ICARDA
Science for Better Livelihoods in Dry Areas

Working Paper 30

Commercial Behavior, Varietal Preferences and Wheat Seed Markets in Ethiopia

Dawit Alemu and Zewdie Bishaw

Acknowledgements

Authors: Dawit Alemu and Zewdie Bishaw

The authors are thankful to the USAID for their financial support for the joint CIMMYT-ICARDA project 'Accelerated Seed Multiplication to Counter the Threat of Stem Rust in Wheat' which supported the survey work. Our special thanks to Ethiopian farmers who participated in the survey. Finally, we would like to thank the assistance of survey team with data collection. The authors take the responsibility of any errors or omissions.

ICARDA Working Papers document the progress of the ICARDA research program and its support to country partners in more than 40 drylands countries. Working Papers are one of ICARDA's global public goods; they capture and share knowledge and learning from projects and research partnerships. Each paper is internally reviewed as part of the center's publishing process.

ISBN: 92-9127 484 4

Keywords: Wheat Seed System, Seed Commercial Behavior, Farmers' Perceptions, Variety Attributes, Attainment Indices, Ethiopia

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icarda@cgiar.org
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International Center for Agricultural Research in the Dry Areas (ICARDA)
PO Box 114/5055, Beirut, Lebanon
January 2016

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Acronyms

A(N)MP	Absolute (Net) Market Position
APHRD	Animal and Plant Health Regulatory Directorate
ASE	Amhara Seed Enterprise
AIMD	Agricultural Inputs Marketing Directorate (federal)
AI	Attainment Index
BoA	Bureau of Agriculture (Regional States)
CSA	Central Statistical Agency
EBI	Ethiopian Biodiversity Institute
EIAR	Ethiopian Institute of Agricultural Research (Federal)
ESE	Ethiopian Seed Enterprise
MoA	Ministry of Agriculture (Federal)
NVRC	National Variety Release Committee
NSPDC	National Seed Production and Distribution Committee
OSE	Oromia Seed Enterprise
PVRPSQD	Plant Variety Release, Protection and Seed Quality Control Directorate
q	Quintal, which represents 100 kg weight
RARIs	Regional Agricultural Research Institutes (Regional States)
SSE	South Seed Enterprise
SRA	Seed Regulatory Agencies

Executive Summary

This working paper presents the commercial behaviors in wheat seed sector, farmers' varietal preferences, and their implications on the wheat seed sector based on the primary data collected from randomly selected 524 wheat farmers in the major wheat growing areas covering 22 woredas (districts) in 11 zones of Amhara, Oromia, Southern Nations, Nationalities and Peoples (SNNPR) and Tigray regions of Ethiopia. About 25% of the wheat producers are in autarkic (neither buying nor selling), 26% in selling and the rest, 49%, are in buying market position for seed. This implies that the formal seed sector can target only slightly more than half of wheat producers. Farmers' perceptions indicate that the value of attainment indices is high for the improved varieties compared to the local landraces. This shows that the improved varieties embody more of the characteristics that are in demand. However, there is a high variability in the attainment indices among improved varieties for different attributes. This suggests the need to target varieties for the different circumstances including yield and disease and drought tolerance. The result also indicated inconsistency between the value of the attainment indices of varieties and the amount of seed supplied by the formal sector, which resulted in a mismatch between the demand and supply leading to considerable carryover of seed every year. These results, therefore, imply the need to promote (i) a market-based seed demand and supply system taking into account the commercial behavior in wheat seed to meet the growing demand and supply of the wheat seed sector in particular and seed sector in general in Ethiopia; and (ii) diversification of seed supply of different bread wheat varieties and increase in the capacity of seed suppliers to effectively respond to the farmers' preferences.

1 Introduction

In Ethiopia, to date, from policy makers to local administrators, from federal public institutions to district (woreda) Bureaus of Agriculture, from national to international NGOs and donors, all are preoccupied with seed issues. There is much emphasis on the seed supply with very little consideration about the demand aspects. Also, there is very limited understanding about farmers' commercial behaviors, and varietal perceptions and their implications on the seed system in general and seed demand and supply in particular.

The Growth and Transformation Plan (GTP) 2010-2015 reflects important measures for transforming the seed system. It aimed at increasing the seed production from the 2012 target of 238,000 tons to 360,400 tons by the end of 2015. For wheat seed these figures are translated from 80,000 tons in 2012 to 102,290 tons in 2015, an increase of 28%. This is sufficient to cover 680,000 ha equivalent to 40% of current wheat area of 1.7 million ha.

In order to achieve these targets and sustain the increase in agricultural production and productivity, the agricultural transformation agenda of the country has prioritized improving the efficiency of the national seed system. Cognizant of this, the Agricultural Transformation Agency (ATA) was established to address some of the key bottlenecks in the agricultural sector. ATA assisted in ratifying the new seed proclamation and identified the interventions that are related to (i) improving the delivery mechanism of source seed from the national agricultural research system, (ii) strengthening the capacity of seed suppliers to ensure the production of sufficient quantity of seed, (iii) developing a more reliable demand assessment and supply management system along the seed value chain, and (iv) establishing a more efficient quality assurance and certification scheme (Alemu, 2011).

The performance of the national seed system has been reported by many authors (Bishaw et al., 2008; Spielman et al., 2010; Alemu et al., 2010; Alemu, 2011). All these reports agree that the formal seed system has a major focus on wheat and maize seed while the performance in other crops is negligible. Nearly 90% of the total formal sector seed supply of the country is accounted for wheat and maize (Bishaw and Louwaars, 2012), yet the annual certified seed supply covers only about 10% of the area for both crops. In general the overall performance of the formal seed sector is still very low (Alemu, 2011; Spielman et al., 2010).

One of the reasons for the poor performance of the seed sector is the unreliable demand estimates linked primarily with the limited consideration of farmers' commercial behavior in seed and varietal preferences. Currently the process for assessing seed demand from farmers and subsequent seed production targets are inconsistent and inaccurate, leading to both over and under-estimation of demand. The centralized seed allocation process is slow and highly dependent on unreliable demand estimates, contributing to delays in delivery and inaccurate targeting in distribution. Moreover, with the recent proliferation of public and private actors and project-wise seed related interventions, seed statistics have become fragmented and difficult to get accurate information, whereas in the past consolidated and reliable information on seed production and distribution was available with a few seed enterprises operating in the country (ESE and Pioneer Hi-bred).

Bishaw and Niles (2012) have outlined critical bottlenecks that need to be addressed for an improvement in the seed system in Ethiopia. These include issues related to seed demand and supply. Currently, there is limited information on wheat seed marketing and reliable seed demand assessment. This paper documents two major characteristics of small-scale wheat producers that have direct implication on matching seed demand with supply, i.e., wheat farmers' commercial behaviors in seed and their varietal preferences. It also presents the implication of these behaviors and preferences in wheat seed demand assessment and marketing.

2 Methodology

2.1 Sampling and sample size

The study on wheat seed marketing focused on major wheat producing regions of the country. The respondents were selected using a multi-stage sampling procedure based on CSA data: first, major wheat production zones were selected based on the total number of wheat producers; and a zone with three percent and above of the total number of wheat producers were considered selecting 11 zones from four regions; second, in each zone two woredas with the highest number of wheat producers were selected; third, in each woreda, two kebeles (lowest administrative units) with the highest number of wheat producers were selected; and fourth, in each kebele, respondent farmers were selected randomly and the sample sizes for each kebele was determined based on proportion to population size (PPS). In total 524 respondents were selected for the study (Figure 1). Data was collected in 2012 using a pre-tested questionnaire by trained enumerators in local languages of the respective study areas.

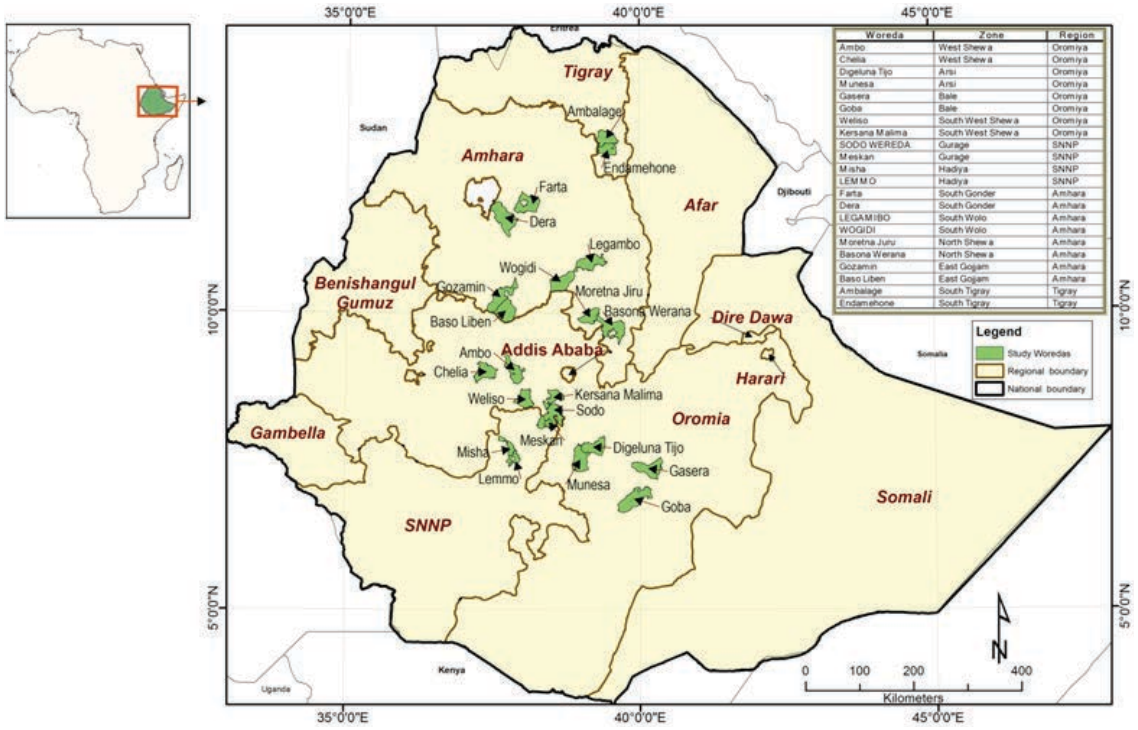

Figure 1. Distribution of the wheat seed sector study areas

2.2 Data analysis

2.2.1 Farmers' wheat seed commercial behaviors

The commercial behavior of a household can be defined taking into consideration different perspectives. From household's market participation perspectives, the commercial behavior can be defined in relation to Net Market Position (NMP) or Absolute Market Position (AMP) of a household either from agricultural outputs or inputs side. For output side, NMP is defined as the ratio of the value of agricultural outputs sold to the total value of agricultural outputs produced by a household, and from the input side, it is defined as the ratio of the value of agricultural inputs acquired from the market to the total value of agricultural production of a household (Von Braun and Kennedy, 1994; Strasberg et al., 1999). On the other hand, AMP is quantified using directly the quantities of sales and purchases of outputs.

In this study, the commercial behavior in wheat seed is described based on the market position estimated using Absolute Market Position (AMP), which is quantified by comparing the quantity of wheat seed sold and wheat seed purchased over a year. The following six types of AMPs were identified:

- Autarky when sales = 0 and purchase = 0
- Only buyer when sales = 0 and purchase > 0
- Only seller when purchase = 0 and sales > 0

- Net seller when sales > 0 and purchase > 0 and sales > purchase
- Net buyer when sales > 0 and purchase >0 and purchase > sales
- Equally seller and buyer when sales > 0 and purchase > 0 and purchase = sales

These market positions are categorized into three classes as (i) autarky, (ii) selling position by merging market positions of only sellers, net sellers and those who are equally sellers and buyers, and (iii) buying position by merging market positions of only buyers and net buyers.

2.2.2 Estimation of determinants of farmers' wheat seed market positions

Conceptually, the determinants of smallholders' commercial behavior in wheat seed can be categorized into external and internal factors. The external factors are related to (i) the relationship of smallholders to technology generation and information dissemination such as research and extension services, (ii) the relationship of smallholders to market institutions such as cooperatives; and (iii) the impact of public goods, including physical infrastructure like road and access to markets, in determining commercial behavior.

The internal factors are related to (i) the impact of household assets, including physical, financial, human, and social capital, and (ii) the role of shocks and risk coping on the market behavior of households. In addition, household's production and diversification decisions and the outcome in terms of commercialization influence commercial behaviors.

The commercial behavior choice can be modeled using a random utilities model in which individual wheat growers face three choices: autarkic (a), selling (s), and buying (b). The utilities associated with each of these choices are designated Ua, Us, and Ub, respectively. This utility is modeled as a function of individual specific characteristic, X, that affects the utility associated with each choice differently. Hence,

$$U_{ji} = X_i\alpha_j + e_{ji}$$

Where: subscript j denotes the choice and subscript i denotes the individual wheat grower. While a utility is not directly observed, it can be inferred from the farmers' choices how they rank some of these alternatives. Thus, if a farmer chooses not to be engaged in any wheat seed transaction, it must be the case that Uai > Usi and Uai > Ubi. If the eji has Weibull distribution, the differences in the ε will have logistic distribution and a multinomial logit (MNL) can be used to estimate the differences in the parameters of a (Maddala 1994).

In order to use MNL, it is important to conduct tests to determine whether the assumptions underlying the MNL specifications are appropriate. Specifically, a Hausman test of the maintained assumption of Independence of Irrelevant Alternatives (IIA) was conducted.

The result of the Hausman test indicated that the null hypothesis (that the MNL model is appropriate for these data) could be rejected, lending limited credibility to the use of this specification. Thus, simple logit model was applied for each choices to identify the determinant factors in each commercial behavior of wheat seed. The logit model is based on the cumulative probability function and is specified as:

$$P_i = F(Z_i) = F(\alpha + \beta X_i = \frac{1}{1+e^{-z_i}} = \frac{1}{1+e^{-(\alpha+\beta X_i)}}$$

Pi is the probability that an individual will make a certain choice, given knowledge of Xi. This probability function is normally transformed for estimation to log $Pi/ (1-Pi) = Zi = \alpha+\beta Xi$.

In the logit model, the unknown parameters are estimated using a maximum likelihood estimator and it assumes that the observed index (Z) is a random variable, which predicts the probability of an individual in choosing a commercial behavior and is stated as:

Log P / (1-P) = Z, where $Z = \beta o + \Sigma \beta j X + \varepsilon$

The probability of an individual farmer's decision to choose a commercial behavior can therefore be directly estimated as P = 1/ (1+e-z). The relative effect of each explanatory variable (X) on the probability of choosing a commercial behavior was measured using

$\delta\rho / \delta x = \beta$ (p (1-p))

2.2.3 Assessment of farmers' wheat varietal perceptions

In order to elicit farmers' preferences, two steps were followed. The first step was identifying the list of attributes that help farmers to characterize the different varieties of wheat. Accordingly, the identified attributes included grain yield, grain size, grain color, early maturity, drought resistance, rust (yellow or stem) resistance, threshability, bread taste/food quality, marketability, straw yield, and straw quality. The second step was eliciting farmers' perceptions using these attributes for the local and improved bread wheat varieties currently grown by them.

Farmers' perceptions about different bread wheat varieties using these attributes were elicited using an empirical approach applied by Sall et al. (2000). The approach uses an index that provides how well a certain variety attributes meet farmers' preferences. It involves application of quasi-arbitrary ordinal weights in which farmers rank the importance of each attribute and how well these attributes are embodied in different varieties. Accordingly, each farmer was asked to judge each attribute of the wheat variety on two scales: first, what is the importance of a given attribute to them (very important

important, not so important) and second, how they judged the quality of the attribute being presented by a given variety (very good, good and poor). Thus, for N farmers, each ranking the characteristics according to their importance and quality, the response matrix is as shown in Table 1. Each entry in the matrix, nij, represents the number of farmers who ranked a particular attribute based on their perception of its importance, j, and their satisfaction with the quality provided by the variety, i. The bottom row entries, Cj, are the total number of farmers who ranked the characteristics according to their importance. The row total, ri, are the total number of farmers who ranked the characteristics as embodied in a variety at a certain level of satisfaction. According to this description:

$$\sum c_j = \sum r_i = \sum\sum n_{ij} = N$$

Table 1. The response matrix of farmers' perception of varietal attributes

Attribute → / Variety ↓	Very important	Important	Not so important	Row total
Very good	n_{11}	n_{12}	n_{13}	r_1
Good	n_{21}	n_{22}	n_{23}	r_2
Poor	n_{31}	n_{32}	n_{33}	r_3
Column total	c_1	c_2	c_3	N

The weighting matrix is presented in Table 2. The row totals (Si) present the supply weights, which are weights assigned to the farmers' perception of how well a specific attribute is being embodied in a given variety. The column totals (di) present the demand weights, which are assigned to the farmers' perception of how important a specific attribute is. Each cell in the matrix is then calculated as:

Table 2. The weighting matrix

	Very important	Important	Not so important	Row total
Very good	w_{11}	w_{12}	w_{13}	s_1
Good	w_{21}	w_{22}	w_{23}	s_2
Poor	w_{31}	w_{32}	w_{33}	s_3
Column total	d_1	d_2	d_3	

Reed et al. (1991) and Sall et al. (2000) propose certain restrictions to be imposed on the weights, so that the following inequalities hold:

a) $w_{1j} > w_{2j} > w_{3j}$ for all j. This implies that regardless of how important a characteristic is, the more favorably the farmer perceives that characteristic being present in the variety under evaluation, the higher the weight is.

b) $w_{i1} > w_{i2} > w_{i3} > 0$ for all i which is rated good or better. This inequality implies that whenever a characteristic embodied in a variety is rated as good or better, the weight should be positive and increase in value as its level of importance increases.

c) $w_{i1} < w_{i2} < w_{i3} < 0$ for all i which is rated poor. This implies that weights for characteristics rated as poor should be negative and decreasing as their importance increases.

d) The above inequalities imply the following restrictions when constructing the supply and demand weights: $S_1 > S_2 > 0 > S_3$ and $d_1 > d_2 > d_3 > 0$.

All demand weights (di) are positive, while the supply weight for a characteristic ranked as poor is negative. The stated weighting scheme ensures that the highest (lowest) weights will be given to those characteristics considered very important and embodied very well (poor).

Given the response weighting matrices, the following indices can be calculated as follow:

$$D = \frac{1}{d_1 N} \sum_{j-1}^{3} d_j c_j$$

The demand index (D) is a measure of how important the farmers perceive a particular characteristic to be. A value of 1 indicates that all farmers perceive the characteristic to be very important. The minimum value of the index is (d3/d1) >0, and is attained when all farmers perceive the characteristic to be of little importance.

$$S = \frac{1}{s_1 N} \sum_{i=1}^{3} s_i r_i$$

The supply index (S) is a measure of the perception of farmers on how well a characteristic is being embodied in a variety. A maximum value of 1 indicates that all farmers perceive the characteristic supplied as being very good quality.

The minimum value will be attained if all farmers perceive the quality of the characteristic being supplied as poor.

$$W = \frac{1}{w_{11}N}\sum_{j=1}^{3}\sum_{i=1}^{3} w_{ij}n_{ij}$$

The attainment index (W) provides a measure of how well farmers' perception of the importance of the characteristic matches farmers' perceptions of how well it is being supplied in the variety. The maximum value of W is 1, which implies a perfect match. In such a situation, all farmers rank a particular attribute as very important and rank the quality supplied by the variety as very good. The minimum value of the index depends on the supply weight Si, chosen, and is calculated to be (si/s1) < 0.

3 Wheat production, varieties and seeds

Wheat is one of the major cereal crops produced by nearly 4.3 million small-holder farmers on 1.4 million ha with an estimated annual production of 2.9 million tons at an average productivity of 2.03 t ha-1 (CSA, 2012). From the total annual wheat production 57%, 26%, 9% and 7%, respectively was produced in Oromia, Amhara, SNNP and Tigray regions.

Though, both bread and durum wheat are produced, the majority of farmers (97%) are engaged in bread wheat production (Table 3). Bishaw (2004) found that 86% and 14% farmers were growing bread and durum wheat, respectively in late 1990s compared to a decade or two earlier where durum wheat estimated to cover about 40% of the wheat area in the country. These dramatic shifts were attributed to the availability of new bread wheat varieties with high yield and better agronomic performance in traditionally durum wheat growing areas of central and northwestern parts of the country (Bishaw et al. 2010). There is a continuous decline in the area under durum wheat production despite the availability of new high yielding improved varieties in recent years and a huge potential demand from local agro-industry.

Table 3. The response matrix of farmers' perception of varietal attributes

Region	Wheat type (% of farmers)		
	Durum	Bread	Both
Amhara	2.6	96.5	0.9
Oromia	-	100.0	-
SNNPR	3.6	94.6	1.8
Tigray	3.6	92.9	3.6
Total	1.7	97.5	0.8
Chi-square		11.96*	

Farmers grow both improved and/or local varieties and source their seed from formal and/or informal sources (Figure 2). Overall, the proportion of farmers that grow improved varieties is 69% and the rest 31% grow local varieties (Figure 2). Earlier studies showed that an overwhelming majority of wheat farmers used improved bread (75.5%) and durum (0.7%) wheat varieties whereas the remaining used obsolete bread varieties (7.8%) and local (bread 2.7% and durum 13.2%) wheat varieties (Bishaw, 2004).

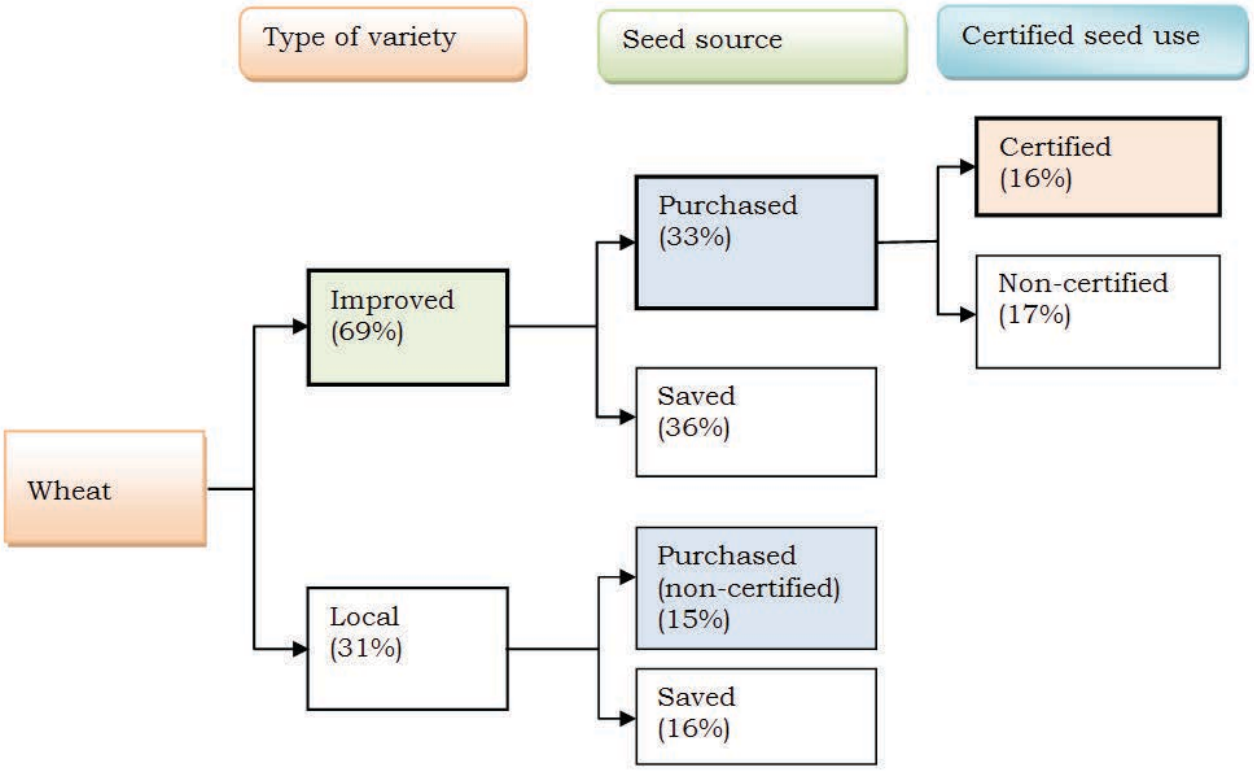

Figure 2. Bread wheat varieties and seed sources

The distribution of users of improved bread wheat by variety is presented in Table 4. The highest percentage of farmers reported the use of Digelu (12.6%) followed by Tuse (11.6%) and Kubsa (9.5%). Though, there is persistence of older improved varieties like ET13 and Pavon, the newly released ones like Kakaba and Danda'a are catching up. The proportion of farmers using different improved varieties appeared to be well spread, with no pre-dominant varieties, probably owing to the decline in area under Kubsa following recent yellow rust epidemics preceding the survey year. Earlier results from late 1990s showed that the top five varieties i.e. Pavon, ET13, Kubsa, HAR710 and Batu were planted by 20.5%, 20.1%, 11.2%, 8.4% and 6.2% of the farmers respectively, and correspondingly occupied 39.3%, 10%, 10.5%, 9.7% and 10.4% of the sample area (Bishaw et al., 2010; Bishaw et al., 2014). Among these the two popular varieties, Pavon and ET13 were planted by 41% of farmers and almost occupied 50% of the sample area.

The data for 2011 showed that the proportion of users was 23.9% for Kubsa, 10.3% for Galema, 8.2% for Dashen, 5.1% for Madda Walabu, and 3.7% for Tusie and correspondingly were grown on 19.6, 7.0, 5.4, 4.2 and 5.3% of the sample area (Chilot et al., 2013). This indicates a considerable decline is the proportion of farmers using the former popular varieties such as Kubsa, Pavon and ET13.

Table 4. Improved bread wheat varieties grown by farmers

Variety	Year released*	Proportion of farmers growing (% of respondents)
ET-13A2	1981	3.4
Pavon76	1982	1.5
Kubsa (HAR1685)	1995	9.5
Galema (HAR710)	1995	6.3
Tuse	1997	11.6
Madda Walabu	2000	1.7
Hawi	2000	0.4
Dure	2001	0.2
Digelu	2005	12.6
Kakaba	2010	1.1
Danda'a	2010	1.3
Others (improved)		19.2
Total		**69.0**

Source: Survey (2012), * MoA (2012)

A significant number of local bread wheat varieties are used by farmers in Amhara (16 varieties) region followed by Tigray (3) and Oromia (1) as shown in Table 5. Some of the local varieties such as Key Sende, Tikur Sende and Zembolela continue to persist in the farming system. Some obsolete improved varieties like Dashen could be considered as local varieties due to its long use by farmers.

Likewise, a number of improved bread wheat varieties are used in Oromia (8 varieties), SNNPR (5), Tigray (4), and Amhara (3) regions. Some of the improved wheat varieties are also grown across these four regions (e.g. HAR1685, HAR604). High adoption rates of improved bread wheat varieties were reported from Ethiopia and elsewhere (Bishaw et al., 2010 and 2011; Chilot et al., 2013).

In 2012, farmers planted wheat seed received from different sources, i.e., own saved seed produced on their farm or purchased seed off-farm from other sources.

Table 5. Improved and local bread wheat varieties grown by farmers

Region	Improved varieties	Local varieties
Amhara	ET-13A2, HAR1685, HAR604	Enate, Kinikina, Kontem, Kuchibiye, Kurest, Logawshebo, Qebetu, Qeye sende, Quchbiye, Qurshet, Sesse, Shamax, Tikur Sende, Trifical Thogoshob, Zembolela
Oromia	Pavon76, HAR1685, HAR604, HAR 1407, HAR1480, Digelu, Danda'a, Kakaba	Abebe, Danshure
SNNPR	Pavon76, HAR1685, HAR604, HAR1407, Digalu	
Tigray	HAR408, HAR1685, HAR604, HAR2501	Bani, Dashen, and Wofiche

Source: Survey, 2012

From the 69% farmers who used improved varieties, 33% sourced the seed through purchase and the rest 36% used farm saved seed. Similarly, from the 31% of farmers who grew local varieties, 15% sourced the seed through purchase and the rest 16% used saved seed (Figure 1). Purchased seed could be non-certified seed from local seed producers or neighbors, other farmers, local traders/markets or certified seed purchased from public/private seed companies, cooperatives or development agencies. Linked with the national seed system, the cooperatives are the only source of certified seed of improved varieties as they distribute seed from the formal sector. Farmers involved as contract seed growers for formal sector, farmers who produce wheat grain and save or sell seed (some as local business) or local grain traders/markets, are the main source of non-certified seed of improved varieties. In Ethiopia, for example, large number of farmers are engaged as contract seed growers for publics seed enterprises and are often allowed to retain 15% of the seed produced (field inspected); and this seed is normally either used in own farm or sold to other farmers as local source of good quality seed but without certification. Accordingly, only 16% of the farmers who grew improved varieties used certified seed from formal sources. In previous studies most farmers also used own saved seed (79%), whereas the rest used purchased seed from informal (12.8%) and formal (8.2%) sectors (Bishaw et al., 2010). The present results showed that the amount of certified seed has almost doubled (to 16%) compared to a decade ago because of massive government drive and supply of certified seed.

Wheat producers' management of farm saved seed along with the role of women is presented in Table 6. Among farmers who used on-farm saved seed, except for treatment, more than 60% of the farmers undertook different seed management measures during production, handling and planting of own seed to maintain good quality.

It was found that women are involved in more than 80% of the seed management activities and/or decisions on the farm along with their male counterparts or individually. Bishaw et al. (2012 and 2013) provided detailed report on wheat seed quality from formal and informal sector in Ethiopia.

Table 6. On-farm wheat seed management and role of women

Management practice	% of farmers who use saved seed (n=173)	Role of women in seed management			
		No role	Limited participation	Equal with men	Women only
Plant seed fields separate from grain fields	63.2	34.3	25.0	36.1	4.6
Keep isolation distance to reduce varietal contamination	65.5	36.6	16.1	45.5	1.8
Better cultivation and weeding of seed fields	69.6	40.3	9.2	49.6	0.8
Rogue off-types in seed fields	67.2	5.2	18.3	74.8	1.7
Thresh seed in separate place	66.7	4.4	21.9	71.9	1.8
Clean seed after threshing	69.6	7.6	16.0	71.4	5.0
Treat seed before storage	50.9	14.9	44.8	37.9	2.3
Store seed separate from grain	76.9	10.8	26.9	57.7	4.6
Clean seed before planting	90.1	6.5	4.5	51.3	37.7
Average	**77.5**	**20.1**	**22.8**	**62.0**	**7.5**

Source: Survey, 2012

4 Wheat seed value chain

4.1 Wheat seed value chain governance

Within the national seed system, the wheat seed value chain actors are pre-dominantly public institutions. Table 7 presents the wheat seed value chain actors along with their important roles and responsibilities in variety development, seed production, marketing and regulation.

The wheat seed value chain can be divided into the following main segments i.e. variety development and release, source (breeder, pre-basic and basic) seed multiplication, certified seed production, and seed marketing.The MoA at the federal level and the BoAs at the respective regional levels have the overall role of governing the national seed system, but the ad hoc National Seed Production and Distribution Committee (NSPDC) has a direct oversight in planning and coordinating seed production and marketing. Recently, there is an attempt to establish independent seed regulatory agencies (SRA) at the federal and regional levels.

Table 7. Major actors and their role in wheat seed sector

Function	Components of seed sector	Institutions/ Committees	Regulatory/ Supervisory agency	Regulatory measures
Plant breeding	Variety development	EIAR, RARIs, and HLIs	MoA	National variety trials
	Variety release	NVRC	APHRD, MoA	Registration (DUS) and performance (VCU) trials
Source seed multiplication	Breeder seed production	EIAR, RARIs, and HLIs	Research Centers	Internal seed quality control
	Pre-basic seed production	EIAR, RARIs, HLIs, ESE, ASE, OSE	BoA, MoA	Seed certification
	Basic seed production	EIAR, RARIs, ESE, ASE, OSE	BoA, MoA	Seed certification
	Basic seed allocation	NSPDC	MoA	Fair distribution among regions and seed producers
Certified seed production	Certified seed production	ESE, ASE, OSE, SSE, cooperatives	Regional SRA, MoA	Seed certification
	Farmer-based seed production	NGOs, farmers	Regional SRA, BoAs	Seed certification
Seed marketing	Seed sales and distribution	ESE, ASE, OSE, Co-operatives, BoAs	BoA, MoA	Guidelines on seed price setting and allocation to respective regions
Seed Certification	Quality assurance	Federal and regional quality control agencies	Regional SRA, BoAs	Field inspection, seed testing and market enforcement
Oversight	Seed demand assessment	BoAs, MoA	BoA, MoA	Bottom-up estimates with adjustment at regional and national levels based on trends
	Planning seed production	NSPDC	MoA, EIAR, RARIs, PSEs	National seed production plan

Source: adapted from Bishaw et al. (2008)

Accordingly, the Plant Variety Release, Protection and Seed Quality Control Directorate (PVRPSQD) at the federal level; Amhara Seeds and other Agricultural Inputs Quality Control and Quarantine Authority in Amhara region; Agricultural Input and Quality Control and Utilization Core Process in Oromia; Agricultural Inputs Quality Inspection and Quarantine Authority in SNNPR; and Seed Quality Control Case Team in Tigray region were established with the main objective to strengthen the regulatory and seed certification system.

4.2 Actors, decisions and linkages in wheat variety development

Variety development is the backbone of the seed system. Wheat research in general and variety development in particular are nationally coordinated at Kulumsa Agricultural Research Center for bread wheat and Debre Zeit Agricultural Research Center for durum wheat under the auspices of the Ethiopian Institute of Agricultural Research (EIAR). Both these centers work closely with other EIAR research centers, regional agricultural research institutes, Ethiopian Biodiversity Institute (EBI) and international agricultural research centers like ICARDA and CIMMYT.

The variety development targets three broadly classified wheat growing agro-ecologies, namely, the highlands (2400-3000 meter above sea level), the mid-altitudes (1800-2400) and the lowlands (1600-1800). The main stream research objectives are (i) developing high grain yielding and (a)biotic stress tolerant wheat varieties adaptable to different growing environments along with improved production practices; (ii) maintaining and multiplying early generation seed (breeder, pre-basic) of released wheat varieties and promoting improved technologies; (iii) characterizing and identifying wheat production and marketing constraints for setting research and/or development agenda in the country.

The wheat research follows three major steps, which include variety development and evaluation; verification and release of new varieties; and variety maintenance, popularization and commercialization of released varieties (Figure 3). Both durum and bread wheat research programs are involved in developing improved varieties using locally available germplasm that are collected by the research and/or by the EBI. The programs have also benefited from wheat germplasm exchange through very close collaboration with International Agricultural Research Centers mainly CIMMYT and ICARDA. Public NARS (EIAR, RARIs) and private seed companies apply for variety release to the Animal and Plant Health Regulatory Directorate (APHRD) of the MoA (now PVRPSQCD) which initiates the verification of candidate varieties on-station and on-farm. The National Variety Release Committee (NVRC) makes decision for release based on its Technical Committee report and deliberations of the application.

The release of a variety could be national or regional and the approval and registration is at the national level through the NVRC. Once the candidate variety is approved for release, then it is registered in the Crop Variety Register of the APHRD and maintained by the respective research center that had released the variety. The 2012 register indicates that 58 bread and 34 durum wheat varieties were released in Ethiopia (MoA, 2012).

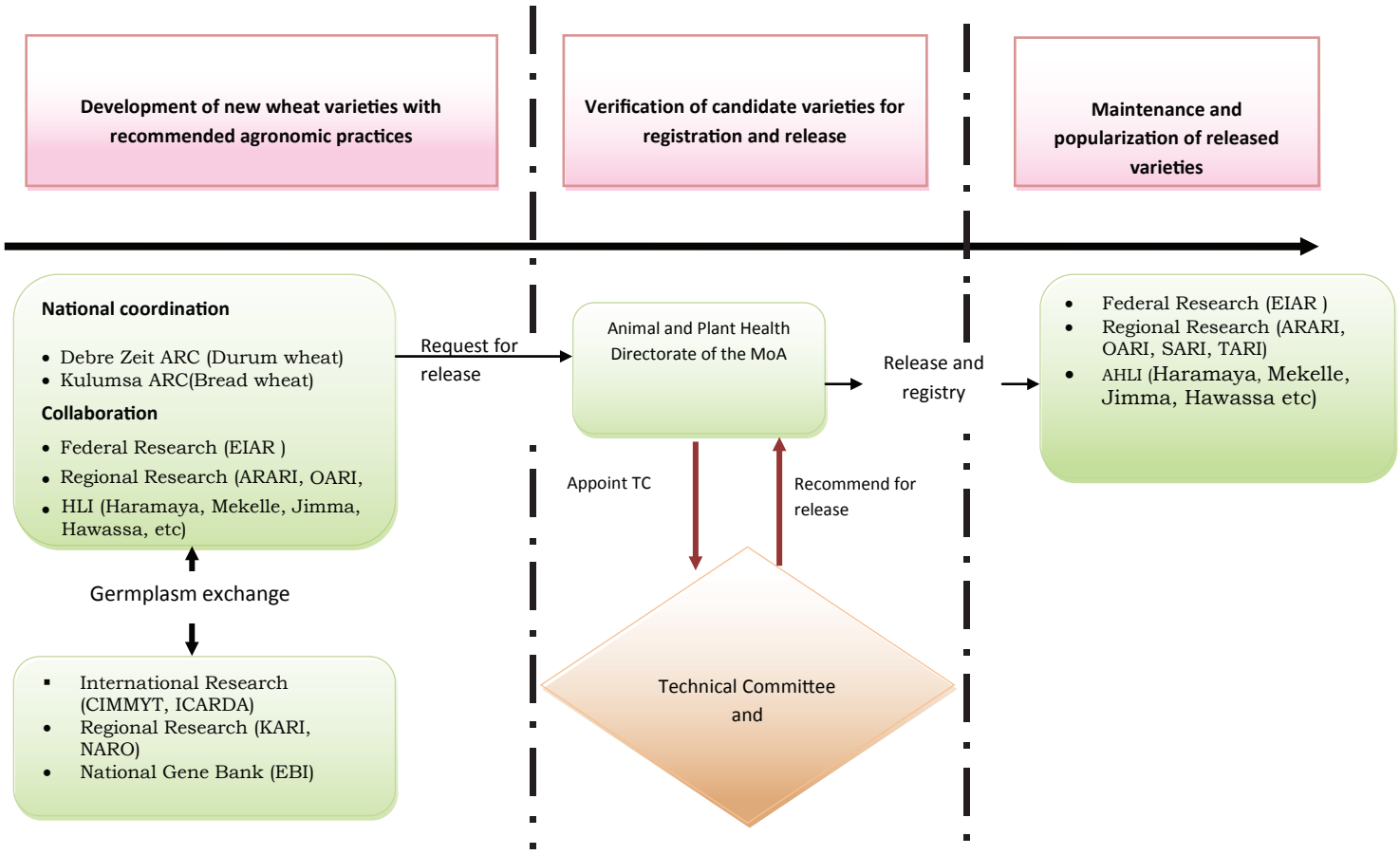

Figure 3. Actors, roles and linkages in wheat variety development, release and maintenance

Source: Adapted from Alemu (2011)

4.3 Actors, decisions, and linkages in wheat source seed [1] production

Table 8 presents the list of released wheat varieties that are still under registration and commercialization. Availability and access to source seed of the required variety in sufficient quantity and time is critical in improving the performance of the whole seed system. In order to supply the required amount of basic seed for a given wheat variety, there has to be sufficient breeder and pre-basic seed multiplied during the previous production season(s). Inadequate planning in the multiplication of breeder, pre-basic and basic seed limits the production of certified seed of required varieties.

To date, the breeder and pre-basic seed multiplication is a primary responsibility of the research centers that have released the varieties. In recent years, basic seed multiplication is shared with public seed enterprises. There is an on-going discussion about sharing responsibilities among public seed enterprises and/or assigning the Ethiopian Seed Enterprise to fully engage in basic seed multiplication for all crops and the regional seed enterprises (ASE, OSE, SSE) to focus on certified seed production.

1 In Ethiopia, source seed includes breeder, pre-basic and basic (equivalent to foundation) seed. Basic seed is provided to public or private seed suppliers to produce certified seed.

The basic seed multiplied by the research center is allocated to certified seed producers, generally to the public seed enterprises, and recently to emerging private seed companies licensed to operate a seed business. The allocation of the basic seed is made by the National Seed Production and Distribution Committee with the approval of the MoA.

Table 8. Wheat varieties released and maintained by NARS

Wheat type	Institute	Agricultural Research Center	Varieties released
Bread	EIAR	Kulumsa	Abola, Bobicho, Danda'a, Dashen, Digelu, Desalegne, Dodotta, ET-13A2, Gambo, HAR1685 (Kubsa), HAR710 (Galema), HAR1709 (Mitike), Hawi, Hidase, Hoggana, Kakaba, Katar, KBG-01, K6295 - 4A, K6290 Bulk, Megala, Meraro, Millennium, Ogolcho, Pavon 76, Sirbo, Simba, Shorima, Tura, Tuse, Wabe, Wetera
		Holeta	Alidoro
	ARARI	Debre Berhan	Bolo, Jiru, Menze, Tsehay
		Adet	Densa, Gasay, Guna, Tay, Senkegna, Shina
		Sirinka	Dinknesh, Tossa, Warkaye
	OARI	Fedis	Jefferson
		Sinana	Dure, Madda Walabu, Sofumar
	SARI	Hawasa	Inseno, Sulla
	TARI	Mekelle	Mekelle-01, Mekelle-02, Mekelle-03
	HLI	Haramaya	Qulqullu
	Hazera Genetics Ltd	Axum Greenline Trading Plc	Galil
Durum	EIAR	Debre Zeit	Asasa, Arsi Robe, Bichena, Boohai, Denbi, Foka, Ginchi, HAR3123, Hitosa, Kilinto, Mangudo, Mukiye, Quami, Robe, Ude, Werer, Yerer
	OARI	Sinana	Bakalcha, Dire, Ilani, Jersa, Lelisso, Oda, Obsa, Tate, Toltu
	ARARI	Sirinka	Flakit, Malefia, Laste
		Adet	Megenagna, Mettaya, Mosobo, Selam
	SARI	Hawasa	Kokate

Source: MoA (2012)

4.4 Actors, decisions and linkages in certified seed production and allocation

The key actors in certified seed production are those who are involved in production, marketing and certification process. Currently, the production of certified wheat seed involves one federal and three regional public seed enterprises; commercial private and state farms; and a number of emerging private seed companies. The private seed enterprises include small-scale operators such as cooperatives, seed associations and private limited companies which are licensed to produce certified seed. Certified seed production is carried out on contract with farmers under farmers' based seed multiplication schemes (FBSMS), commercial private and public estate farms and farms owned by the public seed enterprises (Figure 4). This indicates that the formal wheat seed sector is dominated by the public seed enterprises, though it involves smallholders and commercial farms in the certified seed production.

Currently, the certified seed for wheat is produced by the public enterprises with internal quality control in the absence of adequate external certification scheme. However, regional seed regulatory agencies are being established by regional states for certification purposes (USAID, 2013 and see Section 4.1).

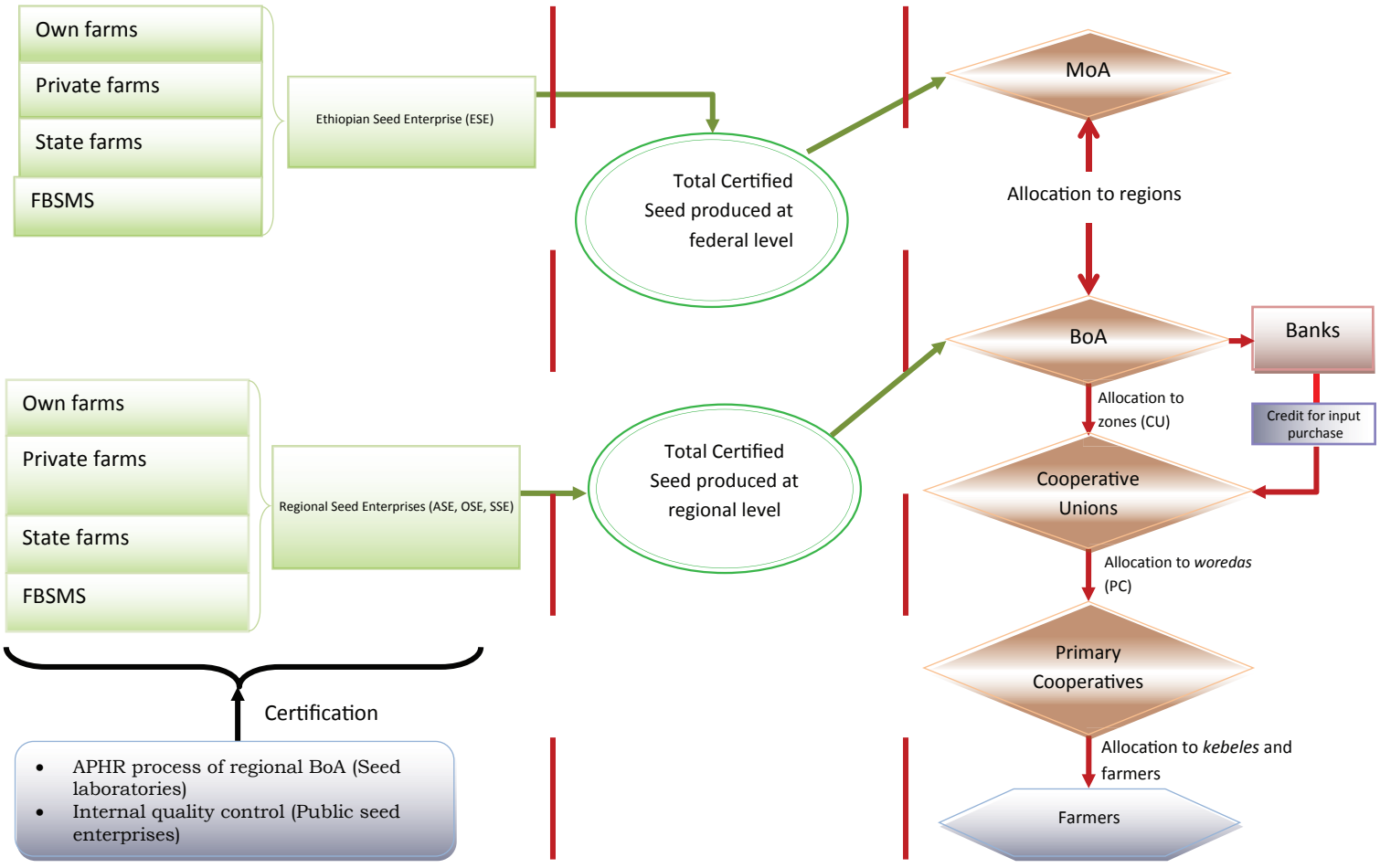

Figure 4. Actors, decisions, and linkages in certified seed production and distribution

4.5 Actors, decisions and linkages in wheat seed marketing and distribution

The formal wheat seed marketing is highly centralized and regulated by the government. The key actors in regulation are the Inputs Marketing Directorate of the MoA at the federal level and the Input Marketing Processes of regional BoAs. The regulatory aspect considers the quantity and prices. The key market actors are the public seed enterprises as suppliers and the cooperative unions and their respective primary cooperatives as distributors.

The certified wheat seed is supplied at the federal level by ESE and at the regional level by the respective regional seed enterprises. In regions, where any public seed enterprise is not yet established or operational, the ESE takes up the responsibility. Regional BoAs normally inform the federal Inputs Marketing Directorate of the MoA, about the quantity of certified seed demanded by variety after considering the quantity supplied by their respective regional seed enterprise. Then, the Inputs Directorate of MoA, based on the recommendations of the National Seed Production and Distribution Committee, makes an equitable appropriation to the respective regions. Regional BoAs then make an allocation to the different cooperative unions targeting different zones where the respective union caters.

Each cooperative union is informed about the amount of certified seed allocated and its source from the different enterprises by the regional BoA. Similarly, the seed enterprises are also informed to which cooperative union they should supply the certified seed. Each union and primary cooperative is assigned to a respective zone and woreda with a mandate area of service provision. Therefore, the unions work closely with zonal BoA and the primary cooperatives with woreda BoA and kebele administration (Figure 3).

The core decision on certified seed prices is made by the board of directors of ESE, which is composed of the Director General of EIAR as chair, two ESE representatives, Director of Agricultural Extension, Director of the Agricultural Inputs Marketing, and Director of the Planning and M&E Directorates of MoA as the members. The set price is communicated to the Agricultural Inputs Marketing Directorate (AIMD) of MoA. The AIMD gives a direction on the price setting mechanism and communicates the amount appropriated and purchase price of seed to the regional Agricultural Inputs Marketing Process of the respective regions. The overall direction in price setting is to sell the certified seed at the same price throughout the country, while taking into account the differences due to overhead, transportation and handling costs.

The procedure of estimating the overhead, transportation and handling costs are provided by the AIMD of MoA and the regions estimate using the procedure what should be the margin for each union. Therefore, the prices of wheat seed are similar except the differences due to overhead, transportation and profit margins of the different unions and primary cooperatives. The profit margins are determined by the Agricultural Inputs Marketing Process of BoA of respective regions and they are slightly different across the regions. For example, the profit margin for cooperative unions in Amhara region is about 5 ETB/quintal, whereas it is 2.50 ETB/quintal in Oromia. Similarly, the profit margin for primary cooperatives is 6 ETB/quintal in Amhara and it ranges from 2.50 to 3 ETB/quintal in Oromia. The wholesale wheat seed prices in 2012 i.e., prices of the public seed enterprises ranged from 1008 ETB/quintal (older varieties) to 1098 ETB/quintal for newly released varieties (Danda'a, Kakaba, and Digelu). The price for Amhara Seed Enterprise was 1,225 ETB/quintal due to higher production cost.

The current price setting mechanism has both advantages and disadvantages (Alemu, 2011). The advantages are: (i) it limits the entrance of excess intermediaries in the market, which helps farmers to get seed at reasonably better prices, (ii) enables farmers with limited access to markets (those in distant areas with poor road) to purchase seed equitably, and (iii) promotes group marketing especially through membership in cooperatives. The disadvantages are: (i) it transfers the cost incurred due to the inefficiency of union and primary cooperatives to farmers, (ii) limits the competitions among the different seed producers, (iii) creates disincentive for seed producers to work and invest in their own distribution systems, and (iv) it is liable to corruption and promotes black market for seed. In recent years, however, direct marketing of seed is being piloted in some districts.

5 Commercial behaviors of smallholders in wheat seed

5.1 Distribution of farmers by commercial behavior in wheat seed

In terms of AMP in wheat seed, about 25% of the wheat producers have autarkic market position. This indicates that a quarter of the wheat producers do not buy or sell wheat seed in a given year or crop season. About 26% of the wheat producers have a selling market position for wheat seed. Almost 50% of the wheat producers on the other hand have a buying market position (Table 9). The results indicate that a considerable number of wheat producers are engaged both in selling and buying of wheat seed of different varieties including farmers in net selling position (14%) and farmers in equally buying and selling position (1%).

Table 9. Commercial behavior of wheat farmers in wheat seed (% of respondents)

Market position	% of wheat producers	Category of market position	Variety used (%)	
			Local	Improved
Autarky (n=129)	24.67	Autarky (25 %)	5	20
Seller only (n=60)	11.47	Selling position (26 %)	4	22
Net seller (n=73)	13.96			
Equally buyer and seller (n=4)	0.57			
Buyer only (253)	48.37	Buying position (49 %)	22	27
Net buyer (5)	0.96			

Source: Survey, 2012

It is interesting to note that a good percentage of farmers used improved varieties in all market positions, specifically 19% of farmers in autarkic position and 21% in selling position. However, in the buying position only 11% used improved varieties (Table 9). These results have a direct implication on the effective demand assessment for seed enterprises engaged in the production and marketing of seed of different wheat varieties. Almost close to 64% of the wheat producers are buyers of wheat seed, which includes all farmers with market positions of 'only buyers', part of 'net sellers' and part of 'net buyers'. In addition, there is a considerable variability among wheat producers in renewing their seed stock and the length of time required to replace it.

In general, farmers demand seed from off-farm sources for various reasons including seed replacement, varietal replacement, uneven seed market development (limited access to market information, limited market actors, etc.), farmers' preferences for seed sources and distribution time, farmers' awareness about certified seed and emergency response. All of these are dependent on factors related to agro-ecology, natural and man-made disasters. This can generally explain the differences among farmers in their decisions when they demand seed, in terms of quantities, frequency and varieties (Minot et al., 2007).

Commercial behavior and seed renewal are somehow related but they are different conceptually especially for saved and purchased seed users. Seed renewal has two dimensions, i.e., seed replacement for varieties that have already been adopted and variety replacement, which is changing to new varieties instead of the adopted ones.

Both the dimensions elucidate the importance of regular replacement of already used seed with certified seed and replacing the existing commercial variety with new ones. In this study, farmers were asked for renewal regardless of seed or variety as a general behavior, whereas, commercial behavior was estimated based on the actual decisions of the farmers during the survey period.

Table 10 presents farmers' wheat seed renewal and its frequency. Accordingly, from among sample farmers about 53% (n=524) reported renewing their seed stock regularly, of which 22% are in wheat seed selling, 16% in buying and the rest 15% in autarkic market position. Farmers reported renewing their seed stock every 2.67 years on average, with significant differences among farmers in different market positions, i.e., every 3.06 years for autarkic, every 2.53 years for selling, and every 2.5 years for farmers in buying market position. The results imply that farmers with autarkic AMP purchase or change seed/variety less frequently compared to those with selling and buying AMP.

The results indicate that irrespective of their market position about 40% of farmers renew wheat seed every two to three years whereas only 5% renew every year and 2% renew after five or more years, and the rest 47% reported that they do not regularly renew their seed stock. Higher proportion of farmers in buying position (33%) reported less renewal of seed, which appears to be associated with higher proportion of seed of local varieties (see Table 9). The 16% farmers in the same market position who have reported the renewal of seed are those who use saved and purchased seed (Table 10).

The amount of wheat seed purchased and sold by AMP is summarized in Table 11. The results indicate that there is statistically significant difference in the average amount of wheat seed purchased and sold among the different AMP categories. The overall average of wheat seed purchased was about a quintal per household at an average price of ETB 816.36 q-1. On the other hand, the amount of seed sold per household was 8.27 q at an average price of ETB 705.63 q-1 and considerable variability among the different market positions in 2011/12 crop season.

Table 10. Bread wheat seed renewal by market position

Market position	Proportion of farmers that renew seed stock (%)			Average renewal time (years)			Distribution of respondents by rate of renewal in years (% of respondents)					
	Yes	No	Total	Mean	N	Std	evvery1 year	Every 2 years	Every 3 years	Every 4 years	≥5 years	Not renew
Autarkic position (129)	15	10	25	3.06	78	1.18	0.6	4.4	5.7	3.1	1.1	9.8
Selling position (137)	22	4	26	2.53	113	.91	2.1	8.4	9.2	1.3	0.6	4.4
Buying position (258)	16	33	49	2.50	86	.99	1.9	6.7	6.5	1.0	0.4	32.9
Total	53	47	100	2.67	277	1.04	4.6	19.5	21.4	5.4	2.1	47.0
	X^2 = 17.44***			F-value = 8.14***			X2 = 119.17***					

Source: Survey, 2012

Table 11. Quantity and price of bread wheat seed purchased and sold by household (2011 crop season)

Market positions		Amount purchased in q	Purchase price (ETB/q)	Amount sold in q	Selling price (ETB/q)
Seller Only (n=60)	Mean	-	-	7.74	690.13
	Std	-	-	8.46	108.18
Buyer Only (n=253)	Mean	0.97	821.51	-	-
	Std	1.04	129.31	-	-
Net seller (n=73)	Mean	1.07	803.47	9.41	717.08
	Std	0.89	143.24	11.46	110.03
Net buyer (n=5)	Mean	3.00	716.10	2.10	746.00
	Std	2.03	125.26	1.56	114.86
Equally buyer and seller (n=3)	Mean	1.33	862.00	1.33	670.00
	Std	0.58	33.65	0.58	185.20
Total	Mean	1.02	816.36	8.27	705.63
	Std	1.05	132.33	10.05	110.82
F-Value		6.57***	1.44	1.49	0.97

Source: Survey, 2012

Note: Quintal (q) is a unit of measure equal to 100 kg; *** indicates significance level at 1%

5.2 Socio-demographic characteristics of respondents by commercial behavior

Socio-demographic characteristics of farmers are among the key factors that determine commercial behaviors.

Table 12 presents a summary of the socio-demographic characteristics of respondents by AMP. There is no statistically significant difference in age and educational level among wheat producers with different AMPs. The family size shows statistically significant difference among AMP categories; and the highest average family size (about 8 people) is for households with selling AMP.

Land and livestock are the main resources of smallholder farmers. Households with selling AMP in wheat seed seem to have more resources compared to households with other AMPs. The average land holding and livestock ownership per household are the highest for households with selling AMP, which is 2.8 ha and 8 Tropical Livestock Unit (TLU)/household, respectively.

One of the key factors in smallholder commercial behavior is access to extension services and markets. About 97% of the respondents reported that they have access to extension related to wheat seed (variety, quality, etc.) and about 90% reported to have access to extension about wheat marketing. Access in terms of distance (km) to the nearest market was found to be statistically different among households with different AMP. Households with selling position, on average, live nearer to the market center compared to the households with buying and autarkic positions.

About 68% of the respondents reported that they are members of cooperatives, with a statistically significant difference noted in the proportion of respondents in the different AMPs (Table 12). The highest percentage of cooperative membership was observed among farmers in the buying market position (72%) followed by farmers in the selling market position (69%). Higher proportions of farmers in the selling/buying AMP are members of the cooperatives compared to other market position. This indicates that cooperatives are a source of seed for its members and non-members. It is reported that cooperatives play an important role in seed provisions to its members (53.2%) and non-members (57.14%) alike (Tanguay et al., 2013).

The average number of crops grown by farmers in a year in different seed market positions is about four and it is found to be similar across the regions. This is highly associated with the similarity of agro-ecological zone and production systems for farmers having different AMPs but living in the same agro-ecology.

Table 12. Description of socio-demographic variables by commercial behavior

Variables	Definition	Autarky		Selling		Buying		Total		F-value
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	
Sex	1=male, 0=female	0.95	0.02	0.99	0.01	0.96	0.01	0.96	0.01	2.02
Age	Number of years	42.97	1.40	43.82	1.10	41.90	0.74	42.51	12.99	1.10
Family size	Number of household members	6.49	0.25	7.76	0.26	6.57	0.17	3.53	2.06	5.35***
Education	Number of years of formal education	5.31	0.48	6.10	0.39	5.57	0.30	5.67	4.80	0.64
Demand	Amount of wheat seed demanded in 100 kg	-	-	0.61	0.07	1.01	0.07	0.65	0.04	0.26
Wheat seed price	Unit price of seed purchased (ETB/100kg)	-	-	810.48	9.15	821.93	8.21	816.36	4.61	0.63
Land rainfed	Size of land cultivated in ha	1.99	0.18	2.83	0.19	1.82	0.11	2.12	1.93	13.12***
TLU	Number of livestock owned in TLU	3.63	0.30	7.71	1.38	3.93	0.22	4.81	8.76	10.34***
Extension wheat seed	Access to extension on wheat seed (1=yes, 0=No)	0.96	0.02	0.97	0.01	0.97	0.01	0.97	0.01	0.177
Extension marketing	Access to extension on marketing (1=yes, 0=No)	0.89	0.03	0.93	0.02	0.90	0.02	0.91	0.01	0.698
Credits	Access to credit (1=yes, 0=no)	0.63	0.04	0.63	0.04	0.68	0.03	0.65	0.02	0.722
Distance to market	Distance to the nearest market in Km	7.64	0.54	5.50	0.49	7.29	0.40	6.90	0.27	4.89***
Membership of cooperative	Member of cooperatives (1=yes, 0=no)	0.65	0.04	0.69	0.04	0.72	0.03	0.68	0.02	2.55*
Number of crops	No of crop types produced	3.80	0.12	3.90	0.15	3.92	0.09	3.88	1.49	0.32
Wheat yield	Wheat yield achieved in previous crop season (q/ha)	20.06	1.09	29.65	1.16	24.31	0.85	24.70	0.59	17.74***

Source: Survey, 2012

5.3 Land allocation and productivity in wheat production by commercial behavior

The market positions show significant differences in land allocation and productivity levels of wheat production (Table 13). Farmers in the selling position of wheat seed allocated more area for wheat production as compared to those in other market positions. On average, farmers allocated 2.12, 1.07, and 0.95 ha of land with selling, buying, and autarkic market positions, respectively. Similarly, farmers with selling market position achieved higher productivity levels for wheat compared to farmers with other market positions. On average, farmers with selling position achieved a yield of 30 q ha-1 compared to farmers with buying position (24 q ha-1) and farmers with autarkic market position (20 q ha-1). This is possibly related with the fact that farmers in selling position are more specialized in wheat production as they allocate more land and better crop management.

Table 13. Land allocation and productivity of wheat by market position

Market positions		**Land allocated for bread wheat (ha)**	**Yield of bread wheat (q ha^{-1})**
Autarkic	Mean	0.95	20.12
	Std	0.94	12.07
	N	128	128
Selling	Mean	2.12	29.70
	Std	2.50	13.44
	N	135	135
Buying	Mean	1.07	24.39
	Std	1.19	13.40
	N	256	256
Total	Mean	1.31	24.72
	Std	1.66	13.51
	N	519	519
F-Value		23.77***	17.74***

Source: Survey, 2012

5.4 Determinants of wheat seed commercial behavior: logit estimates

Earlier studies have documented the macro level determinants of agricultural commercialization with emphasis on the output markets while others have documented the effects of commercial orientation on production, income and/or livelihoods (Pender and Alemu, 2007; Strasberg et al., 1999; Dorsey, 1999; von Braun, 1995). There is a common understanding that agricultural technology and commercialization are complementary catalyzing the rural economic growth process in general and agricultural growth in particular.

Cognizant of this fact, the purpose behind this study has been to elicit the level of commercial orientation and identify the key drivers for improved commercialization. A previous study on teff and maize commercial orientation in Ethiopia has documented that increased teff and maize production are the most important factors contributing to commercial orientation as demonstrated in terms of increased sales; and that increased smallholder access to roads, land, livestock, farm equipment, and linkage to traders are among the key factors that would enable an increased smallholder production and commercialization of these crops (Pender and Alemu, 2007).

In line with these studies, the determinants of commercial behavior of smallholder wheat growers in wheat seed have been identified following the model specified in the methodology. The key determinants for farmers' commercial behavior in wheat seed are found to be related with wheat production characteristics, mainly land allocated for wheat production, resource ownership such as, land size owned, both under rain fed and irrigated condition and livestock, access to credit, and the wheat yield achieved (Table 14).

The land size allocated for wheat production was found to affect negatively the probability to be in wheat seed buying (about 30%) and autarkic (about 5%) market positions. However, land size affects positively the probability of a wheat producer to be in wheat seed selling position (about 11%). This is in line with the expectation that the larger the wheat area the higher the probability to specialize, to have more marketable surplus, and accumulate knowledge on wheat production and its seed management. The land size under rain fed condition is found to negatively influence the probability of a wheat farmer to be in wheat seed selling position and positively the probability to be in autarkic position. On the other hand, the irrigated land size owned is found to influence positively the probability to be in buying position and negatively to be in selling position. Access to irrigated land shows the production potential of the area and more engagement in cash crops, which indicates that farmers in better production areas are more likely to be in wheat seed buying position compared to less potential areas.

Number of crops grown by wheat producers affected positively the probability of wheat farmers to be in selling position whereas it affected negatively the probability to be in autarkic position. Ceteris paribus, diversification in crop production in wheat production areas, increased on average the probability to be in wheat seed selling position, which can be associated to the use of other grain crops for domestic use. Increased wheat yield influences positively the probability of a wheat farmer to be in selling position and negatively the probability to be in autarkic position.

Livestock ownership influenced positively the probability of wheat farmers to be in selling position. This could be associated with the positive role of livestock as draft power source in wheat production in particular and crop production in general. The amount of credit accessed is also found to positively influence the probability of a farmer to be in the wheat seed buying position.

In general, the result indicates that on average the more resources (land, livestock) are allocated to wheat production, wheat farmers tend to specialize in wheat production and to be more wheat seed sellers. This result is in line with the previous studies that have documented the importance of resource ownership and increased production for improved commercial orientation (Pender and Alemu, 2007; Dorsey, 1999).

Table 14. Determinants of the different commercial behaviors: logit estimates

Category	Variables	Buying			Selling			Autarky		
		Coefficient estimates	Standard errors	Marginal effects	Coefficient estimates	Standard errors	Marginal effects	Coefficient estimates	Standard errors	Marginal effects
Demographics	Sex	-0.2315	0.5715	-0.0576	0.9412	0.8040	0.1342	-0.2420	0.5398	-0.0426
	Age	-0.0003	0.0096	-0.0001	-0.0007	0.0099	-0.0001	0.0032	0.0091	0.0005
	Family size	-0.0606	0.0523	-0.0151	0.0743	0.0481	0.0136	-0.0244	0.0477	-0.0040
	education	-0.0435*	0.0252	-0.0109	0.0284	0.0245	0.0052	-0.0078	0.0230	-0.0013
Wheat production characteristics	Land allocated for wheat (ha)	-1.2330***	0.2426	-0.3082	0.6102***	0.1517	0.1119	-0.3185*	0.1690	-0.0526
	Wheat seed price (ETB/q)	0.0011	0.0011	0.0003	-0.0001	0.0012	0.0000	-	-	-
	Number of crops produced	-0.0873	0.0915	-0.0218	0.1527*	0.0827	0.0280	-0.1659*	0.0893	-0.0274
	Wheat yield achieved (q/ha)	-0.0052	0.0107	-0.0013	0.0214**	0.0096	0.0039	-0.0298***	0.0108	-0.0049
Resource ownership	Land owned in ha (rain fed)	0.2128	0.1460	0.0532	-0.2206**	0.0998	-0.0405	0.2679***	0.1038	0.0443
	Land owned in ha (irrigated)	1.9564**	0.9942	0.4891	-2.4299*	1.3610	-0.4456	-0.5177	1.0826	-0.0855
	Livestock ownership (TLU)	-0.0607	0.0411	-0.0152	0.0635**	0.0322	0.0116	-0.0554	0.0407	-0.0092
Access to extension	Access to extension on wheat production	0.4506	0.6597	0.1111	-0.3801	0.6568	-0.0758	0.0041	0.6179	0.0007
	Access to extension on wheat marketing	-0.3707	0.4217	-0.0918	0.2256	0.4312	0.0394	-0.0945	0.3954	-0.0160
Access to credits	Access to credit	-0.1361	0.2526	-0.0340	0.1396	0.2479	0.0253	-	-	-
	Amount of credit accessed	0.0007*	0.0004	0.0002	0.0001	0.0003	0.0000	-	-	-
Access to markets	Distance to nearest market	0.0128	0.0205	0.0032	-0.0242	0.0211	-0.0044	0.0168	0.0186	0.0028
Membership in cooperatives	Membership in cooperative	-0.1284	0.2652	-0.0321	-0.0347	0.2553	-0.0064	-0.2280	0.2425	-0.0386
Demand	Quantity of wheat seed demanded (q)	3.1239	0.3314	0.7810	-0.6631***	0.1599	-0.1216			
	Constant	-0.2685	1.3802		-3.6485**	1.5716		0.6208	0.8970	
	y = Pr (commercial behavior)	0.50			0.24			0.21		
	Number of obs	504			504			504		
	LR chi2(18) =	230.87***			92.41***			34.62***		
	Pseudo R2 =	0.3304			0.1583			0.1632		
	Log likelihood =	-233.908			-245.67			-256.706		

6 Farmers' perception of bread wheat varieties

This section presents how the farmers' perceptions are embodied in the local and improved bread wheat varieties that were grown by farmers during the survey season (2012). Accordingly, the local bread varieties include Bani, Wofiche and Dashen (obsolete improved variety), in Tirgay; Enate, Kinikina, Kontem, Kuchibiye, Kurest, Logawshebo, Qebetu, Qeye sende, Qurshet, Sesse, Shamax, Tekure sende, Trifical Thogoshob, and Zembolela in Amhara; and Abebe and Danshure in Oromia.

The improved bread wheat varieties that are rust resistant were Danda'a, Digelu, ET13, Kakaba, Madda Walabu, and Pavon76, whereas the rust susceptible varieties were Galema, Kubsa, Millenium, and Tuse.

What farmers want in terms of the different varietal attributes is reflected in the demand indices. The results indicate that grain yield and resistance to yellow and stem rust are attributes that are desired most compared to other attributes. It is evident from the supply indices that what was demanded by the farmers is more supplied by the improved varieties than the local ones. Similarly, the low value of attainment indices for the local varieties and the high value for improved varieties show that the demanded characteristics are embodied more in the improved varieties. However, it was found that for some attributes, like field establishment and crop stand and straw yield and quality, local varieties have better attainment indices compared to some of the improved varieties. The values of demand, supply and attainment indices for the different bread wheat varieties are summarized in Table 15, Table 16, and Table 17.

6.1 Yield and grain quality characteristics

Farmers' perceptions about grain yield and quality characteristics (size, and color) show considerable difference among local and improved (rust resistant and susceptible) bread wheat varieties. All the improved varieties demonstrated better attainment index compared to locals. Moreover, all the improved rust resistant varieties have a better attainment compared to the improved rust susceptible varieties. However, Digelu and Danda'a have the highest attainment indices for yield among disease resistant improved bread wheat varieties showing farmers' preference for these two varieties. For grain size, the most preferred was Madda Walabu followed by Digelu among the disease resistant varieties. In terms of grain color, the highest attainment was recorded for Pavon76 among resistant varieties and for Tuse among susceptible varieties. However, earlier reports showed that Pavon76 was rated for its high yield, marketability, and food quality, but less so for grain size and color (Bishaw et al., 2010). Pavon76 and HAR1865 (Kubsa) were widely adopted and appeared to be important in suitability scoring by farmers in south central Ethiopia (Gebeyehu et al., 2002).

6.2 Field establishment, stand and earliness

Rapid germination and emergence are essential for good field establishment and crop stand. In terms of field establishment, crop stand, and earliness, Pavon76 demonstrated the highest attainment index compared to other varieties. Some improved varieties, like ET13, have lower attainment index compared to the local variety for field establishment and stand.

6.3 Disease and drought resistance

Ethiopian farmers are conscious of rusts as constraints of wheat production. In terms of resistance to yellow and stem rusts, all resistant varieties had higher attainment indices compared to local varieties. The highest attainment index was recorded for Madda Walabu variety compared to other disease resistant wheat varieties. However, all susceptible varieties had lower attainment indices for rust resistance even compared to local varieties. Bishaw (2004) reported that about 79% of sample farmers considered rusts to be important wheat-production constraints. Hence tolerance to disease was considered either very important or important by almost half of the farmers, showing their awareness of the susceptibility of wheat varieties. Earlier studies also showed that farmers had concern for less durability of the modern varieties released from research programs (Yirga et al., 1992).

6.4 Food quality and marketability

All improved varieties except Millennium variety demonstrated better attainment indices for food quality and bread taste as compared to local variety and the highest attainment index is recorded for Pavon-76. Similarly, grain marketability is better attained by improved varieties compared to local variety where the highest attainment index was again recorded for Pavon-76, which could be associated with the food quality perceived by farmers. In Ethiopia, it was reported that there was a strong preference for grain color and price difference in wheat (Gebremariam et al., 1991; Agidie et al., 2000) where the prices could reach up to one-third higher depending on the crop and location. White kernel wheat varieties fetched a better price because of consumer preferences for food preparation (Gebremariam et al., 1991).

6.5 Threshability, straw yield and quality

The attainment indices of threshability are better for all improved varieties compared to local landraces except for Millennium, which has low attainment index compared to landraces.

Digelu demonstrated the highest attainment index of threshability compared to other varieties. The preference of farmers for straw yield and quality shows that Danda'a and ET13, among disease resistant varieties, and Millennium, among susceptible varieties, demonstrated lower attainment indices compared to local variety. The highest preference for straw yield and quality was attained by Madda Walabu. It was reported that ET13 was favored by farmers because of its straw yield and quality and tolerance to diseases (Bishaw et al., 2010; Agidie et al., 2000).

Table 15. Demand, supply, and attainment indices for disease resistant bread wheat varieties

Variety attributes	Local			Highland agro-ecology											
				Danda'a			ET-13A2			Madda Walabu			Digelu		
	DI	SI	AI	DI	SI	AI	DI	SI	AI	DI	SI	AI	DI	SI	AI
Grain yield	0.99	0.18	**0.18**	0.97	0.94	**0.91**	0.99	0.35	**0.35**	1.00	0.89	**0.89**	0.99	0.91	**0.91**
Grain size	0.96	0.37	**0.36**	0.93	0.83	**0.75**	0.94	0.40	**0.37**	0.99	0.98	**0.97**	0.97	0.91	**0.89**
Grain color	0.84	0.29	**0.26**	0.80	0.71	**0.55**	0.66	0.53	**0.36**	0.95	0.89	**0.84**	0.93	0.88	**0.82**
Field establishment and crop stand	0.80	0.51	**0.42**	0.78	0.91	**0.72**	0.64	0.59	**0.40**	0.93	0.91	**0.85**	0.89	0.94	**0.84**
Early maturity	0.83	0.18	**0.15**	0.71	0.80	**0.57**	0.70	0.41	**0.29**	0.91	0.72	**0.66**	0.89	0.73	**0.66**
Drought resistance	0.88	0.47	**0.41**	0.84	0.74	**0.62**	0.82	0.38	**0.30**	0.87	0.89	**0.77**	0.88	0.87	**0.77**
Yellow rust resistance	0.91	0.32	**0.30**	0.86	0.71	**0.60**	0.96	0.36	**0.34**	0.93	0.95	**0.89**	0.92	0.85	**0.79**
Stem rust resistance	0.92	0.33	**0.31**	0.87	0.83	**0.71**	0.94	0.37	**0.34**	0.95	0.93	**0.89**	0.95	0.85	**0.81**
Threshability	0.83	0.32	**0.29**	0.71	0.88	**0.60**	0.68	0.53	**0.37**	0.91	0.89	**0.80**	0.89	0.94	**0.85**
Bread taste/food quality	0.89	0.51	**0.45**	0.84	0.80	**0.65**	0.86	0.55	**0.47**	0.92	0.79	**0.74**	0.88	0.74	**0.66**
Marketability	0.87	0.20	**0.18**	0.90	0.86	**0.75**	0.71	0.56	**0.40**	0.94	0.75	**0.71**	0.94	0.73	**0.69**
Straw yield	0.86	0.64	**0.56**	0.81	0.65	**0.53**	0.78	0.59	**0.48**	0.90	0.91	**0.80**	0.87	0.81	**0.72**
Straw quality	0.87	0.65	**0.57**	0.83	0.68	**0.58**	0.79	0.52	**0.44**	0.92	0.98	**0.90**	0.89	0.90	**0.82**

Note: The weights used to calculate the indices are S (3, 1, -1), D (3, 2, 1) ; DI= Demand Index; SI= Supply Index; AI= Attainment Index

In Ethiopia, earlier studies showed that farmers identified as many as 26 technological and socioeconomic factors for growing a particular modern wheat variety or a local landrace (Bishaw, 2004; Bishaw et al., 2010). However, varietal characters such as grain yield, food quality, marketability, grain color, and grain size appeared to be most important in both durum and bread wheat and across all regions substantiating earlier results in central (Negatu et al., 1992; Negatu and Parikh, 1999), southeastern (Alemayehu et al., 1999) and northwestern (Agidie et al., 2000) Ethiopia.

Table 16. Demand, supply, and attainment indices for disease resistant bread wheat varieties (cont…)

Variety attributes	Local			Mid-highland agro-ecology					
				Kakaba			Pavon-76		
	DI	SI	AI	DI	SI	AI	DI	SI	AI
Grain yield	0.99	0.18	**0.18**	1.00	0.88	**0.88**	0.99	0.86	**0.86**
Grain size	0.96	0.37	**0.36**	0.99	0.86	**0.85**	0.99	0.89	**0.88**
Grain Color	0.84	0.29	**0.26**	0.88	0.86	**0.81**	0.97	0.94	**0.92**
Field establishment and stand	0.80	0.51	**0.42**	0.93	0.88	**0.87**	0.94	0.97	**0.93**
Early Maturity	0.83	0.18	**0.15**	0.97	0.86	**0.84**	0.93	0.94	**0.88**
Drought resistance	0.88	0.47	**0.41**	0.90	0.86	**0.79**	0.93	0.89	**0.83**
Yellow rust resistance	0.91	0.32	**0.30**	0.88	0.74	**0.66**	0.88	0.72	**0.63**
Stem rust resistance	0.92	0.33	**0.31**	0.90	0.74	**0.67**	0.90	0.69	**0.63**
Threshability	0.83	0.32	**0.29**	0.87	0.88	**0.77**	0.92	0.89	**0.81**
Bread taste/food quality	0.89	0.51	**0.45**	0.88	0.86	**0.77**	0.85	0.94	**0.81**
Marketability	0.87	0.20	**0.18**	0.90	0.86	**0.78**	0.96	0.97	**0.94**
Straw yield	0.86	0.64	**0.56**	0.84	0.91	**0.78**	0.89	0.81	**0.71**
Straw quality	0.87	0.65	**0.57**	0.86	0.88	**0.80**	0.93	0.86	**0.80**

Note: The weights used to calculate the indices are S (3, 1, -1), D (3, 2, 1) ; DI= Demand Index; SI= Supply Index; AI= Attainment Index

Bishaw (2004) reported that grain yield, food quality, marketability and grain color were rated as very important attributes by farmers to adopt the new varieties. Kotu et al. (2000) also indicated that farmers identified high yield, resistance to sprouting and lodging, seed color and size, and baking quality as important agronomic characters and their perceptions about some of these characters positively influenced their adoption of modern wheat varieties. Negatu and Parikh (1999) reported the positive effects of farmers' perception of modern varieties on adoption and found that grain yield and marketability were the most important varietal characteristics preferred by wheat growers in central Ethiopia.

Bishaw et al. (2010) reported that HAR1685 (Kubsa) was rated high for grain yield (61%), food quality (51%) and marketability (41%). Similarly, HAR710 (Galema) were rated high for grain yield (62%), food quality (51%) and marketability (62%). HAR1685 and HAR604 were broadly adapted and clearly superior, in terms of grain yield potential, yield stability and seed characteristics (Yalew et al., 1997).

Table 17. Demand, supply, and attainment indices for disease susceptible bread wheat varieties

Variety attributes	Local			Mid-highland agro-ecology									Highland agro-ecology		
				Millennium			Kubsa (HAR-1685)			Tuse			Galema (HAR710)		
	DI	SI	AI	DI	SI	AI	DI	SI	AI	DI	SI	AI	DI	SI	AI
Grain yield	0.99	0.18	**0.18**	0.93	0.47	**0.40**	0.99	0.74	**0.73**	0.99	0.84	**0.83**	0.98	0.59	**0.58**
Grain size	0.96	0.37	**0.36**	0.93	0.38	**0.36**	0.96	0.67	**0.64**	0.98	0.87	**0.84**	0.95	0.69	**0.66**
Grain Color	0.84	0.29	**0.26**	0.64	0.29	**0.20**	0.73	0.85	**0.63**	0.95	0.94	**0.89**	0.77	0.73	**0.60**
Field establishment and crop stand	0.80	0.51	**0.42**	0.64	0.69	**0.45**	0.68	0.87	**0.60**	0.90	0.92	**0.83**	0.73	0.80	**0.61**
Early Maturity	0.83	0.18	**0.15**	0.69	0.51	**0.38**	0.76	0.86	**0.66**	0.89	0.91	**0.82**	0.77	0.69	**0.56**
Drought resistance	0.88	0.47	**0.14**	0.82	0.16	**0.17**	0.85	0.50	**0.44**	0.87	0.88	**0.75**	0.84	0.51	**0.45**
Yellow rust resistance	0.91	0.32	**0.30**	0.87	0.16	**0.13**	0.92	0.30	**0.27**	0.90	0.79	**0.72**	0.92	0.31	**0.27**
Stem rust resistance	0.92	0.33	**0.31**	0.87	0.20	**0.17**	0.91	0.33	**0.29**	0.92	0.80	**0.76**	0.91	0.33	**0.29**
Threshability	0.83	0.32	**0.29**	0.80	0.33	**0.28**	0.77	0.90	**0.69**	0.87	0.89	**0.77**	0.79	0.73	**0.59**
Bread taste/food quality	0.89	0.51	**0.45**	0.84	0.42	**0.36**	0.88	0.83	**0.74**	0.84	0.78	**0.66**	0.90	0.50	**0.63**
Marketability	0.87	0.20	**0.18**	0.87	0.33	**0.30**	0.81	0.86	**0.70**	0.94	0.92	**0.87**	0.85	0.75	**0.66**
Straw yield	0.86	0.64	**0.56**	0.87	0.24	**0.21**	0.83	0.73	**0.64**	0.85	0.90	**0.76**	0.86	0.73	**0.64**
Straw quality	0.87	0.65	**0.57**	0.84	0.33	**0.31**	0.83	0.69	**0.60**	0.87	0.94	**0.82**	0.84	0.68	**0.60**

Note: the weights used to calculate the indices are S (3, 1, -1), D (3, 2, 1); DI= Demand Index; SI= Supply Index; AI= Attainment Index

7 Implications of commercial behaviors and farmers' preferences for wheat seed markets

7.1 Wheat seed demand, supply and distribution

The approach followed in seed demand assessment is highly centralized and is managed by the MoA, which employs a bottom up demand-assessment, whereby the regional BoAs develop annual seed demand statistics with input from woredas, development agents (DAs) and individual farmers about their seed needs. This information is aggregated into woreda, regional, and national demand statistics. The result is a rough estimate of the types and quantities of that seed farmers want to purchase the following year in each region. This target is loosely apportioned to the various producers (i.e., ESE and the RSEs). At the end of the production cycle, the government allocates the available supply proportionally through the cooperatives based on the original demand, without considering shifts in demand due to changes in rainfall pattern or market situation (Lakew and Alemu, 2012; Alemu, 2011). Table 18 presents the amount of seed demanded, supplied and distributed during the last five years. Two issues emerge from these figures: first, most of the certified seed produced is primarily bread wheat; and second, though there is a shortage of supply, there is a carry-over seed every year.

Similarly, the distribution of seed currently happens only through existing institutions, such as cooperatives and farmer unions. Based on the demand planning process, MoA allocates, with the assistance of the National Seed Distribution Committee, the type and quantity of seed to be delivered to regions and the regions make the allocation to different cooperative unions, who in turn provide the seed to the primary cooperatives and farmers (Figure 3).

Table 18. Wheat seed demand and supply trends (tons) during 2007-2012

Year	Demand	Supplied	Distributed	% of bread wheat	carry-over
2012	96,755	76,683	67,366	100	9,317
2011	49,185	59,810	53,923	100	5,887
2010	45,182	23,909	23,726	100	183
2009	48,912	14,053	12,322	100	1,731
2008	55,619	13,678	13,605	99	73
2007	19,683	9,276	9,276	98	0

Source: National Seed Production and Distribution Committee, 2013

This centralized system leaves cooperatives – and farmers – with relatively little flexibility in determining the type of seed they get, the time when they get the seeds or the choice of suppliers. This is the key reason for considerable volume of seed carry-overs every year. This arrangement constrains the meaningful development of the private seed sector.

7.2 Commercial behaviors and their implications on wheat seed demand assessment

Conceptually, the commercial behaviors of farmers reflect the status of commercialization of the agricultural sector at the national level or at a specific location, depending upon the degree of coverage. Commercialization can occur on the output side of production with an increased marketed surplus or it can also occur on the input side with an increased use of purchased inputs (Strasberg et al., 1999; von Braun and Kennedy, 1994). In general, as the agricultural production become commercialized, farmers become more market oriented; engage in substituting non-traded inputs in favor of purchased inputs; and tend to specialize in selected agricultural enterprises including cash crops (Pingali and Rosegrant,1995).

Accordingly, the documented commercial behavior of farmers in wheat seed helps to understand the current status of commercialization in wheat production from the input side perspective. Moreover, it helps to clearly understand the wheat seed market along with the nature of seed demand.

In general, seed demand is highly dependent on (i) crop type (hybrid, cross-pollinated or self-pollinated); (ii) production system (commercial vs subsistence); (iii) agro-ecology (favorable vs marginal environment); (iv) commercial behaviors of farmers/farms (varietal choice and possible demand shift); and (v) total number of farmers and/or farm size (Lakew and Alemu, 2012).

For wheat, a self-pollinated crop, farmers are not expected to buy seed every year. As a rule of thumb, wheat seed can be reused at least for a minimum of four years provided that adequate measures are taken to reduce the varietal admixture and maintain the seed quality. This study found that farmers undertake different management practices on wheat fields and harvested grain intended to be used as seed (Table 6). It was also found that the seed renewal rate was reported to be slightly less than three years for 53% of the farmers who reported seed renewal (Table 10), which is within the range of the recommended renewal rate. Furthermore, the result indicated that 47% of the farmers do not regularly renew their seed. Among farmers who renew wheat seed, about 40% of the farmers renew after 2-3 years; and only 2% renew after five or more years. This implies that there are close to 50% of the farmers (47% farmers who renew less regularly and the 2% who renew after five years) who may seem to use seed of inadequate quality.

The overall commercial behavior of wheat farmers presents important implication for seed demand. It was found that 25% of wheat producers are in autarkic market position every year (not buying and selling), 26% in selling position and 49% in buying position. Thus, the formal seed sector can target collectively 64% of wheat producers, i.e., about 49% who are in the buying position and part of those who are in net selling (14%) and part of those who are in equally buying and selling (1%) positions. The target for the formal sector can, of course, vary from year to year depending upon the changes in demand factors. These factors include weather condition, disease incidence and market conditions, mainly price incentives and farmers' awareness about new varieties and the importance of quality seed. The estimates are based on a one year representative national survey in the major wheat producing regions and it is expected that the results will indicate an average national commercial behavior of wheat producers in wheat seed.

The limited consideration of wheat farmers' commercial behavior in seed along with the associated challenges of the seed system has resulted in considerable amount of carry-over of certified wheat seed every year.

In 2011/12, for instance, considering the volume of certified seed supplied in the country, the CSA data of wheat area and the number of farmers engaged in wheat production, the average landholding of half hectare and wheat seed rate of 100 kg ha-1, the total certified seed produced (67,366 ton) could reach close to 1.35 million smallholders of the total 4.3 million wheat farmers. However, the estimates indicate that the total number of farmers that used certified seed were 1.16 million (CSA, 2012). This has resulted in an estimated leftover of certified seed of 9,200 tons (vs official figures of 7,800 tons).

The amount of carry-over seed was slightly lower compared to the estimate made based on our survey, because the official figures were based only on the amount of seed that was in the hands of cooperatives.

7.3 Farmers' preferences and formal wheat seed supply

Theoretically, farmers' varietal preference as an indicator of demand is expected to be reflected in the volume of seed supplied by the formal sector. According to the survey results, 20 local and 10 improved bread wheat varieties were grown by farmers across four major wheat production regions. The Ethiopian formal seed sector is largely dominated by a few varieties of wheat and maize. In 2010, wheat accounted for nearly 64% formal seed supply; and most importantly few wheat (e.g., Kubsa now succumbed to yellow rust) varieties occupy the major share of the seed supply (Bishaw and Louwaars, 2012).

During the last five years, on average 42,454 tons of certified seed of 10 improved bread wheat varieties on the recommended list were produced and supplied by the formal sector every year. Meanwhile, the wheat seed supply has increased from 20,201 tons in 2008/09 to 64,844 tons in 2012/13, an increase of over three-fold. The analysis, however, shows that the top five wheat varieties contributed about 90% of the total bread wheat seed supply.

Specifically, the contributions of Kubsa (HAR1685), Digelu, Pavon76, Galema, and Kakaba were 44%, 13%, 12%, 12%, and 9%, respectively. Kubsa appeared to dominate all varieties occupying on average about 44% of the total bread wheat seed supply, following the outbreak of rust in 2010 though reduced in volume, its supply is the highest among other varieties. The absence of yellow rust outbreak and farmers' preferences due to its high yield led Kubsa to dominate the wheat seed supply landscape, although the variety from the outset was not yellow rust resistant. The continued increase in the amount of certified seed available from the formal sector brought the challenge of seed demand and supply to the forefront, particularly in terms of varietal choices. The situation was exacerbated with the outbreak of yellow rust in 2010 crop season where replacement varieties for Kubsa were urgently demanded.

Table 19 presents farmers' preferences for the main variety attributes, i.e., grain yield and yellow rust and drought resistance along with the trends in formal seed supply of bread wheat varieties. Except for Madda Walabu, Kubsa and Galema varieties, the farmers' preferences seem to be matched with the volume of seed supplied by the formal sector. Analysis of the table reveals many interesting observations regarding varietal mix and seed production of resistant (or susceptible) varieties. In recent past, yellow rust susceptible varieties appeared to dominate the formal wheat seed supply occupying 72%-92% until 2010/11 crop season.Kubsa appeared to dominate the seed supply landscape with an average of 49% over the five year period, but it gradually declined from 77% in 2008/09 to 55% in 2010/11 to 26% in 2012/13 crop season. Galema maintained an average of 13% and never passed the 20% mark during the five years.

The certified seed production of rust resistant varieties reached to 70% in 2012/13 crop season. Among these Digelu and Pavon had high AI for grain yield, rust resistance and drought but maintained a low average of about 11%-12% over the five year period, although Digelu continued to increase from 1.1% to 18% during the five year period. Danda'a and Kakaba are two newly released varieties. They primarily have stem rust resistance and also the combined advantage of resistance to yellow rust and are expected to replace Kubsa and Galema, respectively. In 2012/13, they collectively occupied 42% of the certified seed supply, i.e., 19% for Danda'a and 23% Kakaba. Both varieties appeared to have comparable AI for grain yield among the resistant varieties, even though they rated low for yellow rust resistance.

This requires some precaution in the future. Although these varieties are promoted for stem rust and have been released recently, the dramatic increase in seed availability shows the quick turnaround of the formal sector responding to new threats of diseases, as a result of the external support for accelerated seed multiplication. On the other hand, Mada Walabu was rated equally well for grain yield, yellow rust resistance and drought tolerance. However, availability of seed from the formal sector appears to be non-existent, clearly demonstrating limited varietal choices for farmers.

In terms of the volume of seed supplied, Kubsa continues to dominate even after the yellow rust epidemic, though farmers' preference for it in terms of grain yield and resistance to yellow rust and drought is lower than that of the other improved varieties. The reasons for continuous supply of seed of varieties which do not meet farmers' demands are manifold. Hence there is a problem of carry-over seed. First, the formal sector has a limited capacity to respond to the emerging biotic stresses, like new threats, and shift immediately to new varieties. There is a time lag between release and availability of breeder or basic seed to initiate large-scale seed production and marketing by public or private seed enterprises.

Most NARS have limited physical, financial and human resources for accelerated early generation seed multiplication. Second, there is a lack of clear responsibility about who should invest in the initial promotion of the new varieties that can meet the farmers' choices to create awareness and demand for seed guiding the seed production plan. Moreover, there is insufficient communication and consultation with extension services and seed suppliers. Third, for over a decade, Kubsa was the most popular variety with farmers because of its high yield, although it succumbed to yellow rust disease in 2010. It is still popular with the farmers in the absence of yellow rust epidemics.

Fourth, given the predominance of informal sector, farmers may continue to cultivate Kubsa in the absence of yellow rust problems. Alternative choices should be made available if the formal sector continues to produce and distribute seed of these varieties.

The analysis of the farmers' preferences and the formal sector seed supply can be summarized as follows:

- The formal sector was not able to provide wheat certified seed that commensurate with the farmers' varietal choices. For example, Madda Walabu was rated high for its key attributes preferred by farmers where seed production is negligible or non-existent;
- There is a fluctuation in the amount of seed produced for each variety. For example, the amount of seed of Pavon76 was not consistent in different years although the variety rated reasonably high AI for grain yield, rust resistance and drought.

- The formal sector continues to produce certified seed of wheat varieties which are already susceptible to rusts and do not met farmers' varietal demands. Kubsa continues to dominate as a single variety in terms of seed supply even after the variety
- was clearly found susceptible to yellow rust for at least three years.
  The observed mismatch of farmers' preferences and the formal sector supply is highly associated with the limited incentives for formal sector seed suppliers to invest in variety promotions and the challenge of free rider.

Table 19. Bread wheat varieties and seed supply (tons) by the formal sector (2008-2013)

Disease resistance	Variety	Year released	Farmers' preference (attainment index)			Production seasons				
			Grain yield	Yellow rust resistance	Drought resistace	2012/13	2011/12	2010/11	2009/10	2008/09
Resistant	Danda'a	2010	0.91	0.60	0.62	1,236.3	225.2	0	0	0
	Kakaba	2010	0.88	0.66	0.79	1,465.4	337.0	24.5	0	0
	Digelu	2005	0.91	0.79	0.77	1,174	917.3	561.6	115.1	22.6
	Madda Walabu	2000	0.89	0.89	0.77	0	1.96	115.5	45.8	15.1
	Pavon-76	1982	0.86	0.63	0.83	703.4	521.3	832.3	441.6	114.7
	ET-13A2	1981	0.35	0.34	0.30	0	5.79	3.45	0	0
	Sub-total					4,579	2,008.6	1,537.4	602.4	152.3
Susceptible	Millenium	2007	0.40	0.13	0.17	0	0	24.4	40.6	17.3
	Tuse	1997	0.83	0.72	0.44	83.2	121.4	149.6	60.4	46.7
	Galema	1995	0.58	0.27	0.75	129.8	750.3	806.3	544.7	246.2
	Kubsa (HAR-1685)	1995	0.73	0.27	0.45	1,692.4	947.2	3,140.7	1,988.5	1,557.6
	Sub-total					1,905.4	1,818.9	4,121.0	2,634.1	1,867.8
Total						**6,484.4**	**3,827.5**	**5,658.5**	**3,236.6**	**2,020.1**

Source: National Seed Production and Distribution Committee, 2013

8 Conclusion

In Ethiopia, to date, from policy makers to local administrators, from federal governmental institutions to 'Woreda' Bureaus of Agriculture, from national to international NGOs and donors, all are preoccupied with seed issues. There is a strong zeal and overdrive with great emphasis on supply side, and little concern for the demand side. There is a limited understanding about the commercial behavior of farmers about inputs in general and seed in particular. And also, there is very limited consideration about farmers' preferences for the different wheat varieties available. The findings show that 97.5% of the wheat farmers are engaged in bread wheat production and the rest produce durum wheat. Thus, the assessments made about the commercial behavior of farmers and varietal preferences were mainly related with bread wheat seed in the country.

Farmers grow improved and local bread and durum varieties and source their seed from formal and/or informal sources. The majority of farmers grow improved varieties (69%) showing high level adoption among farming communities. However, the informal sector remains a default supplier of wheat seed, where the majority of farmers use own saved seed which is recycled or purchased off-farm using local social networks. The proportion of farmers who use seed through local purchase is almost twice the size of farmers who purchase seed from the formal sector, which is only 16%. This shows the dynamics of local seed markets. Understanding the commercial behavior of small-scale farmers on wheat seed is critical in demand and supply of certified seed.

A considerable number of wheat producers are engaged both in selling and buying of wheat seed, while about a quarter of them have an autarkic market position, who do not buy or sell wheat seed. Almost half of wheat producers have a buying position, which shows the potential for wheat seed market. Moreover, the study implies that farmers with selling and buying AMP change seed more frequently. Interestingly, the wheat producer farmers who purchase seed from informal sources (32%) and formal sources (16%) and those who are in buying market positions (50%) are in matching numbers (meaning that those in buying position source from informal and formal sources), considering the commercial behavior and seed demand or seed source.

In terms of farmers' practice of seed and/or variety renewal, about 53% of the farmers reported renewing their seed stock regularly, of which 22% are in wheat seed selling, 16% in buying and the rest 15% in autarkic market position. On average, farmers renew their seed stock every 2.67 years (those who renew) with significant difference among farmers in different market positions, where it was every 3.06 years for autarkic, every 2.53 years for selling, and every 2.5 years for farmers in buying market position.

The wheat seed commercial orientation of farmers indicates that on average the formal seed sector can target the wheat producers who are in the buying position and part of those who are in net selling and part of those who are in equally buying and selling position, targeting collectively 64% of wheat farmers. The limited consideration of wheat farmers' commercial behavior in seed and the associated challenges of the wheat seed sector have resulted in considerable amount of leftover certified wheat seed every year. For instance, there was 7,800 tons of certified wheat seed leftover in 2011/12 production season.

The key determinants of each of the commercial behavior in wheat seed were related with wheat production characteristics mainly land allocated for wheat production, resources owned in terms of land size in rainfed and irrigated areas and livestock, access to credit, and wheat yield level achieved. In general, the result indicates that on average an increase in resource allocation to wheat production results in higher probability of wheat producers to be specialized as local wheat seed sellers. This clearly implies the increased competition among actors of the formal wheat seed sector and the more specialized wheat seed producers at farm or local level.

To date, while public research through regional agricultural research institutes, and certified seed production through public enterprises and quality assurance through seed inspection laboratory appear decentralized, certified seed production planning (for public sector) and marketing through cooperatives (excluding pilot direct marketing) is centralized. This critically influences the wheat seed demand assessment at a national level. Specifically, the following issues require due attention:

1) The current state practice of centralized seed production planning based on cultivable land with highly inflated potential demand does not reflect a truly effective seed demand in the country. A market-based seed demand and supply taking into account the commercial behavior in wheat seed is critical to meet the growing demand and supply of the wheat seed sector in particular, and seed sector in general, in Ethiopia;

2) The revealed commercial behaviors' in wheat seed indicates the current and future important role of informal seed supplied by the farmers. Thus, it will be mandatory to strengthen and support farmers in informal or community-based seed production and marketing, especially those farmers with better resource ownership to meet the growing national seed demand as the national policy supports this endeavour;

3) Considering the need to promote available bread wheat varieties to the different agro-ecologies and to reduce the gap between the national and potential productivity levels, to reduce the amount of certified seed leftovers every year, and for overall improvement of the wheat seed sector performance, the public seed enterprises' engagement needs to be market driven (demand assessment, production and marketing) in tandem with expected public role;

4) Even though, the use of improved bread wheat variety is relatively high, the majority of farmers use own saved seed or locally purchased seed of improved varieties; and only 16% used certified seed from formal sources. This is still below the desired level of 25% seed replacement for strictly self-pollinated crops such as wheat. In addition, most wheat farmers do not renew wheat seed and/or variety regularly. This implies the need for enhanced popularization of new improved varieties and awareness creation for seed demand through better extension services and strengthened formal and informal seed sectors.

Recognizing the importance of farmers' subjective preferences and the perceptions of the attributes of the varieties for effective seed demand, an assessment was made to understand how farmers' preferences for important attributes are embodied in the different bread wheat varieties currently under commercial seed production. The results indicate that (i) yield, resistance to yellow and stem rust, and drought tolerance are attributes that are preferred most compared to other attributes; (ii) a high value of supply indices is preferred by farmers and it is more supplied by improved varieties than the local landraces; (iii) a high value of attainment indices for the improved varieties shows that the demanded characteristics are embodied more in the improved ones compared to local varieties; (iv) there is high variability in the attainment indices among improved varieties for the different attributes, which suggests the need to target varieties for different circumstances including disease and drought incidence. This also implies that wheat breeders need to further fine tune the varieties to improve less attained attributes.

The value of the attainment indices compared with the volume of seed supplied by the formal seed sector is not consistent resulting in mismatch in demand and supply and considerable carryover of seed. For effective matching of demand and supply of seed, farmers' preferences, as an important indicator of demand, need to be aligned with the supply of seed for each variety. The results indicate two important issues.

The first issue is the supply of seed varieties which does not meet farmers' demand, hence the problem of carry-over seed. This implies the problem of the formal sector to shift immediately to new varieties (time lag between release and availability of seed), which is highly associated with the lack of responsibility who should invest in the initial promotion of new varieties. The second issue is the limited capacity of responsiveness of the formal sector to emerging biotic and abiotic stresses. For instance, although Kubsa was the most popular variety because of high yield, it succumbed to yellow rust disease in 2010. However, it still continues to dominate wheat seed production in the country.

Despite a long list of released wheat varieties, just a few of them have entered large-scale commercial seed production and were made available to the farmers. The prominence of Kubsa as a mega variety showed the vulnerability of wheat production in the country and its exposure to eminent danger of emerging threats like rust epidemics. The existing federal and regional research systems should be able to address the diverse local needs to meet farmers' preferences and varietal choices. With the establishment of regional seed enterprises, there will be more scope to manage these more specific varieties. An alternative strategy also lies in setting up informal mechanisms to deliver these locally adapted varieties.

Ethiopia's diverse agro-ecology is one of the fundamental challenges faced by breeders in developing 'niche' varieties. In principle, this would require a very extensive and costly testing system to identify a large number of 'pocket varieties' which is very difficult for the formal seed sector to provide a regular supply of certified seed. The results indicate that any single variety does not have the best traits for all production areas. Therefore, for effective consideration of farmers' preferences, the formal sector needs to consider diversification of the supply of seeds of different bread wheat varieties and also improve its capacity to be responsive to emerging challenges. These measures are highly associated with the prices suggesting the need to liberalize the seed pricing system for adequate compensation for diversification and responsiveness in seed supply.

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