000 (Table 14). About 79% of the farmers in Ejere and 98% in Ada Berga were aware of improved varieties of tef.

Table 14. Improved tef varieties under production until the year 2000

<table>
<thead>
<tr>
<th>Variety</th>
<th>Year of release</th>
<th>Seed color</th>
<th>Grain yield (q./ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Research field</td>
</tr>
<tr>
<td>DZ-01-354 (Enatil)</td>
<td>1970</td>
<td>Pale white</td>
<td>24-32</td>
</tr>
<tr>
<td>DZ-01-99</td>
<td>1970</td>
<td>Brown</td>
<td>24-30</td>
</tr>
<tr>
<td>DZ-01-196</td>
<td>1970</td>
<td>Very white</td>
<td>24-30</td>
</tr>
<tr>
<td>DZ-01-797</td>
<td>1978</td>
<td>Pale white</td>
<td>24-30</td>
</tr>
<tr>
<td>DZ-Cr-44</td>
<td>1982</td>
<td>White</td>
<td>18-22</td>
</tr>
<tr>
<td>DZ-Cr-82</td>
<td>1982</td>
<td>White</td>
<td>24-28</td>
</tr>
<tr>
<td>DZ-Cr-37 (Tseday)</td>
<td>1984</td>
<td>White</td>
<td>18-28</td>
</tr>
<tr>
<td>DZ-Cr-255 (Gibe)</td>
<td>1993</td>
<td>Brown</td>
<td>20-30</td>
</tr>
<tr>
<td>DZ-01-355 (Ziquale)</td>
<td>1995</td>
<td>White</td>
<td>24-34</td>
</tr>
<tr>
<td>DZ-01-2053 (Holetta key)</td>
<td>1998</td>
<td>Brown</td>
<td>23</td>
</tr>
<tr>
<td>DZ-01-1278 (Ambo Toke)</td>
<td>2000</td>
<td>White</td>
<td>35</td>
</tr>
</tbody>
</table>

RF = Research field, FF = Farmers’ field, UP = under production


The differences in proportions were statistically significant (P<0.01) implying that extension systems in Ada Berga might have contributed in exposing the farmers to new agricultural technologies as compared to the condition in Ejere. With regards to use, 42% of the farmers in Ejere and 36% in Ada Berga have ever planted improved varieties of tef in the past (Table 15). However, these proportions were not statistically significant (P=0.148) implying that even though a large proportion of the farmers of Ada Berga wereda are aware of improved varieties of tef, the proportion of users was similar. This might be related with unavailability of clean improved seeds and the required inputs in both localities.

Table 15. Proportion of farmers who ever planted improved varieties of tef and other crops

<table>
<thead>
<tr>
<th>Crops weeded</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tef</td>
<td>102</td>
<td>42</td>
<td>144</td>
<td>0.119</td>
</tr>
<tr>
<td>Wheat</td>
<td>21</td>
<td>9</td>
<td>30</td>
<td>0.422</td>
</tr>
<tr>
<td>Maize</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>0.350</td>
</tr>
</tbody>
</table>

Among the farmers who ever used improved varieties of tef, 33% in Ejere and 18% in Ada Berga have adopted improved varieties of tef and planted every year (Table 16) and these proportions were statistically significant (P<0.01). However, lack of clean improved seeds of tef and lack of cash to buy inputs, such as fertilizer and herbicides, were the most important factors responsible for not enabling the farmers to grow improved varieties of tef (Table 17).
Table 16. Proportion of farmers who used tef production technologies every year

<table>
<thead>
<tr>
<th>Technologies used</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Overall sample</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>221</td>
<td>91</td>
<td>2249</td>
<td>445</td>
</tr>
<tr>
<td>Herbicides</td>
<td>221</td>
<td>91</td>
<td>2189</td>
<td>439</td>
</tr>
<tr>
<td>Improved varieties</td>
<td>80</td>
<td>33</td>
<td>41</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 17. Reasons for not planting improved varieties of tef

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Lack of clean improved seeds</td>
<td>55</td>
<td>23</td>
<td>58</td>
<td>25</td>
</tr>
<tr>
<td>Not convinced of benefits</td>
<td>64</td>
<td>26</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Lack of cash to buy fertilizer</td>
<td>63</td>
<td>26</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>Fear of adaptability problem</td>
<td>36</td>
<td>15</td>
<td>44</td>
<td>19</td>
</tr>
</tbody>
</table>

Farmers in Ejere started using improved varieties of *tef* since 1982 while farmers in Ada Berga started using lately in 1995. About 65% of the farmers in Ejere used improved varieties of *tef* in the years 1995–1998 while 91% of the farmers in Ada Berga planted improved varieties of *tef* in the years 1996–1999. This might be related with the National Extension Package Program, which the government is implementing to disseminate agricultural technologies to users. Few farmers have discontinued using improved varieties of *tef* mainly due to unaffordable price of fertilizer (Table 18).

Table 18. Reasons for discontinuing planting of improved varieties of tef

<table>
<thead>
<tr>
<th>Reasons for discontinuing</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Fertilizer (costly)</td>
<td>18</td>
<td>7</td>
<td>39</td>
<td>17</td>
</tr>
<tr>
<td>Low yield</td>
<td>5</td>
<td>2</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Not adaptable</td>
<td>5</td>
<td>2</td>
<td>25</td>
<td>11</td>
</tr>
</tbody>
</table>

About 48% of the farmers in both study areas preferred improved varieties of *tef* to local ones. When the overall sample is considered, 43% and 38% of the farmers preferred improved varieties to local ones in their high yielding ability and high market price, respectively (Table 19). Tef varieties, which fetch good price, were those with white color. Hence, the results seem to indicate that high yielding ability and high demand at the market are the two most important criteria that the breeders need to take into consideration in the *tef* breeding programs.

Table 19. Reasons for preferring improved varieties of *tef* to local ones

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>High yield</td>
<td>111</td>
<td>46</td>
<td>93</td>
<td>40</td>
</tr>
<tr>
<td>High market price</td>
<td>102</td>
<td>42</td>
<td>75</td>
<td>33</td>
</tr>
<tr>
<td>It is preferred for consumption</td>
<td>73</td>
<td>30</td>
<td>49</td>
<td>21</td>
</tr>
<tr>
<td>Its straw is preferred as feed</td>
<td>40</td>
<td>17</td>
<td>47</td>
<td>20</td>
</tr>
</tbody>
</table>

**Fertilizer**

Fertilizer is the most purchased farm input and applied mostly for cereals. Tef is one of the major crops, which gets the highest share of fertilizer among cereals. When the overall sample is considered, 94% of the farmers applied fertilizer on tef every year (Table 16). On the other hand, 5% of the farmers applied fertilizer on tef only sometimes when they get cash to purchase it. In general, the results seem to indicate that almost all farmers used fertilizer on tef. In most cases, farmers on average applied 50 kg/ha DAP and 50 kg/ha Urea. Seyfu (1993) reported based on the research recommendation from Debre Zeit Agricultural Research Center that 60/26 N/P2O5.
kg/ha was recommended on heavy clay soils (vertisols) and 40/26 N/P\textsubscript{2}O\textsubscript{5} kg/ha was recommended on sandy loam soils (Andosols). Urea was also generally recommended to be applied in split applications. On the other hand, most of the farmers did not practice split application of urea. Hence, the results indicate that farmers apply a lower fertilizer rate than the recommended one. This might be due to cash shortage and unaffordable price of fertilizer. This suggests that favorable credit services need to be devised to overcome this problem in the short-run. Extension system also needs to take into consideration in creating awareness on the split application of urea.

**Herbicides**

Herbicide application was one of the packages associated with improved tef varieties. A large proportion of the farmers in both study areas (91% in Ejere and 95% in Ada Berga woredas) have used herbicides on their tef fields to control weeds (Table 16). Farmers in both study areas started using herbicides in the late 1970’s (Table 20). A large proportion of farmers (69% in both study areas) started using herbicides in the 1990’s. The farmers obtained herbicides mainly through Regional Agricultural Development Bureaus with credit. Few farmers also purchased herbicides from individuals from market. Since, tef is more sensitive to weeds than other crops; farmers gave priority to tef for application of herbicides.

<table>
<thead>
<tr>
<th>Year started using of herbicides</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970s</td>
<td>5</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>1980s</td>
<td>60</td>
<td>25</td>
<td>112</td>
</tr>
<tr>
<td>1990s</td>
<td>167</td>
<td>69</td>
<td>326</td>
</tr>
</tbody>
</table>

The results of this study indicated that tef is managed intensively, but received a large proportion of external inputs as compared to other crops. This implies that any of the new technologies for tef production could easily be adopted since there is prior awareness and experiences of using the technologies.

**The Role of Tef in Livestock Production**

Tef plays key role in the livestock production systems and 87% of the sample farmers have reported that crop residue is the second most important source of animal feed next to grazing (Table 21). Among the crop residues, tef ranked first in its availability and preference for animal feed (Table 22). Hence, the straw yield and quality of tef was reported to be as important as grain yield. This suggests that straw yield and quality should also be considered as important parameters that need to be considered in tef breeding programs.

<table>
<thead>
<tr>
<th>Feed sources</th>
<th>Ejere</th>
<th>Ada Berga</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing</td>
<td>222</td>
<td>216</td>
<td>438</td>
</tr>
<tr>
<td>Pasture</td>
<td>86</td>
<td>110</td>
<td>198</td>
</tr>
<tr>
<td>Crop residues</td>
<td>214</td>
<td>197</td>
<td>411</td>
</tr>
<tr>
<td>Improved forage</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Weed</td>
<td>146</td>
<td>111</td>
<td>259</td>
</tr>
<tr>
<td>Concentrates</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Oats</td>
<td>21</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Brewery by-products</td>
<td>100</td>
<td>46</td>
<td>146</td>
</tr>
</tbody>
</table>
Production Constraints and Suggestions

Tef production is affected by a number of factors interrelated to each other. As reported by 86% of the farmers in both study areas, unaffordable price of fertilizer is the priority problem in tef production (Table 23). Even though farmers practice crop rotation to maintain and improve the fertility of the soil, they feel that it is inadequate to grow tef unless supplemented by application of inorganic fertilizer. Farmers perceived that fertilizer price increased dramatically after withdrawal of fertilizer subsidy by the government. This price was perceived to be unaffordable to smallholder farmers. Even though there is a possibility of getting fertilizer through credit, farmers were in fear of their ability to pay back if crops fail due to unforeseen natural calamities. Hence, the government should revise its policy and need to subsidize fertilizer for the farmers. This might encourage farmers to adopt technologies that require fertilizer application. In the end, the government may need to think about installation of fertilizer plants in the country. Other options, such as the use of organic manures prepared from locally available materials might also help to improve the fertility of the soil.

Table 23. Farmers' tef production constraints in the study areas

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Ejere n</th>
<th>Ejere %</th>
<th>Ada Berga n</th>
<th>Ada Berga %</th>
<th>Total n</th>
<th>Total %</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaffordable price of fertilizer</td>
<td>210</td>
<td>87</td>
<td>196</td>
<td>85</td>
<td>406</td>
<td>86</td>
<td>0.62</td>
</tr>
<tr>
<td>Frost</td>
<td>32</td>
<td>13</td>
<td>62</td>
<td>27</td>
<td>94</td>
<td>20</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Unaffordable price of herbicide</td>
<td>41</td>
<td>17</td>
<td>26</td>
<td>11</td>
<td>67</td>
<td>14</td>
<td>0.07</td>
</tr>
<tr>
<td>Unfavorable weather condition</td>
<td>56</td>
<td>23</td>
<td>5</td>
<td>2</td>
<td>61</td>
<td>13</td>
<td>0.01</td>
</tr>
<tr>
<td>Weed</td>
<td>43</td>
<td>18</td>
<td>13</td>
<td>6</td>
<td>56</td>
<td>12</td>
<td>0.01</td>
</tr>
<tr>
<td>Labor problem</td>
<td>18</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>30</td>
<td>6</td>
<td>0.32</td>
</tr>
<tr>
<td>Low price of tef</td>
<td>16</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>23</td>
<td>5</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The second important area that requires attention to improve productivity of tef is extension service. There are several tef production technologies released for use. However, there are farmers who were not even aware of these technologies yet. Hence, extension intervention has a role to play in creating awareness about tef production technologies. Extension services to the farmers need to be strengthened through capacity building of extension staff and creating enabling environment for technology dissemination. Informal local institutions, such as Edir, Equib, Mahiber, etc. could be used as means of information and technology exchange.

A large proportion of farmers who are aware of improved tef varieties were not using due to unavailability of clean seeds. Enabling environment need to be created for the establishment of seed multiplication and certification agencies. Farmer groups could
Tef production systems and constraints

also be formed at a small scale to multiply and distribute seeds to the neighboring farmers.

The results of the study also indicate that farmers require improved varieties of tef that can be used for diversified purposes, such as for food and market. Hence, research intervention should give due attention in generating appropriate tef varieties that could fulfill these farmers' interests. In research intervention, frost and moisture stress tolerance parameters need not be forgotten during generation of improved tef varieties. Researchers should also focus on screening environmentally friendly and economically optimum rates of application of herbicides to control weeds. Development and policy interventions may have their own contributions and roles in creating enabling credit environment for the smallholder farmers.

Conclusions and Recommendations

It was noticed that the farmers systems of tef production was closely similar with the research recommendations. This implies that farmers gave due attention to the management of tef production due the importance of the crop in the food security of a household.

Even though tef is very important at national levels in general and in the study areas in particular, its production and productivity still remained very low. Many years of research efforts have generated and released more than ten high yielding tef varieties and associated packages. However, most of these technologies did not reach to the users. One of the most important problems responsible for this was unavailability of clean seed of improved tef varieties in the farmers' locality. Private companies and public enterprises do not produce and distribute adequate amount of clean seeds of tef. This problem requires the attention of policy makers and development institutes. Strong extension system has also a role to play in creating awareness on the benefits and contributions of the technologies generated to the household food security.

Improved varieties and technologies generated and released for use could not be disseminated fast as expected. This was because of unaffordable prices of external inputs. Improved tef varieties require inputs, such as fertilizer and herbicides, which are imported. As a result, they impose unaffordable costs on the smallholder farmers. This problem indicates the need to revise the fertilizer subsidy policy in the short-run. Research need also be concerned in generating sustainable technologies that could maintain and improve the fertility of the soil, such as organic manures.

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Farmers’ Perception of Soil Erosion and Soil Conservation in Welo

Girma Tesfahun¹, Getaw Tadesse¹, Belete Birhanu¹

Introduction

Ethiopia is a wide country with an estimated area of 1.104 million square kilometer and a human population of above 63 million. Agriculture has always been the backbone of Ethiopian economy accounting for over 50% of the GDP and providing livelihood for over 80% of the population. Peasant households, representing the largest segment of the population, are directly dependent on the use of land resources for their survival (Bekele and Holden, 1999).

In Ethiopia, land degradation, mainly due to soil erosion and nutrient depletion, has become one of the most important environmental problems. Coupled with poverty, fast-growing population, policy failures, and social unrest, land degradation poses a serious threat to national and household food security. This was unfortunately evidenced by the recurrent and chronic food shortages in the rural livelihoods of Welo in particular and North East Ethiopia in general (RRC, 1985).

Since the worst incidence of these food shortages in the early 1970’s, a great deal of soil conservation activities has been carried out. Bekele and Holden (1999) indicated that despite the increasing land degradation problem, the issue of conserving agricultural land was incited by the devastating famine in Welo in 1973-74. The conservation measures taken since then included both physical and biological structures. The physical measures are soil bunds, stone bunds, on-farm terraces, hillside terraces, cut-off drains, and artificial waterways, check dams and micro basins. The biological measures include crop rotation, early planting, aorestation, gully plantation and plantation on terraces.

Though there is no doubt about the priority of soil conservation and about the potential recovery of agriculture through soil conservation, much has not been achieved with the efforts so far. This is not typical of Ethiopia, but similarly, according to Yohannes (1992), in many developing countries soil conservation works have not been as fruitful as was needed on the required scale. Different reasons have been given for the inefficiencies of soil conservation endeavors varying according to the spatial and temporal circumstances. In all cases, anyhow, the lack of understanding of planners about the rural communities’ perception on the causes, effects, and prevention of soil erosion can be identified as the major constraint (Azene 1992; Hudson 1987; Shaxon 1985; Solomon 1994).

Like all other technologies generated and transferred to the farming society, the soil conservation measures need to be well tuned to the existing knowledge base.

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Thus, to have better results out of soil conservation activities, the community should be allowed to speak out how it views the challenge and prevention of soil erosion. Accordingly, this study was conducted for two years (1999 – 2000) with the objective of figuring out what soil erosion means to the farming community and how the community values the soil conservation practices of both indigenous and extension origin.

Methodology

The Study Area

The study was done in four selected districts, namely Bugina, Gubalafto, Legambo and Tehuledere, that represent the different farming systems and agro ecologies of north and south Welo administrative zones of Amhara National Regional State (ANRS). Tehuledere and Gubalafto districts were selected to represent the intermediate agro-ecology with sorghum-tef dominated cropping systems. According to Getaw and Girma (2000), these areas are characterized by rugged landscape with altitude ranging from 1500 to 2000 m, black soil dominated farmlands, and very high population density. The major crops are sorghum, tef, chickpea, vegetables and fruit trees. The most important constraints of agricultural production include land shortage, uneven rainfall distribution; animal feeds shortage that caused overgrazing of hills and gorges, crop pest and animal diseases.

Bugina district represented the semiarid sections of the region that have rugged landform and drought-risk prone cropping system where cereals, pulses, and oil crops are grown. The productivity of the crops is very low and highly variable due to unreliable rainfall and severe degradation of natural resources. Legambo is located in Western Welo and has an altitude ranging from 2200 to 3400 m. This district has quite uncertain climatic set up with rugged topography and two cropping seasons. Both meher and belg production seasons are important though the latter is becoming less dependable these days. This district has very scanty natural vegetation. In some places, stony hills with out vegetation cover dominate the scene. The major production constraints here include farmland shortage, soil degradation, frost, and unpredictable rainfall.

Data Source and Sampling

Both primary and secondary data regarding the relevant variables were gathered. The data collected included whether farmers consider soil erosion as a problem or not, what causes soil erosion, what conservation structures are used, what determines the effectiveness of the different conservation structures, and the like. Some physical data were also gathered.

In all of the four districts, three peasant associations (PAs) were randomly selected and then 10 farm household heads were randomly selected from each PA. Then a questionnaire of both open-ended and closed questions was prepared and forwarded for each of the 120 sample farmers. The questionnaire was prepared based on lessons learnt during the frequent field visits and informal discussions with farmers aimed to understand the existing soil conservation
practices and the way they have been implemented. The data generated this way were summarized and were descriptively presented in aggregate for the four districts.

**Results and Discussion**

**Farmers' Perception**

The perception farmers have about any agricultural constraint they experience determines the responses they would have and the effectiveness of external interventions meant to solve the constraint at hand. In most parts of Ethiopia soil loss has been perceived little by the farmers. These days, however, especially in Welo, farmers are considerably aware of the soil degradation due to soil erosion as it is unfavorably manifesting itself on production and productivity of both crops and animals. All interviewed farmers were found to be aware of the severity of soil erosion as among the major causes for the ever-present crop failure.

Farmers mentioned several reasons for the aggravating soil erosion in their respective farms. In aggregate, farmers' perception about the causes of soil erosion can be described with three categories; namely, the natures of the erosive agents like rain and wind, land management and features of the landscape. More specifically, erosivity of the rain was indicated to be the most important cause for soil erosion. About 38% of the sample farmers responded that the magnitude of rainfall caused erosion (Table 1).

About 13% and 14% of the sample farmers indicated that soil erosion emanates from poor farm land management and from rugged topography, respectively. Lack of vegetation cover was also mentioned as a cause of soil erosion by 13% of the sample farmers while lack of conservation structures was indicated by 8% (Table 1). These observations reveal the fact that, let alone the concerned professionals, farmers were well aware that land is not managed properly according to its capability and the magnitude of erosion agents.

Although most of the interviewed farmers are aware of the causes and effects of soil erosion, some of them are yet to be informed. Nearly, 2% of the sample farmers do not know the causes of soil erosion and almost half (48%) of the sample, farmers associated the unfavorable pattern of the rainfall with God's wrath (Table 1). This perception may have severe impact on effectiveness of natural resource management and requires awareness creation strategies.
Table 1. Farmers' indication of causes of soil erosion

<table>
<thead>
<tr>
<th>Enquiries</th>
<th>Factors</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What causes soil erosion?</td>
<td>Erratic rainfall</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>improper land use</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Rugged topography</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Lack of vegetation cover</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Absence of conservation structures</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Wind</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Do not know</td>
<td>2</td>
</tr>
<tr>
<td>What causes rainfall shortage?</td>
<td>God's wrath</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Deforestation</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Climate change</td>
<td>23</td>
</tr>
</tbody>
</table>

Soil Conservation Measures

The results of this study show that both physical and biological soil conservation measures are practiced in Welo. The physical measures are level soil bunds, level stone bunds, on farm terraces (soil, stone, and soil-stone mix), hillside terraces, cut off drains, artificial waterway, check dams, and micro basins. The biological measures include crop rotation, early planting, contour ploughing, afforestation, gully plantation, plantations on terraces, and area closure.

The extent by which these measures are used differs from place to place and in times. Yet, in general, the physical measures are widely constructed being the readily available technology in the hands of the Bureaus of Agriculture in the region. An enquiry to find out which measure is preferred and constructed by farmers showed that stone terraces are preferred and constructed by about 51% of the sample farmers. The same question revealed that 26% of the sample farmers favored soil bunds as well as stone bunds. Check dams, tree planting, cut-off drains and artificial waterways were also mentioned as preferable structures by a considerable number of sample farmers (Table 2).

In addition to introduced soil conservation structures, almost all interviewed farmers use indigenous practices. The indigenous conservation structures employed by farmers are dib (soil bund stabilized using natural vegetation—commonly left between two farmers' fields) (47%), traditional ditches (45%), single line stone bunds on small rills (33%), grass planting on small gullies (14%), tree and shrub planting on large gullies (6%), and contour plowing (13%) (Table 2). Farmers mostly use biological soil conservation measures along with physical soil conservation structures to increase the stability of the latter.
Table 2. Farmers' preference of soil conservation structures

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Factors</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference for Introduced SC measures (N=142)</td>
<td>Stone bund</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Soil bund</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Check dam</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Strip tree plantation</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Cut-off drain</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Water way</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>3</td>
</tr>
<tr>
<td>Preference between introduced and indigenous measures</td>
<td>Dib</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Traditional ditches</td>
<td>45</td>
</tr>
<tr>
<td>Indigenous soil conservation measures (N=190)</td>
<td>Soil and stone bunds</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Grass planting</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Contour ploughing</td>
<td>13</td>
</tr>
<tr>
<td>Preference between introduced and indigenous measures</td>
<td>Tree and bush planting</td>
<td>6</td>
</tr>
<tr>
<td>Commonly failing structures</td>
<td>Soil bund</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Single stone terrace on farmlands</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Artificial water ways</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Check dams</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Micro basins</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Terraces on sloppy lands</td>
<td>2</td>
</tr>
</tbody>
</table>

Asked about their preferences between extension-introduced and indigenous soil conservation measures, 84% of the respondents preferred the former while 16% of them preferred the indigenous measures. This inclination of farmers did not emanate from the technical soundness of or sustainability of the introduced measures, rather it is due to the way of construction. The introduced measures are implemented through mobilization and food aid.

In identifying the commonly failing soil conservation measures, about 53% and 28% of the sample farmers mentioned soil bunds and single line stone bunds as less durable. If they are well constructed, 2% of the respondents indicated that terraces on sloppy lands do easily fail. Of all the farmers who have soil conservation structures constructed on their plots, 71% of the sample farmers, about 28% reported that the structures on their farms have completely failed.

**Failure of Soil Conservation Structures**

Studies have shown that problems related to approach of planning and implementation, relevance and technical efficiency, heterogeneity of farmer circumstances, livestock feeding, plowing system, land tenure arrangement, topography, and time budget enormously discourage farmers not to accept most of the soil conservation measures (Harweg 1992, Shaxon 1985). The facts behind the ineffectiveness of soil conservation endeavors in Welo as described by farmers are not far from these previous findings.

Of all the sample farmers, 71% pointed out that the existing land tenure arrangement as the reason for the underachievement of soil conservation efforts carried out so far (Table 3). The absence of the feeling of ownership and entitlement of farmers only for usufruct right on the land they till has surely discouraged farmers against conserving the soil on which their livelihoods
mainly depend. Similarly, erratic rainfall was also cited by 54% of the sample farmers as a reason for the ineffectiveness of soil conservation activities. The food for work approach was likewise mentioned as a reason by 33% of the respondents. Farmers explained that this approach has developed a feeling of dependency among the rural community to have the community failing to see the long-term rewards of the conservation structures and dismantle the structures to reconstruct with another food handout. Using only soil as a construction material for conservation structures was mentioned as a reason too by 26% of the sample farmers.

Animals also contributed much for the ever destruction of soil conservation structures. About 25% of the sample farmers consider animals' damage as a major cause for the unsustainability of the measures.

Table 3. Farmers' reasons for the ineffectiveness of soil conservation measures (n=120)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land tenure arrangement</td>
<td>71%</td>
</tr>
<tr>
<td>Erratic rainfall</td>
<td>54%</td>
</tr>
<tr>
<td>Food for work approach</td>
<td>33%</td>
</tr>
<tr>
<td>Construction material</td>
<td>26%</td>
</tr>
<tr>
<td>Trampling by animals</td>
<td>25%</td>
</tr>
<tr>
<td>Obligation in mobilization</td>
<td>10%</td>
</tr>
<tr>
<td>Damage during plowing</td>
<td>8.3%</td>
</tr>
<tr>
<td>Poor drainage of the structures</td>
<td>7.5%</td>
</tr>
<tr>
<td>Intentional destruction</td>
<td>6%</td>
</tr>
<tr>
<td>Poor construction</td>
<td>5%</td>
</tr>
</tbody>
</table>

As it has been said repeatedly, the existing free grazing system allows animals to graze wherever and whatever they accessed particularly during off-season. Farmers are not convinced of using controlled grazing throughout the year because shortage of animal feeds and the attitudinal problem for change of grazing systems that lived with them for long. Local bylaws have been set in some villages to fine farmers whose animals have destroyed conservation structures but it could not be practical. There is no clearly defined institutional set up to implement it. This challenge requires not only fines for misdeeds but also intensive awareness creation.

It was also found that farmers themselves dismantle the structures both intentionally and unintentionally. About 6% of the farmers intentionally destroyed the structures mainly to use the fertile soil stored by the structures for crop production. Farmers feel that the structures reduce farmland and host field pests. About 8% of the sample farmers dismantled the structures on their plots unintentionally during plowing. Farmers highly bother about the spaces between two consecutive terraces on their farmlands. To them, spacing is too narrow to till the fields.

**Farmers' Valuation of Soil Conservation Efforts**

Having been working on their land for long, farmers have their own way of judging the reliability of the different activities related to their plots. In this particular case, farmers were asked to select an approach to undertake soil conservation. Of the 120 sample farmers, 91% suggested an approach with strict
rules with fines against those who dismantle the conservation structures. Again, 89% of the farmers have suggested food for work approach. Soil conservation with labor generated by mobilizing the community was also mentioned by 80% of the respondents. About 11% of the sample farmers mentioned soil conservation by the freewill of the farmer himself/herself as a dependable approach (Table 4).

Community mobilization is the approach currently followed by extension and administration institutions in constructing soil conservation measures. Asked about its advantages, 34% of the sample farmers mentioned higher work force while 27% of them mentioned time and cost saving. Similarly, 19% of the sample farmers mentioned participation of many farmers as an advantage (Table 4). Some 8% of the sample farmers have said it has no advantage.

Table 4. Farmers' comments on the approach of soil conservation works

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Factors</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred approaches</td>
<td>Fine for destruction</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Through food aid</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Mobilization</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Work at freewill</td>
<td>11</td>
</tr>
<tr>
<td>Advantages of Free (I would suggest mass) Mobilization</td>
<td>Increases workforce</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Saves time and cost</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Involves many farmers</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Has no any advantage</td>
<td>8</td>
</tr>
<tr>
<td>Disadvantage of Free (I would suggest mass) Mobilization</td>
<td>Has no disadvantage</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Obligatory</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Labor intensive</td>
<td>10</td>
</tr>
</tbody>
</table>

Regarding disadvantages of soil conservation through mass mobilization, 10% of the farmers said that it is not dependable as the structures are built with inner feeling of obligation. About 10% of the farmers have said the approach is tiresome. Interestingly, 80% of the sample farmers said that this approach has no any demerits (Table 4).

**Farmers' Suggestions on Soil Conservation Measures**

Farmers have a lot to say about what should be done and how it should be done so long as it is related to their physical, social and economic circumstances. As indicated earlier, to make technologies contribute more to the betterment of the rural community, farmers' perceptions and suggestions have to be considered well. This is because, according to Stocking (1985), the characteristics of the innovation as perceived by the potential adopter, not by the expert, are what really matter. Hence, to make conservation measures more sustainable, they must be designed in the context of the people who are the final users.

With this conviction, farmers were asked to suggest the soil conservation measures that should be given higher emphasis and should be adapted widely. As a result, 32% and 18% of the sample farmers suggested higher emphasis should be given to stone bunds and to biological measures, respectively (Table 5). Likewise 17% of the sample farmers suggested further emphasis should be given to check-dams. Many farmers have also suggested more emphasis should be given to dib, degraded land rehabilitation; contour plowing, and area specific interventions.
Table 5. Soil conservation measures identified by farmers for further emphasis

<table>
<thead>
<tr>
<th>Structures and activities</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis on stone bund</td>
<td>32</td>
</tr>
<tr>
<td>Emphasis on biological measures</td>
<td>18</td>
</tr>
<tr>
<td>Emphasis on check dam</td>
<td>17</td>
</tr>
<tr>
<td>Emphasis on Dib</td>
<td>7</td>
</tr>
<tr>
<td>Focus on degraded hills</td>
<td>7</td>
</tr>
<tr>
<td>Area specific intervention</td>
<td>4</td>
</tr>
<tr>
<td>Emphasis on contour plowing</td>
<td>4</td>
</tr>
</tbody>
</table>

Conclusions and Implications

It is very important to learn that most of the sample farmers did not fail to mention soil erosion as a constraint to the traditional and low performing agriculture in Welo. The causes of soil erosion were identified putting erratic rainfall and rugged topography at the forefront. Many farmers also believe that deforestation is the root cause for the erratic rainfall. So aware, the farming community employs both indigenous and introduced soil conservation structures. Stone bunds and dib were found to be the most preferred conservation structures in this region. In addition, there is a worth noting interest on introduced soil conservation structures.

Farmers indicated that soil conservation efforts could not change the performance of their farming and identified the physical structures at large and the preferred soil and stone bunds in particular as easily destructible and less durable. In general terms, farmers held responsible, in order of importance the land tenure system, the erratic rainfall, the food grain handouts attached with conservation activities, materials with which the structures are constructed, lack of animal manure in and around farms, and the like, for the ineffectiveness of soil conservation practices carried out so far.

Farmers have also commented on what approaches should be followed and what conservation practices should be emphasized. The suggested approaches indicate how much importance farmers attach with soil conservation, and the practices selected for scaling up show that the confidence the community has with respect to the measures introduced by different institutions.

All these findings form the ground for the following implications:

- The farming community in the region should be provided with inputs of plantations to protect and rehabilitate the degraded and abandoned lands.
- The physical soil conservation structures have to be well designed in technical terms and should always be accompanied by biological measures. The existing land tenure arrangement, which provides the holder only with usufruct right on his land, has a very adverse implication on effectiveness of soil conservation activities. Therefore, policy options have to be evaluated considering this formidable challenge. The food handouts attached with such long term and crucial activities have to be viewed from the perspective of enhancing the feeling of dependency.
Reference


Introduction

Barley is one of the most important cereal crops grown in Bale highlands. Under private peasant holdings, more than 30% of the total area allocated for cereals was covered by barley (CSA, 1995-1998). In most farming systems of Bale highlands, barley ranks first or second in area coverage. It is produced both in Genna (which usually extends from mid March to early August and Bonna (from early August to end of December) Seasons (Alemayehu and Franzil, 1987; Bekele et al., 1998; Dereje et al., 1996).

Barley contributes to the major share of daily consumption demand of rural households in Bale. It is usually used for making soft pancake (enjera), roasted (kalo), porridge (genfo), besso, kinche soup (shorba), and local beer (tella). In addition, it is used as cash source for a family. Barley is one of the major products marketed in the study area. Usually, men handle sales in large quantities while women take the responsibility of marketing barley in small quantity to meet household requirement (Bekele et al., 1998).

Even though there are many improved barley cultivars released nationally, these varieties are not currently under production in the highlands of Bale. The major bottleneck is their susceptibility to barley shoot fly, (Delia arambourgii). Barley shoot fly can cause a yield loss of up to 100% on susceptible improved cultivars in the season when barley shoot fly incidence is high and when there is rainfall shortage (Sinana Research Center 1996-99).

Thus, farmers in Bale are forced to grow low yielding local barley varieties with farmers’ practices of high seed rate of about 200 kg per hectare mainly to compensate shoot fly damage without fertilizer and insecticide applications. Local cultivars such as Kesele, Akalas, Senef-kolo, Falibay., In order to alleviate or at least minimize barley shoot fly damage considerably, some effective insecticides for treating seeds of barley were identified. However, farmers were not aware of the efficacy of these insecticides. Further more, the profitability of these insecticides was not comprehensively studied. Participating farmers in evaluating technologies will not only create awareness, but also facilitate and fasten further dissemination of technologies, information sharing, and feedback information to researchers. Moreover, it creates an opportunity for farmers to analyze and make decisions, among different alternative barley technologies. Thus, the objective of this study was to evaluate improved and local cultivars under different management practices through participatory approach and assess the economic viability.
Methodology

Composition and Role of Participants
A Farmers’ Research Group (FRG) composed of six to nine farmers, a team of multidisciplinary researchers with six members, and two development agents (DAs) were actively involved in the evaluation of barley technologies. The evaluation was made in Ganna season of the year 2000. Farmers’ group evaluated the technologies from their perspectives, provided information on researchable problem areas and raised questions to explore and further understand the technologies. Development agents assisted in organizing the farmer’s research group and scheduling the time of technology evaluation with researchers. The researchers’ team was composed of researchers from different disciplines of the Sinana Agricultural Research Center. This helped to exploit different ideas from diversified disciplinary knowledge base. Researchers made their own evaluations, received feedback from farmers’ group, initiated and facilitated discussion among the group, and also answered questions raised by farmers’ and DAs.

Treatments
Three barley cultivars Aruso (local), Ardu 12-60B, and Shegie were evaluated at three locations within Sinana district under both farmers’ and recommended practices with (randomized complete block design. Under the recommended management, recommended seed rate of 125 kg/ha, recommended fertilizer rate of 50 kg DAP per ha, and insecticide seed treatment Gaucho 70 was at a rate of 250-milligram active ingredient per 100 kg seed (to control barley shoot fly) were considered. On the other hand, farmers’ management included farmers’ average seed rate of 200 kg per ha, without fertilizer and insecticide applications. For the purpose of simplicity, the terms “treated” and “untreated” are used throughout this paper, though the already stated fertilizer application and seed rates are also implicit besides insecticide application.

Evaluation Procedure and Data Considerations
Before the start of the evaluation process, farmers were oriented about the objective and treatments of the trial. Thorough discussions were made among participants on how and when to evaluate the trials and on what criteria to base the evaluations.

Evaluations were then made at different growth stages of the trials, while the crops were on the field, and after harvest. These helped participants to collect all necessary qualitative and quantitative information on pre- and post-harvest evaluations. Both agronomic and socio-economic data were collected and analyzed. In addition, data from secondary sources were consulted.

During the evaluation process, farmers debated among themselves and reached at a consensus on some aspects. The discussions were made among farmers on different parameters such as tillering, barley shoot fly damage, plant height, maturity, resistance to logging, spike length, plumpness, seed size, seed color, and marketability. Farmers ranked the treatments based on the above criteria. In addition to matrix ranking, statistical analysis, partial budget and marginal analysis were computed.
Results and Discussions

Pre-harvest Evaluation
Severe shoot fly damage was observed on the untreated improved cultivar *Ardu* 12 60-B followed by cultivar *Shegie* at earlier stages of the crop and no considerable damage on local variety *Aruso*. Nevertheless, at later stage of the crops, according to the views of farmers, the presence of ample rainfall enabled the damaged shoots to have better tillering. Hence, at later stages of the crop, the difference in damage severity among treatments was not apparent.

Early maturity was one of the major criteria used by farmers to evaluate barley cultivars. This observation was in line with diagnostic survey result of the same area (Mohammed 1995). Both improved varieties *Ardu*12-60B and *Shegie* were late by about sixteen days than the local cultivar *Aruso*. Farmers felt discomfort with the late maturing varieties. They envisaged difficulty in growing the varieties when the rainfall is not extended towards the maturity period. They also felt that these varieties might create an overlap with harvesting activities of other crops grown. After thorough discussion with development agents and researchers and observations made by all group during the harvest and post harvest period farmers were convinced that the new technologies will not overlap with the activities of other commodities such as wheat.

Farmers appreciated the better tillering capacity of both improved varieties (more tillering on *Shegie*) than the local variety *Aruso*.

Severe logging was observed on the local cultivars especially on the treated one. Both improved cultivars were resistant to logging and were preferred by farmers in this regard. Farmers were interested on spike length of the cultivar *Shegie* both under the recommended and farmers' management, and cultivar *Ardu*12-60B only under the recommended management. They also appreciated the deep green leaves and uniform headings of the improved cultivars *Shegie* compared to *Ardu*12-60B, which lacked uniform heading especially in the untreated case.

Generally, depending on pre-harvest evaluations, farmers preferred the improved varieties to their local variety and showed interest to grow these varieties on small plot in order to acquaint themselves with the varieties before producing them on large farm size in large quantity.

Post-harvest Evaluations
Plumpness, seed color, seed size, yield, and marketability are some of the criteria used by farmers to evaluate barley grains. Depending on these parameters, farmers gave different ranks for the treatments (Table 1).

On average the treated and untreated *Shegie* ranked first followed by treated *Ardu*12-60B, untreated *Aruso*, untreated *Ardu*12-60B, and treated *Aruso* respectively. The severe logging on the treated *Aruso* made it to attain shrinkled grains. This is also justified by its low thousand-kernel weight (28.7 gm) and low hectoliter weight (53.7 kg/ha) as compared to the other treatments (Table 2). In the same token, untreated *Ardu*12-60B was seriously damaged with barley shoot fly and consequently lacked uniformity in its heading. That was why the treated *Aruso* and untreated *Ardu*12-60B were ranked low.
Farmers’ preferred the ‘red’ colored barley grains for making local dishes like *enjera*. The white colored barley is more preferred by urban dwellers because it serves to prepare *kolo*, *bessa*, *tella* (local beer), *genfo* (porridge), *kinche*, and *shorba* (soup), because of this it fetches better price in the market. In any case, farmers have their own indigenous knowledge of changing the seed color of barley depending on their production objective, irrespective of the variety. They indicated that when the objective of producing barley is for home consumption (for *enjera*), the barley grains is harvested early, before it gets dry, and stays piled up on the farm for a certain period of time. When the piles are threshed, the required ‘red’ color of grain will be obtained. If, on the other hand, the objective is for market or sales purposes, the barley crop is left to dry in the field and harvested latter when the moisture content is ‘exhausted’. This makes the grain to attain white colored outer cover. According to farmers, *Genna* season barley is preferred for *enjera* making to the *Bonna* season barley. The latter season is good for white seeded barley production, which is better for sale than for consumption, since there is ample sunshine during harvesting period.

Table 1. Pre- and post-harvest rankings of the treatments by farmers’ research group depending on different evaluation criteria (the smaller the number, the better the rank)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Tolerance to BSF</th>
<th>Tillering</th>
<th>Spike length</th>
<th>Early maturity</th>
<th>Tolerance to logging</th>
<th>Overall rank*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aruso untreated</td>
<td>2</td>
<td>5.5</td>
<td>4</td>
<td>1.5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Ardu12-60B untreated</td>
<td>6</td>
<td>4</td>
<td>5.5</td>
<td>4.5</td>
<td>2.5</td>
<td>6</td>
</tr>
<tr>
<td>Shegie untreated</td>
<td>5</td>
<td>1.5</td>
<td>1.5</td>
<td>4.5</td>
<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>Aruso treated</td>
<td>1</td>
<td>5.5</td>
<td>5.5</td>
<td>1.5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Ardu12-60B treated</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>4.5</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>Shegie treated</td>
<td>3</td>
<td>1.5</td>
<td>1.5</td>
<td>4.5</td>
<td>2.5</td>
<td>1</td>
</tr>
</tbody>
</table>

*Overall rank is computed by ranking the rank sums with the assumption that each pre-harvest criterion has equal weight in the selection process.

Overall farmers preferred the improved variety *Shegie* followed by *Ardu12-60B*, both under the recommended management. Farmers were generally pleased in the participatory approach and expressed their interest to work with researchers.

**Agronomic Performance**

The improved cultivars *Shegie* out yielded the local cultivars *Aruso* by 48.6 % under recommended practice (treated) and by 51.9% under farmers’ management (untreated). Similarly, *Ardu12-60B* out yielded the local cultivars by 40.7% under improved and by 22.3% under local management. The statistical analysis showed that variability of grain yield, among the varieties is highly significant ($P < 0.01$). Besides, these improved cultivars had higher thousand-kernel weights and hectoliter weights than the local variety (Table 2). The difference of the two improved cultivars (*Shegie* and *Ardu 12-60B*) with respect to grain yield and thousand-kernel weights (TKW) were not significant though they were superior to the local variety. It is important to note that shoot fly damage immediately followed by continuous rainfall enhanced the damaged shoots to produce more tillers. This minimized yield reduction due to barley shoot fly. Because of this yield reductions in improved varieties under farmers’ management were not encountered as expected and reported in earlier findings of Sinana Research Center (SRC 1996-1999). Hence, the yields of shoot fly susceptible improved varieties were better than the tolerant local variety.
Table 2. Mean grain yield, thousand-kernel weight, and hectoliter weight of the different barley varieties under farmers' and improved management levels

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Grain yield (kg/ha)</th>
<th>TKW (gm/1000 seed)</th>
<th>Hectoliter weight (Kg/hl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
<td>Untreated</td>
</tr>
<tr>
<td>Aruso</td>
<td>1778.9</td>
<td>1681.1</td>
<td>30</td>
</tr>
<tr>
<td>Artful</td>
<td>2174.8</td>
<td>2365.6</td>
<td>35.3</td>
</tr>
<tr>
<td>Shegie</td>
<td>2690.7</td>
<td>2497.8</td>
<td>37.3</td>
</tr>
</tbody>
</table>

Source: experimental data

Economic Analysis

Partial Budget Analysis

Partial budget crystallizes ultimately into a statement of costs and returns, based on input and output data. The outputs (barley grain yield) adjusted by 5%, to reflect the difference that could occur between the experimental yield and the yield farmers expect from the same treatment. This is used to identify economically viable alternative barley technologies.

Input costs and output prices are obtained from secondary information sources. Hence, farm gate price of barley grains is estimated from average producers’ price of the past four years and it was taken as Birr 0.92/kg. In addition, price of the chemical Gaucho and its application cost were taken as Birr 500/kg of active ingredient and Birr 20/125Kg seed respectively. Fertilizer cost was obtained from actual fertilizer price (Birr 2.48/100kg DAP) that the farmers have to pay while participating in extension package programs. Since price of improved seed of barley at farm level is not known in Bale, local and improved seed prices are taken as equal.

The partial budget analysis showed that varieties Ardu12-60B and Shegie, under recommended management, have 21% and 29% net benefit advantage over the local practice (Table 3). The marginal rate of return (MRR) of 122% and 172% of barley varieties Ardu12-60B and Shegie under improved management over Aruso shows that they are economically viable recommendations. This is by assuming a minimum acceptable rate of return, which is only an approximation of investment goals of the farmers, as 100%. But, economic acceptability of these technologies depends on the changes of input and output prices. In this analysis, Shegie untreated is not considered since there is high risk of occurrence of shoot fly. Therefore, it is quite important to device a mechanism of estimating the range of prices under which a given recommendation will be able to withstand any likely changes in inputs and outputs for at least few years.

Sensitivity Analysis

In order to capture the effect of the likely changes of prices, recalculating the marginal analysis with alternative prices is a very useful technique (CIMMYT, 1988).

Maintaining the minimum rate of return, the prices of the chemical Gaucho and fertilizer constant, and by increasing seed price to Birr 1.55 and 2.50 per kilogram for varieties Ardu12-60B and Shegie respectively makes the recommendation of the technologies viable. Here, with wider acceptable price range, variety Shegie under recommended management is a promising technology that needs to be promoted. It is likely that variety Ardu12-60B could have even higher prices than the stated maximum
acceptable range of Birr 1.55, the need of reducing other cost components such as price of chemicals and fertilizer is very demanding.

Table 3. Partial budget and marginal analysis

<table>
<thead>
<tr>
<th></th>
<th>Arus untreated</th>
<th>ARDU12-60B treated</th>
<th>Shegie treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average grain yield (kg/ha)</td>
<td>1779</td>
<td>2366</td>
<td>2498</td>
</tr>
<tr>
<td>Adjusted yield (kg/ha)</td>
<td>1690</td>
<td>2248</td>
<td>2373</td>
</tr>
<tr>
<td>Gross field benefit (birr/ha)</td>
<td>1554.80</td>
<td>2068.16</td>
<td>2163.16</td>
</tr>
<tr>
<td>Variable cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of chemical (birr/ha)</td>
<td>0</td>
<td>156.25</td>
<td>156.25</td>
</tr>
<tr>
<td>Cost of chemical application (birr/ha)</td>
<td>0</td>
<td>20.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Seed cost (birr/ha)</td>
<td>184.00</td>
<td>115.00</td>
<td>115.00</td>
</tr>
<tr>
<td>Fertilizer cost (birr/ha)</td>
<td>0</td>
<td>124.00</td>
<td>124.00</td>
</tr>
<tr>
<td>Total variable cost (birr/ha)</td>
<td>184.00</td>
<td>415.25</td>
<td>415.25</td>
</tr>
<tr>
<td>Net benefits (birr/ha)</td>
<td>1370.80</td>
<td>1652.91</td>
<td>1767.91</td>
</tr>
<tr>
<td>MRR (%)</td>
<td>122</td>
<td>172</td>
<td>172</td>
</tr>
</tbody>
</table>

Source: experimental and CSA, 1995-1999 data

Conclusions and Recommendations

The improved varieties Ardu12-60B and Shegie were well appreciated, by farmers, for their tillering capacity, resistance to logging, and spike length as compared to the local variety. Grain yield, thousand-kernel weight, and hectoliter weight also made the improved varieties superior to the local. Moreover, variety Shegie was appreciated for its uniform heading, deep green leaves, seed size and plumpness.

Statistical analysis revealed that variability among the cultivars for grain yield and hectoliter weight was highly significant. In addition, economic analysis showed that varieties Ardu12-60B and Shegie, under the recommended management, had 21% and 29% net benefit advantage over the local variety respectively. Their respective MRR was 122% and 172%. Thus, both cultivars are economically viable. The sensitivity analysis undertaken indicated that, with a wider seed price range for Shegie the recommendation is stable. On the other hand, a narrower seed price range for variety Ardu12-60B showed that the ability of this recommendation to withstand the likely changes in seed prices is small.

The study indicated that disseminating cultivars Shegie and Ardu12-60B is justifiable. In addition, seed multiplication and provision of seed to farmers with reasonable prices will fasten the dissemination of these technologies. Extension efforts need to be strengthened to increase the flow of information from researchers to local community to make farmers aware of the technologies.

Provision of the seed treating chemical Gaucho with lower prices and/or with credit to farmers is very essential, besides, developing tolerant and/or resistant barley cultivars to barley shoot fly is an urgent agenda for researchers.

Generally, the study revealed that there is considerable scope for using participatory research methods even at the early stages of the research to develop technologies that are more appropriate.
References


On-Farm Performance of Sorghum Variety, Meko, in the Lowlands of Welo

Girma Tesfahun1, Wondimu Bayu1, and Getaw Tadesse1

Introduction
Sorghum is one of the most important food crops in Ethiopia and is widely grown in the semi-arid regions of the country (Brhane, 1979; Mengistu, 1982). This is more so in Welo where sorghum stands first both in production and in area coverage (Girma et al., 1998; Hailemichael, 1998). The farming community of Welo is faced with chronic food insecurity and hunger. A number of constraints challenge the centuries old traditional crop farming system on which the rural livelihoods entirely depend. Erratic rainfall with consequential dry spell all along a given season is the most important challenge in this part of Ethiopia.

In this regard, therefore, early maturing and drought tolerant sorghum cultivars, which give reasonably high, stable, and sustained yields could play an important role (Abebe et al., 1984). Sorghum varieties like 76T1 #23, Dinkmash 86, Gambella 1107 and Seredo are considered to have the above merits (Hailemichael, 1998). Field observations have revealed that 76T1#23 is widely under production in Kobo while Gambella 1107 still survives in the sorghum rich Oromia zone of the Amhara National Regional State.

Meko has been recently released as an early maturing and better yielding variety for moisture stressed areas along with its package of recommendations. Meko and its accompanying practices have passed through different on-station tests of research. This, however, does not qualify them for outright adoption by the target farmers working in diverse agro-ecologic and socio-economic circumstances. Such a fact necessitates the on-farm evaluation of the entire recommendation. To this end a two-year (1998 – 1999) on-farm experiment was conducted with the basic objective of evaluating Meko and its accomplices on-farm with agronomic, economic and farmers’ criteria.

Materials and Methods
Kobo, Ambassel, and Kalu districts representing three recommendation domains for sorghum production and improvement (Girma et al., 1998) hosted this trial. Kobo represented areas between 1300 and 1500 m producing medium height, small headed, and dependably drought tolerant sorghum varieties. Ambassel and Kalu represented the areas between 1500 and 1800 m producing medium height and medium head sized sorghum varieties. The sorghum varieties around Ambassel are considerably stalk borer and striga

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resistant/tolerant while the varieties of sorghum around Kalu were relatively drought tolerant varieties.

Three representative farms in each district were selected and the trials were conducted on 18 farms (9 farms each year). The treatments were three varieties and two management types. The varieties were Meko (M36121), 76T1#23, and local Jigurtie. The types of management were individual farmers’ traditional management and a recommended management that consisted of row planting, ridge tying, and emergence based weeding, and fertilizing.

The layout of the trial was split plot arrangement in randomized complete block design. The management levels were laid on main plots and the varieties on sub-plots. The sub plots were 10m x 10m wide. Farmers were advised to manage the traditional management main plot the way they normally do. Ridges were 75 cm apart and the space between plants in a row was 15 cm. The ridging was done using a pair of oxen and the local plow – maresha, and the ridges were tied manually at five-meter interval. Diammonium Phosphate (DAP) was applied at the rate of 100 kg/ha, and sorghum seeds at the rate of 15 kg/ha were sown in the ridges. Hand weeding was conducted twice, 20 – 25 and 45 – 50 days after emergence of the sorghum seedlings. Then urea was applied at the rate of 50 kg/ha when the plants reached knee height.

Farmers have judged all the varieties using their own criteria. Farmers have also commented on the simplicity and compatibility of each part of the recommended management. Relevant agronomic and economic data were collected all over the locations. These data included both pre and post harvest parameters. Agronomic data gathered for this study include grain yield, dry stover yield, fresh head weight, and plant height. The data collected for the purpose of economic evaluation included price of fertilizer and crop produces, and cost of labor for ridging, tying, fertilizing, harvesting, and threshing.

At Kobo, it was found that the average wage rate for 1 man day and 1 oxen day to be 6 birr and 30 birr, respectively. At Ambassel and Kalu the average wage rates were indicated by farmers to be 5 birr for 1 person-day and 20 for 1 oxen day. One oxen day was taken to be 6 hours work with a pair of oxen as farmers indicated the rarity of working with more than half a day. A healthy and matured farmer equated one person-day with 8 hours of work.

The fertilizers in their recommended amounts, 100 kg/ha for DAP and 50 kg/ha for urea, costed birr 250 and 80 at Kobo, birr 232 and 74 at Ambassel, and birr 231.25 and 76.10 at Kalu. The price of the sorghum varieties was also taken from the market immediately after harvest. At Kobo, Meko, 76T1#23, and Jigurtie were priced birr 144, 120, and 130 per quintal. At Ambassel, the prices were 135, 120, and 135 in the same order as Kobo. At Kalu, a quintal of Meko was sold for birr 140, 76T1#23 for birr 135, and the local sorghum for birr 142. The analytical tools used to manipulate the data are descriptive statistics, analysis of variance, and partial budgeting.
Results and Discussion

Agronomic Analysis

Significant (P<0.05) grain yield differences among the sorghum varieties and between management practices were detected only at Ambassel, but at Kobo and Kalu significant differences were not observed at all (Table 1). At Ambassel, Meko under recommended management gave the highest significant (P<0.05) grain yield (4012 kg/ha) and the local variety (Jigurtie) under farmers' management gave the least grain yield (1745 kg/ha). The average grain yield obtained from recommended management (3344 kg/ha) was higher when compared with that of farmer's management 2374 kg/ha.

At all the three locations, although the differences were not statistically significant, the local variety out yielded 76T1#23 under both management practices, except with the recommended management at Ambassel (Table 1). This could partly be attributed to the heavy bird damage on 76T1#23, which occurred due to the early maturity of this variety. The improved variety, Meko, out yielded the local variety by 37 and 20 percent at Kobo and by 24 and 54 percent at Ambassel under recommended and farmers' management practices, respectively. Meko has also out yielded the improved variety 76T1#23 at all locations, whereas at Kalu the local variety out yielded Meko under both management types.

With regard to stover yield, no significant differences were detected among the sorghum varieties and between management practices across locations (Table 2). However, at Ambassel the management by variety interaction was significant (P<0.01). The local variety gave significantly higher stover yield (5689 kg/ha) under recommended management. Under farmers' management the same variety gave the least stover yield (2950 kg/ha).

Sorghum fresh head weight was significantly affected by management practices and varieties at Ambassel and only by varieties at Kalu (Table 3). At Ambassel significantly (P<0.05) higher head weight (4082 kg/ha) was obtained under recommended management. Among the varieties, Meko and Jigurtie gave significantly (P<0.05) higher head weight over 76T1#23. Similarly, at Kalu the highest (significant at P<0.05) head weight was obtained from the local variety. Plant height was significantly (P<0.01) different among the sorghum varieties at all locations (Table 4). The local variety was significantly taller followed by Meko. At Ambassel, the recommended management practice significantly improved plant height.
Table 1. Grain yield (kg/ha) of sorghum varieties under improved and farmers management at three locations

<table>
<thead>
<tr>
<th>Variety</th>
<th>Kobo</th>
<th>Ambassel</th>
<th>Kalu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rec. mgt</td>
<td>Farmer mgt</td>
<td>Mean</td>
</tr>
<tr>
<td>Meko</td>
<td>4352</td>
<td>3554</td>
<td>3953</td>
</tr>
<tr>
<td>76T1#23</td>
<td>2905</td>
<td>2351</td>
<td>2628</td>
</tr>
<tr>
<td>Jigurtie</td>
<td>3174</td>
<td>2962</td>
<td>3068</td>
</tr>
<tr>
<td>Mean</td>
<td>3477</td>
<td>2956</td>
<td></td>
</tr>
</tbody>
</table>

LSD (5%)
- Managt: NS
- Variety: NS

CV (%) 28.09

NS- Not Significant
Values powered with different letters are significantly different at P<0.05
Rec. mgt = Recommended management

Table 2. Dry Stover yield (kg/ha) at harvest of sorghum varieties under improved and farmers management at three locations

<table>
<thead>
<tr>
<th>Variety</th>
<th>Kobo</th>
<th>Ambassel</th>
<th>Kalu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imp.*</td>
<td>Farm.**</td>
<td>Mean</td>
</tr>
<tr>
<td>Meko</td>
<td>6552</td>
<td>5096</td>
<td>5824</td>
</tr>
<tr>
<td>76T1#23</td>
<td>4158</td>
<td>4105</td>
<td>4137</td>
</tr>
<tr>
<td>Jigurtie</td>
<td>5774</td>
<td>7505</td>
<td>6640</td>
</tr>
<tr>
<td>Mean</td>
<td>5498</td>
<td>5569</td>
<td></td>
</tr>
</tbody>
</table>

LSD (5%)
- Mgmt: NS
- Var: NS
- Mgmt x Var: 1448

CV (%) 34.09

NS- Not Significant
Values powered with different letters are significantly different at P<0.05
Imp = Improved

Table 3. Fresh head weight (kg/ha) of sorghum varieties under improved and farmers management at three locations

<table>
<thead>
<tr>
<th>Variety</th>
<th>Kobo</th>
<th>Ambassel</th>
<th>Kalu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Imp.*</td>
<td>Farm.**</td>
<td>Mean</td>
</tr>
<tr>
<td>Meko</td>
<td>6204</td>
<td>5278</td>
<td>5741</td>
</tr>
<tr>
<td>76T1#23</td>
<td>4444</td>
<td>3519</td>
<td>3982</td>
</tr>
<tr>
<td>Jigurtie</td>
<td>5555</td>
<td>4963</td>
<td>5259</td>
</tr>
<tr>
<td>Mean</td>
<td>5401</td>
<td>4586</td>
<td></td>
</tr>
</tbody>
</table>

LSD (5%)
- Mgmt: NS
- Var: 826.9
- Mgmt x Var: 833.4

CV (%) 33.52

NS- Not Significant
Values powered with different letters are significantly different at P<0.05
Imp = Improved
On-farm performance of sorghum variety

Table 4. Plant height (cm) of sorghum varieties under improved and farmers' management at three locations

<table>
<thead>
<tr>
<th>Variety</th>
<th>Imp. *</th>
<th>Farm. **</th>
<th>Mean</th>
<th>Imp.</th>
<th>Farm.</th>
<th>Mean</th>
<th>Imp.</th>
<th>Farm.</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meko</td>
<td>191</td>
<td>175</td>
<td>183b</td>
<td>179</td>
<td>164</td>
<td>172b</td>
<td>177c</td>
<td>165cd</td>
<td>171b</td>
</tr>
<tr>
<td>76T1#23</td>
<td>143</td>
<td>144</td>
<td>143c</td>
<td>149</td>
<td>137</td>
<td>143c</td>
<td>143d</td>
<td>135d</td>
<td>139c</td>
</tr>
<tr>
<td>Jigurtie</td>
<td>317</td>
<td>304</td>
<td>311a</td>
<td>313</td>
<td>290</td>
<td>301a</td>
<td>336a</td>
<td>279b</td>
<td>308a</td>
</tr>
<tr>
<td>Mean</td>
<td>217</td>
<td>207</td>
<td>214</td>
<td>197</td>
<td>219</td>
<td>193</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>NS</td>
<td>19.68</td>
<td>NS</td>
<td>24.02</td>
<td>NS</td>
<td>21.97</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mgmt x Var.</td>
<td>NS</td>
<td>23.06</td>
<td>NS</td>
<td>31.06</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV(%)</td>
<td>6.8</td>
<td>8.56</td>
<td>7.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Labour demand difference for the two management types

<table>
<thead>
<tr>
<th>Activity</th>
<th>Farmers' management (birr/ha)</th>
<th>Recommended management (birr/ha)</th>
<th>Labor value difference* (birr/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kobo Ambassel Kalu</td>
<td>Kobo Ambassel Kalu</td>
<td>Kobo Ambassel Kalu</td>
</tr>
<tr>
<td>Ridge making</td>
<td>-</td>
<td>87.5</td>
<td>-87.5</td>
</tr>
<tr>
<td>Tying</td>
<td>-</td>
<td>2.97</td>
<td>2.97</td>
</tr>
<tr>
<td>Sowing</td>
<td>1.23</td>
<td>11.9</td>
<td>11.9</td>
</tr>
<tr>
<td>Seed covering</td>
<td>124.5</td>
<td>20</td>
<td>23.3</td>
</tr>
<tr>
<td>Fertilization</td>
<td>-</td>
<td>-</td>
<td>52.5</td>
</tr>
</tbody>
</table>

* Labor demand of traditional management - labor demand of recommended management

Economic Analysis

An economic analysis is a further look into the experimental variables found to be statistically and agronomically meaningful (Hildebrand and Frederico, 1985). The varieties and the management types have resulted in a significant yield difference only at Ambassel. That is the experiment at Ambassel will be the only case to be considered in the economic analysis. At Ambassel, under the recommended way of production, Meko has given the highest yield and gross benefit per hectare (birr 5,416) calculated based on the unadjusted yield. Under the traditional way of management, 76T1#23 has slightly higher yield than Meko, yet the later has generated the highest gross field benefit of birr 3,621 per hectare (Table 6). Farmers are not interested only in yield size, they are more interested on the benefits acquired from an enterprise, and this should be considered while looking at the values being mentioned.

Table 6. Gross benefits of the three varieties and their differences

<table>
<thead>
<tr>
<th>Location</th>
<th>Variety</th>
<th>Yield (kg/ha)</th>
<th>Value of yield (birr/ha)</th>
<th>Value difference* (birr/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rec* Farm**</td>
<td>Rec* Farm**</td>
<td></td>
</tr>
<tr>
<td>Kobo</td>
<td>Meko</td>
<td>4352</td>
<td>3554</td>
<td>6267</td>
</tr>
<tr>
<td></td>
<td>76T1#23</td>
<td>2905</td>
<td>2351</td>
<td>3486</td>
</tr>
<tr>
<td></td>
<td>Jigurtie</td>
<td>3174</td>
<td>2962</td>
<td>4126</td>
</tr>
<tr>
<td>Ambassel</td>
<td>Meko</td>
<td>4012</td>
<td>2682</td>
<td>5416</td>
</tr>
<tr>
<td></td>
<td>76T1#23</td>
<td>2791</td>
<td>2694</td>
<td>3349</td>
</tr>
<tr>
<td></td>
<td>Jigurtie</td>
<td>3228</td>
<td>1745</td>
<td>4358</td>
</tr>
<tr>
<td>Kalu</td>
<td>Meko</td>
<td>2648</td>
<td>1924</td>
<td>3707</td>
</tr>
<tr>
<td></td>
<td>76T1#23</td>
<td>2102</td>
<td>1815</td>
<td>2838</td>
</tr>
<tr>
<td></td>
<td>Jigurtie</td>
<td>3201</td>
<td>1927</td>
<td>4545</td>
</tr>
</tbody>
</table>

* Recommended management, ++ Farmers' management
Value of the output of recommended management - Value of output of farmers' management.
Rec = Recommended

The crop management types (traditional and recommended) were also compared to select the one that rewards the farmers. Notwithstanding the price difference...
among the three varieties, only Meko is considered in the partial budgeting used for comparing the economic returns of the management types. The grain yield of Meko is adjusted 10% downwards of the original size to take into account the difficulties and mismanagements which could have occurred had the experiment been handled by farmers on a large plot of land.

Under farmers’ way of production, a gross field benefit of birr 3,259 per hectare was generated from the production of Meko. Producing Meko with the recommended management increased the benefit to birr 4875 per hectare. The costs that vary with the type of management were estimated to be birr 99 per hectare for the traditional and birr 464 per hectare for the recommended management. The variable costs included labor (Table 5), fertilizers, and cost of additional working capital. Then, the net benefits per hectare (the difference between the gross field benefit and the total costs that vary) happened to be birr 3160 and 4411 for traditional and recommended methods of production, respectively.

Table 7. Partial budget for the two management types

<table>
<thead>
<tr>
<th>Cost/benefit title</th>
<th>Management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional (birr/ha)</td>
<td>Improved (birr/ha)</td>
</tr>
<tr>
<td>Average grain yield (Kg/ha)</td>
<td>2682</td>
<td>4012</td>
</tr>
<tr>
<td>Adjusted grain yield (Kg/ha)</td>
<td>2414</td>
<td>3611</td>
</tr>
<tr>
<td>Gross field benefits (birr/ha)</td>
<td>3259</td>
<td>4875</td>
</tr>
<tr>
<td>Labor for</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ridge making (birr/ha)</td>
<td>-</td>
<td>69</td>
</tr>
<tr>
<td>Tying (birr/ha)</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Sowing (birr/ha)</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Seed covering (birr/ha)</td>
<td>97</td>
<td>23</td>
</tr>
<tr>
<td>Fertilization (birr/ha)</td>
<td>-</td>
<td>51</td>
</tr>
<tr>
<td>Fertilizer cost</td>
<td>-</td>
<td>232</td>
</tr>
<tr>
<td>DAP (birr/ha)</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Urea (birr/ha)</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Total costs that vary (birr/ha)</td>
<td>99</td>
<td>464</td>
</tr>
<tr>
<td>Net benefits (birr/ha)</td>
<td>3160</td>
<td>4411</td>
</tr>
<tr>
<td>Total cost added</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>Cost of additional capital (50%)</td>
<td>183</td>
<td>548</td>
</tr>
<tr>
<td>Marginal cost</td>
<td>1251</td>
<td></td>
</tr>
<tr>
<td>Marginal benefits</td>
<td>228</td>
<td></td>
</tr>
</tbody>
</table>

Note: Sorghum variety M36121 (Meko) Location Ambassel Price 135 birr/q.

Though the relative magnitude of the net benefits from the two ways of sorghum production can be used to identify which one is more rewarding, farmers are interested to know how much extra cost they would have to incur to get the extra benefits (CIMMYT, 1988). To receive the additional benefit of birr 1251 (i.e., birr 4411 – birr 3160), farmers would have to pay additional birr 548, at 50% rate of interest for working capital, on a hectare basis. The marginal rate of return (MRR) would be then 228% (Table 7). A marginal rate of return of 228% implies that for each birr invested on the recommended method of sorghum production would repay the birr and additional return of 2.28 birr.
The sensitivity of the effectiveness of Meko and its recommended practices to changes in different variables in the farm economy was analyzed under seven scenarios. Analysis with the assumption of 20% decline in grain yield of the sorghum variety resulted in MRR of 169%. Similarly, the assumption of a 10% decline in field price of grain yield made the MRR 199%. An analysis with the assumptions of 10% rise in total costs that vary and 100% increment in the cost of additional working capital resulted in MRR of 202% and 171%, respectively (Table 8).

Table 8. Results of Sensitivity analysis

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Marginal cost (birr)</th>
<th>Marginal benefit (birr)</th>
<th>MRR (%)</th>
<th>Feature of scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>548</td>
<td>928</td>
<td>169</td>
<td>20% decline in grain yield</td>
</tr>
<tr>
<td>2</td>
<td>548</td>
<td>1089</td>
<td>199</td>
<td>10% decline in field price</td>
</tr>
<tr>
<td>3</td>
<td>602</td>
<td>1215</td>
<td>202</td>
<td>10% increase in total cost</td>
</tr>
<tr>
<td>4</td>
<td>730</td>
<td>1251</td>
<td>171</td>
<td>100% increase in cost of additional capital</td>
</tr>
<tr>
<td>5</td>
<td>602</td>
<td>972</td>
<td>161</td>
<td>15% decline in grain yield and 10% increase in total cost</td>
</tr>
<tr>
<td>6</td>
<td>594</td>
<td>1058</td>
<td>178</td>
<td>10% decline in grain yield and 10% increase in fertilizer cost</td>
</tr>
<tr>
<td>7</td>
<td>876</td>
<td>852</td>
<td>102</td>
<td>30% decline in grain yield, scenario 4 and 20% increase in fertilizer cost</td>
</tr>
</tbody>
</table>

With the assumptions of 15% decline in grain yield and 10% increase in total costs that vary, MRR was calculated to be 161%. Likewise, an assumed 10% decline in grain price and 10% increase in fertilizer cost resulted in MRR of 178%. Done the same way, the MRR would nearly be 100% if a combination of 30% decline in grain yield, 100% increase in cost of additional working capital, and 20% increase in fertilizer cost is assumed (Table 8). This is a break-even point below, which farmers would not be willing to adopt the recommended way of producing the newly released variety or Meko.

The marginal rate of returns generated under the different scenarios show significant level of returns for an investment in the recommended way of production. The minimum rate of return for any investment to be accepted by farmers is the opportunity cost of money (or simply the local interest rate), which is 50-100% (Tripp and Wooley, 1989). This minimum interest rate is well met, yet, the significance of shortage of liquid assets in the farming systems of Welo dry lands would be a great challenge as far as employing this recommended way of production is concerned.

**Farmers’ Assessment**

Farmers have commented on the relative performance of the three varieties and the two methods of production. Farmers in Kobo have preferred Meko and 76T1#23 to Jigurtie for their earliness and, as a result, for escaping moisture stress - a critical constraint in the district. Of the two early maturing varieties, farmers selected Meko (M36121) best for bigger head size, milky white color of seeds and thick stalk.
At Ambassel, where Jigurtie is very dominant, farmers favored Meko and Jigurtie for bigger panicle size, and thick stock (farmers call a stalk type good when it is thick for Meko and when it is tall for Jigurtie) for Meko and tall stalks for Jigurtie. Farmers were not relatively interested at 76T1#23, as it was very short and had smaller panicles. Farmers in Kalu have a different observation. Having different sorghum varieties productive under different circumstances, farmers could not be happy with both Meko and 76T1#23. Farmers argued that these varieties mature too early making their management difficult. They also indicated that the maturity time of these varieties do not fit to the schedule farmers have for the various on and off farm activities. For instance, farmers could not scare birds in time. Farmers in Kalu, generally, preferred their own Jigurtie for its stalk and reasonable yield generated in a way that suits the traditional farm management practice.

The shortness of the stalks of Meko and 76T1#23 was also another area for disinterest for those farmers who mainly depend on the sorghum stalk for cattle feed. Farmers have ranked the stalk of Jigurtie the best for cattle feed and as fuel and that of Meko ranked second. Farmers preferred the stalk of Jigurtie for its tall height. Alike the varieties, farmers compared the different recommended practices of sorghum production with their traditional practices. They observed row planting as one of the differences between the recommended and traditional methods of sorghum production. Farmers practiced and evaluated ridge making, sowing in rows, and seed covering too.

As crop planting is an activity, which has to be conducted in a very short and specific interval of time, it is likely that the pressure is very high on the limited oxen and human labor power (Table 5). Farmers, in this case, would not be able to accommodate any recommendation, which adds to this tension. This is why farmers in all of the three districts showed lack of interest in row planting and all activities associated with it like tied ridging. In addition to its association with row planting, farmers for two could not appreciate tied ridging because of two reasons. First, it could not last long on-farm and have its role noticed; second, it aggravates water logging in cases of heavy rainfall and soils with poor porosity.

The recommended frequency and time of weeding sorghum is twice per season at 20-25 and 45–50 days after emergence. Farmers could not be convinced as to how the frequency and periods of weeding can be set for their farming systems with precarious weed infestation pattern. Farmers normally weed whenever the weeds emerge and rarely fix number of times of weeding. Moreover, farmers in moisture stressed areas argue that weeds conserve moisture through carrying dews and in their views; weeds should not always be uprooted.

Fertilizer application was also an area of interest for the farmers who hosted and visited the on-farm trials. The effect of fertilizers on the productivity of sorghum is well perceived by farmers. They have shown considerable interest in applying fertilizer on their sorghum farms; nevertheless, farmers stressed the lack of purchasing power. Again, they would be applying the fertilizer not in rows, instead they are thinking of broadcasting.
Conclusions

The results of the agronomic evaluations illustrated that Meko has a better productivity in Ambassel, an area where farmers have stalk borer and striga tolerant sorghum land races. The grain yield of Meko was less than that of the local variety at Kalu as drought tolerance is among the traits of the local land races. In their evaluations, farmers in Kobo and Ambassel favored Meko, which was virtually better than the other varieties. Therefore, based on the results of this study, Meko can be recommended as a dependable alternative variety for highly moisture stressed areas and areas lacking drought tolerant varieties.

The economic analysis done for Ambassel district, indicated that the recommended management type is more rewarding and reliable under a lot of hypothetical and yet possible variations in the crop production system. However, farmers refuted the compatibility of the recommended management practices with the prevailing traditional system of operation. This, therefore, implies that the way farmers are going to manage its production in these areas would be the traditional way unless the farming system is enormously transformed, including a positive shift in the purchasing power of the community.

References
History and Status of Socio-Economics Research in Ethiopia
Tesfaye Zegeye, Legesse Dadi, and Dawit Alemu

Introduction

In Ethiopia, agriculture is the most important economic activity. It contributes to over 50 percent of the Gross Domestic Product (GDP), employs 85 percent of the labor force, and generates over 90 percent of the foreign exchange earnings. Its contributions are also expressible at household level in its role of enhancing income, food security and social status. The livestock sector contributed approximately 12-15% to the total GDP, 25-30% to value added and allied activities (MEDAC, 1999). The Ethiopian economy exhibited either stagnation or very slow growth over the last two decades. This is more pronounced in the country’s core economic sector, agriculture. With a little over 1 ton per hectare, cereal yields are one of the lowest in the world. Land and labor productivity is low because of the limited application of modern technology. Chemical fertilizer is used by approximately 30 percent of the estimated seven million farm households. Much of the highland suitable for crop production has already been used. Because of population pressure and other factors, farm size has been reduced and fragmented.

Thus, the agricultural sector needs to be intensified through a coordinated system of input supply and delivery, farm finance and reliable access to output markets, and an effective agricultural research and extension systems. The government of Ethiopia recognizing the need for technological progress in agriculture has put agriculture at the heart of its policies. These policies focus on strengthening improved technology generation from the research system and promoting the adoption of new technologies such as improved seeds and fertilizers as well as improving the marketing and distribution of agricultural inputs. Enhanced use of improved technologies seems to be the only means for alleviating poverty and increasing production.

Agricultural research in Ethiopia started in the late 1940s and early 1950s with the establishment of agricultural education institutions such as Jimma and Ambo Agricultural Schools and Alemaya College of Agriculture. The research undertaken during this time was simple experiment that was limited in scope to their academic interest. The government of Ethiopia in 1966 felt the need for the establishment of a nationally coordinated research system and the Institute of Agricultural Research (IAR) was established. The formal research systems which was created with the establishment of IAR was expected to cater to the needs of the agricultural sector in a systematic manner encompassing all the important crops, animal species, forests, soils and water.
Establishment

After two years of experience the management of IAR realizing that agricultural development in general and agricultural production and productivity in particular are affected (positively or negatively) not only by biophysical factor alone, but also by various socio-economic factors, established the socio-economics research as one of its wings. In this regard the management realized that socio-economics research could play an immensely important role in the need assessment, development and dissemination of appropriate agricultural technologies and in evaluating agricultural marketing systems, agricultural policies, and in the organization of production systems. An expatriate staff from the Food and Agricultural Organization (FAO) at the Holetta Agricultural Research Station started the agricultural economics research program in 1968. With change in research themes, emphasis and approaches, the name of the department responsible for socio-economic research changed from Agricultural Economics and Farm Management to agricultural Economics and Farming Systems Research Department. Presently it is called Socio-economics Research Department.

Achievements and Problems

In the early years (1968 –1975), the agricultural economics research program focused on farm management studies production cost analysis and development of farm record keeping formats. The first farm management study was undertaken in the central and western parts of the country (Holetta, Bako, Jima and Mojo). The effect of increasing fertilizer inputs or returns from farming under different types of land tenancy system in Ethiopia was investigated. Subsequently a national farm management survey was initiated in 1974 and was undertaken in collaboration with other agencies such as the Extension Program Implementation Department (EPID), Chilallo Agricultural Development Unit (CADU) and the National Coffee Board (NCB). The survey started in sixteen enumeration areas with 309 farmers who were interviewed throughout the 1974/75 cropping season.

The development of farm record keeping system was aimed at developing record formats for farm management activities that provides the foundation for decision-making. Altogether 18 formats were developed (IAR, 1971). Cost of production studies were conducted for newly released crop varieties at each seed multiplication farm of research centers from 1970 to1988.

After 1975 however, the department’s activities focused on demonstration of available research results as package testing to near by farming communities. It was soon realized that the recommendations gave no superior results over the traditional practices and farmers were justifiably reluctant to accept the recommendations (Tesfaye et al., 1979) Two lessons were learned from this experience: first, the need to study why farmers do not adopt the recommended packages. Second, it was evident that researcher’s knowledge and understanding of the peasant and his circumstance was far from complete. With this rational the department initiated multidisciplinary surveys and
package testing programs. In 1977/78, a multidisciplinary survey was launched around Holetta and Bako research centers to identify constraints. To address some of these constraints, a package-testing program was initiated in 1980. The package of innovations developed includes improved varieties and recommended agronomic practices. Each host farmer provided land, labor, and fertilizer while improved varieties and technical advice were offered by research. Although no formal adoption studies were carried out to assess the impact of the package-testing program, informal surveys conducted around the two centers confirmed that farmers have picked some of the innovations that are compatible to the system. A lesson was also learned that the survey procedures need to be inter-disciplinary and that technology generation process incorporates farmers' knowledge.

Diagnostic surveys of a general type were conducted in different parts of the country particularly in nearby mandate areas of research centers. In each of the surveyed areas the natural and socio-economic circumstances of farmers were described, system trends and major production constraints were identified and recommendations were made.

Based on the results of the diagnostic surveys, different types of on station and on-farm experiments on crop varieties, fertility management, farm implements and other cultural practices were implemented. The farming systems research contributed a lot to enhance the knowledge and understanding of production constraints and opportunities and it provided information for plant breeders and agronomists on major constraints, preferences and priority areas of research interventions. The study also gave and assisted in formulating packages of recommendation that are appropriate to small-scale farmers.

In general, agricultural economics research and policy analysis conducted by the national research systems emphasized the crop sector. Farming systems diagnosis and constraint analysis have been done for some of the areas in which wheat, maize, tef (*Eragrostic tef*) and pulses are grown. Most of the diagnostic surveys have also identified some of the animal sub-system and their constraints. Adoption pattern of technologies of wheat, maize, pulses have been studied in few areas. Such studies however are insignificant for animal production, horticultural crops, forests, soils and water. Production economics and marketing studies of food grains and horticultural crops were very limited. With regard to animal sector, few studies on production cost and marketing of animals and animal products such as meat and milk have been done.

The past agricultural research system has been emphasizing biophysical researches giving inadequate attention to socio-economic and policy studies. There has also been a discipline bias in work force training and employment, heavily militating towards biophysical sciences. It was also observed that biophysical scientists, who were the main actors in the management of the research systems, inclined to think of social scientists and economists as support service givers rather than as researchers. These situations were the major problems that hampered the development of a full-fledged center of excellence for socio-economics research and policy analysis in the national agricultural research system.
After the establishment of commodity research programs in 1985, socio-economic researchers were assigned to work as a member of a multidisciplinary team of each commodity. This decision eroded the duties and responsibilities of the then Department of Agricultural Economics and Farming Systems Research and that of the divisions at center level. From then onwards, little emphasis was given to socio-economic research in terms of human resource and facility development.

**Status**

With the establishment of the Ethiopian Agricultural Research Organization (EARO), the socio-economic research sector was reinstated as a department at the head quarters level and as a division at center level. After its establishment as a department agro-ecology based client oriented and demand driven national socio-economics strategy was developed and approved by the government. The overall goal of the socio-economics sector of EARO is to provide information and analysis towards improving the internal efficiency of the research to develop appropriate technologies and external efficiency that improves the level of utilization of developed technologies. Subsequently, research will be able to contribute in attaining ultimate goals of poverty alleviation and improved welfare of farm households. The socio-economics sector contributes to EARO's vision, mission and goals by:

- Conducting surveys, resource inventory and case studies and characterizing agro-ecologies and farming systems, identifying constraints and opportunities and suggesting alternative solutions;
- Determining levels and identifying factors influencing adoption; conducting studies to assess the impact of technological change on food security, income distribution, nutritional status, resource allocation, efficiency and employment;
- Undertaking on-farm experiment and verification trials in collaboration with technology generators and farmers and evaluating technologies under farmer conditions;
- Undertaking research dealing with the utilization, productivity, profitability and efficiency of resources, risk and risk management, and enterprise choice and farm decision-making;
- Conducting studies and assessing the impact of agricultural and related policies and institutions that have impact on technology generation and transfer, food security, poverty alleviation and resource use efficiency;
- Carrying out research on sustainable management, conservation and utilization of natural resources; investigating the relations between socio-cultural, economic and institutional factors and natural resource degradation; conducting marketing studies;
- Examining the structure, conduct and performance of input and output markets and their implications on agricultural technology development and transfer; food security, poverty alleviation and resource use efficiency;
- Conducting studies and assessing gender roles and rural labor structures; and undertaking studies and assessing consumer preferences and consumption pattern (EARO, 2002).

The expected outputs of the socio-economics sector include information, strong database, and research and policy recommendations. Production and policy constraints and opportunities will be identified and is expected to
contribute to redirecting the focus of crop, livestock and natural resource management research. Rate of technology adoption and the impact of technologies and agricultural related policies on farm production, resource use, income, nutritional status and food security will be quantified and known. Moreover, information on input and output markets will be generated. Research capacity and capability will be developed.

The research activities of the socio-economics research department of EARO are organized in three research programs and nine projects. The description of each research program and project is presented below.

**Production Economics and Farming Systems**

This program is designed to:

- provide information on producers' input use, enterprise choice, productivity, efficiency and the level of risk;
- determine the levels and intensity of adoption of agricultural technologies;
- identify socio-economic, physical and institutional factors that affect adoption of agricultural technologies;
- assess the impact of agricultural technologies on productivity, income distribution, food security, nutrition, resource allocation, return to various factors of production and employment and;
- characterize farming systems within agro-ecologies, identify constraints and opportunities thereby enhance the development and transfer of technologies.

The program is designed to launch three projects entitled characterization of farming systems in agro-ecologies; farm management and production economics research and adoption and impact studies.

Although previous diagnostic studies have helped to redirect research towards farmer's problems, there is a need to create a strong client-oriented participatory technology development approach that could facilitate the generation and dissemination of appropriate technologies. Thus, to make the generation and development of technologies pertinent to farmers' priority problems, resource constraints, physical, cultural and economic environment, characterization and analysis of farming systems from these perspectives will be carried out in different agro-ecologies. To address this and related issues in a comprehensive manner the project entitled characterization of farming systems in agro-ecologies has been institutionalized.

Farm household systems usually consist of three interlinked and interactive sub-systems. These are the household as the decision-making unit, the farm with its crop and livestock activities as production elements of the farming systems and an off-farm component involving one or more of work, market or social relationships. The first of these sub-systems, which is the household as the decision-making unit, is particularly relevant because decisions taken at the farm household level have far-reaching effects on agricultural production. The farm household thus deserves special attention as the basic unit of analysis and development, especially in developing countries. In this regard, it is important to understand the framework within which farm household objectives are set and the methods by which these objectives are achieved. Another characteristic feature of the farm household in small-scale agriculture
is the high proportion of family labor in the total labor input, as well as the high percentage of small-scale farmers, and their responsibility for the bulk of food production in the country. Hence, the farm management and production economics project has been designed to provide information on resource use, enterprise choice, productivity, profitability and risk management and decision making of different enterprises. In addition, agricultural technologies developed by technical scientists need to be tested under more number of farmers’ fields and evaluated for their profitability and system compatibility before demonstration.

Technological Development and Transfer (TDT) increases agricultural productivity and improves the well-being of poor farm families. It will stimulate agricultural transformation by releasing labor and capital from agriculture for employment in manufacturing and other non-agricultural activities, generating food sufficient to feed the agricultural and no-agricultural population at affordable prices.

TDT is a process characterized by four sequential stages: creation of the institutional capacity to develop improved techniques of production, expansion of the technology frontier, transfer of technology to the users, and sustainable changes in long-term productivity. It is the last of these, which may lead to people-level impacts, such as improvement in food security or increased incomes. It is also an important part of an environment, which facilitates agricultural transformation. The adoption and impact of research project is expected to determine the level of technology adoption and identify factors that limit the adoption processes. In addition, it assesses the impact of technological change on the livelihoods of farmers.

This research project by providing information (about these critical factors) will enable policy makers to allocate the country’s resources for research and development programs. The information generated will also help national research and extension to understand the factors that inhibit the adoption of technologies.

**Agricultural Policy and Marketing**

In all countries including Ethiopia there tend to be a substantial government influence on agriculture via regulations and programs relating for example, to tenure, land and water use rights, pest and disease control, labor welfare, credit supply and interest arrangements, etc. In addition, other elements such as exchange rate control, removal of subsidy, road construction or development, education, research funding, structural adjustment program etc, have a significant effect upon agricultural development. Under this program, the following four research projects are designed to address and seek solution requiring the impact of agricultural policies on the livelihoods of small-scale farmers in particular and the public at large. The projects are agricultural marketing and agricultural policy and institutional research. These research projects generate information and recommendation on the implication of agricultural and related policies in:

- poverty alleviation;
- improvement of foreign exchange earnings and management, sustainable utilization and conservation aspects of the country’s natural resources;
• evaluation of the existing agricultural marketing systems in terms of constraints and opportunities;
• consumption patterns and preferences of agricultural products in relation to household expenditure and welfare; and
• enhancement of the role and performance of formal and informal institutions in the development of the agricultural sector.

**Natural Resource Economics**

Ethiopia’s natural endowments are its rich soils, extensive water resources, big reservoir of wild genetic pools (both plant and animal) and rich human and as well as livestock resources. During the past two to three decades efforts were made to conserve, develop, manage and utilize the natural resources of the country. However, these effort have contributed none or at best very little to bring about positive changes in the state of affairs of natural resources in the country, especially when it comes to meeting the overall objectives of sustainable resources utilization of generations (present and future). A rather threatening state of land degradation, loss of biodiversity, deforestation and a vastly expanding process of desertification are vividly manifesting this.

Much of the failures and hence lack of positive impact of these past efforts towards sustainable resources utilization is explained largely by, among other factors, the absence and/or lack of clarity in policies, deficiencies in institutional arrangements and poor co-ordination, and lack of appropriate technology and its dissemination. Two projects entitled the economics of natural resource management and conservation and the economics of land and water resources were designed to address the points outlined above. The program and the projects are expected to provide information on natural resources management and utilization. The focuses of the projects are:

• identifying factors that condition farmers’ resource and resource use decisions;
• examining how resource use and resource management institutions involving different social groups (e.g. women, men) are evolving in response to climatic, demographic and socio economic pressure;
• examining the effect of resource management institutions (e.g. land use rights) on resource use in different agro-ecological zones and how changes in these institutions might promote or hinder environmental objectives; and
• examining polices and incentives to complement efforts and to promote more effective natural resource management.

**Structure of Socio-economics Research**

Research centers are the grassroots organizational units in which socio-economics research activities and SETs (surveys, experiments and trials) are planned and executed. The socio-economics research programs and projects outlined above are responsible to address socio-economic issues of animal production, crop production and natural resource management in a prioritized manner. The socio-economics research sector responsibility of coordinating national socio-economics research emanates from EARO’s responsibility of coordinating the national agricultural research system. It is presumed that the socio-economics research sector coordination department at EARO Head
Quarters facilitates the designing of technically sound socio-economic research programs, projects and research SETs and activities through the provision of training, organizing forums of national and international experience sharing etc. The department coordinates, periodical plan, monitor and evaluate the research programs, projects, SETs and or activities. The coordination is undertaken through different research review system developed, by working together with regional research centers, higher learning institutions and institutions such as the Institute of Development Research, the Ethiopian Development Research Institute, Ethiopian Livestock Marketing Authority, the Ministry of Agriculture, The Ministry of Finance and Economic Development, etc. In addition collaborative research activities are undertaken with international research institutions such as the International Livestock Research Institute (ILRI), The International Wheat and Maize Research Institute (CIMMYT), The International Food Policy research Institute (IFPRI), The International Center for Agricultural Research in Dry Land Areas (ICARDA), The International Center for Research in Semi Arid Tropics (ICRISAT), and research networks such as Eastern and Central Africa Program for Agricultural Policy analysis, Food Net, etc.

**Human resources and facilities**

The availability of adequate work force and required facilities plays a decisive role in the success of any socio-economics research. Having understood the fact the management of EARO has given due emphasis to develop the work force and facilities of the socio-economics research sector. The sector was gradually staffed with the required critical mass of social scientists and assistants and equipped with facilities (computers and office equipment) needed for effective implementation of the programs, projects and research SETs. To mitigate the problem of manpower and enhance efficient utilization of the available researchers different measures have been taken of which provision of training to existing staff members and employment of new staff are worth mentioning. Table 1 and 2 indicate the work force situation of the socio-economics sector at both regional and federal levels.

| Table 1. Work force status of Federal Research Centers As of 2002 |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Level of Education | HQ | Holeta | Debre Zeit | Melkassa | Kulumsa | Jima | Pawe | Wener | Total |
| PhD | 1 | 1 | 1 | 2 | | | | | 4 |
| MSc | 1 | 2*+2* | 3* | 1 | 3 | 1* | | | 7*+6* |
| BSc | 1 | 1* | 1* | 1* | 2* | 1*+1* | | | 3*+7* |
| Diploma | 1 | 1* | 1* | 1* | | | | | 5 |
| Certificate | | 1 | 2 | 1 | 1 | 2 | | | 2 |
| Others | 1 | | | | | | | | 1 |
| Total | 3 | 5 | 7 | 5 | 6 | 4 | 2 | 2 | 22+13* |
| * - on study leave |

| Table 2. Work force status of regional research centers as of 2002 |
|------------------|------------------|------------------|------------------|------------------|------------------|
| Level of Education | Bako | Sinana | Adami Tulu | Awassa | Areka | Sheno | Adet | Shinika | Melkalle | Total |
| PhD | 1 | 1 | 1 | 1* | 1 | 1 | 1* | 1 | 1 | 4+1* |
| MSc | 1+1* | 2 | 1+1* | 2* | 1* | 1+1* | 1+1* | 1 | 1 | 8+7* |
| BSc | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| Certificate | 1 | 1 | 2 | 1 | 1 | 1 | 1 | | 4 |
| Others | | | | | | | | | | 4 |
| Total | 2 | 5 | 2 | 5 | 4 | 5 | 3 | 2 | 2 | 30 |
| * - on study leave |
Conclusions

A great challenge is facing the country’s agricultural sector due to the current globalization trends, and the move towards more liberal market systems that require the national agricultural systems to develop the capacity to respond to market forces, to remain competitive and expand their share of market. The country’s subsistence farming system needs policy support in the area of agricultural technology generation and transfer, marketing and natural resource management; expanding role of the private sector in commercial farms that used to be exclusive preserve of the government; the need to bridging the gap between potential yields and actual farmer yield which requires macro and micro policy analysis. This challenges call for strong socio-economics research at all levels. Thus further capacity building in terms of work force and facilities should be given due emphasis.

References


