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*Full length Research Paper*

# Bread wheat production in small scale irrigation users agro-pastoral households in Ethiopia: Case of Afar and Oromia regional state

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**Conceptually, benefits of irrigation are realized through improvements in agricultural productivity. At household level, agricultural production increases could be followed by improvements in food consumption patterns. The goal of this research is to examine relationship between irrigation, production and consumption patterns for rural smallholders with pre-scaling up of bread wheat (Ga'ambo variety). A survey was undertaken and data collected on demographics, landholdings, irrigation, returns, consumption behaviors, farmer perceptions, experiences, and other related variables. The results show that using irrigation to the production of bread wheat has positive impact in yield. Though overall production increases the agricultural income of households but amounts spend on food for each household did not increase as consequence because the produced wheat was changed as food source in the form of bread, Injera, Qolo and other forms. However better dietary diversity was found on the consumption pattern of the households with higher income since part of the generated yield was supplied as a seed to the surrounding agro-pastoral wheat producers. Integrated approaches are needed to secure a healthy diet when the food supply of the family is increasing from the cereal part. The average total land holding was found 2.9 ha while the average land cultivated in the bread wheat production at the season was 1.4 ha. Average years of experience of agro-pastoral households in using different improved verities were 2.5 years which had good contribution in production management. The seed amount used on average for the production was found 84.5 kg/ha which lies between the national recommendation which is 80 to 90 kg/ha for irrigated areas while the average seed cost was 13.1 birr (Ethiopian currency) per kg. The average yields collected from the small scale irrigation users were found 31.8 quintal (which is about 3,180 kg) yet at individual levels it was varied from 15 to 37.3 quintals the variation was because of management practice with keeping other heterogeneous factors constant.**

**Key words:** Bread wheat, yield, irrigation, land, extension, labor, food consumption, dependency ratio, adult equivalent.

## INTRODUCTION

Wheat *(Triticum aestivum L.)* is one of the important grain crops produced worldwide. Ethiopia is the second largest wheat producer in sub Saharan Africa, next to South Africa, area under wheat cultivation expanded from 1.4 million hectare 2004/05 to 1.6 million hectare by 2010/11 and from these the production yield was 2.9 million tones.

**Table 1.** Wheat import trade in Ethiopia /2005-13/.

| Wheat | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Import $Q_T$ | 862,145 | 328,306 | 384,127 | 1,100,050 | 1,111,522 | 1,048,704 | 953,237 | 851,037 | 792.941 |

Source: Authors elaboration based on UNCOMTRADE data.

**Table 2.** Per capita calories.

| Crop | Urban | Rural | National | % of National |
|---|---|---|---|---|
| Wheat | 200.59 | 309.79 | 294.30 | 12.63 |

Source: Guush Berhane et al. (2011).

Wheat accounts for the fourth largest share of total cereal production (Table 1).

Wheat is not only for making bread, biscuit and pastry products, but also for the production of starch and gluten. The raised bread loaf is possible because the wheat kernel contains gluten, an elastic form of protein that traps minute bubbles of carbon dioxide when fermentation occurs in leavened dough, causing the dough to rise (Hanson et al., 1982).

### *Sources of growth in smallholder agriculture*

Central to the role of agricultural growth in Ethiopia is an understanding of the mechanism by which the agricultural sector itself can grow. Partial equilibrium, taking such factors as prices and demand in other sectors as exogenously given, in order to understand the relationship between the general economy context and the progress of the agricultural sector. Taking agricultural growth to endogenous and understanding how incentives in other sectors drive the direction of agricultural growth is fundamental: these incentives provide the multipliers tat sustain impact of well-designed policies over time.

Within smallholder agriculture, we focus on wheat productivity: First intervention to adopt Ga'ambo variety (bread wheat) which is a new technology to Amibara and Fentale districts.

### *Consumption*

In Ethiopia, wheat grain is used in the preparation of a range of products such as: The traditional staple pancake ("injera"), bread ("dabo"), local beer ("tella"), and several others local food items (that is, "dabokolo","ganfo", "kinche"). Besides, wheat straw is commonly used as a roof thatching material and as a feed for animals. Wheat contributes; approximately 200 calories per day in urban areas compared to about 310 calories in rural areas (Table 2). It accounts for about 12% of the national calorie intake.

### The role of extension

The conventional method of transferring knowledge and experience amongst farmers and so facilitating the scaling of innovations has been the extension service, typically a government institution under the Ministry of Agriculture and Research Institutes.

In addition, extension services have seen significant modifications in the way in which they are provided. Early approaches favored a top-down model where agro-pastoral were passive recipients of the 'knowledge' transferred by extension agents.

Over time, extension training has broadened in scope and is more relevant to the needs of sustainable intensification, covering issues such as nutrition as well as more typical topics such as integrated pest management. It has also been built on participatory models, which treat agro-pastoral as more dynamic participants and sources of knowledge, or even as the trainers' themselves as model agro-pastoral.

### Reaching agro-pastoral

The challenge of reaching agro-pastoral over often large and remote areas has also generated interest in the potential of new technologies to help foster linkages. Pre-scaling up were important for getting innovation to scale and helping deliver knowledge to rural smallholder agro-pastoral over a wide area.

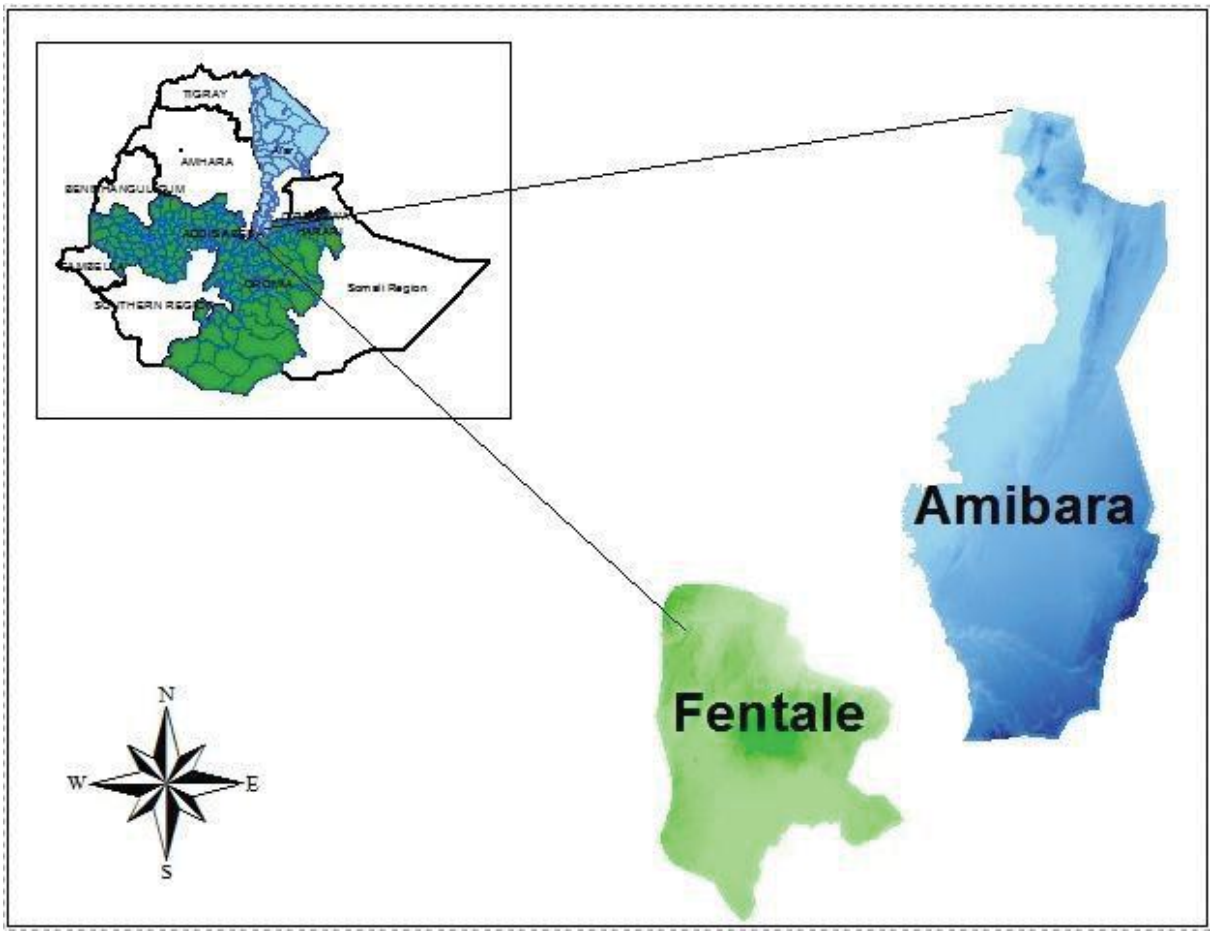


**Figure 1.** Pre-scaling up of bread wheat sample districts.

## METHODOLOGY

### Description of the study area

This research consisted of two sets of experiments namely assessment of bread wheat production in pre-scaling up methods and local marketing systems for the supply. The bread wheat production and marketing systems survey was conducted only in Amibara district of Afar regional state and Fentale district of Oromia regional state of Ethiopia (Figure 1).

Amibara woreda is one of the 30 woredas in the Afar Region and part of the Administrative Zone 3, it is bordered on the south by Awash Fentale, on the west by the Awash River which separates it from Dulecha to the southwest then on the northwest by the Administrative Zone 5, on the north by Gewane, and on the east by the Oromia Region. Towns in Amibara include Awash Arba, Awash Sheleko, Melka Sedi and Melka Were. Based on figures published by the Central Statistical Agency (CSA) in 2008, this woreda has an estimated total population of 63,280, of whom 35,301 were males and while 27,979 females. From the population 16.37% are agro-pastoral both raise crops and livestock, while 1.7% only grow crops and 81.93% only raise livestock.

Fentale is one of the 180 woredas in the Oromia Region of Ethiopia. Part of the Misraq Shewa Zone located in the Great Rift Valley, Fentale is bordered on the southeast by the Arsi Zone, on the southwest by Boset, on the northwest by the Amhara Region, and on the northeast by the Afar Region. The administrative center of Fentale is Metehara; other towns include Addis Ketema. The Fentale woreda has an estimated total population of 82,225 of which 43,510 are male and 38,715 are female (CSA, 2008).

### Bread wheat production and marketing system survey

Amibra district has semi-arid agro-ecologies and bread wheat is grown in irrigated user parts of the district. Therefore, bread wheat production and systems assessment study was carried out in the irrigation user parts of the district. Sample agro-pastoral associations (APs) for this study were selected following random sampling technique. As a result, four peasant associations namely, D-3, Bonta and Bedul- alea and in Fentale district Eilala, Gidara and Derea-sedi Aps were selected as sample Aps from the two pre-scale up districts.

### Innovative markets

As with other approaches, agro-pastoral-research institutes (center) partnerships can be instrumental in generating appropriate market innovations. Interventions to supply agro-pastorals with the resources they need to be productive, innovative and to sustainably intensify are critical. But there are innumerable potential points for innovation along the value chain from field to end users- better methods of harvesting and storage, processing and quality control,

**Table 1.** Household characteristics of the study area.

| Character | Amibara | Fentale | Total | $\chi^2$ |
|---|---|---|---|---|
| **Gender** | | | | |
| Men | 97.3 | 98.1 | 97.7 | |
| Women | 2.7 | 1.9 | 2.3 | |
| | 100 | 100 | 100 | 5.1 |
| **Marital status** | | | | |
| Single | 3.3 | 4.2 | 3.6 | |
| Married | 86.7 | 75.0 | 82.6 | |
| Polygamous | 8.9 | 20.8 | 13.4 | |
| Widow | 1.1 | - | 0.7 | |
| | 100 | 100 | 100 | 4.5 |
| **Education** | | | | |
| Illiterate | 40.0 | 60.4 | 47.1 | |
| Informal | 24.4 | 6.3 | 18.1 | |
| Primary | 16.7 | 10.4 | 14.5 | |
| Secondary | 18.9 | 16.7 | 18.1 | |
| Diploma | - | 4.2 | 1.5 | |
| Degree | - | 2.1 | 0.7 | |
| | 100 | 100 | 100 | 15.0*** |

***, ** and * indicate significance at 1, 5 and 10% respectively, $\chi^2$ the chi- square significance. Source: Survey data (2013).

improved links to markets, and selling strategies.

#### National markets

The biggest challenge in going to scale is to bring not only market information to smallholders but to help them connect to national markets, since this will significantly increase their returns. Local markets are now springing up in many parts of rural Ethiopia. The challenge is to link them to national markets so that agro-pastoral even in remote places can get good prices.

To characterize the wheat production and marketing systems of Amibara district, preliminary visits were made to develop questionnaire. The questionnaire had many open ended questions that allowed respondents to express their opinions on Ga'a mbo bread wheat production and marketing issues. Both secondary and primary data sources were used for this study. Primary data was collected using formal survey. Information was gathered using semi-structured questionnaire. The questionnaire pre-tested prior to the actual survey to assess its clarity and check the possibility of collecting all necessary information using this questioner. The main themes of the survey would be bread wheat production, marketing systems and major constraints and opportunities of bread wheat production and marketing systems that the suppliers encountered. The following are some of the questions included in the questioner.

In bread wheat production system land holding/hh, area of crop land, varieties preference, major diseases and control measures and cost of wheat production were included. In bread wheat marketing bread wheat marketing season, major buyers, price per quintal, factor affecting market price, place of sale and major marketing problems were included.

#### Data analysis

The statistical analysis was conducted using appropriate statistical software; Statistical Package for Social Science (SPSS) Version 16 was used to analyze the bread wheat production and marketing systems data collected through the survey.

According to Wudnesh (1991) the labor input of household members in each activity will calculated as follows:

The labor -hours spent to perform bread wheat production were calculated by using the following formula:

MHY=T*N*F

Where, MHY = labor-hour/household/production season; T = time taken to do the job/day, week or month; N = number of people engaged in the job, and F = frequency per production season.

## RESULTS AND DISCUSSION

### *Irrigation and bread wheat production*

Awash River has created opportunities for irrigation development, which is believed to be a means for livelihood improvement in the basin area. Nighty percent of the respondents is practicing irrigated agriculture only while 10% are rain-fed and irrigation.

### *Socio-economic characteristics of households*

### *Household characteristics*

Almost all the total sampled bread wheat households (95.4%) were men headed while 4.6% of the respondents were women headed households. The marital status of

**Table 4.** Access to extension service.

| Characters | Amibara | Fentale | Total | $\chi^2$ |
|---|---|---|---|---|
| Accessed extension service | 74.4 | 72.9 | 73.9 | |
| No extension service | 25.6 | 27.1 | 26.1 | |
| **Total** | 100 | 100 | 100 | 3.8 |
| **Contact extension service** | | | | |
| Weekly | 15.9 | 18.8 | 16.9 | |
| Biweekly | 19.3 | 14.6 | 17.7 | |
| Monthly | 28.4 | 27.1 | 27.8 | |
| Whenever I want | 20.5 | 24.9 | 22.1 | |
| At production season | 15.9 | 14.6 | 15.5 | |
| | 100 | 100 | 100 | 5.1* |
| **Training wheat production** | | | | |
| Land preparation | 30.6 | 30.3 | 30.5 | |
| Disease and pest control | 22.8 | 23.9 | 23.2 | |
| Post-harvest | 23.8 | 23.9 | 23.9 | |
| Inputs use | 22.8 | 21.9 | 22.4 | |
| | | | 100 | 5.4** |

***, ** and * indicate significance at 1, 5 and 10% respectively, $\chi^2$ the chi- square significance. Source: survey data computed, 2013.

the sample respondents were married (94.2%) while 5.8% were single (Table 3). The average age of the respondents was 46 years with a minimum and maximum age of 22 and 67 years, respectively.

Social, economic and institutional interventions are crucial to innovation for sustainable intensification because they ensure that higher yields and production result in real benefits to agro-pastorals and they provide much of the enabling environment in which bread wheat production with innovation can flourish and be resilient and sustainable. It has been increasingly recognized in recent years that flourishing, efficient and fair markets, both for inputs and produce, are crucial to intensification of pre-scaling up technologies. 'We have seen firsthand the power that providing skills and market access can have in empowering smallholder farmers to boost their production, improve their nutrition and increase their incomes – when managed effectively and coupled with appropriate technologies. In the sample district smallholders irrigation users of a very high proportion have very weak links to markets and other institutions.

### *Agro-pastorals extension services*

As part of the Structural Adjustment Program (PAS), the government of Ethiopia has been increasing the size of the extension service and improving the service provided by development agents but yet focusing on the quality of service and contact frequency matters a lot in technological pre-scaling out to the small holder producers.

The small holder survey reveals that extension agent contact with in the production season yet is low according to the producers key informant discussions in the base line data. From preliminary survey 74.4 and 72.9% of the interviewed had had contact with an extension agent prior to the survey in Amibara and Fentale districts while 25.6 and 27.1% of the agro-pastoral reported that have no access to extension services. In addition, the farmers extension contacts have contribution to the productivity of the yield and quality in the wheat production; yet the survey in the sample producers found (28.4%) were found they have monthly contacts while (15.9%) were found to have contacts of the extension agent at the weekly base on the production season in Amibara Woreda, while in Fentale district (27.1%) establish con-tacts in monthly based yet (18.8%) and (14.6%) where have access to the extension agent in a weekly based and at production season of wheat respectively the chi-square analysis is significant at (5.1) with level of (10%) which states there a significant difference in the contact of extension period (Table 7).

The survey result indicate that training that are given to producers with the production of wheat in the district are land preparation, disease and pest control, post-harvest handling, marketing and input use. From these trainings land preparation was taken by (30.6%) of the producers in Amibara while (30.0%) from the Fentale. The types of assistance provided by extension agents did not have significance variation across samples (Table 4).

### *Land allocated*

Based on the analysis, the average total land holding 2.9

**Table 5.** Average total land holding and average seed price.

| Character | Amibara | Fentale | Total | t-test |
|---|---|---|---|---|
| Average total land holding | 3.45 | 2.43 | 2.9 | 9.2*** |
| Average land for wheat | 1.92 | 0.89 | 1.4 | 9.6*** |
| Years of experience in technologies application | 3.1 | 1.92 | 2.5 | 4.6* |
| Seed used (kg/ha) | 82 | 87 | 84.5 | 5.0** |
| Seed cost( birr/kg) | 12.75 | 13.50 | 13.1 | 9.9*** |
| Average yield per ha | 35.3 | 28.2 | 31.8 | |

***, ** and * indicate significance at 1, 5 and 10% respectively; Seed coast is estimated by the market price of bread wheat seed Source: survey data computed, 2013.

**Table 6.** Household labor contribution.

| Characteristic | Amibara | Fentale | Total | $\chi^2$ |
|---|---|---|---|---|
| Family size | 7.1 | 5.5 | 6.3 | 15.7** |
| Adult equivalent | 6.3 | 5.2 | 5.0 | 98.0*** |
| Dependency ratio | 1.5 | 1.3 | 1.2 | 20.1** |

***, ** and * indicate significance at 1, 5 and 10% respectively; Source: Survey data, 2013.

ha from the total sample yet the distribution in the sample area varies with 0.25 and 3.12 ha, while the average land allocated for wheat production was found 1.92 and 0.89 ha in Amibara and Fentale districts respectively. The seed amount used per hectare was ranged from 80 to 90 kg/ha and average price per kg 12.65 birr (Table 5).

The owned cultivated bread wheat land size of sample respondents varied from 0.25 to 3 ha with an average holding of 1.4 ha and a standard deviation of 0.54.

## Household labor contribution

According to CSA (2012), the average family size of Ethiopia is (5.4). However, in the study district the average family size in bread wheat producer households is 6.3. As a result, the adult equivalent varies from (7.1) to (5.5) in Amibara and Fentale households respectively (Table 6). The adult equivalent shows that Amibar households have better labor input than of Fentale.

Household dependency ratio shows the economically inactive labor compared with the economically active one. It is measured by dividing the number of non-working members; children under the age of 15 and elders above the age of 64 who cannot work by the economically active family members. Dependency ratio is widely used to measure the economic labor of the household and the burden on the members of the labor force within the household in the farming system in our case bread wheat production of Ga'ambo variety.

Dependency ratio is negatively related with income and economic labor of the household. Accordingly, the dependency ratio in district shows that each 100 economically active person had 150 and 130 extra person to feed in the Amibara and Fentale household respectively (Table 6). This shows that there is more dependency in the Amibara than Fentale in the bread wheat pre-scaling up technology users.

This contain an imperative connotation for the load on members of the labor force within the household which is positively correlated with high level of workload in the rural household context due to their high participation both in productive and reproductive activities that can affect productivity of wheat production system and the households have to produce more to feed the inactive labor.

### *Participation of family labor in bread wheat production*

**Farm activities:** Farm activities include land preparation, plowing, sowing, weeding, harvesting, threshing, transporting and storage. As shown in Table 7, about 73 and 56% of land clearing tasks were performed by both gender of the family members in Amibara and Fentale areas, respectively, yet ranking it 84.4% in Amibara are tasks shoulder by men while 81.3% in Fentale. In the case of gaping 72.2 and 65.5% were done by both parts of the families considering gender issues but ranking it 63.3 and 72.8% were activities that are done by women part of the families in Amibara and Fentale districts respectively.

There is a strong justification that more labor hours spent in Fentale with production of bread wheat. The t-value for differences shown in Table 8 suggests a significant difference in the production levels of wheat at the 0.05 level of significance. In Ambra households spent

**Table 7.** Families labor participation in bread wheat production activities.

| Activities | Participation | | Rank | |
|---|---|---|---|---|
| | Amibar | Fentale | Amibar | Fentale |
| **Land clearing** | | | | |
| Men | 14.44 | 31.25 | 84.44 | 81.25 |
| Women | 1.11 | 2.08 | 4.44 | 6.25 |
| Both | 73.33 | 56.25 | 0.00 | 0.00 |
| No participation | 11.11 | 12.50 | 11.11 | 12.50 |
| **Plowing** | | | | |
| Men | 24.44 | 37.50 | 56.67 | 50.00 |
| Women | 1.11 | 0.00 | 3.33 | 0.00 |
| Both | 34.44 | 12.50 | 0.00 | 0.00 |
| No participation | 40.00 | 50.00 | 40.00 | 50.00 |
| **Planting** | | | | |
| Men | 6.67 | 12.50 | 27.78 | 22.92 |
| Women | 5.56 | 8.33 | 62.22 | 54.17 |
| Both | 77.78 | 56.25 | 0.00 | 0.00 |
| No participation | 10.00 | 22.92 | 10.00 | 22.92 |
| **Gapping** | | | | |
| Men | 4.44 | 5.80 | 26.67 | 16.30 |
| Women | 13.33 | 18.12 | 63.33 | 72.83 |
| Both | 72.22 | 65.22 | 0.00 | 0.00 |
| No participation | 10.00 | 10.87 | 10.00 | 10.87 |
| **Weeding** | | | | |
| Men | 1.11 | 8.33 | 66.67 | 27.08 |
| women | 2.22 | 2.08 | 22.22 | 60.42 |
| Both | 85.56 | 77.08 | 0.00 | |
| No participation | 11.11 | 12.50 | 11.11 | 12.50 |

Source: Survey data, 2013.

341.71' hours per four months in the production process bread wheat while 520.88' hours are spent in Fentale districts. This can be indicate that the more labor hours spent in the production activities can help the agro-pastorals to manage the efficiency of increasing yield yet efficiency are not only the matter of more time spent so further data are required for efficiencies analyses. On the other direction more time spent by household in Fentale area can for go in the expense other activities like livestock management or other activities yet out weight of comparative advantage must be considered which need further investigation.

In alkaline soils mono-ammonium phosphate (MAP) and ammonium polyphosphate (APP) can have an advantage over Di -ammonium phosphate (DAP). From this information the pH value of this soil is greater than 7 which were 8.2 in Amibara and 8.1 in Fentale sample district.so we can conclude that these soil is alkaline soils. Due to these value you can recombined that MAP and APP fertilizer can have an advantage over DAP. From the above result of the soil we can conclude that the EC value of the soils are less than 4 ds/m or 4 mmhos/cm and the PH value are less than 8.5.so, the soil type is non-saline soil. The organic matter (OM) in soil may account for anywhere from 3 to 75% of the total P in a soil (not necessarily the same as "available P").due to these literature these soil value of OM and TN are moderate. So, to form good condition for plant growth need more nitrogen source (urea) rather than DAP. Since; urea is a source of nitrogen and correlation with organic matter (Table 9).

## CONCLUSION AND RECOMMENDATION

We believe that innovation for sustainable intensification is going to be essential if food and nutrition security is to be achieved in Ethiopia. It is a significant challenge. Inevitably in a briefing paper of this nature we raise more questions than we answer. Most important it is clear that we will need partnerships and research organizations to embrace the goal of sustainable intensification; we will

**Table 8.** Mean difference of average labor-hour spent on production process.

| Statistical analysis | Amibara | Fentale |
|---|---|---|
| Average labor-hour per house hold in bread wheat production season 4 months | 341.71 | 520.88 |
| t-value | 7.21*** | |

***, ** and * indicate significance at 1, 5 and 10% respectively.
Source: Survey Data (2013).

**Table 9.** Farm soil analysis.

| Woreda | pH | E.C(ds/m) | %Total OC | % OM | % TN | Ca+Mg | %Clay | %Silt | %Sand | Texture class |
|---|---|---|---|---|---|---|---|---|---|---|
| Amibara | 8.2 | 0.38 | 1.22 | 2.11 | 0.11 | 20.2 | 25.2 | 26 | 48.8 | Sandy clay loam |
| Fentale | 8.1 | 0.47 | 1.31 | 2.26 | 0.11 | 21.2 | 23.2 | 22 | 54.8 | Sandy clay loam |

Source: Survey Data (2013).

need fair and efficient markets; we will need systems of education that produce the Ethiopian innovators of tomorrow; for agro-pastoral innovation to be embedded in formal processes, and most importantly we need new technologies to address a wide range of food and nutria-tion security and environmental challenges in a variety of contexts. But for this to happen we have to develop appropriate cultures and institutions for innovation. In turn we will need supportive government policies and leadership creating enabling environments fit for the purpose of innovation for sustainable intensification of agricultural technologies at small scale irrigation users. We believe the questions raised in this paper provide the basis of an agenda for research, dialogue and policy making as we go forward for intervention with different agricultural technologies for food security with environ-mental development in addressing nutrition values for healthy society. For this to improve this paper argues that agro-pastorals need few key interventions, each requiring innovation in social, economic and institutional arenas.

Practical and policy interventions to improve farmer links to markets are as follows:

1. Facilitate access to high-quality seed, fertilizer and other inputs, storage materials that are practical and low-cost and professional advice.
2. Build the institutional capacity of agro-pastorals to allow them to self-organize at sufficient scale and complexity and thus benefit from collectively accessing credit, input and output markets.
3. Deliver market information on quality standards, prices and risks as well as support and advice to assist fledgling agro-pastoral enterprises to increase in size, impact and competitiveness.
4. Increase public sector investment in rural infrastructure, research and extension to improve physical access to inputs, services and markets and media access to information, for example on agro climatic risks.

## Conflict of Interest

The authors have not declared any conflict of interests.

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