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Review Paper

The roles of Effective input supply and service delivery methods for Transformation of smallholder crop production systems empirical evidence from Ethiopia

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***Abstract*—A key institution that boosts the productivity of smallholder farmers is the provision of agricultural inputs and services. Essential agricultural technologies in Ethiopia include high-quality seeds, seedlings, agrochemicals, veterinary care, livestock, artificial insemination, credit, and production and processing equipment, mostly supplied by the government. The lack of private sector involvement poses a significant challenge to meet farmers' demands for improved seeds. This outlines the main actors and their roles within Ethiopia's official seed system. The development of new varieties is the responsibility of universities, regional agricultural research institutes, and the Ethiopian Institute of Agricultural Research. They also participate in the production of basic seeds. At the federal level, the National Variety Release Committee is in the role of deciding whether or not the kinds that researchers have suggested will be formally registered and made available for production. Seed production is carried out by the Ethiopian Seed Enterprise, Regional Seed Enterprises, private businesses, Seed Producers Cooperatives, and unions. During the production, processing, and selling of seeds, the Ministry of Agriculture and the Regional Bureau of Agriculture carry out regulatory tasks. However, they made very little contribution, with 96% of the sector coming from the informal seed system. This indicates the necessity for a change in policy.**

Keywords*—*smallholder farmers, agricultural input supply, formal seed system, informal seed system, productivity, Seed Producer Cooperatives

I. INTRODUCTION

Agriculture in Sub-Saharan Africa remains the backbone of its economy and sustains the livelihoods of the bulk of its poorest households. The agriculture sector within the countries of Sub-Saharan Africa (SSA) contributes on average 15 % of Gross Domestic Product (GDP) and accounts for around 57 percent of employment. Developments in agriculture are of particular importance to the region's poorest households because many poor reside in rural areas where employment alternatives are scarce. Empirical evidence confirms that growth within the agriculture sector is one of the most effective ways to scale back poverty [72].

Agriculture is that the commonest livelihood strategy and therefore the basis for the Ethiopian economy. The agriculture sector contributes 39% of the national GDP [69], and 83% of the population is engaged in agriculture. The bulk (90%) of the agricultural population relies mainly on crop-livestock systems and natural resources for his or her livelihoods, and nearly 60% of the land coverage is under non-pastoral production systems [27]. Mixed crop-livestock production may be a regular activity within the highlands of the country [74].

The government in Ethiopia has implemented various agricultural policies like market liberalization, structural adjustment, Agricultural-Led Industrialization, Sustainable development, and Poverty Reduction Program, Participatory and Accelerated Sustainable Development to Eradicate Poverty and successive Growth and Transformation Plans I and II to boost productivity in agriculture between 1991 and 2016 [76]. Since 2011, the policy focus has shifted towards growth and transformation of the economy 'Growth and Transformation Plan I for 2010/11–2014/15' (GTP I) (FDRE 2010) and 'Growth and Transformation Plan II for 2015/16–2019/20') (GTP II) [54]. The vision of those plans is to rework the structure of the economy from an agricultural to an industry- and service-driven economy and make Ethiopia become a middle-income country by 2025.The main pathway to transformation is planned to be through export-oriented production schemes. the govt set strategic policy priorities for investment in areas like infrastructure and energy development. Recently, the manufacturing sector has become the most priority area of investment and incentive systems; and across the country, a dozen industrial parks (estates) are being constructed. they're to be equipped with infrastructure – roads, communication, water, and energy supply. Legal, advisory and administrative services are highly decentralized. These efforts have helped the country to draw in foreign direct investment [71].

There are different structural reforms and market liberalization and therefore the change within the agricultural sector in Ethiopia. The role of state-owned farms has dramatically declined and instead the involvement of personal investors in agricultural production has increased. This

policy shift has also re-defined the role of agricultural cooperatives [31]. Government policy allows and encourages the high involvement of personal companies and other entities, including cooperatives, in agricultural production and marketing [14]. Large areas of agricultural production are now shifting to crops that are important for food security, crops used as raw materials for industries (e.g., malt barley for a brewery, bread wheat for flour factories, durum for pastry), commercially traded crops (e.g., haricot bean, sesame), and crops with high market price (e.g., vegetables). Efforts are made to enhance the agricultural productivity and economic development of the country [54].

Ethiopia's rural development policy and methods prioritize the transformation of smallholder subsistence agriculture to market-orientated production. The govt is investing heavily in agriculture with attention on public extension services by deploying considerable human and financial resources. For instance, the Ethiopian government has allocated quite 16% of its annual budget to agricultural development and attained an annual mean agricultural rate of growth of quite 8% for the last 8 years. This is significantly above the agreement among CAADP member countries to allocate 10% of their national budgets to agricultural development and attain a mean annual agricultural rate of growth of 6% (CAADP, 2009). To facilitate the transformation of in Ethiopia agriculture, the government has established the Agricultural Transformation Agency (ATA) to support the Ministry of Agriculture (MoA) and other implementing partners to realize national targets for poverty reduction, food security, and growth by removing systemic bottlenecks within the sector [9].

The other policy perspective is to rework smallholder agriculture from subsistence towards commercially oriented agriculture [29]. Although the strategy isn't clear, the overall expectation is that smallholder production will constitute sources of materials and inputs for the emerging manufacturing sector. The other approach is the promotion of public and personal (foreign and domestic) large-scale commercial farms. The policy expectation on the transformational capacity of this agricultural regime was high, but the outcomes are mixed. Large-scale commercial farms that planned to supply food crops were generally unsuccessful [10].

In general, scholars and policymakers view that trade liberalization in developing countries negatively affects rural households' welfare by depressing world agricultural product prices, that advanced countries have a comparative advantage in agricultural technologies. As an example, removing import tariffs on farming commodities benefits consumers from lower consumption costs, but leave agricultural producers susceptible to competition from foreign agricultural producers that end in both lower profits and wages in developing countries. The microeconomic agricultural household theory argues that agricultural market liberalization adversely affects agricultural producers' welfare and positively influences rural household consumers' welfare in developing countries [76].

Ethiopia's government has imposed restrictions on exports of cereal crops to stabilize domestic supply and encourage oilseed, pluses, and occasional exports that have either a positive or negative impact on welfare. The govt has used agricultural export policies within the sort of export taxes and export bans on different agricultural commodities. The tax on coffee export was abolished in 2002 following declining coffee prices within the international markets. The govt banned the export of major food grains to scale back the food price for urban consumers. The domestic grain prices were tried to scale back by banning the exportation of teff, wheat, maize, and sorghum in December 2006. In June 2008, banning is applied to the exportation of all cereals. The chart has been taxed at 29% since 1993. The oilseed and pulses are free of export taxes [60]. The Ethiopian government has used overvalued exchange rates to tax farmers and promote oilseed, pluses, and occasional exports that increase costs of agricultural production [3].

The government of Ethiopia has employed several agricultural policies to extend productivity and production in agriculture, efficiency within the processing and marketing chain that have a considerable positive effect on rural households' welfare. Policy instrument in structural adjustment program is market liberalization to boost crop productivity and production, rural households' participation in emerging markets and increase their income through commercialization and, therefore, enhance rural households' welfare (Wang et al. 2009). The fertilizer markets were liberalized to maneuver the fertilizers from sources to the farmers or final users. The govt of Ethiopia has authorized monopsonies and monopolies' powers to Agricultural Input Supply Enterprise to import and distribute fertilizers in 2005. Like private companies, this enterprise has imported pesticides and herbicides and distributed these inputs to farmers through cooperatives. Several agricultural inputs, like pesticides, herbicides, tractors, and mixed harvesters are imported and distributed to farmers by private companies. Cooperatives are given monopoly's power to distribute fertilizers to farmers [42].

Ethiopia Ministry of Agriculture has liable for conducting adaptive research and transfer of technology and played a key role within the provision of inputs, particularly fertilizers and pesticides. The agricultural input supply enterprise (AISE has the first responsibility of input supply (fertilizers, pesticides, seeds, and credit) for the peasant sector. AISE operates under the MOA and gathers demands, arranges the importation and distribution of inputs with a robust emphasis on fertilizers and pesticides. AISCO managed over 600 distribution centers throughout the country although little has been achieved in certified seed marketing and distribution (Zewde, 2004).

In Ethiopia's context, the essential and important introduction of technology services is that the provision of improved inputs/services like seeds, seedlings, agrochemicals, drugs, veterinary services, heifers, Artificial insemination, credit, production, and processing tools. Most of those inputs were supplied through the office of agriculture-related to the package. While this has contributed to the event of agriculture, several sources indicate that improved inputs/services are usually briefly supplied, and delivery is usually untimely. Government policy is now stimulating diversification of input/service provision, involving the private sector [39].

The farming sub-sector of Ethiopia is characterized by traditional rain-fed and low productive techniques of production and thus, is prone to the recurrent natural calamity

of drought, which leaves famine and death in its wake. Ethiopian farmers have difficulties in feeding their households on their increasingly fragmenting land, using traditional and backward practices of production. Hence, the drastic need to improve agricultural productivity and production through the adoption and adaptation of improved agricultural technologies and techniques is outward. [64].

Despite the considerable level of investment, the Government of Ethiopia has been putting in the agricultural sector, which is close to 13% of the total government expenditure, Ethiopia's agriculture is still characterized by the application of low inputs, low value of product, and vulnerable to frequent climatic shocks. Due to the limited use of technological packages and inputs, there are still major gaps between farmers' attained yield and the potentially attainable yield for most crops [75].

This paper was reviewed the roles of Effective input supply and service delivery systems for the Transformation of smallholder crop systems in the case of Ethiopia. This review assessment addresses the next objective: Describe the existing Agricultural Input and service delivery systems, analyzed the input supply chain, examined the Adoption, yield response, and profitability of agricultural Inputs and services, identify challenges of input and service delivery sector Development, Recommend Alternative model of agricultural input and service delivery system and suggest policy and institutional reforms in the sector.

II. Methodology of review assessment

This review was assessed through primary and secondary sources data. The data sources mainly captured from google scholar like journal articles, research papers, books, and annual conference papers were incorporated. The other sources of documents for this review paper were addressed through mobile call and contacting focal person the mentioned offices of Agricultural Transformation Agency, Ethiopian Institute of Agricultural Research, Ministry of Agriculture, Ethiopia commodity exchange, etc.

1) Search Strategy The search strategy was systematically designed to retrieve empirical evidence regarding the impact of agricultural input supply and service delivery on the transformation of smallholder crop production in Ethiopia.

2) Identification of Information Sources

- To capture a holistic view of both academic research and policy-oriented data, the search was conducted across four categories of databases:
- International Multidisciplinary Databases: Google Scholar, ScienceDirect (Elsevier), SpringerLink, and Taylor & Francis Online.
- Subject-
  Specific Agricultural Repositories: AGORA (Access to Global Online Research in Agriculture), CABI (Common-wealth Agricultural Bureaux International), and AgEcon Search.
- Institutional and Gray Literature: The Ethiopian Agricultural Transformation Institute (ATI) digital library, Food and Agriculture Organization (FAO) corporate document repository, and the World Bank Open Knowledge Repository.

Local University Repositories: Institutional archives of Haramaya University and Addis Ababa University were manually searched for relevant doctoral dissertations and master's theses to ensure the inclusion of localized empirical data.

3) Search for Keywords and Boolean Logic A "building block" search approach was utilized. Keywords were categorized into four thematic pillars. Boolean operators (AND, OR) were applied to combine terms within and across pillars.

Pillar Keywords and Search Strings

Pillar 1: Target Group "Smallholder farmers" OR "Rural households" OR "Peasantry" OR "Small-scale producers"

Pillar 2: Inputs & Services "Input supply" OR "Improved seeds" OR "Fertilizer" OR "Agrochemicals" OR "Extension services" OR "Service delivery" OR "Agricultural credit"

Pillar 3: Transformation "Agricultural transformation" OR "Productivity" OR "Commercialization" OR "Technology adoption" OR "Market participation" OR "Efficiency"

Pillar 4: Context "Ethiopia" OR "Sub-Saharan Africa"

Example of a full search string:

("Smallholder farmers" OR "Rural households") AND ("Input supply" OR "Improved seeds" OR "Extension services") AND ("Transformation" OR "Commercialization" OR "Productivity") AND "Ethiopia"

4) Inclusion and Exclusion Criteria To maintain the quality and relevance of the evidence, the following criteria were established:

Temporal Scope: Studies published between 1995 and 2022 were included to reflect the transition from early structural adjustment periods to contemporary transformation strategies.

Nature of Evidence: Priority was given to empirical studies that utilized household-level survey data, econometric modeling, or longitudinal case studies.

Language: Only studies published in the English language were considered.

Thematic Focus: Literature must have explicitly addressed the role or impact of input/service delivery on a transformative outcome (e.g., shifting from subsistence to market-oriented farming).

Exclusion Criteria: Studies focusing strictly on the biological or genetic aspects of crop breeding without socio-economic analysis; opinion pieces; and studies focused exclusively on large-scale commercial estates.

5) Screening and Selection Process The selection process involved three distinct phases:

Phase 1 (Screening): Initial records were screened by title and abstract to exclude duplicates and irrelevant topics.

Phase 2 (Eligibility): Full-text articles were retrieved and assessed against the inclusion/exclusion criteria.

Phase 3 (Snowballing): Backward citation tracking (searching the reference lists of included articles) and forward citation tracking (identifying newer articles that cited the included works) were performed to ensure no seminal studies were missed.

6) Data Extraction and Synthesis Extracted data were categorized into a thematic matrix including: (i) type of input/service studied, (ii) methodology used, (iii) key determinants of adoption, and (iv) the specific transformative impact observed (e.g., yield increase or income growth).

III. LITERATURE REVIEW

The way the 'agricultural transformation' is getting used in policy and program documents, or daily conversations within the various national languages like *Amharic*, *Oromifa* lack clarity about what it means, or what could also be expected of it; neither is their agreement on the way to start the transformation processes. Even more disconcerting is that the absence of 'clarity of the concept of agricultural transformation within Ethiopia's academic and policy discourse. Needless to mention, the concept of agricultural and rural transformation must be 'clear' and 'objective', that is, it must express, with exactness, the underlying assumption about necessary and sufficient economic, social and technological changes, and offer unrestricted guidance for policy and program action. Besides, transformation isn't only about the processes involved, it's also about the understanding that it creates jobs, increases incomes, improves and livelihoods, and protects natural resources [40].

A. Agricultural and Rural Transformation in Development Literature

The most generally accepted characterization of agricultural transformation describes the shift from highly diversified, subsistence-oriented farms towards more specialized production, and market supply. Agricultural transformation as offering 'specialization in production, greater use of purchased inputs, greater resource flows to farming, and substantial cuts in unit costs of production from technological changes.' actually, numerous characterization and descriptions of agricultural transformation abound: agricultural populations move out of farming, becoming hooked into the market, the rising ratio of agribusiness value-added as a part of rural-centered agricultural transformation, aggregation of small farms, technologies responding to factor prices (land, labor, and capital), increased infrastructure, higher information/communication penetration, and integration of agriculture into a wider economy. this were not suggest what performance matrix should be deployed to know and measure if a change is happening at the specified speed and scale. And most markedly, international transformation literature doesn't specialize in the standard of lives of the agricultural population or on changes in their wellbeing, except through implicit assumption about ending hunger and poverty [34;56].

A variety of other objectives for agricultural transformation are shown in development literature, especially since the mid-20th century. The more immediate and first objectives of investing in agricultural transformation are "to reduce hunger and poverty", which provides an agricultural led development strategy that might produce more food, and generate more employment within the short run, as has been the case with Ethiopia's policy guidance of the Agricultural Development Led Industrialization (ADLI). The hunger and poverty reduction objectives are important for developing countries like Ethiopia, but they ought to not be the last word goal of agricultural transformation. This must be modernizing the agricultural sector for the future and improving the agricultural living conditions of the population, thereby reducing poverty and hunger [40].

B. Models of agricultural structural transformation

Three models of agricultural structural transformation were identified in several pieces of works literature. One is the classical European model of agricultural transformation of the mid-nineteenth century, which was facilitated by the economic Revolution. Labor demands rose within industry and, consequently, agriculture was 'relieved' of a high density of population with the result that farm consolidation, and accumulation became possible [47]. The pull factor of the main exit of rural labor to urban areas was the industrialization process (Gollin et al. 2016). At an equivalent time, European agriculture was ready to supply food to a population that had doubled in size and was increasingly engaged in non-agricultural work. The expansion in trade and manufacturing, which was integrated with agriculture-led there to being operated within the market and industrial principles that reinforced its competitiveness. This allowed agriculture within the industrialized countries to get capital and wealth that also spread innovation and technological progress within the sector. This successively created the capacity to deploy high-input resources (energy, machinery, fertilizer, improved seeds) that powered productivity. During the post-industrial period, the economics of the developed economies led to the provision and protection of in-depth systems of subsidies and support to agriculture which defined its evolution [47].

The other agricultural development model is that of the revolution that happened in Central America, but primarily Asia, within the mid-1960s to the 1970s. Studies about the Asian conditions preceding the revolution indicate important lessons. The Asian agricultural system was dominantly smallholder and, until the mid-1960s, hunger and malnutrition were predominant in Asia. Nevertheless, many of the Asian countries were already investing and expanding their irrigation systems and farmers were using fertilizer. The introduction of high yielding cereal varieties, which were more aware of plant nutrients, wasn't only fitting to the conditions and practices of the farming system that existed; it also accelerated the use of irrigation and fertilizer, which grew by 2.1 percent and 10.75 percent respectively between 1967 and 1982 [16].

Moreover, interacting and functioning systems of extension, credit, infrastructure, and research resulted in the successful diffusion of innovations. The introduction of exploitation and consolidation programs among smallholder farmers played a positive role in mitigating farmland losses and improving agricultural productivity [46]. Additionally, to those

agriculture-focused efforts, the role of the state was vigorous. Many Asian states sustained high levels of public investment infrastructure and promoted manufacturing sectors, and these are recognized as major reasons for the big increase in food production in Asia. Also, surplus labor moved from agriculture to more productive sectors, like manufacturing and high-value services [62].

The relevance and applicability of the models specified above, especially the revolution to contemporary Africa [38]. Contrasting to European agricultural transformation, which produced high-input, large-scale agricultural systems, the Asian case, which maintained the smallholder agricultural system as its dominant form, appears to be more relevant for Africa. Hence, the Asian experience has been appealing to Africa. Continental initiatives, like the Alliance for a revolution in Africa, regard the revolution as Africa's pathway to reworking its agriculture. AGRA argues that the potential to accelerate an African revolution depends on input intensification [2]. Nevertheless, this ambition isn't without challenges. Whether Africa can afford to adopt heavy use of inorganic fertilizers and pesticides in light of the high economic costs and negative ecological impacts may be a key question. Similarly, progress in water and irrigation development in Sub-Saharan Africa is low (about 4 percent achieved) as compared to south Asia (39 %) and East Asia (29 %) [26].

The third model or pattern which appears in rural Africa is smallholder diversification. Two opposing strands of thought are often identified within the conceptualization of diversification. One conceptualizes diversification as a survival or subsistence strategy by the poor that's born out of multiple crises, i.e., economic, political, and environmental [6;68], urbanization, population pressure, and rising global food prices. [15] It argues that African smallholder households haven't any choice but to diversify their incomes through off-farm activities. Therefore, African smallholder diversification strategies signify not only a process towards multiple occupations but a structural shift within the relative importance of agriculture-described by some as a de-agrarianization and de-peasantization process. The key message here is that diversification out of agriculture is seen as a survival strategy for many African smallholders [58].

C. Ethiopia's input systems and markets from a historical perspective

The Government of Ethiopia (GoE) has consistently emphasized agricultural productivity growth and food security in its long-term development strategies. Key components of those strategies go back to the mid-1960s with the introduction of policies and programs specifically aimed toward increasing access to modern inputs and extension services for the country's largely smallholder-based agricultural sector.

The first such programs were organized as Comprehensive Integrated Package Projects (CIPPs) and promoted by the Imperial regime during the amount 1968–1973. On the bottom, implementation focused on the promotion of recent inputs, credit, extension services, and the formation of cooperative societies, and was highlighted by area development programs: the Chilalo Agricultural Development Unit (CADU 1967), the Wolaita Agricultural Unit (WADU 1970), and the Ada District Development Project (ADDP 1972). Thus, by the Imperial era, Ethiopia's extension services reached only about 16 percent of the farming population, while input and credit provision catered largely to the feudal class instead of the smallholder population engaged in food production [59].

The first Minimum Package Program (1971–1979) attempted to expand access to modern inputs like improved seed and fertilizer, while simultaneously reducing the extent and price of services provided to smallholders. A minimum package area comprised about 10,000 farm households residing along a main all-weather road for 50–75 km and faraway from the road for 5–10km on each side. Although the program was designed during the Imperial era, its implementation continued into the military Derg regime that followed (1974–1991). During this latter regime, economic reforms undertaken by the Derg led to significant changes in Ethiopia's rural landscape (Wubneh 2007). Since the end of the *Derg* in 1991, the GoE has introduced new policies to intensify cereal production, accelerate agricultural growth, and achieve food security under a national economic strategy known as Agriculture Development Led Industrialization (ADLI) (FDRE 2006a). During the 1990s, ADLI set in motion a series of reforms that sought to generate a more supportive macroeconomic framework, liberalize markets for agricultural products, and promote the intensification of food staple production using modern inputs, especially seed and fertilizer packages [67].

D. Agricultural input use and supply systems of smallholder farmers

Agricultural inputs like improved seeds, fertilizers, and agrochemicals are important in improving soil fertility and reducing the negative effects of weeds, pests, and diseases. Intensification of agriculture with these inputs requires both availabilities of input, rural finance, and competitive marketing systems. Intensification, therefore, involves the development of supply chains around smallholder farmers, with simultaneous and complementary investments altogether links within the supply chain. The institutional support services of credit, input supply, and extension are important to make these agricultural inputs easily available to smallholders and improve the technical skills and knowledge of farmers in properly using and managing these inputs. Studies indicate that differences in access to those services have significant effects on the intensity of input use and overall crop and livestock productivity. Smallholders who have access to credit for input purchase and provide systems have used fertilizer and chemicals more intensively and attained higher crop productivity per hectare of land [30;37;67]. For instance, smallholder farmers who accessed credit for improved seed purchase achieved approximately a 13 percent yield increase compared to those that didn't have access [13]. The research results of the Amhara Regional Agricultural Research Institute also indicated that farmers could achieve a yield advantage of 17–41 percent in sorghum, 110–113 percent in barley, and 19–32 percent in teff production through the utilization of improved seeds over the present national average yield of 23.69, 19.65, and 15.75 quintals per hectare (q/ha) respectively [11;23].

2.4.1. Agricultural input Use and consumption in Ethiopia

TABLE I. POLICY REGIMES AND DEVELOPMENT PROGRAMS IN AGRICULTURAL INPUT SYSTEMS AND MARKETS, 1957–1995

Period	Intervention/Event	Focus/Objectives	Remarks
1957-1967	First and Second Five-Year Development Plans	Develop large-scale commercial farms and coffee exports	Subsistence farming was neglected
1968-1973	Third Five-Year Development Plan (Comprehensive Integrated Package Projects)	Transport infrastructure development; dissemination of high-input technologies, credit, and extension; formation of cooperative societies.	Implementation revolved around three comprehensive extension programs that focused on high-potential areas only.
1971-1979	Minimum Package Program I (MPP-I)	Expand geographic coverage of the comprehensive extension programs; provide fertilizer, credit, and extension to "minimum package areas."	Fertilizer procurement is managed by the Agricultural and Industrial Development Bank (AIDB), and distribution is managed by the Ministry of Agriculture (MoA).
1978	Agricultural Marketing Corporation (AMC)	Improve management of agricultural input importation, storage, and transport by handing over control of these tasks to the AMC.	MoA maintains the role of distributing fertilizer to farmers, disbursing credit, and estimating fertilizer demand through approx 18,000 peasant associations.
1980-1985	Minimum Package Program II (MPP-II)	Expand input supply and extension service coverage three-fold.	The actual provision of inputs and extension was limited due to lack of financial support for MPP-II; increasing inefficiency in MoA and AMC; fertilizer overstocking due to inaccurate demand estimates; and poor institutional coordination of input deliveries.
1984	Agricultural Input Supply Corporation (AISCO)	Improve the importation and distribution of fertilizer and marketing of other agricultural inputs.	As a successor to AMC, AISCO was limited by the lengthy bureaucratic process needed to secure foreign exchange, high freight costs, lack of proper port facilities, high inland transport costs, inaccurate demand estimates, and organizational inefficiency.
1986-1995	Peasant Agricultural Development Program (PADEP)	Provide inputs, credit, and extension services to smallholders organized into approximately 2,900 farmer service cooperatives (SC) using a Training and Visit (T&V) extension approach.	As a successor to MPP-II, PADEP aimed to cover 8 development zones across the country, but only received financing sufficient for 3 zones, all located in high potential areas.

Source: [67]

Ethiopia's experiences over the past 15 years, and the issues raised by these experiences, are summarized underneath for each of the major components of the country's agricultural input system and market—seed, fertilizer, and extension.

TABLE II. POLICY REGIMES AND DEVELOPMENT PROGRAMS IN AGRICULTURAL INPUT SYSTEMS AND MARKETS, 1995–PRESENT

Period	Intervention/Event	Focus/Objectives	Remarks
1991-1995	Partial liberalization of the fertilizer market	Open the importation, wholesaling, and retailing of fertilizers to private companies.	Undertaken by the Transitional Government of Ethiopia (TGE). Fertilizer prices remained pan-territorial and subsidized.
1993–1999	Participatory Demonstration and Training Extension System (PADETES)	Promote improved seed-fertilizer-credit packages (primarily for maize and wheat) through a "training and visit" approach piloted by Sasakawa Global 2000.	PADETES demonstrated on a pilot basis that yields could be doubled with the application of modern inputs in Ethiopia.
1995–present	National Agricultural Extension Intervention Program (NAEIP)	Scale up the PADETES approach to the national level as a means of boosting cereal yields and output.	Efforts to scale up the PADETES approach were less successful than the piloting demonstrated by Sasakawa Global 2000.
1997-98	Fertilizer price liberalization	Eliminate subsidies and deregulate the price of fertilizer at the wholesale and retail levels.	Liberal prices have not resulted in a competitive market due to the government's continued control over marketing and credit.
2000-07	Shifting industry structure	Private companies withdraw from the fertilizer market in 2000, succeeded by "holding" companies; cooperative unions enter the market in 2005, followed by the withdrawal of "holding" companies" in 2007.	The Agricultural Input Supply Enterprise (AISE) and cooperative unions emerge as the only actors engaged in fertilizer importation and also the largest players in the wholesale and retail markets, in conjunction with the regional input supply and extension systems.

Source: [67]

The use of recent agricultural inputs is considered as the key to raising crop productivity and overall agricultural production in Ethiopia. The govt places a high priority on making modern agricultural inputs, particularly fertilizer and improved seed, more available to farmers. This report describes the patterns of use of agricultural inputs by farmers in Ethiopia. it's supported the 2012 Baseline Survey administered by the International Food Policy Research Institute for the Ethiopian Agricultural Transformation Agency (ATA). The ATA Baseline Survey includes a household

TABLE III. PERCENT OF FARMERS USING EACH INPUT BY REGION

Region	Percent of farmers using		
	Purchased seed	***Fertilizer***	***Pesticide***
Tigray	34	70	10
Amhara	57	68	23
Oromia	52	45	52
SNNP	70	52	11
Total	56	56	31
N=	3,000	3,000	3,000

Source: [8]

survey, a community survey, and a cooperative survey. The household survey used a stratified random sample of three,3000 farm households within the four main regions of Ethiopia: Tigray, Amhara, Oromia, and therefore the Southern Nations, Nationalities, and People's (SNNP) region. The households are dispersed across 100 woredas and 200 kebeles. to collect more in-depth information on the 83 woredas initially identified because of the ATA zone, these woredas are oversampled. In other words, 67 of the 83 ATA woredas were selected to be included within the sample [8].

2.4.2. Share of farmers using modern agricultural inputs

General, about 56% of farmers within the four main regions of Ethiopia used chemical fertilizer on a minimum of one plot within the agricultural year 2011-12, including both Belg and Meher seasons. This percentage is somewhat above the 49% of farmers using fertilizer within the 2008 Ethiopia Agricultural Marketing Household Survey also administered by IFPRI. The proportion of farmers using fertilizer varies from 45% in Oromia to 70% in Tigray. The purchased seed isn't necessarily certified seed or maybe an improved variety, since it includes seed purchased from other farmers and grain traders. The share of farmers using purchased seed was highest within the SNNP region (70%) and lowest in Tigray (34%). Pesticides are less widely used than purchased seed and chemical fertilizer, being reported by one-third of the farmers. Nonetheless, the share of farmers using pesticides within the 2012 survey (31%) is above the share reporting pesticide use within the 2008 survey (21%). The very best share of farmers is in Oromia, where over half the farmers used pesticides (Table 3).

IV. EMPIRICAL FINDINGS

A. Agricultural input markets

B. Seed systems and markets

A seed is an important input in crop production. the utilization of quality seeds of improved varieties contributes up to a 50% increase in yield per hectare [18]. The standard seed also triggers the utilization of other accompanying agricultural inputs like fertilizers and pesticides [1]. The success of the revolution in Asian countries is especially attributed to a mixture of things like the supply of high-yielding varieties, access to other complementary inputs, investments in irrigation schemes), favorable output markets, and enabling policy environments [2;4].

In Ethiopia, a rise in crop production is especially attributed to area expansion (40%), indicating the limited role played by other inputs like a seed within the overall performance of crop production. The performance of the seed sector in Ethiopia is way below the specified level, negatively influencing crop productivity [62]. One major factor for the low performance of the seed sector may be limited commitment, the lack of ownership to implement endorsed strategies and legal frameworks in the least levels of state structures. Also, lack of role differentiation, lack of accountability, limited capacity across institutions, and a less favorable business and investment environment within the sector are major challenges within the Ethiopian seed sector [4].

A formal system of seed production started in 1979, with the establishment of the Ethiopian Seed Corporation [17]. In 2018, the entire seed supplies of cereals, pulses, and oil crops were estimated at 1,351,000 quintals (**MoA**,2018a). To succeed in the present level, seed production has seen an annual average rate of growth of 10.5% since 1995, and 19% since 2004. Despite this, the availability of seed from the formal seed system is a smaller amount than 20% of the seed employed by farmers. The formal system is dominated by four large parastatal enterprises (Ethiopia, Oromia, Amhara, and South Seed Enterprises) contributing 75% of the entire volume of the seed of cereals, pulses, and oilseeds. Excluding the Unions, there are only a limited number of personal seed producers in Ethiopia whose primary focus is on hybrid maize, that their current share is about 40% of the entire volume of hybrid maize seed produced, slightly above their share (35%) in 2011 (ESA, 2018a) [4].

C. Seed Marketing Development

Seed marketing in Ethiopia is largely directed by the government. It was in 2011 that a new option of marketing, Direct Seed Marketing (DSM), was introduced at the pilot level [7;41]. The pilot was found successful and gradually scaled up to 228 woredas in 2018 [9]. Currently, there are two major seed marketing channels in the country. With the centralized distribution system, seed demands are collected by the office of agriculture and used for the allocation of produced seed. The seed is distributed through cooperatives, and in some regions through the *woreda* office of agriculture. With DSM, producers sell their seeds, through agents or their shops, to farmers in the designated *woredas*. In 2018 60% of the seed is marketed through DSM in proportionally fewer woredas, while the remaining 40% is distributed through centralized systems in the four major regions, in proportionally more *woredas*. Currently, in the four regions, 76% of maize seed and 62% of wheat seed is sold through DSM, but in far fewer woredas compared to the total. The results showed that if access were

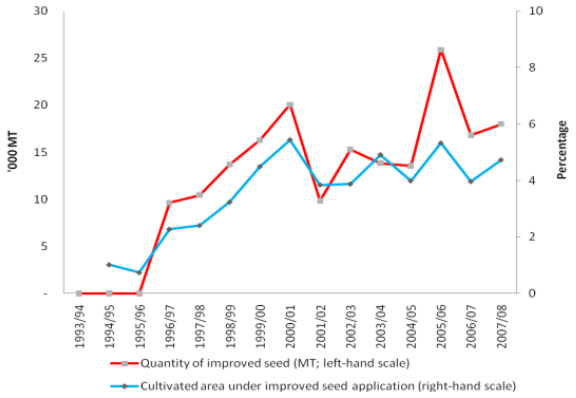
created, farmers would use more certified seeds, which, in turn, will contribute to increased productivity and production [4].

From a conceptual viewpoint, seed systems and markets are subject to a minimum of three unique constraints: three market failures—that complicate the first stages of seed market development. These constraints are contestable property rights concerning the development of cultivated varieties (cultivars); absent institutions within the marketplace for improved cultivars; and knowledge asymmetries within the exchange of seed between buyers and sellers. The problems within the context of Ethiopia's seed system and market, that specialize in the (a) adoption of improved seed, (b) the demand and provide for improved seed, and (c) the seed industry structure discussed because the following [67].

D. Improved seed adoption

Official estimates from the Central Statistics Agency (CSA) show that while the entire quantity of improved seed supplied nationally has been increasing since 1996–97, farmer use of improved seed covered a mean of only 4.7 percent of cropped area in 2007–08. Various surveys similarly report low adoption rates, for instance, just 3 percent consistent with the nationally representative Ethiopia Rural Smallholder Survey (ERSS) conducted in 2005. To make certain, most farmers still rely totally on farmer-to-farmer exchanges or saved seeds (Belay 2004). For improved open-pollinated varieties like wheat and teff, farmers don't necessarily get to purchase seed each season as they might hybrid maize. Rather, they could purchase seed every 4-5 years to exchange their stocks of saved seed with seed that features a higher level of purity, and thus better performance when cultivated (Doss et al. 2003). an outsized portion of wheat cultivated in Ethiopia is improved wheat. Lantican et al. (2005) reported that in 2002, 71 percent of all wheat areas within the country were sown with improved varieties. Kotu et al. (2000), Beyene (1998), and Zegeye (2001) report improved wheat adoption in selected woredas starting from 42 to 80 percent during various years within the 1990s. Yet as a sign of just how common long-term seed recycling is among Ethiopian smallholders, Lantican et al. (2005) find that only 43 percent of the world under improved wheat varieties was sown with varieties released since 1995.

Concerning maize, CSA reports that the world under improved varieties and hybrids has grown from 5 percent in 1998 to twenty percent in 2008. Lantican et al. (2005), the bulk of the improved maize was accounted for by hybrids. Regarding teff, barley, and sorghum, the opposite main cereal crops cultivated in Ethiopia, adoption rates are relatively less than both wheat and maize. In short, the conventionally-cited figures:1 percent adoption of improved varieties and 4-5 percent of the cropped area under improved varieties—obscure the extensive uptake of improved wheat and, to a lesser extent, improved maize, in Ethiopia. Moreover, these figures obscure high rates of seed recycling and low rates of seed replacement, suggesting challenges for the promotion and adoption of new cultivars among smallholders [67]. Figure *1* Area under improved seed application and quantity of improved seed distributed, for cereals only, 1993–94 to 2007–08



Source: CSA, various years [67]

D. Seed demand and supply

Estimates of market demand for improved seed in Ethiopia are based entirely on official projections that are developed at the kebele level then transmitted through official channels to zonal and regional levels, after which they're aggregated nationally to supply estimates of the sort and quantity of seed that must be supplied within the coming season (Alemu et al. 2007). The responsibility of responding to those demand estimates lies primarily with the state-owned Ethiopian Seed Enterprise (ESE). On the availability side, the assembly and distribution of improved seeds have been stagnant since about 2000. At about this same time, the availability of improved seed channeled through the regional extension and input supply system began to come short of official estimates of demand (with a 72 percent shortfall in 2008 for the five major portions of cereal). Limited production capacity at ESE for certified seed, combined with insufficient provision of the breeder and pre-basic seed from the research system, contribute much to those shortfalls. Assuming that demand estimates aren't wholly inaccurate, demand has consistently fallen in need of supply, as shown in Table 4.

Shortcomings in seed quality and timeliness of delivery have been longstanding issues in Ethiopia. Poor cleaning, broken seeds, low germination rates, and the presence of mixed seeds have been reported in ESE-supplied seed. Besides, reports are common of seed being distributed after the optimal planting time or of varieties being distributed that are not appropriate to changes in farmers' expectations of seasonal weather conditions at the local level [28;30].

1) The status of the Ethiopian seed industry Low adoption rates and shortfalls in the supply of improved cultivars can be partly attributed to bottlenecks emerging from the structure of the seed industry and the regulatory agencies that oversee it. The seed industry in Ethiopia involves a range of both public and private sectors. The national research system—headed by the Ethiopian Institute of Agricultural Research (EIAR) and comprised of a range of federal research centers, regional research centers, and agricultural universities and faculties—is charged with developing improved varieties and breeder and pre-basic seed needed by other players in the industry. Regulatory functions such as varietal release reviews and

TABLE IV. SEED SUPPLY SHORTFALLS IN ETHIOPIA, 2005–08

Crop	Supply as a percentage of official demand			
	2005	*2006*	*2007*	*2008*
Wheat	20	38	23	24
Maize	53	28	60	48
Teff	5	12	22	19
Barley	16	18	10	7
Sorghum	Na	7	16	48

Source: MoARD, various years cited in [67]

seed certification are performed by various departments of the MoA [17].

Basic and authorized seed production is administered by the ESE, which relies on its farms alongside private companies, private subcontractors, state farms, and cooperatives, to bulk up the seed that's supplied to the regional extension and input supply systems. Improved certified seed is supplied to Ethiopian smallholders primarily through regional, state-run extension, and input supply systems that operate with a degree of guidance from the Federal Ministry of Agriculture and Rural Development (MoARD). This regional system is made up of regional bureaus of agriculture and rural development (BoARDs), their woreda (district) offices, and extension agents working at the kebele level. These organizations collaborate closely with farmers' cooperatives and regional credit and savings institutions in both supplying inputs and disbursing credit [67].

The major stakeholders and their roles in the formal seed system of Ethiopia. The Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), and universities are responsible for developing new varieties. They are also involved in basic seed production. The National Variety Release Committee (NVRC), at the federal level, is responsible for making decisions on whether or not the varieties proposed by researchers would be officially registered and released for production. The Ethiopian Seed Enterprise (ESE), Regional Seed Enterprises (RSEs), private companies, SPCs, and unions engage in seed production. The Ministry of. Agriculture (MoA) and the regional Bureau of Agriculture (BoA) undertake regulatory activities during seed production, processing, and marketing. The following tables show a list of stakeholders involved in the formal seed system:

†EIAR-Ethiopian Institute of Agricultural Research; RARIs-Regional Agricultural Research Institutes; NVRC-National Variety Release Committee; ESE-Ethiopian Seed Enterprise;

RSEs Regional Seed Enterprises; and SPCs-Seed Producer Cooperatives.

††MoA-Ministry of Agriculture; and BoA-Bureau of Agriculture.

The following figure shows a schematic diagram of the seed system.

2) Challenge on Ethiopian Seed Sector Development

Quality seed production remains a challenge to the Ethiopian seed sector development Some of the reasons for failing

TABLE V. MAJOR STAKEHOLDERS IN THE FORMAL SEED SYSTEM AND THEIR ROLES

Seed system components	Involved stakeholders†	Regulatory stakeholders††	Regulatory measures
Plant breeding	EIAR, RARIs, Universities		
Variety release	NVRC	MoA	Distinctiveness, uniformity, stability
Breeder seed production	EIAR, RARIs, Universities		
Pre-basic seed production	EIAR, RARIs, Universities, ESE, RSEs	MoA, regional BoA	Seed quality assurance
Basic seed production	ESE, RSEs, private companies, SPCs	MoA, regional BoA	Seed quality assurance
Certified seed production	ESE, RSEs, private companies, SPCs, unions, farmers based seed production	MoA, regional BoA	Seed quality assurance

Source: [25]

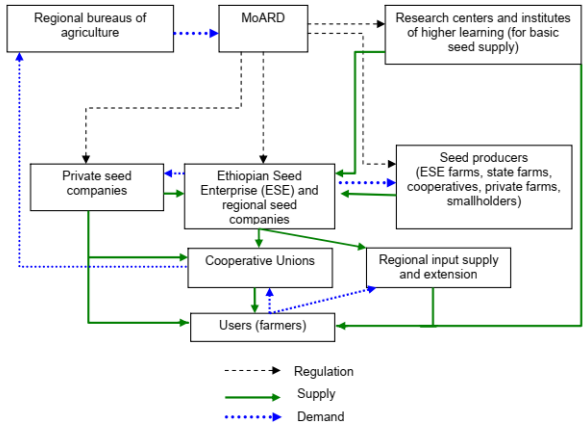


Fig. 1. A schematic of the Ethiopian seed system

Source: [67]

to transform the seed production system are discussed underneath.

a. Limited availability of crops and varieties for Early generation seed (EGS) production

The failure to put in place a coordination system that governs quality EGS production and accountability, as laid down by the mandate given by different legal frameworks.

3) The lack of a market-driven seed production system

• The Government does not consider seed as a marketable commodity and does not develop yet full trust in private producers, which may be related to several reasons including

unethical behavior of few domestic private producers and their low capacity to respond to market demand.

• Inefficient out-growers management system; [45]

4) Limited capacity for seed production

5) Limited commercialization and limited adoption of released varieties • Local companies do not have exclusive user rights on public varieties. The Proclamation on plant variety protection was not implemented since the first proclamation in 2006, because of government disinterest [53].

6) International seed marketing and distribution practices and lessons Unlike Ethiopia, international seed marketing and distribution (including promotion) is done directly by seed producers using their own sales personnel, agro-dealers, and stockiest:

• Bangladesh has more than 20,000 seed dealers.

• In Uganda seed distribution is mainly done through agro-dealers, agents, and distributors.

• In Kenya, seed distribution typically occurs via a chain of distributors: agents (large wholesalers), sub-agents, stockiest (agro-dealers), and sub stockiest (kiosk and other small vendors who are not agro-dealers, but sell seed in season) and

• In Morocco, both the public (400) and the private sector (100) have over 500 seed sale points where the private sector has the right of access to use the public networks [18].

7) National experience • In Ethiopia, Pioneer Hi-Bred/Ethiopia has a strong marketing force (sales agronomists, woreda focal persons, Pioneer extension person/model farmer, and temporary sales forces); it also provides after- sale services, including agronomic management and complaint handling (ESA, 2018). Internationally, a seed is not only an input but also a commodity that is traded in both domestic and international markets. As a result, large volumes of seed are traded at a significant amount of value in several countries. **Table 6** shows the volume and value of seed exports by some countries. Similarly, **Table 7** presents the volume and value of seed imported by some countries. Ethiopia has no seed exports, only seed imports (for vegetable seeds). Many countries like Chile, China, and India allow the production of seed of varieties released elsewhere for export purposes without requiring registration of such varieties [18].

E. Ethiopia's fertilizer market

The growth in agricultural production and fertilizer use has been particularly remarkable. In more than two decades following the introduction of fertilizer under the *Freedom from Hunger* program in the late 1960s, fertilizer use grew from 3,500 tons in the early 1970s to only about 34,000 tons in 1985. By contrast, it grew from 140,000 tons in the early 1990s to about 650,000 tons in 2012.

Changes in fertilizer policies coincided with several high-profile agricultural programs. The three most visible initiatives are the Agricultural Growth Program (AGP), the Growth and Transformation Program (GTP), and the Agricultural Transformation Agency (ATA). The recent push for increasing fertilizer use has been largely driven by GTP, which sets annual cereal production targets for each region. Increasing the distribution of chemical fertilizer and improved seed have been the key drivers for achieving these targets. These programs have had some success as fertilizer imports jumped from 440,000 tons in 2008 to 890,000 tons in 2012. Fertilizer availability (import plus a change in stocks), however, far exceeded total consumption, resulting in Only 30–40% of Ethiopian smallholders use fertilizer; those who do apply on average 37–40 kg per hectare, significantly below recommended rates. The growing problem of carryover stock implies a mismatch between the government's targets and the demand for fertilizer under current policies, infrastructure, and institutions [54;67].

1) Fertilizer use patterns In Ethiopia, chemical fertilizer is primarily used for cereal production. According to the Ministry of Agriculture and Rural Development's (MoARD) statistics, cereals account for 90% of the county's total chemical fertilizer consumption; and during 2005/2006–2010/2011, only two regions, Oromia and Amhara, accounted for 70% of total consumption—Oromia alone accounted for about 40%. The shares of the other two major cereal-growing regions, SNNP and Tigray, were 10% and 3%, respectively.

Detailed estimates of both cultivated and fertilized areas from the Central Statistical Agency's (CSA's) shown in Table 5. Urea and DAP are only considered because they are the two main types of fertilizers used in the country. Three important trends are observed in the table. First, there is an increasing trend in both cultivated and fertilized areas. While the cultivated area has increased from about 7.0 million hectares in 2003/2004 to 9.7 million hectares in 2010, representing a 38.6% growth, the fertilized area has more than doubled from 1.12 million hectares to 2.31 million hectares during the same time. Second, more teff crops appear to have received fertilizer than any other cereal crops, in all regions except SNNP. At the national level, teff farming has consistently accounted for more than 40% of fertilized land. In 2010/2011, of the total fertilized area of 2.31 million hectares, 981,000 hectares were allocated to teff, which is almost 75% more than maize or wheat. It may seem counter-intuitive that farmers would use higher amounts of fertilizer in a low-yielding crop like teff. However, this is consistent with the fact that teff prices have been increasing in real terms for many years [51;61]. As a result, relative prices (fertilizer to teff) have become more favorable than other cereals. Besides, due to ease of storage and long shelf life, farmers in Ethiopia attach some intrinsic value to teff.

Finally, fertilizer use in other cereals (e.g., barley, sorghum, rice, and millet) is very small compared to the three major kinds of cereal. Since 2003/2004, about 2.6 million hectares, equivalent to 35% of total land planted, were allocated to these cereals; but only about 4% of them received any fertilizer. Furthermore, in high-potential regions of Amhara and Oromia, the share is even smaller—of the 1.9 million hectares allocated to these crops, only 102,000 hectares are fertilized. Since they are non-tradable and account for a smaller share of domestic consumption, the economics of fertilizer use in other cereals has not been favorable [60].

Data on fertilizer use suggests that a significant portion of smallholders use fertilizer: 39 percent according to CSA and

TABLE VI. SEED EXPORT BY VOLUME AND VALUE FOR SOME COUNTRIES, 2016

Country	Quantity (metric tons)				Value (USD million)			
	Vegetable crops	flowers	Field crops	Total	Vegetable crops	flowers	Field crops	Total
Brazil	111		53,467	53,578	15		153	168
Chile	1299	23	35,200	36,522	138	11	125	274
China	9175	581	23,500	33,256	113	15	69	197
Egypt			1,800	1,800	1		1	2
India	3544	77	25,556	29,177	48	2	33	83
Kenya			730	730			5	5
Korea	625		500	5,625	52		15	67
Mexico	1133		90,525	91,658	14		151	165
Philippines	790			790	7			7
South Africa	1653		124,00	125,653	33		77	110
Tanzania	66	66	1,017	1,149	6	2	3	11
Thailand	1700			1,700	72		55	127
Turkey	1870	1	19,253	21,124	22	2	57	81
Uganda			55,000	55,000			12	12
Vietnam			4,000	4,000	1		11	12
Zambia			1,500	1,500			25	25

Source: Exports of seed for sowing by country [4] values ≥ USD 1 million are reported

TABLE VII. SEED IMPORT BY VOLUME AND VALUE FOR SOME COUNTRIES, 2016

Country	Quantity (metric tons)				Value (USD million)			
	Vegetable crops	flowers	Field crops	Total	Vegetable crops	flowers	Field crops	Total
Brazil	875	5	49,915	50,795	72	3	62	137
Chile	231	5	7,233	7,469	24	1	27	52
China	9,665	20		9,685	177	14	127	318
Egypt			2,179	2,179	29		21	50
Ethiopia*	229			229	7			7
India	4,040	29	25,742	29,711	64	9	34	107
Kenya			4,500	4,500			16	16
Korea	2,182	285		2,467	69	7		76
Mexico	2,005	1	32,908	34,914	331	1	130	462
Philippines	1,612			1,612	14		11	25
South Africa	1,474	7	70,225	71,706	37	1	79	117
Tanzania	244			244	3			3
Thailand	1,761	1		1,762	23	1		24
Turkey	1,067	4	25,000	27,071	98	3	66	167
Uganda	457			457	7			7
Vietnam			52,120	52,120			34	34
Zambia	164			164	2			2

Source: Exports of seed for sowing by country (ISF, 2016); values ≥ USD 1 million are reported; note that in 2019 Ethiopia imported 600 metric tons of hybrid maize, with a value of over USD 6000 [4]

32 percent according to the 2005 ERSS survey. Teff, wheat, and maize cultivation account for most of the fertilizer use. However, data on application rates tell a slightly different, and often confusing, story about the intensity of fertilizer use in Ethiopia (Figure 4). Fertilizer use intensity, when measured in terms of kg/ha of arable and permanent cropland, is currently estimated at 17 kg/ha of nutrients (about 29 kg/ha of a commercial product), which is similar to application rates elsewhere in the region but considerably below comparable smallholder highland farms in neighboring Kenya (applied to 70 percent of maize fields at an average dose for all fields of 45 kg/ha) (Ariga et al. 2008). When measured in terms of kg/ha of land under grain production, the figure increases to 21 kg/ha of nutrients (about 37 kg/ha of a commercial product). And when measured in terms of kg/ha of land under grain cultivation where fertilizer is applied (which accounts for 89 percent of all land cultivated in Ethiopia), the figure increases to 48 kg/ha of nutrients (about 83 kg/ha of a commercial product), which begins to approach application rates in Asia.

There is also some evidence suggesting that these high fertilizers use intensity figures may be overstating the case. A study EEA/EEPRI (2006), indicates that up to a third of farmers covered by PADETES have dis-adopted the seed-fertilizer technology packages over time, likely due to the high cost of inputs, insufficient credit, and credit rationing, a lack of varieties with traits appropriate to farmers' needs, and other factors.

Sources**:** MoARD, various years; CSA, various years.

Chemical fertilizer, a more obvious private good than seed, also possesses several features that complicate the early stages of market development. The development of fertilizer markets may require a point of public intervention in financing and market infrastructure development until markets mature. Issues within the context of Ethiopia's fertilizer market, that specialize in the (a) uptake of fertilizer, (b) fertilizer prices and profitability, and (c) the fertilizer industry structure [43; 55].

Fertilizer acceptance

TABLE VIII. PLANTED AND FERTILIZED AREA (000 HECTARES) BY REGION AND BY CROP, 2000/2001–2010/2011

		2003/2004			2007/2008			2010/2011		
Regions	Crops	Planted	Fertilized	% Fertilized	Planted	Fertilized	% Fertilized	Planted	Fertilized	% Fertilized
Amhara	**Cereal**	**2,402**	**345**	**14.4**	**2,923**	**646**	**22.1**	**3,271**	**925**	**28.3**
	Maize	258	82	31.8	397	168	42.29	472	241	51.1
	Wheat	333	94	28.3	427	154	36.2	499	243	48.7
	Teff	826	144	17.4	1,047	292	27.9	1,014	387	38.2
	Others	985	25	2.6	1,052	31	3.0	1,286	54	4.2
Oromia	**Cereal**	**3,168**	**583**	**18.4**	**4,052**	**771**	**19.0**	**4,576**	**961**	**21.0**
	Maize	786	150	19.0	969	151	15.6	1,109	249	22.5
	Wheat	556	138	24.8	769	240	31.2	816	217	26.6
	Teff	820	238	29.1	1,083	345	31.9	1,289	447	34.6
	Others	1,006	57	5.7	1,231	35	2.8	1,362	48	3.5
SNNP	**Cereal**	**688**	**72**	**10.4**	**785**	**92**	**11.7**	**857**	**191**	**22.3**
	Maize	216	17	8.1	249	38	15.2	237	55	23.0
	Wheat	115	28	24.1	119	26	22.1	131	47	35.9
	Teff	183	23	12.6	235	24	10.0	265	76	28.8
	Others	174	4	2.1	183	4	2.3	224	13	5.9
Other	**Cereal**	**741**	**130**	**17.6**	**970**	**141**	**14.5**	**986**	**233**	**23.7**
	Maize	106	11	10.7	152	13	8.8	144	20	14.0
	Wheat	95	29	30.9	111	26	23.9	107	49	45.8
	Teff	160	54	33.8	200	58	28.7	192	71	37.1
	Others	380	35	9.3	507	44	8.6	542	93	17.1
National	**Cereal**	**6,999**	**1,130**	**16.1**	**8,730**	**1,649**	**18.9**	**9,691**	**2,310**	**23.8**
	Maize	1,367	260	19.0	1,767	371	21.0	1,963	565	28.8
	Wheat	1,099	289	26.3	1,425	447	31.4	1,553	556	35.8
	Teff	1,989	459	23.1	2,565	718	28.0	2,761	981	35.5
	Others	2,544	122	4.8	2,973	114	3.8	3,413	207	6.1

Note: The figures include only DAP and Urea, which CSA began reporting separately from other organic fertilizers since 2003/2004. **Source:** [60]

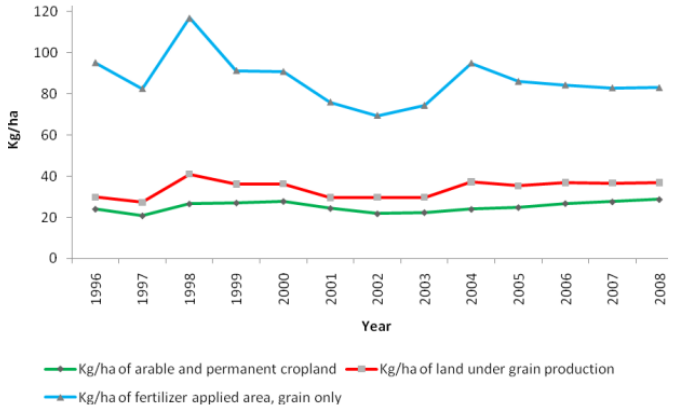


Fig. 2. Fertilizer use intensity, 1996–2008

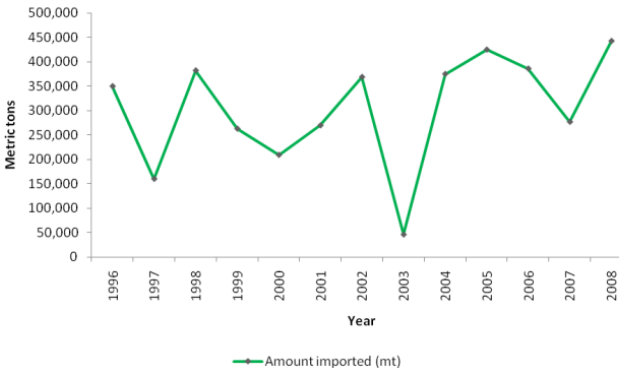


Fig. 3. Fertilizer imports, 1996–2008

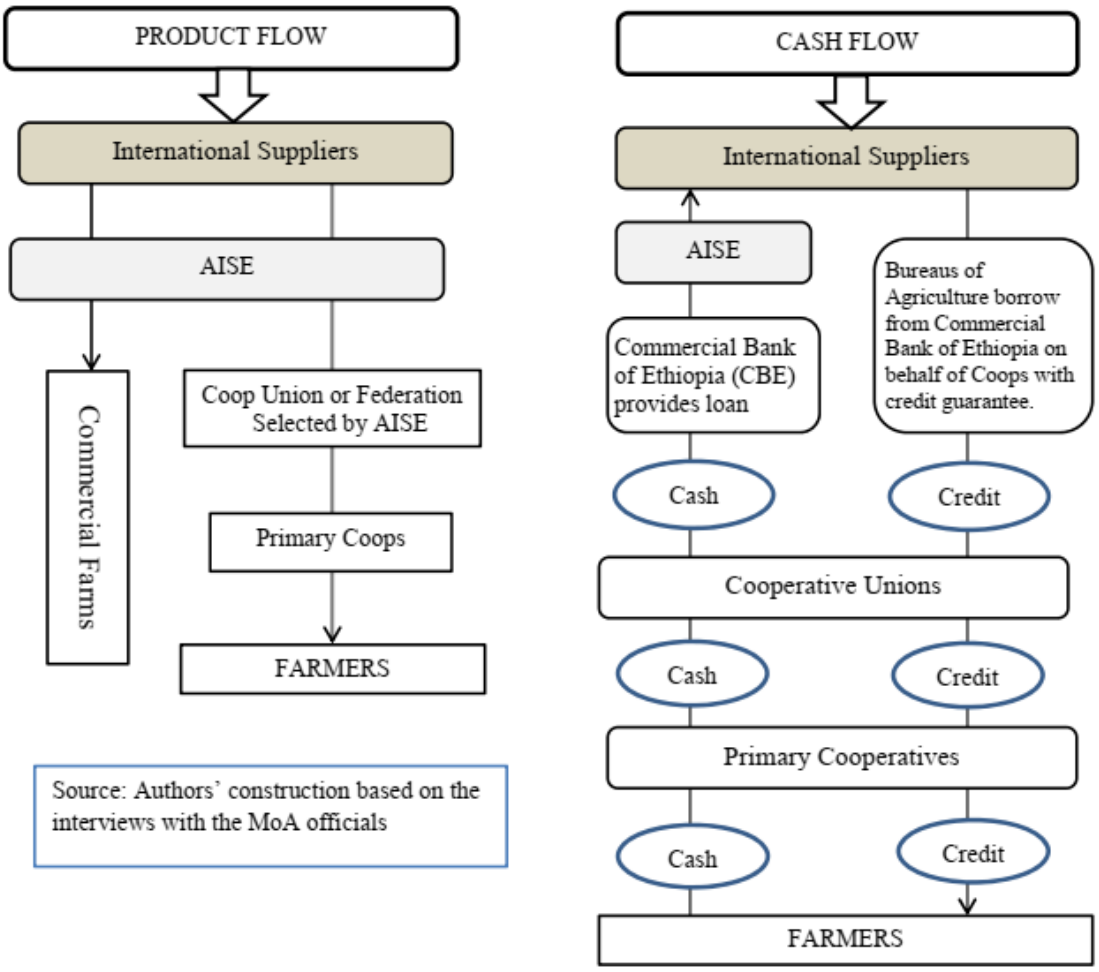
Source: MoARD, [67].

The uptake and use of chemical fertilizer in Ethiopia (primarily DAP and urea) can be assessed in several ways—in terms of total fertilizer imported, percentage of farmers using fertilizer and improved seed-fertilizer packages, percentage of cultivated land under fertilizer application, and household-level estimates of fertilizer application per hectare. When measured in terms of quantity imported, fertilizer use in Ethiopia has increased from 250,000 tons in 1995 to 400,000 tons of product in 2008 (Figure 3). This growth of total fertilizer consumption is more than the average for Sub-Saharan Africa over the same period [21;48].

2) Fertilizer value chain

a) Key actors and decision-making process The fertilizer value chain in Ethiopia involves numerous actors who perform three broad sets of activities, which are: (i) import planning, (ii) import execution, and (iii) marketing and distribution. The import planning begins with a demand assessment, conducted by the district agricultural bureau based on the data collected by the extension workers (DA), through focus group/ community surveys. Some primary cooperatives also conduct demand assessments. The estimates by the DA and cooperatives are reconciled by the bureau offices before sending them to the zonal offices. The zonal offices aggregate woreda-level data and then send the estimates to the Bureau of Agriculture and Rural Development (BoARD). Finally, MoARD aggregates the regional estimates and comes up with the national demand estimates. The net import requirement is determined by deducting the previous year's carryover stocks from the current year's demand.

In executing the imports, the Ministry prepares tender documents and invites a consortium of public institutions (Ministry of Finance and Economic Development [MoFED], National Bank of Ethiopia [NBE], Commercial Bank of Ethiopia [CBE], and Quality & Standard Control office) to review and approve projected demand, arrange necessary foreign exchange, and open international procurement tender. Since 2008, the execution of imports has been carried out exclusively by AISE. The logic for giving monopoly power to AISE is to take advantage of the economies of scale. The idea is simple: importing in large quantities gives a buyer more bargaining power to negotiate lower prices. Also, large-



Source: [60].

Fig. 4. Product and cash flows in the Ethiopian fertilizer value chain.

scale imports can arguably reduce transaction costs and make value chain management more efficient. A recent Ministry of Agriculture (MoA) report argues that there was a discount of 2–4% per ton for bulk purchases of 25,000 MT or more (MoARD, 2012). AISE was selected again as the sole importer of fertilizer on behalf of farmers' cooperative unions [60]. The following figure shows fertilizer market value chain supply (product and cash flow):

F. The recent development input promotion

1) Input use and supply systems in the crop sector The government introduced a range of economic reforms, this strategy was the introduction of several large-scale programs designed to intensify cereal production with improved seeds, chemical fertilizers, and credit. The intensification campaign focused on cereals in the moisture-reliant highlands, where 60 percent of the rural population live and where the strategy had the best chance of success. Results indicate that crop technology packages could make a huge difference in productivity. Maize yield, for example, can be increased from current farmers' yields of 3.4 to 12 tons per hectare [52] if farmers use the right type and quantity of improved seed and fertilizers with proper management practices [23].

The government introduced the Participatory Demonstration and Training Extension System (PADETES) in 1994/95 to carry out the intensification program. This was later supported by a large-scale demonstration program led by Sasakawa Global 2000. The program followed a technology-based supply-driven intensification strategy consisting of enhanced supply and promotion of improved seeds and fertilizers, on-farm demonstration of improved farm practices and technologies, improved credit services for input purchase, and close supervision of farmers' extension plots. Over ten years, PADETES reached about 40 percent of the roughly ten

million farm households in Ethiopia. Data from millions of demonstrations carried out through PADETES (3.6 million in 1999) indicated that the adoption of seed-fertilizer technologies could more than double cereal yields and would be profitable to farmers in moisture-reliant areas (Crawford et al. 2003). Cereal-producing farmers' participation in the extension program reached 3.5 million in 2014 from 2.4 million in 2000, during which time cereal yields increased from 1.12 to 2.33 tons per hectare [28;30;34].

The recent smallholder intensification program has drawn prominent attention to the role of chemical fertilizer, seed, and credit. According to CSA reports, between 2011 and 2015 use of fertilizer and improved seeds increased by 78 percent and 154 percent respectively. Similarly, farm credit increased from 8.1 to 150.2 million birr, and the number of farmers participating in the extension program rose from 2.57 million to 3.64 million during the same period. Pesticide use grew by 197 percent in 2010 from 1,390.2 tons of pesticides in 2005 [34].

Improved seeds: Seed is one of the important inputs for the intensification of smallholder agriculture. Increasing the quality of seeds can increase the yield potential of the crop by significant amounts and is thus one of the most economical and efficient inputs to agricultural development [32]. The availability of quality seeds is the foundation for food production and productivity and is a precursor to crop and food diversity and security. In Ethiopia, a significant number of improved varieties of various crops are released by the national agricultural system, there has been limited use of improved seeds (4 percent) by most of the farmers [22]. Thus, the adoption of improved seeds in Ethiopia has generally been disappointing. Official estimates suggest that while the total quantity of improved seed supplied nationally increased over time, farmers' use of purchased seeds in 2011 covered an average of only 5.6 percent of cropped area, with a high of 28 percent for maize. Most farmers still rely on farmer-to-farmer exchanges or saved seeds, even for improved varieties [13].

The seed system in Ethiopia has two broad constituents, namely formal and informal systems. Each of the systems plays a key role in the development, multiplication, processing, storage, distribution, and marketing of seeds in the country.

The formal seed system is dominated by the public sector: This is mainly a government-supported system. Several public institutions are involved in, and it has legal grounding. The main actors of the formal system include the National Agricultural Research Systems (NARS), the Ministry of Agriculture (MoA), and the Ethiopian Seed Enterprise (ESE). Recently, decentralized regional seed enterprises (RSEs) were also established as public seed enterprises (Amhara Seed Enterprise-ASE, Oromia Seed Enterprise (OSE), and Southern Nations Nationalities and Peoples Region Seed Enterprise, SRSE) [67].

These formal systems are guided by a policy framework for agricultural research and technology generation. It describes legal procedures, such as variety release, intellectual property rights, certification programs, seed standards, and contract laws and enforcement. So far, NARS has released 960 varieties of 114 different types of crops up until 2014 [52]. Among these, cereal, pulse, and oil crops accounted for about 36, 19, and 9 percent respectively. ESE alone was able to produce 111 different seeds of just 26 different crop varieties in 2009. Seed multiplication by ESE mainly focused on two cereal crops (wheat and maize) and the annual supply of certified seed by the enterprise does not exceed 20,000 tons [50]. Wheat and hybrid maize constitute about 85 percent of the total output of the enterprise. However, the annual average seed requirement for cereals, pulses, and oilseeds is estimated to be over 400,000 tons [23;24].

The informal seed system is the dominant system: This system is not regulated by government policies. Instead, it is implemented by farmers themselves and is highly localized. Five key features distinguish the informal from the formal system; the informal system is traditional, semi-structured, operates at the individual/ community level, uses a wide range of exchange mechanisms, and usually deals with small quantities of seeds often demanded by farmers. In the context of Ethiopia, this system is extremely important for seed security, for the bulk of seed in the country is usually supplied via the informal system. About 60–70 percent of seed used by Ethiopian smallholder farmers is saved on-farm and exchanged among farmers and the remaining 20–30 percent is borrowed or purchased locally. The informal seed system (either self-saved or farmer-to-farmer exchange) accounts for 96 percent of the seed used by smallholder farmers, while the share of improved seed is about 4 percent. Many farmers rely on the informal seed supply system for the following main reasons [22].

Ethiopia's seed system continues to be dominated by the informal sector. The formal seed system has not been able to cope with the demands, and it is dominated by the public sector. Although the government implemented several policies to entice the private sector as an engine for the growth of the Ethiopian economy (including a plant breeder's act that came into effect in 2006), private investment in Ethiopia's seed market has been severely constrained by several entry barriers. Spielman (2008) identified three main barriers: (1) the private seed enterprises face high costs of building distribution networks that must compete with the state's distribution system that ties seed with fertilizer and credit [72]. (2) the private enterprises must contend with the similarly high costs of navigating the regulatory system, accessing financing from the formal banking sector and meeting the stringent collateral requirements; and (3) private investment has also been dissatisfied by relatively low nominal prices for seed sold by ESE, despite the possibility of bringing these prices into closer alignment with international benchmarks that price hybrid seed at about a 10:1 ratio over the grain price (versus the 5:1 used in Ethiopia) [11].

Pesticides: The incidence of diseases, insects, and weeds is a serious problem for the crop sector in the country. According to [22] reports, the estimated area of cultivated land treated with pesticides increased from 1.31 million hectares in 2005 to 2.24 million hectares in 2011. This implies that the extent of crop damage due to diseases, pests, and weeds expanded from 12 to 17 percent of the total cultivated land of the country, with the high of 22 percent for cereals, to which the country allocated about 80 percent of the total cultivated land over the same period. In the case of high-value crops (such as horticulture), the damage grew to 7 percent in 2011 from 2 percent in 2005. The damage affects most of the horticultural crops grown in the country. Most horticulture crops in the Amhara region, for instance, are highly affected by disease and insect pests of various types. Diseases affecting horticultural crops such as pepper and citrus are very critical in the region.

G. Agricultural mechanization

Agricultural mechanization can be defined as the use of all tools, implements, and machinery from simple and basic hand tools to more sophisticated and motorized equipment (FAO, 2016). Based on the power sources, three levels of mechanization can be differentiated: human power-based mechanization, animal power-based mechanization, and mechanical power-based mechanization (Malabo Montpellier Panel, 2018). African farming systems remain the least mechanized of all continents (Pingali, 2007). Several factors have been attributed to limit mechanization and hindering government and private sector efforts to promote mechanization among smallholder farmers in Africa. They range from market failures that limit access to machinery and spare-parts supplies, missing institutions especially those that would be required to ensure adequate technicians and skilled personnel to operate and repair farm machinery, to governance challenges such as political interest, elite capture, ineptness, and corruption that constrain the government and hinder the private sector's involvement in machinery importation, among others. Recent assessments show a positive correlation between agricultural machinery growth and agricultural output growth in Africa [57].

Studies indicated that in many developing countries up to 80% of farm power is provided by the human muscle (FAO, 2010). In Ethiopia, in addition to human muscle, oxen draft is the dominant source of farm power for land preparation and planting particularly in cereal-based systems. In agroforestry systems, hand-hoe is the dominant farm implement, and human muscle is used for all farm operations [75].

Notwithstanding the intensification of agriculture that has been targeted in the subsequent development programs of Ethiopia, the utilization of mechanized power was so limited in the country. The promotion of using modern technologies was focused on chemical fertilizer and improved seeds while the issues of smallholder mechanization and improving farm power has hardly got any attention. For policymakers in Ethiopia, the displacement of the rural labor force due to farm, mechanization remained the main concern as one of the unfavorable outcomes from the expansion of agricultural mechanization. With this, policy debates prevailed across the A world that mechanization and land consolidation have often occurred in parallel. This is justified with the efforts undertaken towards large mechanization in the past in most of the sub-Sahara African countries (SSA), which resulted in farm consolidation and disappearance of small farms (Mrema et al., 2008). The situation ended up with the displacement of smallholders and hired labor (Baudron et al., 2015; [75].

Despite the big potential of agriculture in Ethiopia, the low level of engineering technology input in agriculture has been one of the main constraints hindering the modernization of the country's agriculture and food production systems. One of the major causes for the disappointing performance and low contribution of agricultural mechanization to agricultural development has been the fragmented approach to mechanization issues (FAO, 2013). Investment in mechanization has only taken place on large commercial farms or through government schemes (FAO, 2010). The agricultural GDP per hectare of cultivated land is at about half of Kenya or Morocco. In 2007, the figure was USD 587 per hectare for Ethiopia, USD 1,190 per hectare for Kenya, and USD 1,150 per hectare for Morocco. Addressing this productivity gap would yield substantial benefits for both growth and food security (BMGF, 2010). (Ibid).

1) Ethiopia Agricultural Mechanization Strategy The Ethiopian Agricultural Transformation Agency (ATA) and the Ministry of Agriculture (MoA) have developed a draft Agricultural Mechanization Strategy based on the experience of different countries (including China and Brazil) and stakeholder consultations. The draft mechanization strategy is a comprehensive document that puts different agricultural mechanization options for different farm sizes. The strategy targets to achieve increment in farm power from its current 0.1 kW/ha to 1 kW/ha by 2025. The strategy also states clearly how mechanization could help in increasing the income of smallholder farmers by reducing postharvest losses. According to this strategy, through increasing the domestic supply of agricultural types of machinery, there is a tendency to increase the overall productivity of land, improve the timeliness and effectiveness of work, and decrease drudgery in field operations. Furthermore, the strategy plans to promote agricultural mechanization technologies making up at least 30% of the user population, reducing the use of animal power by 50% so that mitigate carbon-emission and environmental degradation [75].

H. Marketing systems of agricultural products of smallholder farmers in Ethiopia

One of the main reasons for the low productivity of smallholder farmers in Ethiopia is a lack of markets to absorb even the small amount of marketable surplus of their products. This is mainly because most of the farmers living in the same village usually produce similar products to sell at the same local market. This not only forces farmers to sell their products at lower prices but also negatively affects future food production and consumption as farmers plan production based mainly on the price incentives of the previous year's market. According to [49], the main reasons for the low prices of farmers' products include asymmetric market information through illegal brokers distorting the marketing process (misuse of supply, demand, and price information in favor of traders); lack of market diversity (excessive supply of similar products by most farmers to the same local markets); and lack of agro-processing industries [11].

Studies also indicated that there is a high post-harvest loss of agricultural products in the country, ranging from 25 to 30 %, and the loss is even higher in the case of perishable crops (fruits and vegetables) and animal products (such as milk). The losses occur at the farm level during harvest and transport and in the store. Lack of appropriate technology (cold storage), lack of food processing units, and poor market linkage and information delivery systems among smallholder farmers and potential buyers/agribusiness firms are factors that contribute to the losses.

The development of the agro-processing industry in Ethiopia is very slow. The establishment of the agro-processing industry and cold storage is a capital-intensive investment and requires a continuous supply of input that may not be fulfilled at this developmental stage. Thus, large-scale, high-value food processing that uses smallholder products scarcely exists (except in the brewery sector). Instead, small-scale, home-made processors (for juices, and processing potato to chips) are common in urban areas (ibid.). Lack of vibrant and high-value processing plants means that opportunities to replace imports, create a profitable market for the smallholder producers, and generate productive employment are severely undermined. It also means that the horticulture and dairy sectors are risky for farmers as their products are highly perishable.

I. Institutional support services for agricultural input supply and output marketing

The involvement of the private sector in Ethiopia in agricultural service provision is limited. The government almost exclusively provides agricultural extension services. In an apparent attempt to solve some of the coordination problems in service delivery, the extension programs coordinate the provision of credit and the supply of inputs (especially improved seeds, agrochemicals, and fertilizers). The role of farmer cooperatives in service delivery is also increasing over time. Where farmer cooperatives are strong, the extension service works closely with the cooperatives.

Credit services Since 1994, the regional governments in Ethiopia have used a 100 % credit guarantee scheme to stimulate the uptake of the PADETES improved seed–fertilizer packages. Under this system, about 90 percent of fertilizer is delivered on credit at below-market interest rates, displacing what had largely been retail sales from the private sector. To finance the packages, credit is extended to farmers by the state-owned Commercial Bank of Ethiopia, through cooperatives, local government offices, and, more recently, microfinance institutions (MFIs) and one cooperative bank. Cooperatives have gradually assumed responsibility for part of the guaranteed credit program, which has reached some four million farmers with guaranteed credit of nearly US$70 million in recent years. The financial products on offer, and their associated interest rates, are generally limited to seed and fertilizer purchases, animal fattening, beekeeping, and several other recognized investments [28].

Extension services in Ethiopia were first introduced in the 1950s. Since the 1980s, Ethiopia's extension system has followed a 'training and visit system' that was introduced under the PADETES program. Agricultural extension services in the context of Ethiopia mainly focus on improved seeds, fertilizers, and credit for the smallholders. Agricultural extension in Ethiopia has traditionally been financed and provided almost entirely by the public sector. The current program has expanded the extension coverage in Ethiopia and claims to reach around four million farmers [30]. It is expected that this coverage will increase further. Since 2004, some 60,000 new extension agents have been deployed throughout the country, thus expanding the size of the public extension staff fourfold. Also, Farmer Training Centers (FTCs) are being constructed in each kebele (the smallest administrative unit in Ethiopia), and the total number of FTCs reached 18,000 by the end of 2008. The FTCs are designed as local-level strategic locations for farmers to receive information, training, demonstrations, and advisory services, and include both classroom and demonstration services. Each FTC is staffed with three development agents (DAs) (one each in the areas of crops, livestock, and natural resource management) and supported by a peripatetic DA covering several FTCs and trained in cooperatives management or a related field. Currently, in some of the irrigation potential districts, the program allows one additional irrigation expert to be assigned at kebele level aiming to promote irrigation-oriented horticulture production in the region, although there is still a lack of horticulture graduates experts.

This program in Ethiopia represents a significant public investment in extension, amounting to more than US$50 million annually (about 2 % of agricultural GDP). While many farmers seem to have initially adopted the packages promoted by the extension system, about a third of the farmers who have hosted a package had discontinued its use, while poor extension services were the main reason for non-adoption. Moreover, extension effectiveness in Ethiopia continues to be measured in terms of targets for physical input use, at the expense of emphasizing the efficiency and profitability of input use. Most extension workers are engaged in distributing seed, fertilizer, and credit packages. This hampers the provision of technical advice [30].

The hierarchical nature of the extension system does little to encourage and integrate the inherent resourcefulness and knowledge of the farmers and rural communities [33].

Besides, the continued imposition of targets from the top and weak local capacity has not permitted the emergence of dynamic, demand-driven extension systems. Despite such limitations, agricultural extension services play an effective role in enabling smallholders to use more inputs and attain higher crop productivity. Smallholder farmers who participated in the extension program used fertilizer more intensively and attained significantly higher crop productivity per hectare. Nevertheless, the marketing extension component is rather weak in facilitating farmers' participation in crop markets. There is a need to rethink the current agricultural extension system to incorporate marketing issues and continue its role in improving agricultural productivity through training and transferring knowledge and information to the smallholder farmers [33]. These challenges are recognized, and several changes are being introduced to address these deficiencies. To get beyond a focus on cereals, packages have been developed to support other crop and livestock enterprises, improve post-harvest technology, and encourage natural resource management. Recognizing the diversity of smallholder farming systems in Ethiopia, classifications have been developed to divide the country into several distinct agro-ecological zones, which have been used in the development of more appropriate zone-specific packages. Input distribution is being shifted away from extension to input supply offices and cooperatives, thus freeing extension agents to provide more technical advice [44].

J. *The role of cooperatives in agricultural input supply and output marketing*

In Ethiopia, cooperatives have been organized in a modern way since the early 1950s. Currently, there are 60,126 Primary Cooperatives with 9,393,201 farmer members, 326 cooperative unions comprising 8,932 Primary Cooperatives, and four Federal Cooperative Unions. They have capital of about 11.3 billion birrs and cash deposited of more than 5.2 billion birrs. These farmers' organizations are involved mainly in agricultural sectors and financial sectors (saving and credit cooperatives). The existence of such large numbers of farmers' organizations can be taken as a good opportunity for smallholder agriculture to transform via addressing the constraints (e.g., inadequacy and untimely delivery of inputs, shortage of finance/capital, weak bargaining power, poor access to market information, inaccessibility of improved technologies and infrastructures) and efficient and sustainable use of unexploited potential in the country (e.g. potential markets for agricultural outputs indicated by an increasing presence of food processing companies, and the collective resources created by cooperatives and unions – capital, land, productive labor and indigenous knowledge and experience of farming, helping build the financial capacity, bargaining power and competitiveness of smallholders both in domestic and export markets) [3].

For farmers' organizations to play a prominent role in the transformation of smallholder agriculture it is essential to provide supportive policy and institutional frameworks, as well as build their skills and technical capacities until they can fulfill their functions on their own. They can potentially play important roles in rural finance, agricultural input supply, agricultural output marketing (market linkage between farmers and potential buyers), and value-adding activities (agro-food processing industries). Farmer organizations are also vital in the management of irrigation schemes, which are expanding rapidly in the country, and in the development of the horticulture sector.

V. RECOMMENDATIONS

Conclusion and policy implication

Providing agricultural inputs and services significantly boosts smallholder farmer productivity. In Ethiopia, key inputs and services include improved seeds, seedlings, agrochemicals, medications, veterinary care, heifers, artificial insemination, credit, and production/processing tools, largely provided by the public sector. A major challenge is the lack of a seed system with private sector involvement to meet farmer demand.

In Ethiopia's formal seed system, the Ethiopian Institute of Agricultural Research, Regional Agricultural Research Institutes, and universities develop new varieties and produce basic seeds. The National Variety Release Committee approves varieties for registration and production. Seed production is handled by the Ethiopian Seed Enterprise, Regional Seed Enterprises, private businesses, SPCs, and unions. The Ministry of Agriculture and Regional Bureaus of Agriculture regulate seed production, processing, and sales, but contribute only 4% of the total seed supply, with the informal seed system accounting for the remaining 96%. This indicates policy shift is needed.

Policy implication

- Ethiopia's smallholder farmers lack sufficient input and support services due to a constrained supply within the government-dominated system.
- Engaging the private sector is crucial, but faces institutional and profitability challenges, such as increased financing costs stemming from the government's seed monopoly.
- Strengthening and expanding institutional services are vital for market-oriented and intensified smallholder agriculture, necessitating private sector involvement to ensure the supply of improved agricultural inputs.
- In order to offer incentives for the private sector, well-designed market liberalisation and incremental institutional changes are necessary because the current production system does not give seed producers with strong motive to make their firm more independent of the government.
- The complex risks associated with selling agricultural products are a significant issue that can be resolved by improving marketing connections, such setting up contract farming agreements between producers and prospective customers.
- The establishment of suitable market linkage and information delivery systems between farmers and potential buyers can be facilitated by farmers' organizations, such as cooperatives and unions. This will give smallholder farmers more bargaining power, better access to various support services (such as inputs, credits, extension, and training), secured markets for their products, and more control over traders' supply of expensive, low-quality seeds and pesticides.
- To play a crucial role in connecting producers and potential buyers, the government must take the initiative to mobilize and strengthen existing cooperatives and unions. They should also capitalize on their economies of scale by engaging in agro-processing and other value-adding activities.
- The current rural and agricultural development policy carefully examined the likelihood of mechanization impacts; it encourages the introduction of simple machines that complement labour and are compatible with energy-saving technologies like conservation agriculture.

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