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Performance of Direct Seed Marketing Pilot Program in Ethiopia

Lessons for Scaling-up

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ACRONYMS

ATA	Ethiopian Agricultural Transformation Agency
BoA	Bureau of Agriculture (regional-level)
CSM	Conventional seed marketing
DA	Development Agent (farmer-level agricultural extension agent)
DSM	Direct seed marketing
DUS	Distinctiveness, uniformity, and stability (test of new crop variety)
ESE	Ethiopian Seed Enterprise
FCU	Farmers’ cooperative union
FPC	Farmers’ primary cooperative
IFPRI	International Food Policy Research Institute
KPI	Key performance indicator
MoA	Ministry of Agriculture (federal-level)
SNNP	Southern Nations, Nationalities, and Peoples (region)
SPFPC	seed producer farmers’ primary cooperative
SPFPCU	seed producer farmers’ primary cooperative union
VCU	Value in cultivation and use (test of new crop variety)
WoA	Woreda office of Agriculture (woreda-level)

ABSTRACT

This study evaluates the impact in the main cropping season of 2015 of a new approach to the distribution of improved seed in Ethiopia, known as Direct Seed Marketing (DSM). Under DSM, seed producers are allowed to sell seed directly to farmers, in contrast to the conventional seed marketing (CSM) system in which seed passes from seed producers to regional Bureaus of Agriculture to woreda Agricultural Offices to Development Agents, cooperative unions, and primary cooperatives, who, in turn, sell the seed to farmers. The study is based on a survey of 800 farmers, 118 agricultural extension workers, 75 seed sellers, and 24 seed producers in Amhara, Oromia, Southern Nations, Nationalities, and Peoples (SNNP), and Tigray regions. The performance of the DSM program in 2015 was evaluated on eight criteria: seed availability, sufficiency of supply, timeliness of delivery, seed pricing, quality, ensuring accountability for low-quality seed, ease of purchase, and use of public resources.

The results indicate that DSM had heterogeneous effects across the different regions, showing the need to strengthen the sharing of experiences with the program across the regions of Ethiopia to scale up DSM’s benefits. However, when we consider the overall DSM program without regional disaggregation, the DSM and CSM systems do not differ significantly on most of the eight criteria, although DSM required significantly less of the time of the farmer-level agricultural extension agents, the Development Agents. DSM performed as well as CSM across the eight criteria examined, while requiring 39 percent less time for the involvement the Development Agents. Farmers’ subjective views of DSM were quite positive. On most criteria, 50 to 65 percent of farmers said DSM performed “better” or “much better” than CSM. The study also identifies specific areas where the performance of DSM needs to be improved. A review of international experience with seed systems is used to provide some additional recommendations regarding the longer-term development of seed systems in Ethiopia.

1. INTRODUCTION

1.1. Background

Crop production is a key subsector in agriculture in Ethiopia, accounting for 69 percent of agricultural production and more than 30 percent of the national gross domestic product (EEA 2013). However, the subsector is still characterized by low productivity due to low adoption of improved crop technologies (Dorosh and Rashid 2012; MoA and ATA 2014). One of the most important bottlenecks of crop agriculture is the low use of improved seed, defined as first-generation varietally-pure seed produced by a seed company or the government (Alemu 2010; Alemu et al. 2010; Spielman et al. 2012; MoA and ATA 2014). Most of the seed used by farmers is either grain saved from the previous harvest or grain purchased from other farmers or traders for use as seed. Such seed may be descended from improved varieties, but not being first-generation certified seed, it has lost some of its yield potential and other attributes.

Table 1.1 presents the percentage of farmers who used improved seeds for the major cereal crops grown in Ethiopia between 2010 and 2015. Despite slight improvements over time, only one-fifth of smallholder farmers used improved seeds for cereal crops. Maize growers are the most intensive users of improved seed, as a quarter of all maize farmers used some type of improved maize varieties.

Table 1.1. Share of farmers who used improved cereal seed in Ethiopia, 2010-2015

Crops	2010/11	2011/12	2012/13	2013/14	2014/15	Average
All cereals	14.7	18.4	18.3	21.5	24.1	19.5
Teff	1.7	2.4	2.1	4.6	3.5	2.9
Barley	0.6	0.8	0.6	0.8	0.8	0.7
Wheat	7.4	9.9	5.6	7.7	9.2	7.9
Maize	18.8	21.7	23.4	27.6	32	24.7
Sorghum	0.1	0.2	0.1	0.4	0.3	0.2

Source: Authors' computations based on annual Agricultural Sample Survey reports of the Central Statistical Authority of Ethiopia.

The proportion of cultivated area planted to improved seed has also been remained low over this period, although a slight improvement has been observed for wheat and maize (Table 1.2). Overall, these results are similar to those for improved seed use. For barley and teff, the change has been mixed, with teff increasing, albeit from a very low base, and barley showing a slight decrease. The increase in the share of the area of maize planted to improved seed was, on average, four times larger than the increase in the area of wheat planted to improved seed, the crop with next largest increase in the share of crop area planted with improved seed. Despite their importance as food and income sources, the area of teff and barley planted with improved seeds remains insignificant.

Table 1.2. Share of cereal area planted with improved seeds in Ethiopia, 2010-2015, percent

Crops	2010/11	2011/12	2012/13	2013/14	2014/15	Average
All cereals	7.3	8.5	8.3	10.1	11.7	9.2
Teff	1.4	1.8	1.4	3.1	2.5	2.1
Barley	0.0	1.0	0.9	0.6	0.6	0.8
Wheat	6.2	8.4	4.3	5.6	7.4	6.3
Maize	28.1	30.6	33.5	40.0	46.4	35.8
Sorghum	0.0	0.2	0.0	0.2	0.1	0.1

Source: Authors' computations based on annual Agricultural Sample Survey reports of the Central Statistical Authority of Ethiopia.

According to the 2012 farm survey carried out by the International Food Policy Research Institute (IFPRI) for the Ethiopian Agricultural Transformation Agency (ATA), the 2012 ATA Baseline Survey, the percentage of growers using purchased seed was just 24 percent for white teff, 28 percent for wheat, 41 percent for maize, and 38 percent for haricot beans. However, it is important to note that most of these purchases were from other farmers and from traders, implying that many farmers likely were buying ordinary grain to use as seed. The share of purchased seed that was bought from a cooperative or Bureau of Agriculture (BoA) was 34 percent for white teff, 38 percent for wheat, 58 percent for maize, and 15 percent for haricot beans. We can estimate the share of farmers using certified seed by multiplying the percentage of farmers purchasing seed by the percentage of those that purchased seed that obtained the seed from a cooperative or BoA. These calculations indicate that the share of farmers using certified seed was 8 percent for white teff, 11 percent for wheat, 24 percent for maize, and 6 percent for beans (Minot and Sawyer 2013).

The very low improved seed use in Ethiopia can be attributed to different supply and demand side constraints. From the supply side, non-availability or late supply, insufficiency, poor quality, and pricing problems have been observed with improved seed. Absence of improved varieties for diverse crop commodities has been associated with limited public and private investment in improved seed researcher and development. There also has been seed supply shortages for existing varieties due to insufficient certified seed production, which resulted in pre-basic and basic seed supply shortages from the national agricultural research system. In addition, poor weather conditions, as seed production is done almost exclusively under rainfed conditions, and a poor seed demand forecast system have also caused seed supply shortages. Among the physical seed quality problems, insect pest attack, misshapen or irregular colored seed, poor seed germination rates, and adulteration with foreign matter are observed. In addition, farmers also report manifestations of seed quality problem at emergence (e.g. poor seed germination), at flowering stage (e.g. mixed tassel colors in the case of hybrid maize), and during harvest (e.g. mixed grain color). Due to poor planning and logistical reasons, the late supply of seeds after the ideal planting time has also hindered increased use of improved seed. Moreover, high seed prices are also considered to be one of the determinant constraints on improved seed adoption by farmers.

From the demand side, limited awareness of farmers on the characteristics of improved varieties; low income; poor access to agricultural input credit, including for the purchase of improved seeds; and shifts in the preferred characteristics of improved seed demanded by farmers due to changes in weather conditions constrain demand for improved seed (Alemu 2010; Alemu et al. 2010; Spielman et al. 2013).

To address some of these demand and supply side constraints, the Ethiopian seed system heavily relies on public resources for improved seed development, multiplication, distribution, promotion, and marketing. These public investments are costly to government, particularly at local level, with the woreda administration needing to divert part of their budget into payments for seed procurement and transport costs, and local agricultural extension agents spending time in managing locally the distribution of improved seed. In addition, foregoing actively engaging the private sector in the seed business results in missed opportunities for local input market strengthening. As a result, the non-availability of seed, insufficient supplies of seed when available, late provision of seed for planting, price competitiveness, and related problems have been common within the country's seed system (MoA and ATA 2014; MoA and ATA 2015).

In order to address some of the systemic issues within the seed sector, the government of Ethiopia, together with its development partners, introduced a pilot program of Direct Seed Marketing (DSM) in Amhara region in 2011 (Benson et al. 2014; Astatkie et al. 2012). DSM is designed as a mechanism through which both public and private seed producers directly supply adequate amounts of quality seed to farmers in convenient places and in a timely fashion, selling the seed to the farmers directly at competitive prices. The goal is to ensure increased access and use of improved seed of high quality by smallholder crop producers (MoA and ATA 2014). As an alternative seed marketing strategy, DSM aims to contribute to a dynamic, effective, efficient, and well-regulated seed sector that enables growers to have timely access to varied, sufficient, affordable, and high-quality certified seeds at competitive prices (Benson et al. 2014).

As a pilot program, the performance of DSM has been jointly followed up, monitored, and evaluated by the Ethiopian Ministry of Agriculture (MoA), the ATA, regional Bureaus of Agriculture (BoA) in the pilot areas, the Integrated Seed Sector Development (ISSD) program, and other federal and regional stakeholders in the seed sector (Astatkie et al. 2012; Getahun et al. 2014; Nefo et al. 2014; Astatkie et al. 2015; Haileselassie et al. 2015; MoA and ATA 2015). However, the data and information obtained under the pilot program were site specific, which makes it difficult to generate national level information. In addition, data were collected from small samples that makes it difficult to generalize, and the reports generated were meant mostly for internal communications. Responding to the request of ATA, IFPRI performed an operational evaluation of this pilot program in 2013 (Benson et al. 2013). In 2015, ATA requested IFPRI to do an updated study based on DSM's performance and assess the progress made by DSM since its inception based on specific key performance indicators (KPIs): seed availability, quality, sufficiency, price competitiveness, supply timeliness, and suppliers' accountability.

However, the DSM program needs to be put in the context of an on-going series of interventions designed to improve and modernize the Ethiopian seed sector. Additional policy reforms will be needed to address problems such as the slow rate of development of new seed varieties for farmers, the chronic under-supply of improved seed, and the challenge of making improved seed affordable and more accessible to small scale farmers throughout the country. Some guidance in this process is available from the experiences of other countries, particularly those developing countries that have been able to facilitate the development of a dynamic, efficient, and inclusive seed sector.

1.2. Objectives

This study has two overall objectives. The first is to evaluate the performance of the DSM pilot program interventions in 2015. The experiences with DSM of farmers, agricultural extension agents, and other stakeholders will be compared to those involved with the conventional seed marketing (CSM) system based on the following performance indicators: seed availability, quality, sufficiency, price competitiveness, timeliness, and accountability. In addition, the study aims to assess the progress DSM has made since its inception across the same indicators. This evaluation is to generate recommendations for improving the effectiveness of DSM in the short term.

The second objective of the study is to examine the experiences of other countries in promoting the growth and development of their seed sectors. Although every country has a unique set of historical, political, and institutional characteristics, all countries face similar challenges in developing new seed varieties to match farmer needs, multiplying the seed to commercial scale, and distributing the seed to farmers in a cost-effective manner. This international experience should shed light on best practices for seed policy and seed program development, with implications for the medium- to long-term efforts to modernize the Ethiopian seed system.

1.3. Outline of the report

Section 2 presents some background information about the DSM program. Section 3 describes the data and methods used in the study. Section 4 provides the results of the evaluation of the DSM system in comparison with the CSM system. Section 5 uses the international experience of seed systems along with the economic characteristics of seed as a commodity to identify international best practices for improving the seed sector. Section 6 summarizes the major findings of the DSM study, highlights recommendations for improving DSM in the short term, and summarizes the implications of the review of international best practices for seed policy and seed program development in Ethiopia in the medium to long term.

2. THE DIRECT SEED MARKETING PILOT PROGRAM IN ETHIOPIA

2.1. Rationale

In the formal grain crops[1] seed system of Ethiopia, the highest share of varietal development and certified seed production has been undertaken by government organizations. The federal and regional level public research institutions, the Ethiopia Institute for Agricultural Research, the Amhara Agricultural Research Institute, the Oromia Agricultural Research Institute, the Southern Agricultural Research Institute, and the Tigray Agricultural Research Institute, play a leading role in crop varieties development and breeder and pre-basic seed production in the country. While significant contributions from the national agricultural universities and global research partners from the CGIAR system have been made to varietal development and certified seed production, the role of both the domestic and the international private sector has been negligible in this regard. In 2011, the total agricultural research investment of the country was estimated to be USD 87.2 million. Of which, 80 percent was provided by the Ethiopian government with the remaining by foreign donors (Beintema et al. 2014). The public seed enterprises are responsible for the greatest share of basic seed production and certified seed multiplication in the country. These enterprises include the Ethiopia Seed Enterprise, Amhara Seed Enterprise, Oromia Seed Enterprise, and Southern Seed Enterprise. Although private seed firms are involved in certified seed production, they only cover about 10 percent of the total seed supply, producing mainly hybrid maize seed. The largest private seed company is Pioneer Hi-Bred plc, which primarily produces hybrid maize seed (Alemu 2010; Alemu et al. 2010; Benson et al. 2014).

Formal grain crops seed marketing in Ethiopia also is primarily practiced by public agencies. It is up to the public research institutions to demonstrate newly released crop varieties using small-scale test plot. MoA and its line offices in the regional states popularize these varieties on a larger scale to farmers through the public agricultural extension system (Spielman et al. 2012). The other seed marketing activity that requires public resources is seed demand assessment (Lakew and Alemu 2012; Spielman and Mekonnen. 2013; Benson et al. 2014). Local level seed demand is assessed by kebele-level agricultural extension workers (AEW) in collaboration with kebele administrative officials. Kebele-level seed demand is aggregated and reported to the woreda office of agriculture (WoA), which in turn verifies the seed demands, compiles the assessment, and reports to the zone department of agriculture. The zone department of agriculture also verifies, compiles, and reports to the regional Bureau of Agriculture (BoA). Finally, the BoA verifies, compiles, and reports these aggregated projections to MoA. Based on the forecasted demand and the government's plan, MoA and the BoAs allocate the projected quantity of seed to be produced for procurement from both public and private seed companies.

The allocation and distribution of the seed procured also involves significant investment of public resources. At the federal level, seed is allocated to the different regions by a committee formed from the input marketing directorate of the MoA, various seed enterprises, and the Ethiopia Institute for Agricultural Research. Seed allocation is based on both demand and seed availability. Seed distribution into different regions is facilitated by the input marketing department of the MoA and its line offices in the regions, zones, and woredas. These government offices assign their input supply experts to facilitate seed transportation, storage, and distribution from central warehouses to local level distribution sites. In addition, the WoAs provide financial grants from their budget to seed producers for advance seed purchase until seed fees are collected from woreda farmers. More importantly, the kebele-level AEW are intensively involved in facilitating local level seed distribution and fee collections. Although farmers' primary cooperatives (FPC) and farmers' cooperative unions (FCU) are the primary actors for selling seed, the woreda and kebele-level AEWs are also involved in seed selling depending on the location of the seed

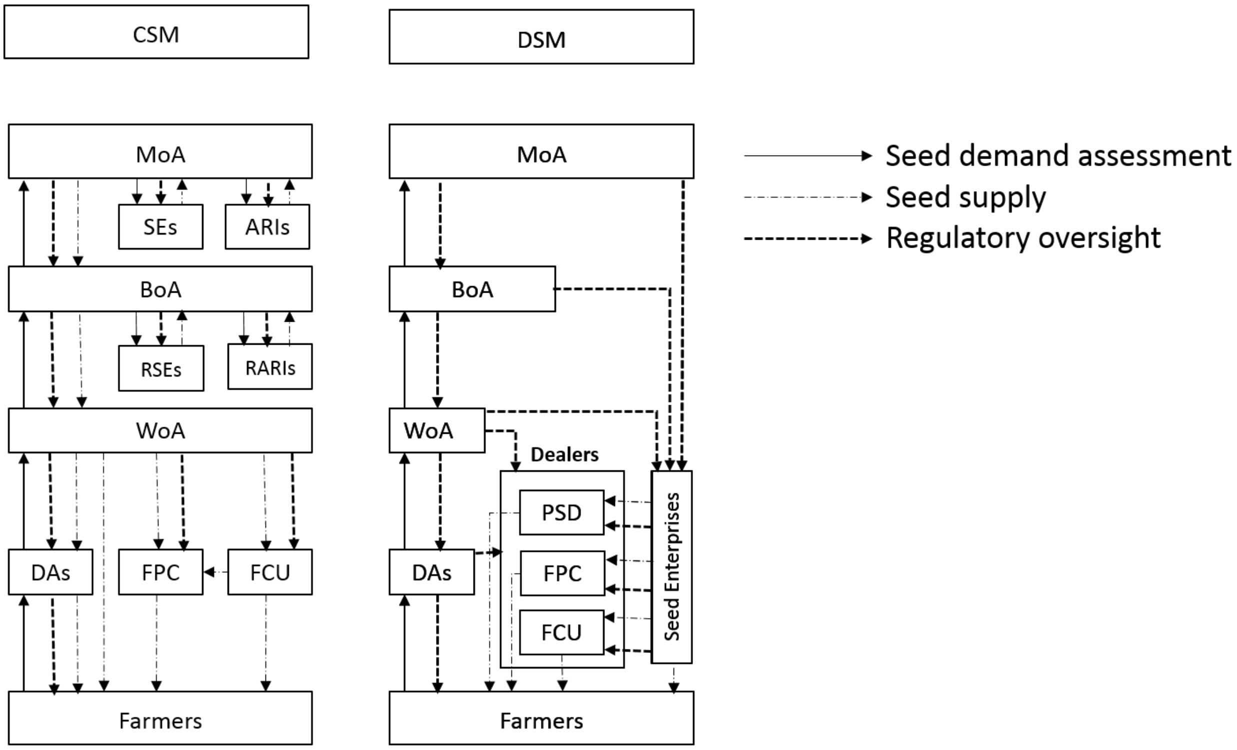
[1] Grain crops refers to cereals, pulses and oilseeds. These crops accounted for 88 percent of the total cultivated area and 75 percent of total crop production in the main production season of 2015.

transaction. We define this public resource-based seed development, production, and marketing system as the conventional seed marketing (CSM) system. CSM is the principal seed delivery system and accounts for the distribution of more than 80 percent of improved seed in the country.

While CSM is the primary seed delivery system, it lacks elements of market competition that reduces its overall efficiency. For example, the producers whose seed is distributed through government agricultural agencies and cooperatives engage in very little marketing. The government essentially creates their market for them via the demand estimates beginning at the kebele-level by AEWs. There is little, if any, competition between the seed producers to gain market share, except possibly concerning access to information on pending government contracts for the supply of seed. The CSM system also is time consuming, with it generally taking between four to six months from the start of the demand assessment exercise until seed is actually delivered to farmers. Moreover, the CSM systems does not provide seed producers with a strong incentive to supply seed with the traits required by farmers.

These and other problems, including around seed quality, have prompted MoA and ATA to explore innovative mechanisms for improving seed distribution – most notably, the DSM system (MoA and ATA 2014). In DSM, both public and private seed companies are assumed to do their own seed demand assessment. In addition, they are to directly supply adequate quality seed demanded by farmers in convenient locations at competitive prices using either their own sales staff or hiring private agents, including FPCs and FCUs.

Figure 2.1. Seed demand assessment and supply flow through the Conventional Seed Marketing and Direct Seed Marketing systems in Ethiopia



Source: Authors
CSM = conventional seed marketing; DSM = direct seed marketing; MoA = Ministry of Agriculture (national level); SE = seed enterprises; ARI = agricultural research institutes; BoA = Bureau of Agriculture (region level); RSE = regional seed enterprises (regional government); RARI = regional agricultural research institutes; WoA = Woreda Office of Agriculture; DA = Development Agent (farm-level agricultural extension agent); FPC = farmers' primary cooperative; FCU = farmers' cooperative union; PSD = private seed dealer.

The seed demand, supply, and distribution process in both the CSM and DSM system is depicted in Figure 2.1. The left side of the diagram shows the design of the CSM system, while the DSM system is depicted on the right side of the diagram. Even though both CSM and DSM rely on the agricultural structure of government for the demand estimation, DSM has considerably shortened the seed distribution chain by letting seed producers directly sell their seed to the farmers. In consequence, under DSM seed producers are accountable to farmers for the quality of their seed. Increased traceability of the seed and accountability for seed quality are the main features of DSM that are expected to increase farmers' trust in private seed suppliers. DSM is also designed to motivate producers to promote their seed and to compete with other producers on the basis of seed quality. The private seed firms must provide information to farmers to increase their market share and build more sustainable seed businesses. This, in turn, is designed to be an incentive for the seed producers to invest in seed quality improvement.

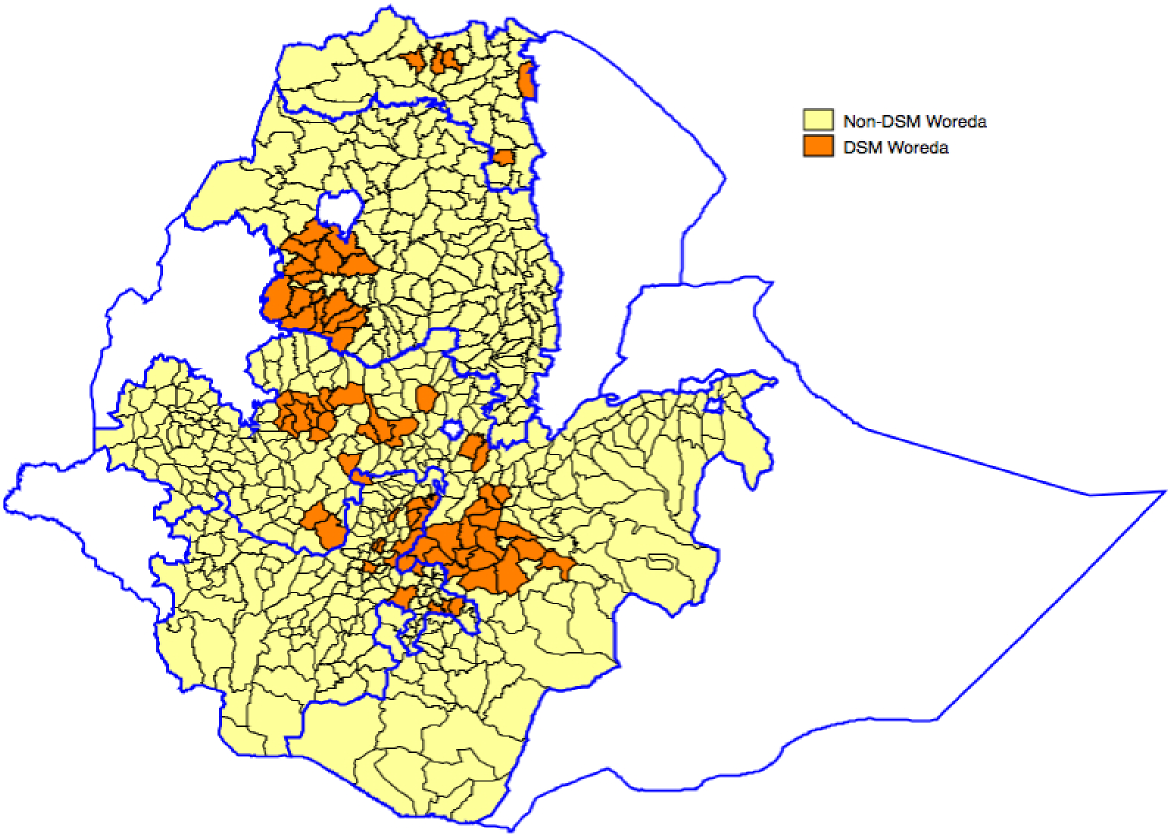
Moreover, DSM should save the time and resources of development agents and experts at different levels of government who have been engaged with the conventional seed distribution marketing system. This has at least three implications. First, with government agencies no longer quite so responsible for supplying seed to farmers, development agents and experts can concentrate on their main responsibilities—extension and advisory services. Secondly, farmers will no longer hold government extension agents at either the kebele or woreda levels accountable for poor quality seeds. Under DSM, the producers themselves, either through private agro-dealers or primary agricultural cooperatives, will be responsible for seed quality. This should significantly improve the relationship between farmers and development agents. Finally, DSM is designed to significantly reduce the burden on government's budget for the seed demand assessment, production, and distribution costs currently incurred under CSM.

2.2. Geographical coverage of the Direct Seed Marketing program in 2015

DSM was initially piloted in Dangla and South Achefer woredas in Amhara region in 2011. The Ethiopian Seed Enterprise (ESE) of the government supplied maize hybrid BH660 in Dangla, while Avallo International, a private seed company, supplied maize hybrids BH660 and BH540 in South Achefer woreda (Astatkie et al. 2012; Benson et al. 2014). Based on lessons from the Amhara region pilot project, Oromia and SNNP regions adopted DSM in 2012. In Oromia, DSM was piloted in two woredas and only focused on hybrid maize seed. This was supplied by both ESE and the Oromia Seed Enterprise (Nefo et al. 2014; Benson et al. 2014). In the same year, SNNP piloted DSM in five woredas (one for hybrid maize seed and the remaining woredas with wheat seed). ESE supplied only hybrid maize, while the South Seed Enterprise supplied hybrid maize and wheat (Getahun et al. 2014; Benson et al. 2014). Unlike the other regions, Tigray DSM piloting began in 2014 with open pollinated varieties (OPV) seed for wheat, teff, and barley in three woredas. Three seed producer cooperatives, one in each woreda, supplied the seed (Haileselassie et al. 2015). Amhara region briefly interrupted the program in 2012 but re-started and expanded DSM in 2013 (Astatkie et al. 2012; Benson et al. 2014). In subsequent years, the geographic coverage of the DSM system expanded in the four major crop producing regions, with increases in the number of woredas in which DSM was implemented in each region. DSM coverage in 2015 is mapped in Figure 2.2.

DSM was operational in 82 woredas throughout the country in 2015. Oromia region had the largest number of DSM pilot woredas, followed by Amhara and SNNP regions, with Tigray region having the fewest. However, it should be noted that this is an absolute comparison of woredas and does not account for the relative size of each region – while Tigray has the fewest number of DSM woredas it also has the fewest number of rural woredas.

Figure 2.2. Location of Direct Seed Marketing woredas in the four regions of Ethiopia in which the program was implemented in 2015



Source: Authors. DSM = direct seed marketing.

2.3. Crop coverage of Direct Seed Marketing program in 2015

Seed for seven different crops were provided under DSM in 2015 (Table 2.1). The DSM programs in SNNP and Tigray provided seed for five crops, Oromia provide seed for four crops, while Amhara only supplied two. All four regions provided wheat seed, and all but Tigray provided maize seed. Teff seed was also provided by DSM in all but Amhara region. However, the extent to which seed of various crops was distributed across many woredas varies significantly. Maize and wheat are the primary crop types supplied. Hybrid maize seed was distributed under the DSM program in 51 of the 82 DSM woredas (62 percent), while wheat seed was distributed in 41, or half, of all DSM woredas. At the other extreme, improved seed for barley, potato, and faba bean was provided in only one or two woredas in total.

Table 2.1. Number of Direct Seed Marketing pilot woredas in 2015

Description	Amhara	Oromia	SNNP	Tigray	Total
Administrative zones in which DSM was piloted, no.	3	8	7	4	22
Woredas in which DSM was piloted, no.	23	38	16	5	82
Hybrid maize seed supplied woredas, no.	23	18	10	0	51
Teff seed supplied woredas, no.	0	4	1	4	9
Wheat seed supplied woredas, no.	6	22	9	4	41
Haricot bean seed supplied woredas, no.	0	1	6	0	7
Barley seed supplied woredas, no.	0	0	1	1	2
Potato seed supplied woredas, no.	0	0	0	1	1
Faba bean seed supplied woredas, no.	0	0	0	1	1
Crops for which seed was supplied, no.	2	4	5	5	7

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015) . DSM = Direct Seed Marketing.

DSM was not the sole system for improved seed distribution in the DSM targeted woredas. The extent to which the DSM system supplied seed in a woreda depended on the crop production potential of the woreda, the type of seed provided, and the availability of seed suppliers. Some farmers in DSM woredas were supplied through the CSM system with seed for both DSM and non-DSM crops. As such, in DSM woredas, both the DSM and CSM systems were operational, the former supplying seeds only for the targeted DSM crops with the latter supplying seeds both for DSM and non-DSM crops.

For instance, in Amhara region, only hybrid maize and wheat seeds were directly marketed under the DSM program. Only in six of the 23 DSM woredas (26 percent) were seed of both hybrid maize and wheat directly marketed. The remaining DSM woredas received only hybrid maize seeds. While wheat was identified as one of the DSM crops in the region, however it was not supplied (targeted) in most of DSM woredas. DSM seed, like wheat and teff, and non-DSM crop seed, like sorghum, were supplied through the CSM system in these woredas in which the DSM system only provided hybrid maize seed. Similarly, in the Oromia region, only 18 percent of the DSM woredas supplied seed for both hybrid maize and wheat. The remaining DSM woredas received only hybrid maize seeds. While SNNP and Tigray regions had far fewer DSM intervention woredas than Amhara and Oromia, seed for a greater variety of crops was provided in each woreda. For example, 38 percent of DSM woredas in SNNP region provided maize, wheat, and haricot bean seed, although teff and barley were provided in only one SNNP woreda. Four of the five DSM woredas in Tigray provided both teff and wheat seeds. In Atsibi Womberta woreda in Tigray, wheat, faba bean, barley, and potato seed was provided under the DSM program, making it the lead DSM woreda nationally in providing seed for the greatest diversity of crops.

2.4. Primary actors in Direct Seed Marketing program in 2015

There are a range of actors involved in implementing DSM:

- Smallholder farmers located in the pilot DSM woredas and who grew the DSM crops are the primary actors under the program, as they purchase improved seeds directly from both public and private seed producers.
- Seed producers involved in DSM in 2015 included the four public seed enterprises (ESE, and the seed enterprises of Oromia, Amhara, and SSNP regions), 18 private seed companies (including Pioneer Hi-Bred, Alemayehu Mekonnen Farm, Avallo, EthiAgriCEFT, Yimam Tesemma, and others), nine seed producer farmers' primary cooperatives (e.g., Zeresenay in Tigray), and five farmers' cooperative unions – Merkeb in Amhara, Meki Batu and Raya Wakana in Oromia, and Edget and Sidama in SNNP.
- These seed producers supplied seed to agreed sites and sold the seed directly either using their own staff or hiring local seed dealers or marketing agents. Individual or private seed dealers and, farmers' primary cooperatives or cooperative unions involved in seed production also served as seed marketing agents, receiving commissions for their service. Individual agents were selected based on their business experience, their ownership of a store, and their reputation for honesty in their community.
- Woreda and kebele-level agricultural extension agents were also involved in DSM. In addition to their regular duties around agricultural advisory service provision, these agents are involved in seed demand assessment, seed dealer identification, and storage and transport facilitation for seed.
- At the regional level, the BoA is responsible for demand assessment, coordination of regional level seed production and allocation, undertaking capacity building activities, and overseeing the entire DSM implementation process.
- MoA has the mandate to oversee the implementation of DSM across the four regions.
- ATA is involved in identifying systemic bottlenecks of DSM, generating enhanced understanding of the intervention and disseminating information for evidence-based decision making for policy, strategy, and program advocacy around seed system strengthening in Ethiopia.

- Other non-governmental organizations, like the Integrated Seed Sector Development (ISSD) program, also play a key role in the seed sector, guiding the design of the DSM program and supporting its implementation.

3. DATA AND METHODS

3.1. Description of key performance indicators

The study used eight key indicators to evaluate the performance of the DSM system: seed availability, sufficiency, timeliness, quality, price, ease of purchase, cost reduction, and accountability (Table 3.1). Using direct household surveys as well as secondary data, we measured farmer's level of satisfaction and their perception of progress made by DSM in terms of improving the seed marketing system across these indicators.

Table 3.1. Key performance indicators for the Direct Seed Marketing operational evaluation

Indicator	Description
Availability	Getting the same type of seed as requested or ordered
Sufficiency	Getting sufficient quantity of seed as demanded, requested, or ordered
Timeliness	Getting seed at the right time with reference to the ideal planting time
Quality	Getting seed that meets certain physical quality standards of farmers
Competitive price	Being able to purchase seed at fair price relative to that which other seed sellers are charging
Convenience	Being able to obtain seed in shops nearby with minimal frequency of visits
Cost reduction	Being able to sell or distribute seed with minimal direct involvement of agricultural extension workers on seed marketing related activities
Accountability	Farmers are able to inspect the seed and receive compensation for poor quality

Source: Authors

3.2. Data

The study used both primary and secondary data to address the research questions. The primary data was collected from samples of farm households, seed producers, seed sellers, and woreda- and kebele-level agricultural extension workers using structured questionnaires prepared for each group of respondents. The surveys were undertaken from October to November 2015, focusing on the DSM pilot program woredas of Amhara, Oromia, SNNP, and Tigray regions. For comparison purposes, sample respondents were drawn from both DSM and neighboring non-DSM woredas.

The household survey considered two groups of households. The first is made up of farm households from DSM pilot program woredas who purchased at least one type of DSM seed through the DSM system. The second group are made up of farm households from non-DSM woredas who purchased seed of at least one of the DSM crops through the CSM system. Both groups were part of the 2013 DSM survey (Benson et al. 2014). In the 2013 DSM survey, 320 farmers in DSM pilot woredas and 180 farmers from non-DSM woredas in Amhara, Oromia, and SNNP were surveyed. In order to create a panel data set, these households were revisited in the 2015 DSM survey, and 301 DSM and 174 non-DSM respondents were successfully interviewed in the second-round. However, all non-DSM woredas (except one in SNNP) from which comparison farmers were drawn became part of the DSM pilot program. This means, there were not enough control farmers from the original 2013 DSM sample to make comparisons. In addition, there was a need to cover sample households from Tigray who were not part of the 2013 DSM survey, as well as expansion woredas from the other three regions. Therefore, an additional 199 farm households from DSM pilot program woredas who purchased seed at least for one of the DSM crops through the DSM system and 176 farm households from non-DSM woredas who purchased seed at least for one of the DSM crops through the CSM system were selected, making for a total sample of 800 farmers (Table 3.2).

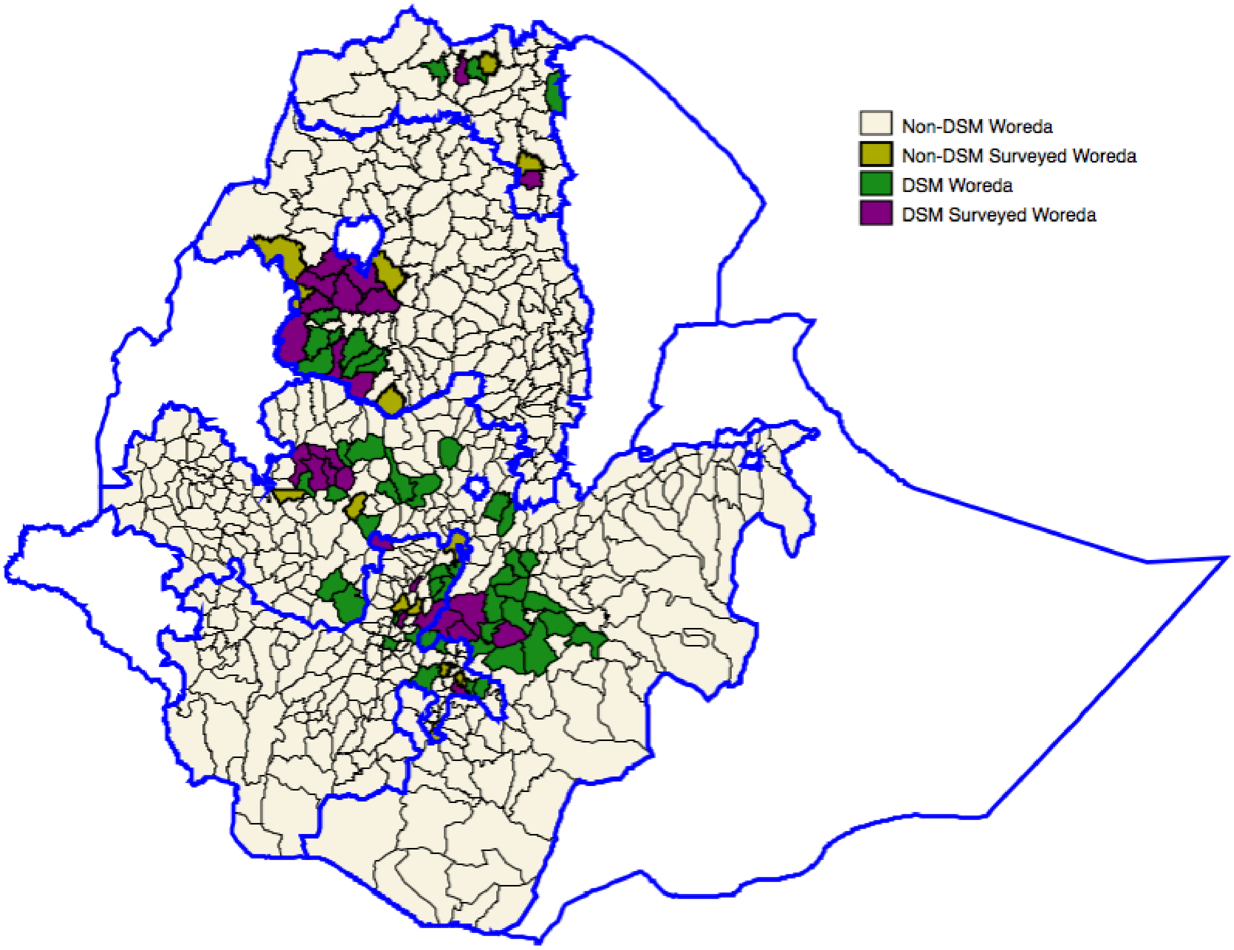
Table 3.2. Sample size of the 2015 Direct Seed Marketing farmers' survey by region, Ethiopia

Region	DSM woredas	DSM woredas surveyed	Sample households in DSM woredas	Non-DSM woredas surveyed	Sample households in non-DSM woredas
Amhara	23	9	179	3	60
Oromia	38	9	180	3	60
SNNP	16	5	100	7	140
Tigray	5	2	40	2	41
Total	82	25	499	15	301

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing.

The sampling of the second group of farmers involved three stages. First, representative DSM and non-DSM woredas were purposively selected. The methodology for this determination was based on geographical proximity to DSM woredas, comparable production potential, and the expectation that these non-DSM woredas would be later incorporated into DSM. Second, two representative kebeles were randomly selected from each woreda. Finally, 10 farm households were randomly selected in each kebele out of the total farm households who purchased improved seeds of the DSM crops. The locations of survey sites are given in Figure 3.1. The household survey collected information on socioeconomic and demographic characteristics, crop production practices, including use of improved seeds, and the farmer's perception on the performance of DSM in 2015 as compared to the CSM system.

Figure 3.1. Location of the 2015 Direct Seed Marketing survey by region



Source: Authors

The seed producer survey was administered to 24 seed producers and included all the largest public seed producers and selected private and cooperative seed producers that were operating in the sample woredas. The survey collected detailed information on seed production and marketing trends by crop type and variety, perception of producers of the DSM system, and challenges faced by seed producers related to access to inputs, production, and marketing.

The seed seller survey encompasses 75 last-mile seed distributers, i.e., individual dealers, primary cooperatives, and agents of seed producers. The survey covered the majority of seed sellers found in the sample woredas. The seed seller's questionnaire focused on topics related to marketing strategy (i.e., quality, packaging, promotion, and pricing) and the challenges they faced in sustaining their business. It also collected information on the seed seller's business profile and their perception of the performance of DSM as compared to CSM concerning the key performance indicators.

The agricultural extension agents' survey was administered to 118 agents – 61 percent at kebele-level, 32 percent at woreda-level, and 7 percent at zone-level. The information collected from the agricultural extension agents included that on trends in seed demand and supply and whether DSM contributes to solving some of the systemic problems that the seed sector has been facing.

The research team also discussed with several seed system specialists concerning international best practices. These best practices include incentive mechanisms to attract private actors into the seed sector and various approaches to build operational capacity towards developing vibrant wholesale and retail networks.

3.3. Methods of data analysis

The study principally used descriptive statistics to analyze the data from the household, seed seller, and seed producer surveys. Different tests were employed to determine whether or not the difference between DSM and CSM on key performance indicators were statistically significant: (i) Pearson Chi-square test to measure level of statistical significance of the association for categorical responses; (ii) two-sample Wilcoxon rank-sum (Mann-Whitney) tests to ascertain associations for ordinal responses; and (iii) the two independent sample t-test procedure to determine the equality of means between respondents who purchased seeds either through the DSM or the CSM system.

4. RESULTS

4.1. Sample household characteristics

The summary of basic socioeconomic variables of the respondents are given in Table 4.1. Considering all sample households, the average age was the same for both DSM and CSM (non-DSM) respondents.

Most of the respondents were able to read and write, and there was virtually no statistical significance difference between DSM and CSM respondents across the regions, with the exception of Amhara, where the proportion of respondents in DSM survey sites who can read and write was higher than the proportion of respondents in CSM survey sites at the 10 percent level of statistical significance. However, there was intra-regional variation. The highest percentage of respondents who can read and write was from Tigray region, whereas the lowest was from Oromia. Except in Tigray region, the average maximum formal school year attained by DSM respondents was higher than for CSM respondents. However, statistically significant differences exist only in the Amhara and Oromia regions. SNNP region has the highest average formal school year attainment, whereas the lowest was from Amhara region.

Most of the respondents were from male headed households. This could be attributed to the nature of the study target population. Households that purchase improved seeds either through DSM or CSM system tend to be larger, more asset rich, male-headed households (Kasa et al. 2015). As a result, the proportion of female-headed households in our sample is smaller than the proportions of 10 to 20 percent that we usually expect in the Ethiopian rural farm community context.

Table 4.1. Basic socioeconomic characteristics of Direct Seed Marketing survey sample household heads in 2015

	All		Amhara		Oromia		SNNP		Tigray	
Description	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**
Age, years	43	43	44	44	42	41	43	41	43	45
Can read & write, %	72	74	72*	74	62	69	74	79	83	85
Formal school year, no.	4.3	4.3	2.2**	3.1	3.4*	4.4	5.3	6.1	5.4	4.7
Married, %	95	94	90**	97	98***	92	96	94	93	90
Male headed, %	94	95	90***	98	98	94	95	94	93	90
Family size, persons	7.6**	7.0	7.0	6.5	7.1	7.3	8.5**	7.6	5.9	6.2
Farm experience, years	22	21	22	21	22	21	23	21	21	22
Own land size, ha	1.78	1.86	2.37***	1.71	1.82**	2.37	1.83	1.62	0.63	0.77
Managed land size, ha	1.69***	2.04	2.81***	1.96	1.56***	2.66	1.46	1.47	1.02	1.03
Observations	*301*	*499*	*60*	*179*	*60*	*180*	*140*	*100*	*41*	*40*

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.
Note: Statistical test results are for a means comparison of characteristics between CSM and DSM sample households across the entire sample and by regions. *** significant at 1%, ** significant at 5%, and * significant at 10%

The sample households are larger than the average national rural household size of 5 persons. There is no statistical significance difference between households in CSM woredas and those in DSM woredas in terms of the size of agricultural land holding over the entire sample, although differences are seen in Amhara and Oromia. However, survey households in DSM woredas managed larger plots of land, which is statistically significant at 1 percent level. At regional level, this pattern is observed in Oromia region. However, in Amhara region CSM households managed larger plots of land than DSM households. The difference is also statistically significant at 1 percent level.

4.2. Use of improved seeds by respondent households

The improved seed use of sample households for the DSM crops is given in Table 4.2. Among the households surveyed, the percentage that grew maize was somewhat larger for DSM respondents. About

80 percent of CSM respondents and 86 percent of DSM respondents grew improved maize in the main production season of 2015. In addition, DSM respondents grew maize over a larger area. A majority of the maize area of the surveyed households was planted with improved maize varieties in all regions. For all regions, except Amhara, the percentage of maize area covered with improved maize seeds was higher for DSM respondents than for the CSM respondents. For instance, in Oromia, the percentage of maize area planted to improved maize was 8 percentage points higher among DSM respondents than among the CSM respondents. In contrast, in Amhara, the percentage of the maize area cultivated by CSM respondents that was planted with improved seed was 4 percentage points higher than for the DSM respondents. Cultivation of open pollinated maize verities in backyard plots has been a common practice in the region. However, cultivation of hybrid maize varieties as field crops is relatively a recent phenomenon.

Table 4.2. Improved seed use profile of sample households for major crops in 2015

Description	**All**		**Tigray**		**Amhara**		**Oromia**		**SNNP**	
	CSM	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**
Maize growers, %	82**	88	23	29	100	99	87	88	89	89
Improved maize growers, %	80**	86	13	20	100	98	87	87	87	89
Maize area, ha	0.52***	0.77	0.03	0.04	0.82**	0.67	0.67***	1.19	0.45	0.49
Improved maize area, %	93	94	56	67	97**	93	88**	96	95	96
Teff growers, %	67**	68	70	73	55**	71	72**	56	70***	81
Improved teff growers, %	40	37	45	51	13***	37	12	15	63	71
Teff area, ha	0.38	0.41	0.25	0.28	0.24***	0.38	0.34	0.38	0.49	0.56
Improved teff area, %	58	51	63	63	23***	50	13***	24	88	84
Wheat growers, %	45	39	100**	85	33	39	22	29	44	37
Improved wheat growers, %	41	34	98	80	33	34	10**	23	42	37
Wheat area, ha	0.29	0.29	0.49	0.36	0.56**	0.26	0.03***	0.39	0.23	0.16
Improved wheat area, %	91	86	93	87	96**	85	46**	79	97	97
Haricot bean (HB) growers, %	16	20	5	22	0	3	20	21	24***	48
Improved HB growers, %	11	13	0	0	0	0	8	14	20***	38
Haricot bean area, ha	0.03***	0.10	0.00**	0.05	0	0.01	0.05***	0.14	0.05***	0.20
Improved HB area, %	70	62	0	0	0	0	42	66	84	78
Barley growers, %	21	18	45	39	12	21	3**	13	25***	11
Improved barley growers, %	10***	2	15	15	0	1	0	1	17***	3
Barley area, ha	0.07	0.06	0.12	0.08	0.04	0.06	0.01***	0.07	0.09***	0.02
Improved barley, %	4	7	0	55	0	0	0	5	6	0
Observations	*301*	*499*	*60*	*179*	*60*	*180*	*140*	*100*	*41*	*40*

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.
Note: Statistical test results are for a means comparison of characteristics between CSM and DSM sample households across the entire sample and by regions. *** significant at 1%, ** significant at 5%, and * significant at 10%

Table 4.3 shows that most reported that they used purchased seeds. Some also used their own saved seeds, with and a few gifts and in-kind exchanges of seed being reported. The proportion of maize growers who used purchased seeds was more than 95 percent in both DSM and non-DSM woredas. As discussed earlier, the share of purchased seed among the survey households was much higher than for typical Ethiopian farmers. It is also significantly higher than the results of the 2012 farm survey carried out for the ATA that estimated the overall share of purchased seed in Amhara, Oromia, SNNP, and Tigray regions at 56 percent (Minot and Sawyer 2013). By crop, the 2012 survey estimated the share of purchased seed for maize grain, white teff, mixed teff, wheat, and haricot bean at 41, 24, 12, 28, and 38 percent, respectively. Our higher estimates probably reflect the fact that the DSM program was launched in major maize growing woredas with longer experience of hybrid maize seed use.

Table 4.3. Source of seed by crop and Direct Seed Marketing status in 2015, percent of survey households

	Maize		Teff		Wheat		Haricot bean		Overall	
Seed source	CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM
Purchase	96	95	78	83	85	81	84	82	88	89
Own saving	2	2	17	15	15	17	6	15	10	8
In-kind exchange	0	1	2	1	0	1	0	0	0	1
Gift	1	3	3	1	0	1	9	3	2	2
Observations	*247*	*439*	*202*	*339*	*135*	*195*	*48*	*100*	*63*	*90*

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

4.3. Performance of the Direct Seed Marketing program

Here we present the results of the performance assessment of DSM based on the key performance indicators. Each indicator was evaluated based on 2015 performance and over the years since DSM became operational in each of the study sites. The latter is based on respondent's perceptions about the progress made towards achieving the objectives set for each indicator. Comparison between the DSM and CSM system is undertaken for both the 2015 intervention as well as over the years since inception.

4.3.1. Seed availability

Performance of DSM in 2015 in terms of seed availability

One of the criticisms of the Ethiopian seed system has been its inability to supply the type of seeds that farmers request for that particular crop year. Accordingly, one of the objectives of the DSM pilot program has been to improve the match between farmer demand for seed and the seed that is made available. In 2015, the demand for hybrid maize seed from DSM targeted woredas in Amhara, Oromia, and SNNP was estimated at 4,595.5, 4,413.3 and 984.7 metric tons, respectively. However, only 77, 71, and 56 percent of this amount of hybrid maize seed was supplied in Amhara, Oromia, and SNNP, respectively. The lowest proportion of seed supplied to seed demand was 33 percent for improved wheat seed in SNNP (Appendix Table 1).

Considering the responses of the surveyed farmers, 96 percent of those who put in seed orders for the 2015 main production season received the type of seed they ordered. Disaggregated by DSM participation, 97 percent of the CSM respondents and 95 percent of the DSM respondents received the type of seed they ordered (Table 4.4). Although the differences are statistically significant, both systems performed quite well.

In SNNP, the percentage share of the CSM respondents who received the type of seed they ordered was larger than for the DSM respondents. Unlike in the other regions, this pattern could be due to the lower support that DSM appears to receive from concerned government officials in SNNP. Frequent changes to the DSM woredas, allowing agricultural extension workers in some woredas to serve as seed dealers for seed enterprises, and a limited commitment of relevant government officials to effective implementation of DSM in the region, suggest implementation problems in SNNP that limit the effectiveness of the DSM program.

However, the reverse was true in Amhara region. Active leadership of the regional BoA in DSM planning, implementation, monitoring and evaluation; an absence of direct involvement of AEW in seed selling; and maintaining the original and further expanding the DSM pilot woredas were all observed there. In Amhara region, the percentage share of the DSM respondent who received the type of seed they ordered was larger than the CSM respondents by 5 percentage points. If we disaggregate the results by DSM crops and regions, the proportion of improved maize seed delivered and matched with the initial farmers' orders was higher for seed purchased through DSM than the CSM system in Amhara region whereas the reverse was true in SNNP.

While these differences between CSM and DSM performance on seed availability were statistically significant in SNNP and Amhara, no statistically significant differences were found for Oromia region, and hybrid maize seed was not supplied through DSM in Tigray. There was no statistical significance difference between CSM and DSM for the other DSM crops in all regions.

Making available the seed desired by farmers seems to be constrained by the effectiveness of the government's seed demand assessment, by production bottlenecks, and by marketing policies. Poor demand assessment leads to mismatches between farmer demand and the actual seed provided. There are also certified seed production constraints like basic seed and land shortages, and unfavorable weather conditions, which limit the quantity of seed produced. In addition, delayed seed procurement processes, poor logistical planning, inadequate transport, and a shortage of storage facilities contribute to insufficient seed.

Table 4.4. Farm household survey respondents that received the improved crop seed they ordered in 2015, by crop, percent of those that ordered crop seed

	All		Amhara		Oromia		SNNP		Tigray	
Crop	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**	**CSM**	**DSM**
Maize	95	92	92***	99	89	85	98**	93	100	n/a
Teff	99	100	100	n/a	100	100	98	100	100	100
Wheat	100	99	100	100	n/a	100	100	96	100	100
Haricot bean	100	100	n/a	n/a	100	n/a	100	100	n/a	n/a
All crops	97**	95	95***	100	87	88	100***	96	100	100
Observations	*301*	*499*	*60*	*179*	*60*	*180*	*140*	*100*	*41*	*40*

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). n/a = not applicable; DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.
Note: Statistical test results are for a means comparison of characteristics between CSM and DSM sample households across the entire sample and by regions. *** significant at 1%, ** significant at 5%, and * significant at 10%

Also contributing to seed availability is the number of DSM seed suppliers participating in each DSM program woreda. Seed availability in DSM woredas may be influenced by the number of DSM seed suppliers. For instance, in 2015 in Amhara, there were an average of four seed producers participating in DSM per woreda. This relatively high number of seed suppliers perhaps contributed to more DSM farmers receiving the seed they requested than CSM farmers in Amhara region did. In contrast, SNNP had an average of just one DSM seed producer per woreda, which may have contributed to DSM farmers in SNNP being less likely than CSM farmers to receive the type of seed requested.

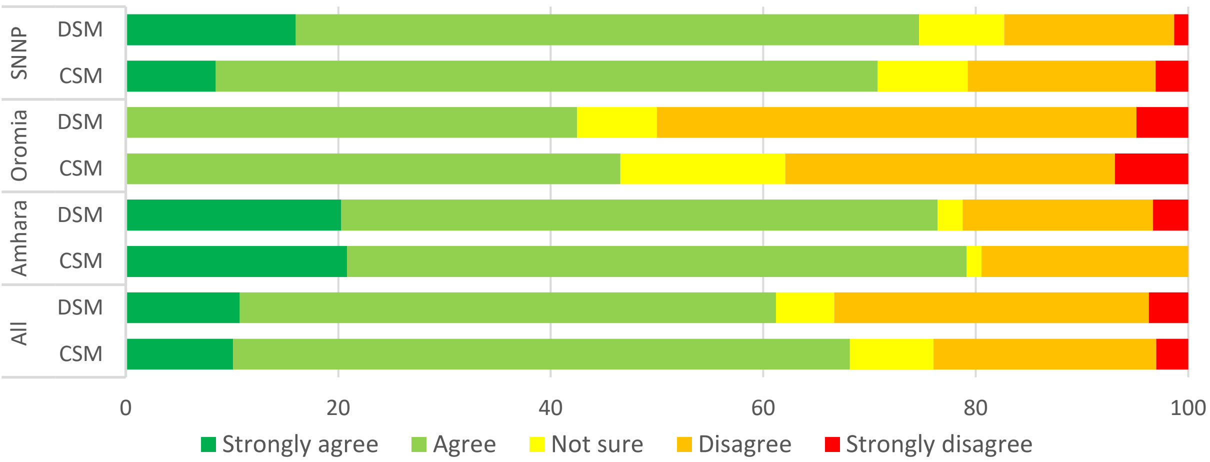
In Oromia, there were four DSM seed producers per woreda but no statistically significant difference was found in seed availability between CSM and DSM woredas. This suggests that other factors than the number of DSM seed producers per woreda may affect seed availability, including crop and variety diversity, timeliness of seed delivery, and whether the different suppliers delivered seed at the same time.

Respondents were also asked if they agreed or disagreed with the statement "The seed marketing system is helping to supply seeds that most farmers need" using a five-point Likert scale: strongly agree, agree, not sure, disagree, and strongly disagree. At the aggregate level[2], both farmers who purchased improved maize seed through DSM and their counterparts in CSM control woredas indicated high overall satisfaction with seed availability (Figure 4.1). CSM respondents indicated a slightly higher satisfaction

[2] Tigray was omitted because hybrid maize seed was not sold through DSM.

(68 percent) than did DSM respondents (61 percent), but the difference was not statistically significant[3]. Satisfaction varied across regions, however, being highest in Amhara and lowest in Oromia. In Oromia, no respondents indicated that they *strongly agreed* with the statement.

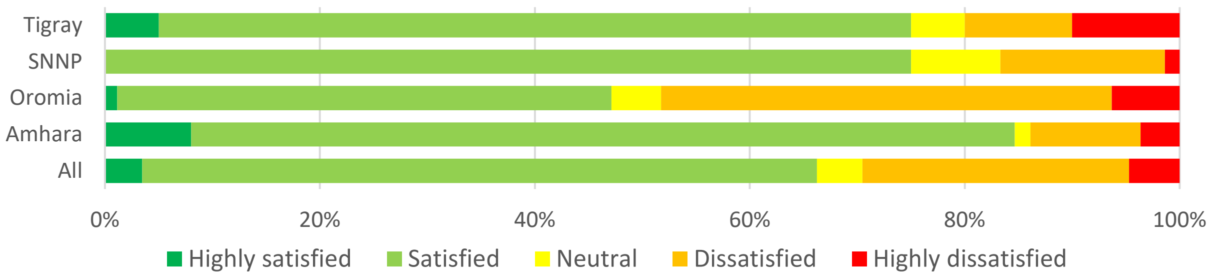
Figure 4.1. Surveyed farmers agreement with statement that "CSM/DSM is helping supply seed that farmers need", percent



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

The survey also asked farmers in the DSM woredas about the performance of DSM in 2015 in terms of ensuring seed availability. The results in Figure 4.2 are roughly comparable to those in Figure 4.1, with the exception that Tigray is now included because of data availability. More than 65 percent of respondents are satisfied or highly satisfied with DSM in terms of ensuring seed availability. The highest satisfaction rates are reported in Amhara region, followed by SNNP and Tigray regions. However, close to half of the respondents in Oromia region were dissatisfied or highly dissatisfied with DSM in terms of availing the right seed requested by farmers. The relative similarity with Figure 4.1 suggests stable satisfaction levels with DSM over the entire period of operation.

Figure 4.2. Satisfaction of surveyed farmers with Direct Seed Marketing in terms of seed availability in 2015, percent



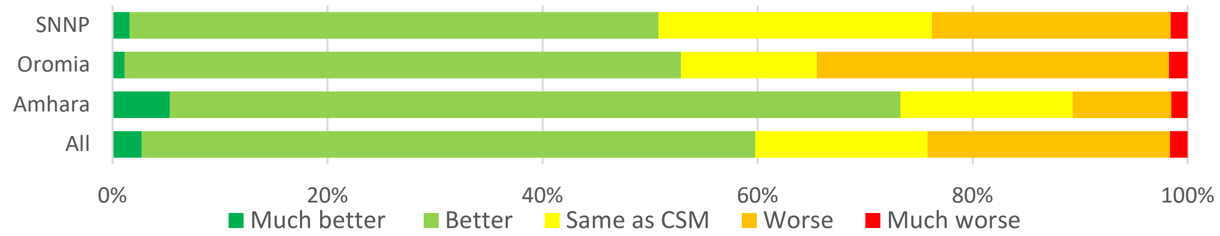
Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015).

The survey also asked farmers in DSM woredas to compare their experiences in previous years between DSM and CSM. Close to 60 percent of respondents agreed that DSM was "better" or "much better" than the CSM system in terms of availing seeds that they requested (Figure 4.3). This view was widely held in Amhara (73 percent). But, even in SNNP and Oromia, a majority felt that DSM was "better"

[3] Using the Mann-Whitney test, we fail to reject the null hypothesis that the two samples are drawn from populations with the same distribution (z = -1.44 and P = 0.150). This implies that there is no statistically significant difference between the two groups at the 10% level of significance.

or "much better" than CSM. Contrasting much better or better with worse or much worse responses (i.e., netting out the no difference responses), farmers are more than twice as likely to favor DSM over CSM, 60 percent to 24 percent respectively. Regional patterns similar to those seen in previous figures are maintained. At the positive end, Amhara respondents are over eight times more likely to prefer DSM, while Oromia farmers prefer DSM at 52 percent satisfaction as compared to 33 percent for CSM.

Figure 4.3. Comparison by surveyed farmers of Direct Seed Marketing to Conventional Seed Marketing in terms of seed availability in 2015, percent

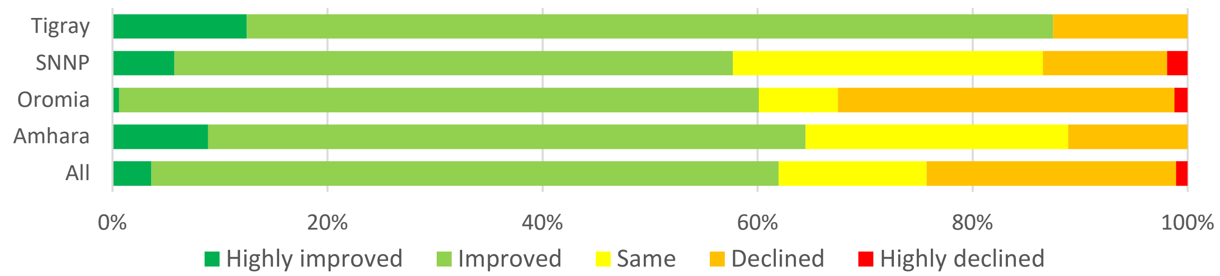


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

Progress of Direct Seed Marketing towards improving availability of seeds since program began

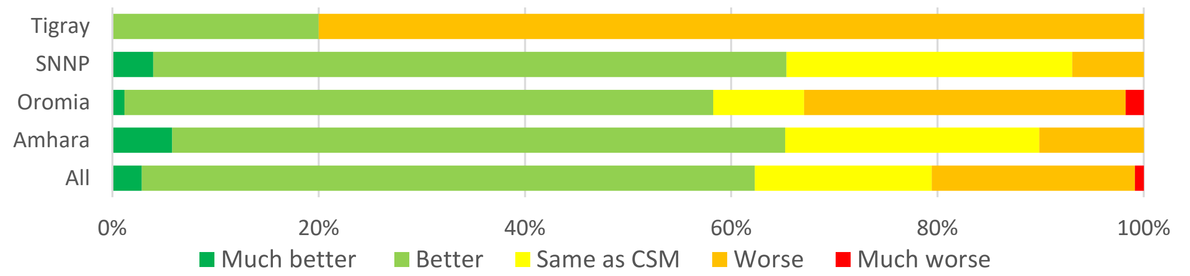
Although different regions have piloted DSM at different years, respondents were asked for their overall perception about of the progress of DSM in terms of ensuring availability of seeds since they have experienced it. More than 60 percent of all respondents agreed that the DSM pilot program has been improved or highly improved in this regard.

Figure 4.4. View of surveyed farmers on progress of Direct Seed Marketing in terms of ensuring seed availability since the Direct Seed Marketing program started, percent



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

Figure 4.5. View of surveyed farmers on progress of Direct Seed Marketing compared with Conventional Seed Marketing in terms of seed availability



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

The respondents were also asked to compare the progress made by DSM and CSM over the years in terms of ensuring seed availability. Most respondents agreed that the improvements made by DSM has been better or much better than the CSM system (Figure 4.5.).

4.3.2. Seed supply sufficiency

Performance of Direct Seed Marketing in 2015 in terms of seed supply sufficiency

In the main production season of 2015, 13,818 metric tons of seed of different crop types and varieties were supplied to farmers in DSM pilot program areas through DSM in the four main crop producing regions of Ethiopia (Table 4.5). Of this, most was sold, with only 11 percent reported as carry over. However, variations are observed among the regions and crop type. For instance, a significant proportion of teff seed supplied in Oromia and Tigray was left unsold.

Table 4.5. Seed supply, sales, and carryover through Direct Seed Marketing in 2015

Crop	Amhara	Oromia	SNNP	Tigray	All
Total seed supplied, mt					
All crops	3,742.3	8,467.6	1,253.6	354.3	13,817.8
Maize	3,542.3	3,142.4	552.8	--	7,237.5
Teff	--	21.1	15.0	21.2	57.3
Wheat	200.0	5,292.1	598.0	56.1	6,146.2
Haricot bean	--	12.0	85.8	--	97.8
Barley	--	--	2.0	45.0	47.0
Potato	--	--	--	220.0	220.0
Faba bean	--	--	--	12.0	12.0
Total seed sold, mt					
All crops	3,179.0	7,646.9	1,215.5	243.2	12,284.6
Maize	3,049.6	3,100.0	552.8	--	6,702.4
Teff	--	10.4	15.0	10.7	36.1
Wheat	129.4	4,524.6	578.5	50.5	5,283.0
Haricot bean	--	12.0	67.2	--	79.2
Barley	--	--	2.0	45.0	47.0
Potato	--	--	--	125.0	125.0
Faba bean	--	--	--	12.0	12.0
Carry-over seed, percentage of seed supplied					
All crops	15	10	3	31	11
Maize	14	1	0		7
Teff		51	0	50	37
Wheat	35	15	3	10	14
Haricot bean		0	22		19
Barley			0	0	0
Potato				43	43
Faba bean				0	0

Source: Authors' compilation from regional BoA and ATA (2015). "—" = not applicable.

Most survey farmers were able to buy the quantity of improved seed of hybrid maize, teff, wheat, and haricot bean they required in both the CSM and the DSM systems (Table 4.6). While at the national level, a greater percentage of farmers purchased improved seed through CSM than through DSM, there are several important caveats to be considered. Among the important qualifiers to these figures are DSM not be implemented in all regions, structural issues that limited DSM seed delivery to sellers, and the need for DSM to work through the inevitable early implementation problems as compared to the long-standing CSM structures.

Table 4.6. Survey farmers who were able to buy all the seed they required seed in 2015, percent

Crop	All		Amhara		Oromia		SNNP		Tigray	
	CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM
Hybrid maize	75	73	73	88	48	57	86	84	100	--
Teff	89	82	84	--	83	70	91	83	100	91
Wheat	91	82	92	100	--	76	87	76	97	97
Haricot bean	87	89	--	--	83	71	88	94	--	--

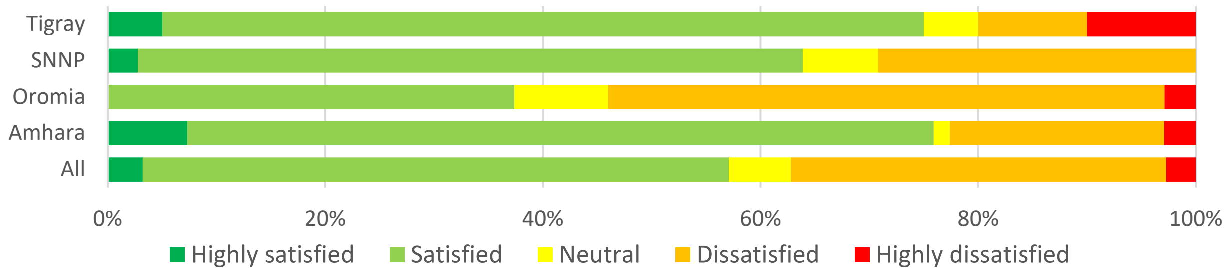
Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). "—" = not applicable; DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

At the regional level, there were significant variations in 2015 in the ability of farmers to obtain the seed they required. Perhaps reflecting the overall satisfaction with seed availability identified earlier, the highest proportion of hybrid maize growers who were able to buy sufficient amount of seeds through the DSM system was reported in Amhara region, whereas the lowest was in the Oromia region. This low satisfaction in Oromia region can be attributed partly to the lower supply of seeds there relative to the seed requested and may be more of an institutional supply issue rather than a direct fault of the seed delivery system. For instance, in the DSM pilot woredas in West Arsi zone, only 50 percent of the requested seed was supplied and sold. There was a significant shortage of preferred BH660, BH661, and Pioneer hybrid maize varieties in the region. In addition, less preferred seed types were provided in some areas, which reduced overall demand for improved seed as well. Finally, the late onset of rainfall in some parts of the region created a corresponding shift in farmers' demand to different varieties. Seed producers were unable to respond to this shift in demand, so this also was among the contributing factors to the low proportion of hybrid maize farmers who were able to buy the amount of seed they needed.

However, the proportion of respondents in Amhara and Oromia regions who purchased hybrid maize seeds through the DSM system was higher than the proportion of respondents who purchased hybrid seeds through CSM by 14 and 8 percentage points, respectively. The same pattern was observed for wheat seed supply adequacy in Amhara region. The reverse was again seen in Oromia region. The CSM system was better than DSM in Oromia in terms of supplying adequate quantities of teff and haricot bean seeds. Mixed results were found for the sufficiency of other cereal seeds in SNNP region. DSM was better in supplying haricot bean seed, while CSM was better in supplying adequate amounts of teff and wheat seed.

The study also assessed the perceptions of farmers from the DSM pilot woredas about the performance of DSM in terms of ensuring adequate seed supply in 2015 (Figure 4.6). More than half of the respondents were satisfied or highly satisfied with DSM in this regard. However, again there is significant regional variation. Respondents from Amhara region were most satisfied with the DSM performance in supplying adequate amounts of seed, followed by respondents from Tigray and SNNP. Consistent earlier results presented, more than half of the respondents in Oromia region were dissatisfied or highly dissatisfied. Put another way, respondents were twice as likely to be dissatisfied or highly dissatisfied in Oromia (53 percent) as compared to Amhara (23 percent). Regional lessons from both Amhara and Oromia for improving DSM interventions are discussed later.

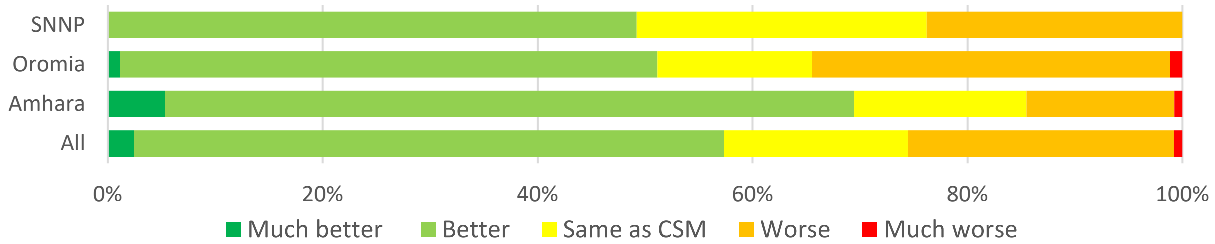
Figure 4.6. Satisfaction of surveyed farmers with Direct Seed Marketing in terms of adequate seed supply in 2015



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The study also compared the performances of DSM and CSM in terms of ensuring supply of adequate quantity of seeds in 2015 (Figure 4.7). Close to 60 percent of respondents said DSM was doing better or much better than the CSM system in terms of ensuring adequate seed supply. Contrasting DSM and CSM directly, 57 percent of respondents preferred DSM, 26 percent preferred CSM, and about 17 percent were indifferent. As was the case with overall seed availability, DSM was preferred to CSM by more than two to one for all respondents. Regionally, the lowest proportion of respondents who said DSM was doing better or much better than the CSM system were from SNNP, although Oromia was only slightly better at 50 percent. Amhara was the standout, preferring DSM by almost 70 percent of the total responses. On the negative side, fully one-third of all farmers surveyed in Oromia ranked DSM worse or much worse. This was above the national average of about 25 percent and lower than Amhara at only 15 percent somewhat dissatisfied.

Figure 4.7. Comparison of Direct Seed Marketing and Conventional Seed Marketing system in terms of adequate seed supply in 2015

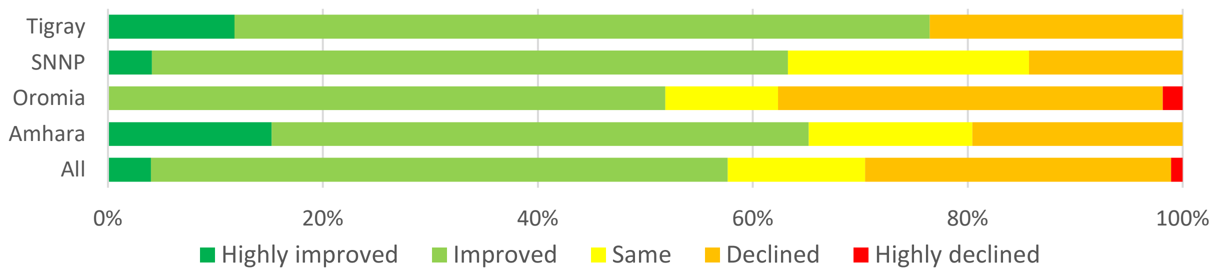


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM =Conventional Seed Marketing.

Progress of Direct Seed Marketing towards ensuring adequate seed supply

The study also assessed the perceptions of survey households about the progress made by the DSM pilot program in terms of improving adequate seed supply since its inception in the study sites (Figure 4.8). The majority of respondents in Amhara, SNNP, and Tigray said DSM has improved or highly improved seed supply over the years. The highest proportion of such respondents were from Tigray followed by Amhara, SNNP, and Oromia regions.

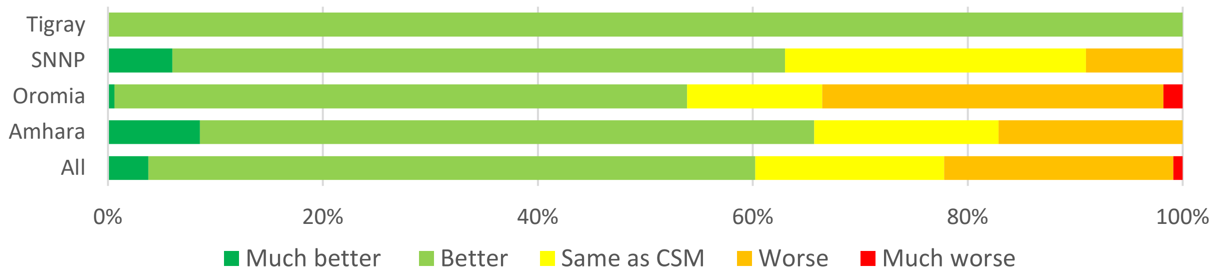
Figure 4.8. Progress of Direct Seed Marketing in terms of adequate seed supply since program started



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The study also assessed the perceptions of survey households about the progress made by DSM compared to the CSM system for the same indicator since the pilot program has started in the study sites (Figure 4.9). Considering all the cases, more than 60 percent of respondents said DSM was doing better or much better than the CSM system in terms of ensuring adequate seed supply to farmers.

Figure 4.9. Progress of Direct Seed Marketing compared with Conventional Seed Marketing in terms of adequate seed supply



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

4.3.3. Timeliness of seed supply

Performance of Direct Seed Marketing in 2015 in terms of timeliness of seed supply

Considering the ideal planting time in their village, respondents were asked if the seed they required was provided in a timely manner (Table 4.7). Most respondents reported purchasing or otherwise acquiring their seed either before or during the ideal planting time. Eight percent of hybrid maize growers who purchased seeds through DSM and 9 percent of those who purchased their maize seed through CSM in Oromia received seeds after the ideal planting time. This could be attributed to poor planning, logistics, and other capacity limitations of seed producers. The relatively late arrival of seeds for DSM in Oromia could be another factor in the dissatisfaction with DSM among survey farmers in the region.

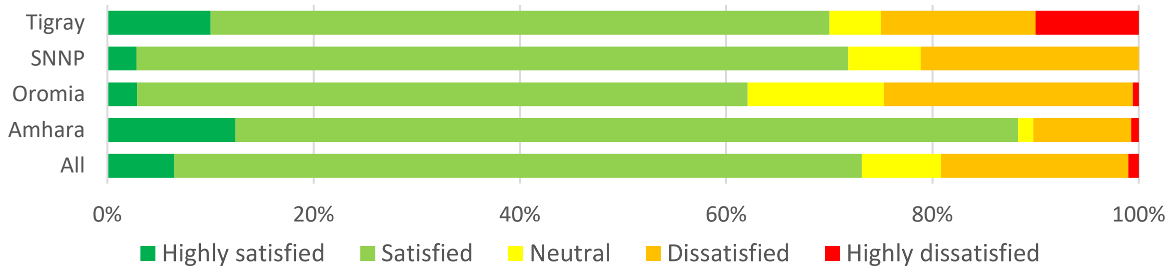
Table 4.7. Hybrid maize seed acquisition timing in 2015, percent of hybrid maize growers among survey households

Region	DSM status	Before planting	During planting	After planting	Chi²(2)	P-value
All	CSM	82	15	3	15.104	0.001
	DSM	68	28	4		
Amhara	CSM	92	6	2	0.490	0.782
	DSM	95	5	1		
Oromia	CSM	35	57	9	0.048	0.976
	DSM	37	55	8		
SNNP	CSM	96	2	2	4.990	0.082
	DSM	91	9	0		
Tigray	CSM	67	33	0	--	--
	DSM	--	--	--		

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

The study also assessed the level of satisfaction and perception of respondents in DSM pilot woredas about the performance of DSM in terms of enabling timely supply of seeds in the main production season of 2015. More than 70 percent of respondents were satisfied or highly satisfied with DSM as it enabled timely seed supply (Figure 4.10). The highest satisfaction rate was reported in Amhara region, while the lowest was in Oromia.

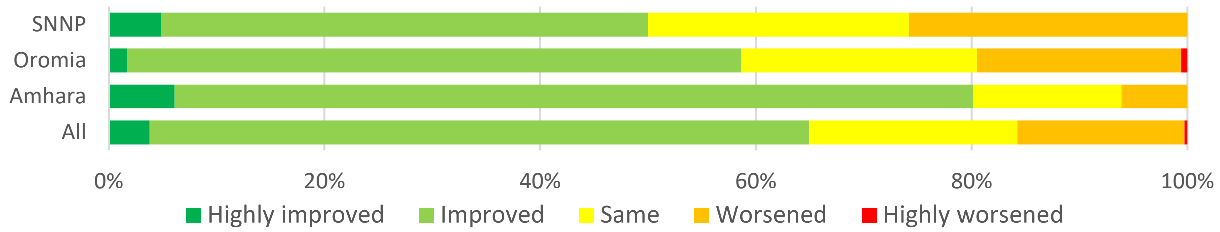
Figure 4.10 Satisfaction of respondents about Direct Seed Marketing in terms of timeliness of seed delivery in 2015



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

In addition, the study compared the performances of DSM and CSM in terms of ensuring timely supply of seeds in the main production season of 2015 (Figure 4.11). At the national level, 65 percent of respondents believed that DSM had been improved or highly improved in ensuring timely supply of seed. The highest percentage of respondents who viewed that timely supply of seed had improved relative to CSM came from Amhara region, followed by respondents from Oromia and SNNP regions.

Figure 4.11. Comparison of Direct Seed Marketing and Conventional Seed Marketing system in terms of timely delivery of seeds in 2015

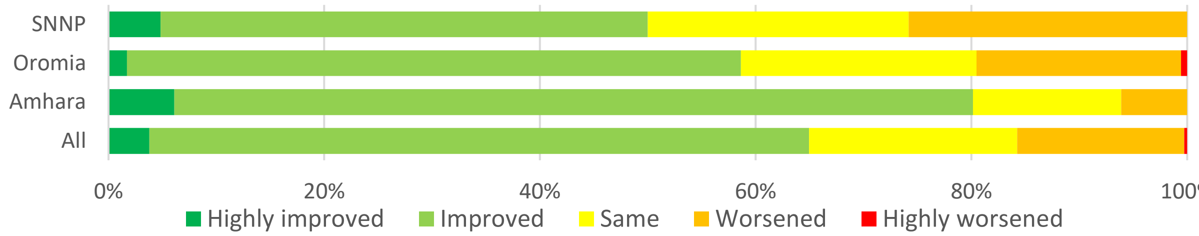


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

Progress of Direct Seed Marketing towards ensuring timely supply of seeds

The study also assessed the perceptions of respondents in DSM woredas about the progress made by DSM in terms of improving timely supply of improved seeds since it became operational in their kebele (Figure 4.12). The majority of respondents in Amhara, Oromia, and SNNP felt that DSM has improved or highly improved over the years in terms of enabling timely supply of seeds. The highest proportion of such respondents were from Amhara region, whereas the lowest was in SNNP.

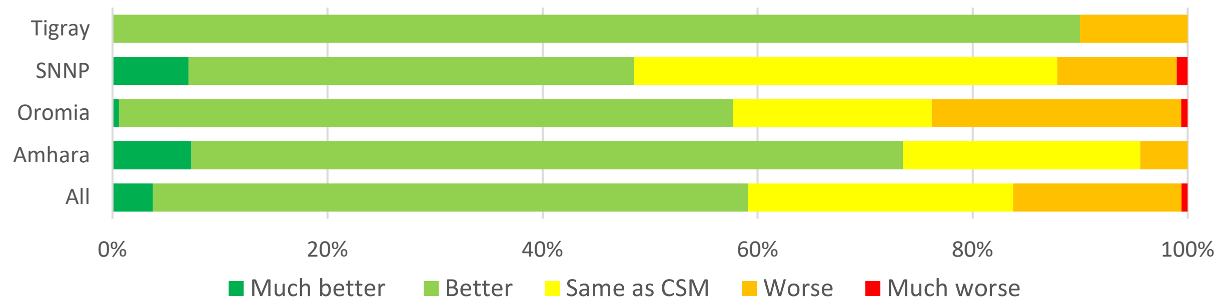
Figure 4.12. Progress of Direct Seed Marketing in terms of timely supply of seeds since it has started



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The study also assessed the perception of respondents about the progress made by DSM compared to the CSM system in terms of ensuring timely supply of seeds since the pilot program started in their kebeles (Figure 4.13). The majority of respondents said DSM was doing much better or better than the CSM system in the timely supply of seeds.

Figure 4.13. Progress of Direct Seed Marketing compared with Conventional Seed Marketing in terms of timely seed supply



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

4.3.4. Seed pricing

Performance of Direct Seed Marketing in 2015 in terms of price competitiveness

One of the objectives of DSM is to ensure prices competitiveness in the seed business so that smallholder farmers will be able to purchase seeds at market-determined rates. Prices for certified seeds of public varieties produced by parastatal seed enterprises and marketed through DSM have been determined by relevant departments and agencies within the federal Ministry and regional Bureaus of Agriculture. By design, private seed companies have been free to set their own prices for certified seeds of public varieties that they produced and supplied through DSM. However, the private seed producers usually have been uncertain about setting seed prices different than the prices set for the parastatal seed companies by the government for the same varieties. The private seed producers believe farmers to be very sensitive to marginal price differences for the same variety and mostly they prefer to follow the prices already set for the public varieties by the public seed enterprises. This is the case despite that they might have varying cost structures. For example, DSM seed suppliers could have relatively better quality seed, more convenient seed delivery mechanisms, or higher costs of production due to having to rent land for seed production.

Pioneer Hi-Bred Ethiopia and Alemayehu Mekonnen Farm are the two seed firms in Ethiopia that produce seeds of their own hybrid maize varieties working within DSM. These firms set their own prices for their proprietary varieties. Table 4.5 presents the average seed prices of different varieties in the main production season of 2015. The prices of hybrid maize seed are higher than seed for self-pollinated crops, like teff, wheat, and haricot bean. The Pioneer Hi Bred Ethiopia hybrid maize varieties, Shone and Limu, had the highest prices. These are the varieties that most hybrid maize growers prefer, but they are in short supply. Shone, a hybrid maize variety; Tsedey, a teff variety; and Kakaba, a wheat variety, if supplied through DSM had relatively lower prices than if supplied through the CSM system. However, BH540 and Hawas Dume were supplied through DSM with relatively higher prices compared to their CSM prices.

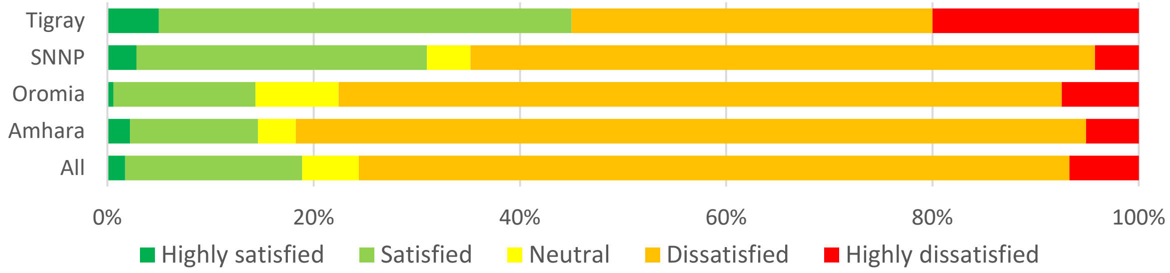
Table 4.8. Average seed prices of major crop varieties sold in Ethiopia in 2015

Varieties by crop type	Mean seed price, ETB/kg CSM	DSM	Difference	t-statistic	p-value (two-sided)
Hybrid maize varieties					
BH660	19.9	20.3	-0.5	-0.693	0.490
BH540	26.4	28.7	-2.3	-2.812	0.006
Shone (PHB-30G19)	42.0	39.8	2.2	1.710	0.089
Limu (PHB-3812)	41.7	42.2	-0.5	-0.235	0.819
Teff varieties					
Quncho (DZ-Cr-387)	24.2	23.0	1.3	0.611	0.550
Tsedey (DZ-Cr-37)	25.1	22.3	2.8	1.870	0.065
Wheat varieties					
Kakaba (Picaflor #1)	15.9	14.4	1.5	1.750	0.085
Kubsa (HAR 1685)	13.0	13.5	-0.5	-0.330	0.760
Haricot bean varieties					
Nasir (Dicta-105)	16.2	14.9	1.3	0.656	0.516
Hawassa Dume (SNNPR-120)	13.6	19.0	-5.4	-2.040	0.056

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

Respondents were also asked to state their level of satisfaction with DSM in terms of ensuring competitive prices for seeds in 2015. The majority of respondents are dissatisfied or highly dissatisfied with DSM in this regard. The proportion of dissatisfied respondents reached more than 80 percent in Amhara region. In this region, there were situations in which all the seed producers assigned in one location did not sell their seed at the same time. For example, one of the seed producers waited to bring seed to market until the other seed suppliers finished selling. There were reports that stronger private seed firms attempted to distort the local seed market through paying unreasonably high commission to seed dealers, which resulted in those dealers neglecting to promote the sale of seed from the other private seed firms with lower commission, regardless of product quality differences. Varying commissions had an impact on price competitiveness locally. In addition, seed prices might not be competitive for several other reasons. First, in most cases, the average number of seed producers and distribution centers per woreda were relatively few. Second, though the average number of seed producers and distribution centers per woreda seems adequate, the varieties they supplied might not preferred by farmers. Finally, in order to expect price variations for the same varieties in the same location, there should be significant variations in product quality, packaging, promotion, and other marketing strategies, which was not the case in most DSM locations.

Figure 4.14. Satisfaction of survey households with Direct Seed Marketing in terms of the program ensuring competitive prices in 2015



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

Progress of Direct Seed Marketing towards ensuring competitive seed prices

In the earlier roll-out phase of the DSM program, seed producers charged flat rates for seed of the same variety in different geographical locations. However, in recent years, some private seed producers have started setting their own seed price. For instance, Yimam Tesema and EthioAgri-CEFT were among the private seed companies supplying hybrid maize seed to farmers through DSM in Amhara region in 2015. For the public hybrid maize variety BH660, the former charged ETB 2,032 per quintal (qt - 100 kg), while the latter ETB1,972/qt in every woreda where they sold their seed. This price difference partly reflects production cost variations between the two companies. For instance, EthioAgri-CEFT produces seed on its own farm, whereas Yimam Tesema uses contracted out-growers, which has extra cost implication. Over time, DSM should further develop more market-oriented pricing that should enhance efficiency and reflect premiums for seed quality and improved service provision by the seed producers to farmers. Earlier in the DSM program, these companies only competed through the amount of commission payments to seed selling agents (Benson et al. 2014).

4.3.5. Seed quality

Performance of Direct Seed Marketing in 2015 in terms of quality seed supply

The DSM program seeks to ensure the supply of quality seeds to farmers. Seed suppliers are encouraged to allow farmers to check the quality of the seed before purchase, hence ensuring transparency. Although the percentages are relatively low, nationally DSM suppliers are more likely to allow farmers to inspect seeds before purchase (Table 4.9). However, of those survey households who purchased hybrid maize seed, both through the CSM and DSM systems, only 18 percent were allowed to check the quality of the seed supplied at the selling sites. Although only for teff was there a statistically significant difference nationally between the CSM and the DSM systems on whether farmers were allowed to check the quality of the seed before purchase, there were some statistically significant differences at the regional level for other crops.

Table 4.9. Percentage of respondents who checked seed quality before purchase in 2015

Region	Crop type	CSM	DSM	Difference between CSM and DSM	Chi^2	p-value
All	Hybrid maize	8	12	-4	3.95	0.047
	Teff	14	29	-15	5.99	0.014
	Wheat	20	27	-7	1.69	0.194
	Haricot bean	23	38	-15	1.28	0.257
	All	18	18	0	0.03	0.890
Amhara	Hybrid maize	6	22	-16	9.14	0.002
	Teff	7	--	--	--	--
	Wheat	11	25	-14	0.74	0.388
	All	7	18	-12	9.60	0.002
Oromia	Hybrid maize	4	6	-3	0.66	0.418
	Teff	17	30	-13	0.36	0.551
	Wheat	0	9	-9	0.20	0.655
	Haricot bean	40	71	-31	1.19	0.276
	All	15	13	2	0.25	0.619
SNNP	Hybrid maize	7	5	2	0.33	0.564
	Teff	11	4	7	0.95	0.330
	Wheat	4	6	-2	0.12	0.732
	Haricot bean	20	24	-4	0.08	0.784
	All	14	9	5	2.79	0.095
Tigray	Hybrid maize	71	--	--	--	--
	Teff	53	75	-22	1.45	0.228
	Wheat	56	79	-23	3.90	0.048
	All	58	76	-18	5.03	0.025

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.
Note: "--" indicates the seed of the corresponding crop was not sold in that specific region

The percentage of respondents who purchased hybrid maize and teff seeds through the DSM system and were allowed to check the seed quality was higher than the respondents who purchased through the CSM system by 4 and 15 percentage points, respectively. Both differences were statistically significant at the 5 percent level. Considering all the DSM crops, the percentage of respondents in Amhara, SNNP, and Tigray regions who purchased seeds through the DSM system and allowed to check the seed quality were higher than their counterparts who purchased seeds through the CSM system. Regionally, the percentage of respondents in Amhara who purchased hybrid maize seeds and respondents in Tigray who purchased wheat seeds through the DSM system and allowed to check the seed quality were higher than their counterparts who purchased the seeds through the CSM system. Farmers usually check the physical quality of the seed, which includes pest attack, admixtures (foreign matter), shape and size, damage, color, and moisture.

As indicated in Table 4.10, 21 and 26 percent of the total respondents who purchased improved seeds of the DSM crops through the CSM and the DSM system, respectively, reported seed quality problems. Unexpectedly, the proportion of respondents who purchased seeds through DSM and reported seed quality problems was about 5 percentage points higher than those who bought seed through the CSM system, a statistically significant difference. This may be due to the newness of the DSM program. Over time, price mechanisms may be built in around perceived quality differences. High-quality seed sellers can establish better prices or greater market share through these types of consumer experience. Overall, the DSM program needs to work on issues of seed quality.

Table 4.10. Percentage of respondents who observed maize seed quality problem in 2015

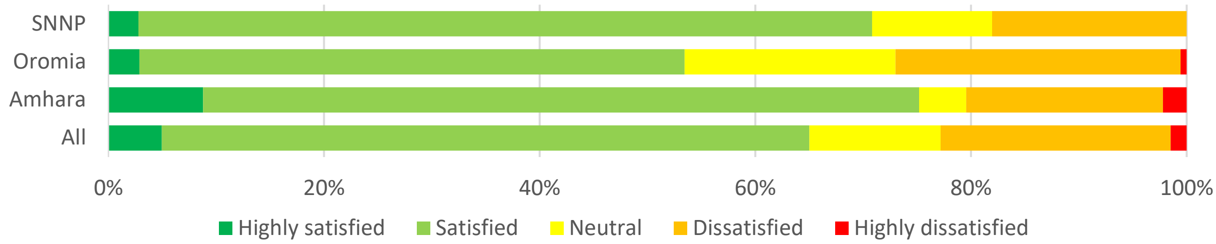
Region	Crop type	CSM	DSM	Difference between CSM and DSM	Chi²	p-value
All	Hybrid maize	33	36	-3	0.676	0.411
	Teff	10	0	10	4.923	0.026
	Wheat	10	20	-11	5.860	0.015
	Haricot bean	7	13	-6	0.482	0.487
	All	21	26	-5	4.340	0.037
Amhara	Hybrid maize	25	34	-9	2.127	0.145
	Teff	18	--	--	--	--
	Wheat	12	25	-13	0.629	0.428
	All	19	26	-7	2.420	0.120
Oromia	Hybrid maize	53	37	16	4.914	0.027
	Teff	0	0	0	--	--
	Wheat	0	42	-42	1.395	0.238
	Haricot bean	0	29	-29	1.714	0.190
	All	49	36	13	3.768	0.052
SNNP	Hybrid maize	31	39	-8	1.320	0.251
	Teff	7	0	7	1.736	0.188
	Wheat	11	9	2	0.084	0.771
	Haricot bean	8	6	2	0.088	0.767
	All	19	19	1	0.023	0.078
Tigray	Hybrid maize	100	--	--	--	--
	Teff	6	0	6	0.671	0.413
	Wheat	5	0	5	1.532	0.216
	All	5	0	5	2.977	0.084

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.
Note: "--" indicates the seed of the corresponding crop was not sold in that specific region

However, there were mixed results when the analysis is disaggregated by crop type. The proportion of respondents who purchased teff seeds through DSM and reported seed quality problems was zero, while 10 percent of their CSM counterparts observed seed quality problem. In contrast, the proportion of respondents who purchased wheat seeds through DSM and reported seed quality problems was 11 percentage points higher than those who bought the same seed through the CSM system. Regionally, a statistical significance difference was observed between CSM and DSM for observed quality problems in hybrid maize seed. Respondents who purchased seed through DSM and observed seed quality problems were 16 percentage points lower than their CSM counterparts, a statistically significant difference.

The study also assessed the perceptions of hybrid maize growers in DSM pilot woredas who participated in the survey about the performance of DSM in terms of ensuring good quality seed supply in the main production season of 2015 (Figure 4.15). Considering all cases, the majority of respondents were highly satisfied or satisfied that DSM enables the supply of good quality seed. About 23 percent were highly dissatisfied or dissatisfied with the performance of DSM, as they observed some sort of seed quality problems. Among the three regions piloted for direct selling of hybrid maize seeds, Amhara region had the highest proportion of respondents who were highly satisfied or satisfied, followed by SNNP and Oromia.

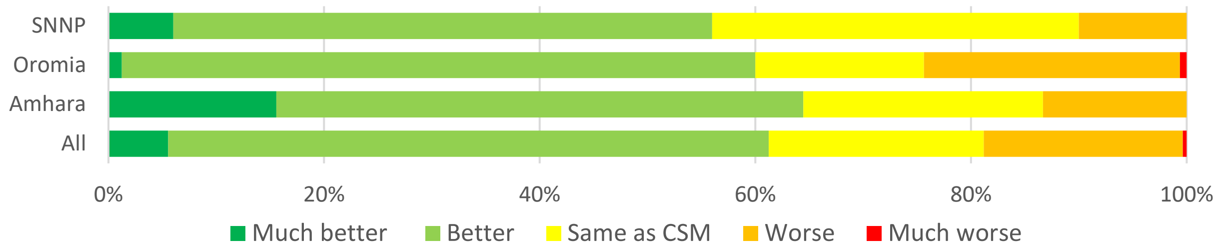
Figure 4.15. Satisfaction of respondents about Direct Seed Marketing in terms of ensuring quality seed supply in 2015



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

In addition, the study compares the performance of DSM to CSM in terms of ensuring supply of quality seeds in 2015 main production season (Figure 4.16). The majority of respondents said DSM was doing much better or better than the CSM system in terms of ensuring the supply of good quality seeds, while only 19 percent said DSM was much worse or worse than CSM. Generally, the perception is good, but Table 4.10 indicates that improvements in seed quality can be made.

Figure 4.16. Comparison of Direct Seed Marketing system to Conventional Seed Marketing system in terms of quality seed supply in 2015

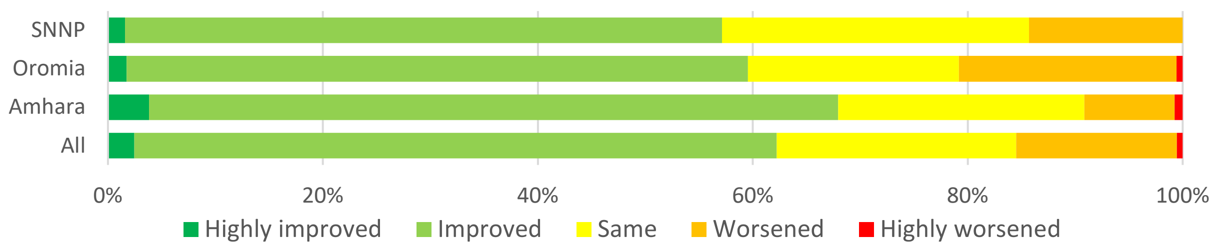


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

Progress of Direct Seed Marketing towards ensuring quality seed supply

The study also assessed the perceptions of respondents in DSM pilot sites about the progress made by DSM in terms of improving the supply of quality seeds. A majority of respondents said DSM has improved or highly improved over the years in terms of enabling the supply of good quality seeds (Figure 4.17). The greatest number of positive responses were from Amhara region followed by Oromia. Relative to other questions in the survey, the overall perception that seed quality has deteriorated with DSM is low. Only about 15 percent of the respondents said the performance of DSM has worsened or highly worsened. Put another way, respondents were more than four times more likely to say seed quality had improved under DSM than has worsened.

Figure 4.17. Progress of Direct Seed Marketing in terms of quality seed supply since program started

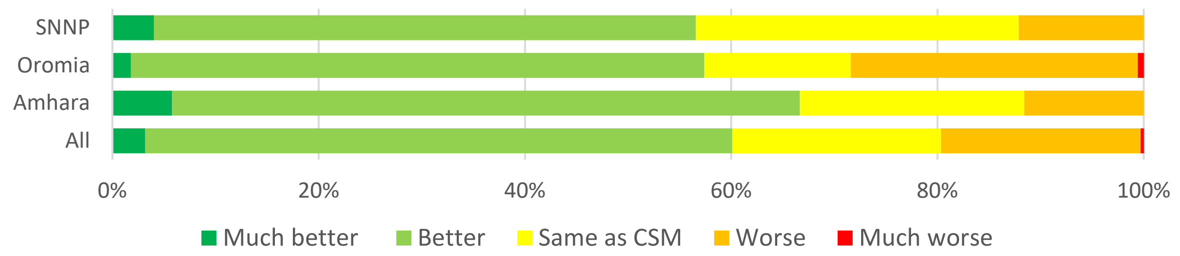


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The study also assessed the perception of respondents about the progress made by DSM compared to the CSM system in ensuring supplies of quality seeds since the pilot program started in the study sites

(Figure 4.18). Most respondents said DSM has been doing better or much better than the CSM system in terms of ensuring the supply of good quality seeds, with only 20 percent believing that DSM was much worse or worse than CSM.

Figure 4.18 Progress of Direct Seed Marketing compared with Conventional Seed Marketing in terms of quality seed supplied since Direct Seed Marketing program started



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

4.3.6. Ensuring accountability

Performance of Direct Seed Marketing in 2015 in terms of ensuring accountability for poor quality seed sell

Another objective of DSM is to ensure that farmers get appropriate compensation if the seed that they purchase from seed producers is identified as poor quality (Table 4.10) For the hybrid maize growers surveyed who reported seed quality problems, 64 percent of those that had purchased seeds through CSM reported the seed quality problems, while 47 percent of those that purchased seed through DSM reported the problem. These problems were reported either to the kebele level agricultural extension agents, to woreda office of agriculture experts, or to the seed sellers themselves. However, only 3 percent of survey households who reported quality problems with their seed obtained replacement seed in compensation.

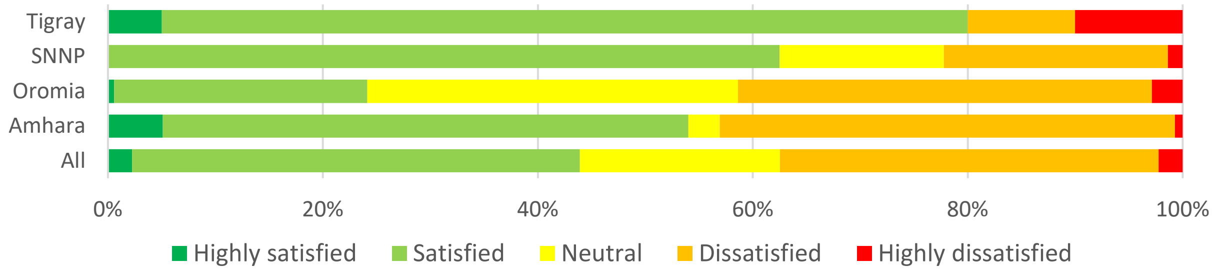
Table 4.11 Hybrid maize growers with seed quality problems who reported it, percent

	CSM	DSM	Difference between CSM and DSM	Chi^2	p-value
All	64	47	18	7.60	0.007
Amhara	83	54	29	5.10	0.024
Oromia	58	35	23	4.98	0.026
SNNP	61	62	-1	0.00	0.926

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

DSM respondents' perception about the performance of DSM in terms of ensuring accountability of seed producers and sellers for poor performance of crops due to seed quality problem was also assessed (Figure 4.19). Close to 40 percent of respondents were dissatisfied or highly dissatisfied with the performance of DSM in this regard. Somewhat surprisingly, the proportion of such respondents with negative perceptions was highest in Amhara region, although followed closely by Oromia. The lowest proportion of dissatisfaction was in the Tigray region.

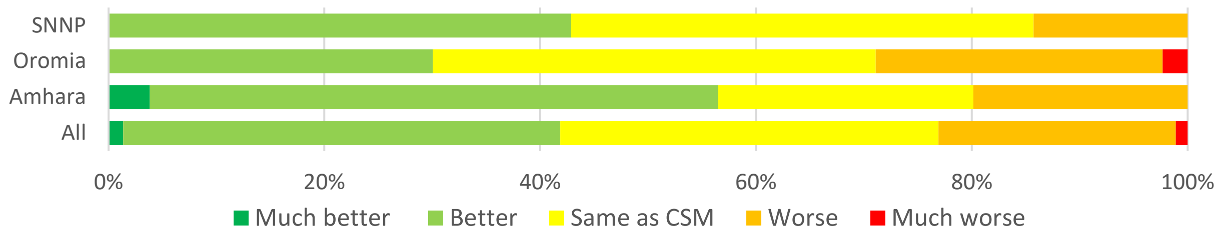
Figure 4.19. Satisfaction of respondents about Direct Seed Marketing in terms of ensuring accountability in 2015



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The study also compared the performance of DSM to CSM in 2015 in terms of ensuring accountability of seed producers and sellers for poor quality seed sales based on the perceptions of respondents in DSM woredas who purchased improved seeds through both the DSM and CSM system (Figure 4.20). Respondents believed that DSM was better or much better than CSM by an about a two to one margin.

Figure 4.20. Comparison of Direct Seed Marketing and Conventional Seed Marketing system in terms of ensuring accountability in 2015

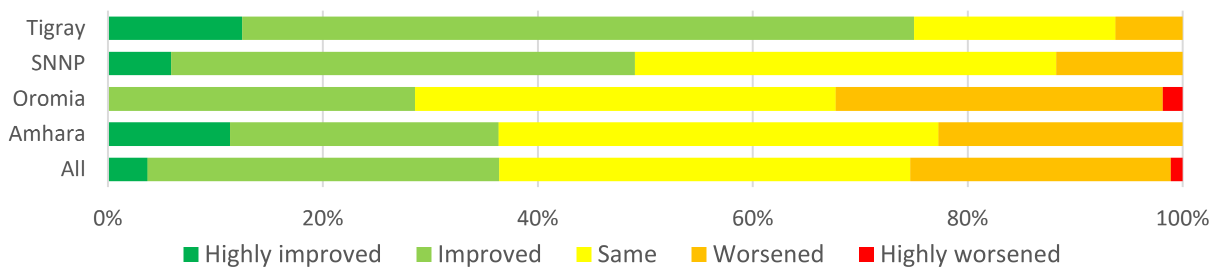


Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing

Progress of Direct Seed Marketing towards ensuring accountability for poor quality seed sales

The study also assessed the perceptions of the respondents in DSM woredas about the progress made by DSM in terms of improving the accountability of seed sources for sub-standard seed supply and sale to farmers (Figure 4.21).About 38 percent of respondents indicated that DSM has not demonstrated any substantive changes in accountability for poor seed since it was introduced in their woreda. However, close to the same percentage share of respondents also believe that DSM has improved or highly improved in terms of ensuring accountability. About a quarter of the respondents believe that DSM has worsened or highly worsened accountability for poor quality seed sales.

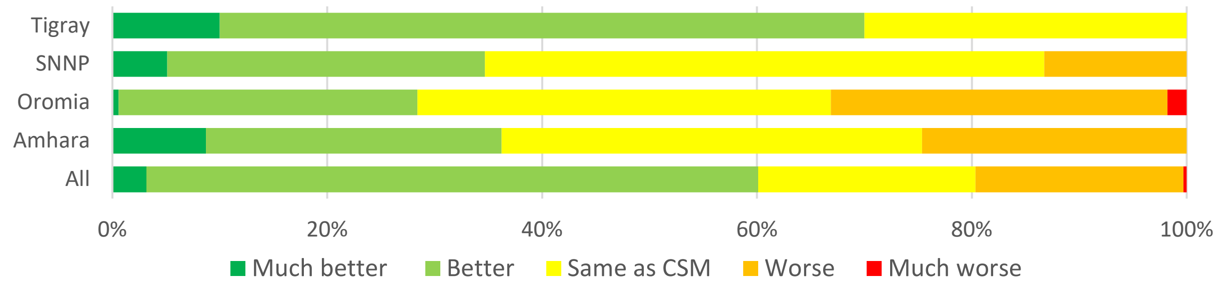
Figure 4.21. Progress of Direct Seed Marketing in terms of ensuring accountability for poor quality seed sold



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015)

The comparison of the DSM system to the CSM system in terms of the progress made in ensuring accountability is presented in Figure 4.22. The majority of DSM respondents who purchased seeds through both the DSM and CSM system believe that DSM has shown better or much better improvement than the CSM system in terms of ensuring the accountability of seed sources when complaints are made over poor quality seed. From a regional perspective, most of the respondents in Tigray appreciated DSM in this regard, while only 28 percent in Oromia believed positive progress has made by DSM in terms of accountability for poor seed quality regard. None of the respondents in Tigray region said DSM's progress was worse or much worse than CSM, whereas more than 33 percent of the respondents in Oromia did.

Figure 4.22. Progress of Direct Seed Marketing compared with Conventional Seed Marketing in terms of ensuring accountability



Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). CSM = Conventional Seed Marketing.

4.3.7. Service delivery convenience

Considering the aggregated responses on the locations where farmers collected or bought improved seeds in 2015 for all DSM crops, kebele centers were the most common locations, followed by woreda towns, sub-woreda centers, other neighboring kebele centers, and other woreda towns. The least frequent location for obtaining seed was village centers. This implies that most of the respondents who relied on either the DSM or the CSM system received seeds relatively close to their households. However, CSM kebele centers are closer to farmers' houses than DSM kebele centers. The same pattern was observed across almost all the different regions and crops (Appendix Table 2). This likely can be attributed to the limited number of seed producers participating in the DSM program and their capacity to transport and deliver seeds to each kebele center.

The distance to seed distribution sites, measured in minutes for single way walking, and the frequency of visits made by CSM and DSM respondents are presented in Table 4.11. As the mean and median values were not similar, suggesting some extreme outliers, we present medians. A test of independence between the CSM and DSM on these measures using the Wilcoxon rank-sum test was also performed. The median distance of hybrid maize and teff seeds distribution site for both CSM and DSM was 30 minutes. However, respondents in wheat DSM woredas traveled an additional 10 minutes as compared to their CSM counterparts. Statistical tests indicate a presence of dependence between DSM participation and travel time. Regionally, wheat distribution centers in DSM pilot sites in SNNP region were the farthest from the residences of surveyed farm household, with DSM respondents traveling three times farther than CSM respondents.

In terms of frequency of visits, most of the respondents obtained their seed in one visit. However, there was significance difference between CSM and DSM in the case of hybrid maize seeds. DSM respondents were able to collect their hybrid maize seed in single visit whereas the CSM respondents had to visit twice. This principally was observed in Amhara region. Contrary to this, wheat seed buyers in DSM sites in SNNP visited seed shops twice to make seed purchases whereas CSM seed buyers only visited once. These mixed results across different regions and crops could be attributed to information availability to the farmers about the seed supply, as well as timing and convenience of seed business shops operational time. Through CSM, seed is distributed by cooperatives. Most of the cooperatives are operated by non-paid members. The sales agents generally do not have a business orientation due to poor private incentives. As a result, seed shops could be closed when farmers want to buy seed. Therefore, farmers usually do multiple visits before they make their purchase.

Table 4.12. Distance of seed distribution sites and number of trips

Region	Crops	Travel time in minutes, median			Number of trips, median		
		CSM	DSM		CSM	DSM	
All	Hybrid maize	30	30		2	1	***
	Teff	30	30		1	1	
	Wheat	20	30	***	1	1	
	Haricot bean	20	30		1	1	*
	Overall	30	30		1	1	***
Amhara	Hybrid maize	30	30		2	1	***
	Teff	20	--		1	--	
	Wheat	30	20		1	1	
	Overall	25	30		2	1	***
Oromia	Hybrid maize	30	30		1	1	
	Teff	30	30		1	1	
	Wheat	75	30		2	1	
	Haricot bean	45	30		1	1	
	Overall	30	30		1	1	
SNNP	Hybrid maize	30	30	*	2	2	***
	Teff	40	30		2	1	
	Wheat	20	65	***	1	2	*
	Haricot bean	18	30		2	1	
	Overall	30	30		2	2	
Tigray	Maize	20	--		1	--	
	Teff	20	23		1	1	
	Wheat	20	20		1	1	
	Overall	20	23	**	1	1	

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

4.3.8. Public-sector cost of seed marketing

Performance of Direct Seed Marketing in 2015 in terms of reducing seed marketing related public expenditures

In the CSM system, most seed marketing related costs are covered by government. The major seed marketing related duties of public agricultural extension workers (AEW) and the corresponding average number of days each AEW spends on them per year is summarized in Table 4.13. On average, each AEW spends 104 days per annum for seed marketing related activities under CSM and only 51 days under DSM. Among seed marketing activities, undertaking the seed demand assessment most time for AEWs under both the CSM and the DSM systems, followed by reporting and communicating identified seed demands, advance payment collection and transfer, and facilitating seed transportation and distribution. However, DSM-related activities take fewer working days than those for CSM. More specifically, DSM helped to save an average of seven working days per annum. These results imply that DSM has important implication for saving the time of AEW so that they can focus on agricultural extension work, reducing unnecessary public expenditures related to see marketing in the form of per diem, transport, and other costs.

Table 4.13. Average number of days public agricultural extension workers spent per year for seed marketing related activities, 2015

Seed marketing related activities	CSM	DSM	Difference between CSM and DSM	t-statistic	p-value
Undertaking seed demand assessment	26	17	9	1.81	0.072
Reporting & communicating seed demands	18	9	9	2.31	0.022
Advance payment collection and transfer	9	3	6	2.08	0.038
Facilitating seed transportation from source	7	4	3	1.86	0.063
Facilitating seed storage	8	5	3	1.63	0.103
Facilitation seed distribution	14	6	8	4.16	0.000
Seed fee collection and transfer	7	1	6	3.19	0.002
Other seed marketing related duties	15	6	9	2.99	0.003
Overall mean	104	51	53	3.59	0.000

Source: Authors' computation based on data from the Direct Seed Marketing agricultural extension workers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

4.4. Perceptions of seed producers about the performance of the Direct Seed Marketing program

In the 2015 seed producers' survey, 24 general managers, branch managers, deputy managers, seed production and marketing department heads, and other staff members of the different seed producer organizations were interviewed. Forty-two percent of the interviewees were from private seed firms, 33 percent from seed producer farmers' primary cooperatives (SPFPC) and seed producer farmers' primary cooperative unions (SPFPCU), and 25 percent from public seed enterprises. As the sample size is small, the results were not disaggregated by region. The subsequent sections present the opinions about DSM of seed producers that participated in the program in 2015 and about its progress over the years in comparison with the CSM system.

4.4.1. Typology and distribution of seed producers participated in Direct Seed Marketing

Private seed firms, SPFPCs, SPFPCUs, and public seed enterprises sold improved seeds of different crop types and varieties directly to farmers in the DSM pilot woredas. Table 5.1 presents the typology and regional distribution of these seed producers. Among the public seed enterprises, the Amhara Seed Enterprise supplied seed in Amhara, Oromia Seed Enterprise in Oromia, and South Seed Enterprise in SNNP region, whereas the Ethiopia Seed Enterprise supplied in all the regions. The Ethiopia Seed Enterprise served as the sole public seed enterprises that supplied improved seeds in Tigray, in addition to SPFPCs. Tigray region does not have a regional public seed enterprise and the existing few private seed firms in Tigray were not involved in the DSM pilot program in 2015. The largest number of private seed firms hat involved in DSM was in Amhara region, followed by Oromia. In contrast, Amhara region has the lowest number of SPFPCs and SPFPCUs involved in DSM, whereas Oromia and Tigray regions had the highest concentration. On average, four seed producers per DSM woreda participated in Amhara and Oromia while only one seed producer participated in each DSM woredas in SNNP and Tigray regions.

Table 4.14. Seed producers involved in Direct Seed Marketing in 2015 by region, number

	Amhara	Oromia	SNNP	Tigray	Total
Public seed enterprises	2	2	2	1	4
Private seed firm	8	6	4	0	18
SPFPC or SPFPCU	1	3	2	3	9
Total	11	11	8	4	31

Source: Authors' compilation from Regional BoA and ATA (2015). SPFPC = seed producer farmers' primary cooperative; SPFPCU = seed producer farmers' primary cooperative union.

4.4.2. Perceptions of seed producers about the performance of Direct Seed Marketing

To assess the perceptions of seed producers about the performance of DSM itself and in comparison with CSM, respondents to the seed producer survey were asked to rate their level of satisfaction. The key performance indicators (KPIs) used were related to availing seed required by farmers (availability), adequacy of seed (adequacy), providing seed at the right time (timing), selling seed at a reasonable price (pricing), supplying quality seed (quality), ensuring accountability of actor in the seed sector (accountability), and seed access in remote locations (access).

Level of satisfaction of seed producers about the performance of Direct Seed Marketing in 2015

Table 4.15 presents the level of satisfaction of seed producers about the performance of DSM in 2015. Although most respondents were satisfied or highly satisfied with DSM's performance based on most the KPIs, some remained dissatisfied in terms of availing the seed requested by farmers in sufficient quantity. According to the respondents, lack of adequate breeder, pre-basic, or basic seed; lack of market incentives; lack of land for certified seed multiplication; lower financial capacity; and poor promotion of available technologies were, in order of importance, the challenges seed producers faced to produce diversified seeds as requested by farmers. Similarly, the challenges of seed producers to supply adequate quantities of seed included lack of adequate breeder, pre-basic, or basic seed; lack of land for certified seed multiplication; and lower financial capacity. Although few, some respondents were not happy about the seed quality supplied through DSM in 2015. The problems that seed producers had in maintaining the quality of seed included lack of infrastructure and facilities for seed cleaning and storage, lack of price incentives, a poor regulatory system, poor quality basic seed, knowledge gaps in storage management, and lack of commitment.

Table 4.15. Level of satisfaction of seed producers about the performance of Direct Seed Marketing in 2015, percent of respondents

	Highly satisfactory	Satisfactory	Not sure	Unsatisfactory	Highly unsatisfactory
Availability	19	48	5	29	0
Adequacy	11	37	5	47	0
Timing	5	89	0	5	0
Pricing	5	90	5	0	0
Quality	25	60	5	5	5
Accountability	25	75	0	0	0
Access	5	60	30	5	0

Source: Authors' computation based on data from Seed Producers' survey (2015)

Respondents also compared the performance of the DSM and the CSM systems in 2015 based on the KPIs (Table 4.16). Respondents believed that DSM performed better or much better than CSM in terms of ensuring accountability of stakeholders if farmers had complaints about the seed they bought. Respondents indicated that the accountability of seed producers could be improved under DSM, as farmers knew who produced the seed since they often had purchased the seed from the producers. However, in the case of CSM it is hard for the farmers to know the seed source as it passes through lengthy seed procurement procedures. Even if they might know the seed producer, reaching those producers with complaints is almost impossible due to geographic distance and ownership transfers, as either the government or cooperatives buy the seed first before it is sold to farmers. Similarly, respondents were also satisfied with the performance of DSM compared with CSM in terms of timely delivery of seed, quality, and pricing. Although the majority of respondents believe that DSM did better or much better than CSM in terms of seed availability and adequacy, still a significant proportion of respondents believed that DSM was worse or much worse than CSM. In the same way, half of the respondents also said that DSM did worse or much worse than CSM in terms of ensuring remote areas had access to seed. As DSM is in its pilot phase and has been operational in relatively few areas, this result was expected. Some other producers were also dissatisfied with the timing of supply and pricing of seed.

Table 4.16. Level of satisfaction of seed producers about the performance of Direct Seed Marketing compared with Conventional Seed Marketing in 2015

	Much better	Better	Same as CSM	Worse	Much worse
Availability	13	33	13	33	7
Adequacy	7	43	14	36	0
Timing	7	71	0	21	0
Pricing	0	57	29	14	0
Quality	7	50	43	0	0
Accountability	7	79	14	0	0
Access	0	36	14	50	0

Source: Authors' computation based on data from Seed Producers' survey (2015)

Seed producers faced several challenges concerning relatively late seed delivery, including, by order of importance, a shortage of seed storage facilities in seed selling areas, lack of own transport vehicles, administrative bureaucracy, poor transport service to remote areas, absence of adequate seed processing plant, and limited financial capacity. Respondents also mentioned that the direct or indirect influence of public seed enterprises and government officials to set different prices, fear of loss of market for their seed, and absence of significant difference in the cost of production of their seed as their principal challenges in setting competitive seed prices.

Perceptions of seed producers about the performance of Direct Seed Marketing over the years

Table 4.17 presents the results of the level of satisfaction of seed producers about the progress of DSM over the years. Most of the seed producers interviewed stated that DSM has improved or much improved in terms of all the KPIs. However, a few stated that DSM has been getting worse in terms of supplying diverse seed and adequate quantities.

Table 4.17. Level of satisfaction of seed producers about the progress of Direct Seed Marketing since program started

	Much improved	Improved	Same as CSM	Worse	Much worse
Availability	15	55	20	10	0
Adequacy	5	55	25	15	0
Timing	15	65	15	5	0
Pricing	10	50	35	5	0
Quality	15	70	15	0	0
Accountability	0	83	17	0	0
Access	5	60	30	5	0

Source: Authors' computation based on data from Seed Producers' survey (2015)

Respondents were also asked to compare the progress made by DSM to that of CSM in terms of the KPIs (Table 4.18). According to the respondents, the progress made by DSM has been better or much better than CSM in terms of all the KPIs, except access.

Table 4.18. Level of satisfaction of seed producers about the progress of Direct Seed Marketing compared with Conventional Seed Marketing

	Much better	Better	Same as CSM	Worse	Much worse
Availability	7	50	21	21	0
Adequacy	7	43	43	7	0
Timing	7	71	21	0	0
Pricing	14	43	29	14	0
Quality	7	57	36	0	0
Accountability	7	71	21	0	0
Access	7	33	20	40	0

Source: Authors' computation based on data from Seed Producers' survey (2015). CSM = Conventional Seed Marketing.

5. INTERNATIONAL BEST PRACTICES IN SEED SYSTEMS

The DSM evaluation sheds light on the direction forward for the Ethiopian seed system over coming years. However, it is also useful to consider longer-term strategies for modernizing the Ethiopian seed sector. With that in mind, this section examines international patterns in the evolution of seed systems.

A seed system can be defined as the set of organizations, rules, and relationships in a supply chain that generates seed for farmers, matching farmer demand for seed in terms of volume, type, and timing. The stages in the supply chain include the development (or importation) of new varieties of seed, the multiplication of seed to achieve sufficient volume, and the marketing of seed to farmers. An effective seed chain also has mechanisms to assess farmer demand for different types of seed, with this information being incorporated into production planning.

Because of the nature of seed as an economic product, seed systems involve a mix of public and private sector activity. Furthermore, the role of the public sector varies depending on the type of seed and the level of development and the policy choices of the country in question. This makes it difficult to identify a single set of best practices that all countries should follow. At the same time, the international experience of national or regional seed system development combined with economic theory on the roles of the public and private sectors provide some guidelines for the most useful way for governments to support the development of a productive and efficient seed system.

5.1. Varietal development

One of the main challenges for the Ethiopian seed system is how to increase the rate of development of new varieties of important crops. Between 1999 and 2009, Ethiopia released an average of 10.4 new cereal varieties per year. Although this rate is higher than in many African countries, it is less than the 17.7 releases per year in Kenya and the 60 releases per year in South Africa (Gisselquist 2013).

Varietal development refers to the breeding research and testing that results in the creation of new varieties of a crop that have some advantage over existing varieties in terms of yield, disease resistance, drought tolerance, speed of maturation, product attributes (including taste, size, and color), or other characteristics. Crop breeding is a time-consuming and technically difficult task. Developing a new variety can take 5 to 30 years of work by trained breeders, agronomists, and other scientists. Furthermore, it is risky in that the final product may not perform better than existing varieties or, even if the new variety may have higher yields, it may be unacceptable to farmers for reasons not anticipated by researchers.

However, varietal development can generate significant benefits for the economy. For example, the annual Ethiopian wheat crop is worth US$ 637 million (FAO 2016), so a new variety that increases yield by just 5 percent and is adopted by 30 percent of farmers would generate returns of almost US$ 10 million per year. This intuitive argument is confirmed by hundreds of econometric studies of agricultural research and development which reveal rates of return of 30 to 50 percent per year (Fuglie et al. 2007).

The international experience is that virtually every country provides public funds for agricultural research to develop new crop varieties. As shown in Table 5.1, the level of public support for agricultural research is generally between 0.1 percent and 2.5 percent of the value of agricultural output. Within sub-Saharan Africa, public spending on research is relatively high in South Africa (2.05 percent) but the average among the 38 countries for which there are data is 0.5 percent. The African Union has set a target for investment in agricultural research as a share of agricultural GDP of 1.0 percent for the continent, but the share for Ethiopia is 0.2 percent (Beintema et al. 2014).

Table 5.1. Public expenditure on agricultural research as a share of agricultural GDP, selected countries and regions, percent

Country or region	Percent of agricultural GDP
Ethiopia	0.20
Kenya	0.91
Tanzania	0.33
Uganda	0.88
Nigeria	0.29
South Africa	2.05
Sub-Saharan Africa (average)	0.51
African Union target	1.00
Brazil	1.82
China	0.50
India	0.40
United States	2.10

Sources: For the United States, Fuglie et al. (2007). For all others, IFPRI (2016). GDP = Gross Development Product.

The role of the private sector in agricultural research varies by a country's level of development. In Ethiopia, as in much of sub-Saharan Africa, the public agricultural research centers under the Ethiopian Institute for Agricultural Research account for virtually all the spending on agricultural research, including varietal development (Beintema et al. 2014). In this, Ethiopia is typical of other countries in sub-Saharan Africa, where the private sector accounts for less than 5 percent of research expenditure. Much of the private sector research in agriculture carried out in Africa is concentrated in South Africa. In China, private agricultural research has grown from 3 percent of the total in 1995 to 16 percent in 2006 (Chen et al. 2012). In the United States, more than half of all spending on agricultural research and development is carried out by the private sector (Fuglie et al. 2007). There is a clear pattern in which the relative importance of the private sector in agricultural research rises with a country's level of economic development. The implication is that Ethiopia should prepare for a future in which private seed companies play a more significant role in the generation of new crop varieties, which is complementary to that of the public agricultural research system.

The importance of the private sector in agricultural research also varies by commodity. A large share of private sector investment in varietal development is focused on hybrid seeds and vegetable seed. In sub-Saharan Africa, almost all private-sector activity in varietal development is focused on hybrid maize seed. In India, the private sector plays a significant role in varietal development, but it focuses on vegetable seed and hybrid grains, while the public sector generates open-pollinated varieties. Only in middle- and high-income countries, such as the United States, do private seed companies carry out varietal research on open-pollinated varieties.

Economic theory sheds some light on international patterns of public and private investment in varietal development. The genetic information contained in a new seed variety can be considered a public good.[4] One of the characteristics of a public good is that it creates economic benefits, but cannot be profitably produced by private firms because of the nature of the product. This is because once the variety has been

[4] Public goods are characterized by *non-rivalry* and *non-excludability*. Non-rivalry means that consumption by one person does not reduce consumption by someone else. Non-excludability means that it is difficult or costly to limit the distribution of the product, making it difficult to collect money from users. Although an individual bag of seed is a rival good and excludable, the new seed variety in general is a non-rival, non-excludable good.

released, it is relatively easy for buyers to reproduce and distribute the variety widely. For example, one bag of maize seed can be turned into 30 bags of (second generation) seed within a few months.

Another reason that private firms have difficulty capturing the value of a new seed variety is that seed is an *experience good*, meaning that the quality of the seed is not obvious at purchase and is generally not known until the seed is used (or "experienced"). Consumers are unwilling to pay the full price of a good without being sure of the quality. The reputation of the producer or the vendor often becomes important in the case of experience goods. Sometimes, third-party certification schemes or government standards are used to address this market failure. But in the case of seed in developing countries, it is difficult for new seed companies to earn a reputation for quality, and government seed certification services are not always reliable or effective.

In light of these issues, how do we explain private-sector investment in hybrid seed and vegetable seed, as well as investment in other seeds in high-income countries? The good performance of hybrid seed lasts only one year. For example, the seed produced by a crop of hybrid maize performs very poorly, requiring the farmer to purchase new seed each season. Similarly, vegetable seeds are difficult to harvest and re-use because they are often small and perishable, requiring special care to re-use. And in high-income countries, private seed companies can invest in research on varietal development of open-pollinated varieties with the expectation of making a profit because of stronger patent-protection rules and the reputation they have acquired over time.

Table 5.2. Comparison of regulations regarding registration of varieties

Country or region	**Regulations concerning registration of seed varieties**
Ethiopia	According to the 2013 Seed Proclamation, any variety to be released must be registered by the Ministry of Agriculture. It is not legal to import or export seed without getting permission from the Ministry. Draft regulations call for one season of VCU and DUS testing for varieties already registered in another country, and two seasons for varieties not registered elsewhere.
Kenya	Variety registration is required for food crops but not vegetable crops. Registration is based on two years of testing or one-year of testing if already registered within the East African Community.
Tanzania	Registration is required for new varieties of all crops, and registration is based on two years of DUS testing and one year of VCU testing.
COMESA	Proposed rules will establish a COMESA-wide seed register. Any variety registered in two or more COMESA countries would be included and could be legally sold in member countries.
South Africa	Registration is required for new varieties of all crops, but registration is based on one year of DUS testing.
Ghana	All seed sold must be registered. Registration requires VCU and DUS testing for field crops and vegetables.
India	Seed varieties do not need to be registered. Before 1988, it was illegal for private seed companies to introduce new varieties based on imported seed, but now this is allowed.
Bangladesh	Registration requires two years of DUS and VCU testing for the five main crops, but is free and automatic for all other crops.
Turkey	Before 1982, registration required several years of VCU and DUS testing. After 1982, seed companies can do their own VCU testing and the acceptance rate increased substantially.
European Union members	Automatic registration if registered in another EU country. If not, field crops require two years of VCU and DUS testing, while vegetable crops require one year of DUS testing.
United States	Variety registration is voluntary.

Source: Gisselquist, 2013; FDRE, 2013. COMESA = Common Market for Eastern and Southern Africa; DUS = distinctiveness, uniformity, and stability; VCU = value in cultivation and use.

Another policy issue related to seed varieties is the legal conditions under which a new variety can be sold to farmers. Table 5.2 summarizes the regulation of variety registration in selected countries. Seed policy may make varietal registration optional or mandatory, and the rules may vary across crop categories. Most commonly, such regulations differ between field crops (cereals, pulses, oilseeds, etc.) and vegetables. In addition, there are differences in the type of testing that is necessary before a variety can be registered.

One type of testing is for distinctiveness, uniformity, and stability (DUS) to confirm that the seed actually represents a new variety. Seed may also be tested for value in cultivation and use (VCU), which examines whether the variety has advantages in cultivation (e.g., yield and pest resistance) or use (e.g., taste and texture of the product).

Most countries require one or two years of VCU and DUS testing for variety registration, but many provide easier or automatic registration for varieties of vegetables, minor crops, or varieties that have been registered in neighboring countries. Variety registration is voluntary in the United States and India, and in Bangladesh for all but five crops. It is also worth noting that reforms of seed policy over the past 20 years have generally relaxed seed registration requirements.

5.2. Seed multiplication

Seed multiplication refers to the multiple cycles of planting the seed and harvesting the grain for replanting. Multiplication must be done under carefully controlled conditions to avoid contamination of the seed with genetic material from other varieties, other crops, or weeds. The conditions are particularly tightly controlled in the early generations of seed production, but less so in the later ones. The number of generations necessary to reach the desired volume depends partly on the crop. Each maize seed can produce 30 seeds for the next generation, whereas the ratio is 10:1 for wheat and 5:1 for beans.

In many developing countries, seed multiplication is carried out by research stations or by state-owned seed companies on state farms. The last cycle of multiplication may be contracted out to medium- and large-scale farmers who agree to follow certain seed crop management procedures. Given the right policy environment, private seed companies will emerge to carry out all stages of multiplication from the initial breeder seed produced by researchers. Initially, these seed companies make use of imported or public-sector breeder seed, but eventually they may expand into the development of new varieties. As private seed companies become more important, the role of the government in seed production narrows to registering seed companies and certifying the quality of the seed, leaving activities related to the technical production of the seed to the private firms.

This makes sense from the point of view of economic theory, as there is no particular economic rationale for public-sector seed multiplication. Since seed companies receive the germplasm in the form of breeder seed, there is no excludability issue. Seed remains an experience good, so the seed companies and the seed certification service must earn reputations for quality in order to convince farmers that it is worth paying a premium for commercial improved seed rather than saving or buying ordinary grain for replanting.

In spite of the advantages of allowing the development of private seed companies, a number of regulations make it difficult to do so. First, the establishment of private seed companies may be prohibited in some countries and restricted in many others. In a number of African countries, registration as a seed company involves meeting detailed criteria regarding staff training, equipment, and seed distribution network. In South Africa, seed companies do not need to register, but the locations used for seed processing, packing, and sales must meet some reasonable criteria. At the other extreme, seed company registration is automatic in Bangladesh, India, the European Union, and the United States, requiring only submission of information about the company (Gisselquist 2013).

In addition, private seed companies are initially dependent on access to good-quality germplasm, either from public agricultural research institutes or imported from external seed developers. If the quality or the quantity of breeder seed is uneven, this affects the profitability of the seed company as well as threatens its reputation with farmers.

Third, seed companies are affecting by government regulations regarding seed certification. Ghana and Tanzania have the most restrictive regulations, requiring certification for all crops. Kenya, Turkey, and the

EU require certification for field crops but not for vegetables (Table 5.3). In contrast, South Africa, Bangladesh, and the United States make seed certification voluntary for all crops.

Table 5.3. Comparison of regulations regarding seed certification

Country or region	Regulations concerning seed certification
Ethiopia	Certification is required for all crops
Kenya	Certification is voluntary for vegetable crops, but required for field crops.
Tanzania	Certification is required for all crops.
South Africa	Seed certification is voluntary for all crops.
Ghana	Seed certification is required for all crops.
India	Seed certification is voluntary except for varieties released by public research institutions.
Bangladesh	Seed certification is voluntary for all crops for retail sale.
Turkey	Certification is voluntary for vegetable crops, but required for field crops.
European Union members	Certification is voluntary for vegetable crops, but required for field crops.
United States	Seed certification is voluntary.

Source: Gisselquist (2013) and FDRE (2013).

Over time, many countries have reformed their seed policies to allow for a greater role for private seed companies. In India, public agricultural research institutions and state-owned seed corporations dominated the seed system in the 1960s and 1970s. However, reforms in 1988 and 1991 established a framework for greater private-sector participation in the seed sector. Initially, vegetable seed markets were liberalized, and seed companies focused on the production of hybrid vegetable seed. Later, these seed firms started selling hybrid sorghum and millet, followed by hybrid maize, cotton, and rice. Currently, there are over 400 domestic and six multinational seed companies operating in India. Private firms account for 60 to 70 percent of seed sales for pearl millet, sorghum, and hybrid maize. However, the public-sector research system still plays a role in developing new open-pollinated crop varieties and providing breeder seed to cooperatives and seed companies for multiplication (Spielman and Mekonnen 2013).

5.3. Seed marketing

Seed marketing refers to the sale of seed to farmers. Seed vendors should be knowledgeable about the strengths and weaknesses of the different crop varieties they offer and be able to provide farmers with unbiased information. If they sell a range of agricultural inputs, this makes input purchases easier for farmers. The seed retailing network should also be efficient so that it can operate on small margins, keeping the price of seed low. And finally, the system should feature a large network of vendors, making it easy for farmers to physically access seed and other inputs.

In many low-income countries, seed distribution is carried out by a state-owned seed enterprise, by extension agents, and by agricultural cooperatives. This was the dominant approach in Ethiopia under the piloting of the DSM program. State-owned seed enterprises have been criticized for high costs because the staff are salaried civil servants with less incentive to serve the needs of their customers. Extension agents are knowledgeable, but using them to distribute seed is an unnecessary distraction from their core function of providing advisory services to farmers. Cooperatives have much lower costs and better incentives to assist their member-farmers, but cooperatives do not always have the skilled personnel to provide advice to their farmer-members on the use of inputs.

Private agro-input dealers play a larger role in the distribution of seed, fertilizer, and other agricultural inputs in African countries with more developed seed systems, such as South Africa, Kenya, and Ghana. For example, Ghana has left input distribution entirely to the private sector. An inventory in 2009 identified 3,425 agro-input dealers, which indicates a density of one dealer per 100 km^2, which implies that the average distance between a farmer and a seed dealer is less than 4 km.[5] A survey of dealers indicated that 66 percent sold improved seed, with maize and vegetable seed being the most common types sold (Krausova and Banful 2010).

In Kenya, the state-run seed system began to deteriorate in the 1980s as a result of high costs, late delivery, mismanagement, and political interference. The seed sector was liberalized in 1996, but the response of the private sector was slow, partly due to the existence of various input-subsidy programs. In the mid-2000s, several programs were launched to promote the growth of a professional network of agro-input dealers, providing start-up credit, training, and the formation of an association of input dealers with its own code of conduct. In addition, the program promoted the distribution of smaller bags of seed, more appropriate to the needs of small farmers. As of 2009, there were more than 7,000 agro-input dealers in Kenya. One study attributes the growth in input use in Kenya to the increase in the density of the network of agro-input dealers, reducing the mean distance to the nearest dealer from 8.4 km in 1997 to 3.4 km in 2007. The higher density and better road connections have increased competition and reduced marketing margins (Ariga and Jayne 2009; Odame and Muange 2012). Based on the experience in Kenya, programs to promote the development of networks of agro-input dealers have been implemented in Tanzania, Malawi, Zimbabwe, Mali, and Sierra Leone, among other countries. Most of these programs include training, credit, and the formation of professional associations (Chinsinga 2012; CNFA 2016).

The density of the network of agro-input dealers depends partly on the demand for improved seed, but it is also affected by price policy and business regulations. Price controls and other restrictions inhibited the emergence of private seed companies in Kenya in the 1980s and early 1990s (Odame and Muange 2012). Similarly, hyperinflation combined with price controls and numerous programs to distribute subsidized inputs created an unfavorable environment for private agro-input dealers in Zimbabwe during the 2000s. As a result, the number of registered dealers declined by 85 percent, from over 2,000 in the year 2000 to just 300 in 2010 (Muganda 2012).

The regulation of seed dealers as businesses also has an effect on the sector. Almost all countries require registration of input dealers, but there are wide differences in the requirements (Table 5.4). In the United States, the EU, India, and Bangladesh, registration is either not required, automatic, or very easy. Kenya, Tanzania, and Ghana have more detailed requirements, but they are not too burdensome.

Table 5.4. Comparison of regulations regarding registration of seed dealers

Country or region	Regulations concerning registration of seed dealers
Ethiopia	According to the 2013 Seed Proclamation, registration is mandatory. Each seed dealer must have a Certificate of Competency.
Kenya	Registration is required but only nominal requirements
Tanzania	Registration is required but requirements are modest
South Africa	Registration of business not required, but premise must meet modest requirements.
Ghana	Registration is required but requirements are modest
India	Registration is required but automatic
Bangladesh	Registration is required but automatic
European Union members	Registration is required but only nominal requirements
United States	No federal registration, but states may require registration

Source: Gisselquist (2013), FDRE (2013).

[5] If each dealer covers a circular area of 100 km^2, the radius of the circle is 5.6 km. If the households are uniformly distributed over the circle, then half of them live less than 4 km from the center. Since households are often clustered and dealers are generally located in those clusters, the average distance will generally be less than 4 km.

5.4. Informal seed systems

In addition to the formal seed system described above, there is an informal seed system in which farmers use grain saved from the previous harvest, exchanged with neighbors, or purchased from traders and other farmers. Most seed used by farmers in sub-Saharan Africa is obtained through these informal channels. In a study of five African countries and Haiti, McGuire and Sperling (2016) found that 90 percent of the seed used by small-scale farmers in these countries comes from the informal sector. According to surveys conducted by Ethiopia's Central Statistical Authority, seed saved by farmers or supplied through the informal sector is used on 64 percent of the maize area, 94 percent of the wheat area, 98 percent of the teff area, and more than 99 percent of the barley and sorghum area of the country.

Although it is often assumed that seed obtained through the informal sector represents local varieties (also called landraces), DNA testing suggests that a large share of this seed is descended from improved varieties. In other words, the distinction between the formal and informal sector is not between seed of improved varieties and local varieties, but rather between first-generation improved varieties and seed which includes considerable amounts of improved germplasm recycled over several generations of planting.

In addition, it should be noted that saving seed is not a practice limited to developing countries. For example, in the United States, saved seed is used for 90 percent of the wheat area, roughly half of the soybean and cotton area, and 5 percent of the maize area (USDA 2004). One reason for the large difference between wheat and maize is that wheat is self-pollinated, so improved wheat seed retains its superior crop performance for many years. In contrast, maize is cross-pollinated, so performance of the variety is reduced by genetic mixing each year. One implication of this is that saving seed is not necessarily a reflection of inadequate supply, lack of purchasing power, or uneducated farmers. In some cases, saving seed, particularly for wheat and other self-pollinated crops, may be an economically rational decision.

In many African countries, the sale of seed that has not been certified is not recognized in the seed legislation, meaning that the sale of seed in the informal sector is technically illegal. Although such regulations are rarely enforced, the legal uncertainty around producing a crop for sale as seed makes it risky for a small-scale farmer to grow seed for local sale. Although considerable resources are devoted to the formal seed sector, which serves only a small share of the seed requirements of farmers in Ethiopia, the informal sector is treated with benign neglect, at best. Even small improvements in the transparency and efficiency of the informal seed sector could yield substantial gains in terms of agricultural production and in improving the welfare of farming households across Ethiopia.

6. SUMMARY AND RECOMMENDATIONS

6.1. Summary of evaluation of Direct Seed Marketing program in 2015

Most seed in Ethiopia is grain saved from the previous harvest, obtained from another farmer, or purchased from a trader. The share of seed that is purchased from a cooperative or the Bureau of Agriculture is about 36 percent for maize, 6 percent for wheat, and 2 percent for teff (Table 1.2). In order to increase grain yields, the government seeks to expand the availability of improved seed. Under the CSM system, seed enterprises supply improved seed to the regional BoAs, who distribute it to WoAs, who supply the seed to DAs, cooperative unions, and primary cooperatives, who in turn distribute the seed to farmers. The ATA is experimenting with an alternative system in which seed enterprises are allowed to sell directly to private seed distributors and primary cooperatives, thus streamlining the seed supply channel. This report reviews the experience of the DSM system.

A comparison of the household characteristics of households in DSM woredas and those in control woredas show no notable differences. This give us confidence that the households in DSM woredas are otherwise similar to households in the control group, at least in terms of observable characteristics. About 85 percent of the surveyed households grew maize, and among maize growers, about 83 percent grew improved maize varieties. About two-thirds of the farmers in the sample grew teff, and of these, roughly 40 percent grew improved varieties. Less than half of the sample grew wheat.

The performance of the DSM system was measured on eight dimensions: seed availability, sufficiency of supply, timeliness of delivery, seed pricing, quality, ensuring accountability for low-quality seed, ease of purchase, and use of public resources. The results for each dimension are summarized below.

Seed availability: Is DSM able to deliver the type of seed requested by farmers? The farm survey asked farmers whether they had received the type of seed that they had requested. Overall, over 95 percent of farmers reported receiving the type of seed they requested, with no statistically significant difference between CSM and DSM farmers. Across all four regions, more than 90 percent of farmers reported that they received the type of maize seed that they requested. In Amhara, the performance of the DSM system in supplying maize seeds that matched the requests was significantly better than was the case with the CSM system. Farmers were also asked whether they agreed that the seed system was providing the seed that most farmers need. The responses, on a five-point scale, were not significantly different between DSM and control woredas. Over 85 percent of surveyed farmers in Amhara reported being satisfied or very satisfied, while the corresponding share in Oromia was less than 45 percent. SNNP fell in between Amhara and Oromia in terms of the level of satisfaction with seed availability. When farmers in DSM woredas were asked to compare DSM and CSM, 60 percent said DSM performed better the CSM, while 15 percent said they performed equally.

Sufficiency of supply: Another common problem with the seed system in Ethiopia is that the supply of improved seed does not match demand. The survey asked farmers whether they were able to purchase enough seed to meet their need. Overall, DSM and CSM performed at about the same level for hybrid maize and haricot bean. On the other hand, the conventional seed marketing system performed better than DSM in the case of teff and wheat in that a higher share of CSM farmers reported having obtained sufficient supplies compared to DSM farmers.

DSM farmers reported a relatively high level of satisfaction with the seed supply. Almost 60 percent said they were satisfied or very satisfied. Performance varied by region, however, with more than 70 percent being satisfied or very satisfied with the adequacy of seed supply in Amhara and Tigray, but less than 40 percent of the farmers in Oromia were satisfied or very satisfied. Similarly, close to 60 percent of farmers said that DSM did better or much better than CSM in terms of ensuring adequate supply.

Timeliness: The third seed problem examined in the study was timeliness of seed supply. Overall, it seems that late delivery of seed was a more common problem in DSM woredas than in CSM woredas. In DSM woredas, just 68 percent of farmers received the seed before planting, while in CSM woredas, the share was 83 percent. Given this performance, it is surprising that more than 70 percent of farmers said they were satisfied or very satisfied with the timeliness of seed delivery in DSM woredas. Similarly, in comparing CSM and DSM systems, more than 60 percent said that DSM was better or much better than CSM in terms of timely delivery of seed.

Seed pricing: Another dimension along which DSM was evaluated was seed pricing. The farm survey compared the prices for important varieties of maize, wheat, teff, and haricot beans. Of the ten varieties whose prices were compared, only one variety showed a difference between the average CSM and DSM price that was statistically significant – maize variety BH540, on average, was more expensive in the DSM woredas (28.7 birr/kg) than in the CSM woredas (26.4 birr/kg). The other nine varieties showed no statistically significant difference in price.

Farmers expressed considerable dissatisfaction with the price of seed in DSM woredas. Less than 20 percent of the farmers were satisfied or very satisfied with the price of seed in the DSM woredas. This is somewhat surprising given the lack of significant differences in price between CSM and DSM woredas.

Seed quality: DSM suppliers were encouraged to allow farmers to check seed quality before buying. The percentage of farmers that were allowed to check the quality of their hybrid maize and teff seed was higher in DSM woredas than in CSM woredas, although the pattern did not extend to other crops. Overall, more farmers reported seed quality problems in DSM woredas (26 percent) than in CSM woredas (21 percent). Seed problems were most common for hybrid maize, with more than one-third of farmers reporting a problem with this type of seed. In spite of the greater share of farmers reporting problems in DSM woredas, a majority of farmers (61 percent) said that DMS was better at providing quality seed than CSM.

Accountability: The DSM system was designed to hold seed producers accountable for the quality of the seed they produce. Of those farmers with seed quality problems, a smaller share of farmers in DSM woredas (47 percent) reported problems compared to CSM woredas (64 percent). Almost 40 percent of farmers were dissatisfied with the system of accountability for seed quality. Thus, it is surprising that a majority of farmers who experienced both systems felt that DSM was better or much better than CSM in ensuring accountability for seed quality.

Ease of purchase: The farmer survey was designed to evaluate the convenience of seed purchase using the DSM system. We find that across all crops the median time to walk from the residence of the surveyed farmers to the point of purchase was 30 minutes for both DSM and CSM woredas. The time to the point of purchase was longer for DSM than CSM for wheat in SNNP and in Tigray, but for other regions and other region-crop combinations, there were no statistically significant differences. In addition, farmers in DSM woredas needed to make fewer trips to obtain the seed they needed. This was particularly true for hybrid maize.

Cost to public sector: The final performance criterion considered was the cost of seed distribution in terms of public sector resources. We compared the number of days spent on seed marketing by DAs. Overall, the DSM system requires an average of 51 days of DA time compared to 104 days for the CSM system. In other words, DSM reduces the DA's workload by one half compared to CSM, freeing up time that they can spend on training and advisory tasks that are the core of their responsibilities.

Generally, the lack of significant difference between DSM and CSM for many of the KPIs in the household survey could be attributed to the positive externalities of the targeted capacity building activities for DSM over the CSM system. The MoA, in partnership with ATA, BoA, and other development partners, organized DSM awareness creation, planning, implementation and evaluation workshops and developed guidelines for federal, regional, zonal, and woreda seed experts and decision-makers. In most cases, the persons who participated in the DSM capacity building activities are also those who led decision-making related to CSM. This suggests that there is a high likelihood of adapting and using DSM related knowledge, and skills acquired within the DSM system to improve CSM performance. As a result, it might be hard to see significance differences between the DSM and CSM systems for many of the KPIs used.

The inter-regional variation in farmer satisfaction suggests differing degrees of DSM implementation by regional officials. The relatively positive experiences of Amhara can be contrasted to the less positive outcomes reported in SNNP. There seem to be a wide variety of possible reasons for this, such as numbers of DSM providers and consistency of DSM pilot woredas. But, fundamentally this may be the result of regional commitment. At the very least, regional experience sharing could help the overall success of DSM going forward.

Concerning seed producers, most of them were satisfied or highly satisfied with the performance of the 2015 DSM based on the majority of KPIs. However, some remained dissatisfied with how well the program provides the seed requested by farmers in sufficient quantities. Lack of adequate breeder, pre-basic, or basic seed; poor market incentives; a shortage of land for certified seed multiplication; lower financial capacity; and poor promotion of available technologies remain as challenges for seed producers. They also said DSM performed better or much better than CSM in terms of ensuring accountability of stakeholders if farmers had complaints about the seed they bought. Unlike the chain of supply for CSM, the accountability of DSM seed producers is improved as farmers can better know who produced the seed they purchased. Similarly, seed producers believed that there was improvement in DSM in most of the KPIs when compared with CSM. However, there were some concerns about seed availability and adequacy.

6.2. Recommendations for the Direct Seed Marketing program

Overall, how does the DSM system compare to the CSM system? Based on the objective measures of the eight performance indicators, we see mixed results.

- In terms of seed availability, over 90 percent of farmers were satisfied with the type of seed they received, but there was no statistically significant difference between CSM and DSM.
- Regarding sufficiency of supply, the two systems performed equally well in delivering hybrid maize and haricot bean seed, but CSM performed better in the case of teff and wheat.
- Seed prices were roughly the same in the two systems for nine of the ten varieties tested.
- Seed quality problems were somewhat more common in DSM woredas than in CSM woredas, particularly for hybrid maize.
- In terms of accountability, a smaller share of DSM farmers who had seed quality problems reported it compared to CSM farmers.
- The ease of seed purchase was the same in terms of median travel time to a point of sale, but the DSM woredas required fewer trips to obtain the needed seed.
- In terms of the public-sector cost, DSM required 50 percent fewer days of effort by DAs, the farm-level agricultural extension agents, compared to CSM.

These results indicate that the DSM program has not met all the expectations regarding the key performance indicators. Taken by itself, one might question the value of scaling up DSM in Ethiopia, but three factors contribute to a more positive assessment of the program.

First, although DSM has not performed better than CSM in most of the performance criteria, it has performed as well as CSM. Importantly, in the case of DSM, there was a sharp reduction in the time required by DAs for seed marketing activities. DSM reduced the public-sector cost of seed distribution with no net reduction in performance in terms of seed availability, sufficiency of supply, price, and ease of purchase.

Second, it is important to recognize that the DSM system has only been in effect for a few years, so the various actors are still learning their new roles. If DSM can equal the performance of CSM after just a few years, there is a fair chance that, as the system is refined and as participants learn their roles, it may outperform CSM over time.

Third, and perhaps most importantly, the subjective evaluation of the DSM system on various performance indicators is almost uniformly positive. It is not clear why the subjective evaluations are so positive, but farmers in the DSM woredas who have experience with both DSM and CSM are quite consistent in rating DSM more highly on numerous criteria. Sixty percent of them say that DSM was better at supplying the right seed; a similar share report that DSM was better at supplying sufficient quantities of seed; more than 60 percent said DSM provided seed in a more timely way than CSM; 61 percent believe DSM provided higher quality seed; and a majority rated DSM higher in terms of accountability.

The results also provide some guidance regarding specific areas that need improvement in the implementation of the DSM system.

- In general terms, the implementation of DSM seems to have been most successful in Amhara and least successful in Oromia, with the experiences for Tigray and SNNP falling in between these two regions. This was the case in farmer perceptions of seed availability, sufficiency of seed supply, and other performance indicators. Since the DSM program started in Amhara, this difference may reflect greater experience with DSM there. In addition, as mentioned above, there may be differences across regions in the level of confidence and commitment to the concept of DSM.
- In terms of sufficiency in supply, there is a need to improve the supply of teff and wheat under DSM.
- With regard to seed prices, the only statistically significant different between CSM and DSM prices was for the maize variety BH540, which was somewhat more expensive in DSM woredas. It would be worth exploring why this was the case in order to address the problem for coming years.
- Seed quality was most often a problem for hybrid maize. Again, efforts to improve seed quality could begin with the case of hybrid maize.
- One of the most common complaints about DSM concerns the system of accountability for seed quality. Roughly 40 percent of the respondents were dissatisfied with this aspect of DSM.
- The travel time to the point of purchase was generally similar in CSM and DSM woredas. One exception was wheat seed in Tigray and SNNP, for which farmers in DSM woredas reported significantly longer trips than farmers in CSM woredas.

6.3. Recommendations for seed system development in Ethiopia

The DSM evaluation provides some guidance for improving the Ethiopian seed system over the next few years. But, it is worth thinking about additional steps that can be taken to accelerate the release of new crop varieties, expand the capacity of the seed system, and increase the availability of improved seed at the farm level. Guidance for the evolution of the Ethiopian seed system over the next 5 to 10 years can be found in the experience of other countries and the economic principles behind seed as a commodity.

Cross-country comparisons reveal a wide variation in the number of new varieties released per year. The rate of release of new crop varieties in Ethiopia is better than in some African countries but lags far behind South Africa and Kenya. Global studies show that public investments in breeding and other types of agricultural research have high rates of returns. In order to accelerate the pace of varietal development, which is what motivates the growth and performance of the seed sector, the government should pursue the following:

- Increase public investment in agricultural research and development until it reaches at least 1.0 percent of the value of agricultural output. This is approximately five-times the current level of investment in Ethiopia (ASTI 2016). Predictability in this flow of funds to agricultural research from one year to the next is also important, so a credible five-year plan would allow better use of resources.
- Do not require or expect that public-sector agricultural research and development activities will be economically self-sufficient. Although the activity produces benefits for society, these benefits cannot be easily captured as a source of revenue.
- Create an enabling environment for private seed companies to carry out varietal development research. Initially, these efforts will focus on hybrid and other seed that is difficult for farmers to reproduce.
- Reduce the required testing for variety registration to one or two years at most, and consider making registration automatic or voluntary for vegetable seed varieties and other minor crops.
- Prepare for the development of the COMESA variety catalogue by committing to provide automatic registration of varieties in the catalogue. Acceptance of a variety by COMESA will be based on registration in at least two other COMESA countries.

Another recurrent problem in Ethiopia is the lack of seed production capacity. International experience and economic theory suggest that private firms can play a useful role in expanding capacity in the seed system, initially in seed multiplication and eventually in varietal development. What are the elements of the policy environment that allow seed companies to take responsibility for seed multiplication?

- State-owned seed enterprises should make use of contract farmers to produce the last generation of seed (certified seed).
- The government should reduce or eliminate subsidies to support state-owned seed enterprises. These parastatal seed enterprises should continue to receive breeder (basic) seed from research institutions, but on the same terms as private seed companies.
- Ethiopia could relax restrictions on international trade in seed. One approach is for countries in a regional pact to mutually recognize seed that has been approved by other countries in the region, as is emerging within the COMESA group of countries.
- The government must make it clear that private-sector seed production is allowed and encouraged through enabling legislation and policies that are consistent with the seed law.
- Public agricultural research units should make breeder (basic) seed available at subsidized prices to state-owned and private seed companies on an equitable basis.
- The seed certification service should be efficient, fair, and impartial, allowing certification to earn a reputation and giving farmers assurance that certified seed is high-quality seed.
- In order to allow the seed certification service to earn a good reputation, it should be a semi-autonomous body so that it will be insulated from pressure from state-owned seed enterprises to certify all their seed, regardless of quality. It is in the long-run interest of both farmers and seed companies that the certification service establishes a reputation for impartiality.
- While many countries require seed companies to have their seed tested and certified by the government certification service, it is not clear that this is necessary. Particularly as seed companies mature, the desire for companies to preserve their reputation may make certification unnecessary.

Farmer demand for improved seed is based partly on price and quality, but also accessibility. The experience in Kenya and other countries shows that increasing the density of reliable, well-informed seed vendors can stimulate farmer demand. We identify the following guidelines for promoting an effective seed retailer network:

- Seed retailing should be open to private dealers, cooperatives, and other vendors in order to maximize the number of points of sale and minimize the distance farmers must travel to purchase seed.
- Seed price and margin controls should be avoided as they are likely to stifle the development of a large network of agro-input vendors. It is preferable that the seed system rely on competition and price information to ensure affordable prices.
- Streamlining the requirements to register private agro-input dealers will help increase the number of dealers in rural areas, thus reducing the distance to the average farmers. A number of countries make approval of registration of seed retailers automatic.
- Training input dealers is a cost-effective way to deliver information about agricultural inputs to farmers.
- Creating an association of agro-input dealers with a code of conduct is a way to promote professionalism and long-term commitment to the field, reducing the likelihood of dealers knowingly distributing counterfeit products.

The informal sector represents the main source of seed in most developing countries, but government policy toward the informal sector ranges from suspicion to benign neglect. There is agreement among seed specialists that the following reforms could improve the informal seed sector:

- Revise the seed law to explicitly recognize and acknowledge the fact that most farmers continue to rely on the informal seed sector for most of their seed requirements.
- Consider adopting “quality declared seed”, a designation proposed by the FAO (2006) for a type of seed that follows certain production guidelines, but the seed is not tested and certified.
- Consider adopting “truth-in-labeling” regulations, where any type of seed may be sold if the labeling is accurate. Such a system requires farmer training and awareness campaigns so that they understand the difference between certified seed and other seed.
- Promote connections between the formal and informal seed sectors. For example, selected farmers could act as seed producers for a village or district, receiving certified seed and multiplying it for local distribution. This provides a way to distribute (second generation) certified seed more widely at a reasonable cost.

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APPENDIX

Appendix Table 1. Seed demand and supply by region, 2015

Crop	Amhara	Oromia	SNNP	Tigray	All
Total seed demand, mt					
All DSM Crops	4,761.8	*ND*	2,940.7	*ND*	
Maize	4,595.5	4,413.3	984.7	*NA*	
Teff	*NA*	*ND*	15.0	*ND*	
Wheat	166.3	*ND*	1,807.0	*ND*	
Haricot bean	*NA*	*ND*	131.0	*NA*	
Barley	*NA*	*NA*	3.0	*ND*	
Potato	*NA*	*NA*	*NA*	*ND*	
Faba bean	*NA*	*NA*	*NA*	*ND*	
Total seed supplied, mt					
All DSM Crops	3,742.3	8,467.6	1,253.6	354.3	13,817.8
Maize	3,542.3	3,142.4	552.8	*NA*	7,237.5
Teff	*NA*	21.1	15.0	21.2	57.3
Wheat	200.0	5,292.1	598.0	56.1	6,146.2
Haricot bean	*NA*	120	85.8	*NA*	97.8
Barley	*NA*	*NA*	2.0	45.0	47.0
Potato	*NA*	*NA*	*NA*	220.0	220.0
Faba bean	*NA*	*NA*	*NA*	12.0	12.0
Seed supplied as ratio of seed demand, percent					
All DSM Crops	79	*ND*	43	*ND*	
Maize	77	71	56	*NA*	
Teff	*NA*	*ND*	100	*ND*	
Wheat	120	*ND*	33	*ND*	
Haricot bean	*NA*	*ND*	65	*NA*	
Barley	*NA*	*NA*	67	*ND*	
Potato	*NA*	*NA*	*NA*	*ND*	
Faba bean	*NA*	*NA*	*NA*	*ND*	

Source: Compiled from regional BoA and ATA (2015)
Note: ND refers to "no data"; NA refers to "not applicable"

Appendix Table 2. Where survey households purchased their seed in 2015, by crop and region, percent of survey households

Region	Distribution center	Hybrid maize		Teff		Wheat		Haricot bean		Average	
		CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM	CSM	DSM
All	Woreda center	24	16	29	40	11	26	25	40	22	31
	Sub-woreda center	4	13	4	0	8	1	0	0	4	4
	Kebele center	65	57	58	53	77	70	66	53	66	59
	Village	0	2	4	2	0	2	6	3	3	2
	Other kebele center	6	8	3	0	2	0	0	3	3	3
	Other woreda center	1	3	1	4	1	1	3	0	2	2
Amhara	Woreda center	0	9	7	0	4	0	0	0	3	2
	Sub-woreda center	15	16	12	0	19	20	0	0	12	9
	Kebele center	69	63	70	0	69	80	0	0	52	36
	Village	0	0	0	0	0	0	0	0	0	0
	Other kebele center	15	10	10	0	4	0	0	0	7	3
	Other woreda center	0	2	0	0	3	0	0	0	1	0
Oromia	Woreda center	2	22	14	10	33	11	33	63	21	26
	Sub-woreda center	0	15	0	0	0	0	0	0	0	4
	Kebele center	88	47	57		33	83	50	38	57	56
	Village	0	3	0	10	0	4	0	0	0	4
	Other kebele center	7	9	0	0	33	0	0	0	10	2
	Other woreda center	4	5	29	20	0	2	17	0	12	9
SNNP	Woreda center	47	21	47	65	30	63	23	32	37	45
	Sub-woreda center	0	1	1		70	37	0	0	18	13
	Kebele center	53	74	45	35	0	0	69	59	42	42
	Village	0	3	7	0	0	0	8	5	4	2
	Other kebele center	0	1	0	0	0	0	0	5	0	1
	Other woreda center	0	0	0	0	0	0	0	0	0	0
Tigray	Woreda center	13	0	0	17	0	13	0	0	3	7
	Sub-woreda center	0	0	0	0	0	0	0	0	0	0
	Kebele center	88	0	94	83	100	87	0	0	70	43
	Village	0	0	0	0	0	0	0	0	0	0
	Other kebele center	0	0	0	0	0	0	0	0	0	0
	Other woreda center	0	0	6		0	0	0	0	2	0

Source: Authors' computation based on data from the Direct Seed Marketing farmers' survey (2015). DSM = Direct Seed Marketing; CSM = Conventional Seed Marketing.

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