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The state of agricultural extension services in Ethiopia and their contribution to agricultural productivity

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ACRONYMS AND ABBREVIATIONS

AES	Agricultural extension service
AGP	Agricultural Growth Program
ATVET	Agricultural Technical and Vocational Education and Training colleges
CSA	Central Statistical Agency
DA	Development Agent
FTC	Farmer Training Center
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
ICT	Information and communications technologies
IFPRI	International Food Policy Research Institute
MoA	Ministry of Agriculture
MoANR	Ministry of Agriculture and Natural Resources
NAEIP	National Agricultural Extension Intervention Program
PADETES	Participatory Demonstration and Training Extension System
SMS	Subject matter specialist
SNNP	Southern Nations, Nationalities and Peoples' region

ABSTRACT

Agriculture extension services are critical for promoting the adoption of improved farm technologies to increase productivity. Ethiopia has heavily invested in its agriculture sector in recent years, including in its massive public agricultural extension system, which is the largest in Africa. Ethiopia has also registered substantial economic progress in recent years, largely attributable to agriculture growth. To what extent is Ethiopia's investment in agriculture – particularly in its extension system – linked to recent productivity growth? We document the state of the extension system in Ethiopia and review the empirical evidence on the links between the key extension services provided, adoption of modern inputs, and agricultural productivity. In particular, we take stock of the provision of agricultural extension services, synthesize the evidence on the performance of the system, and suggest ways that it might contribute to accelerating agricultural growth and poverty reduction in the years ahead.

While the state of Ethiopia's agricultural extension system is commendable in terms of its reach and intensity, as measured by the extension agent per farmer ratio, it faces challenges that impair the system from realizing its intended goals. An inflexible delivery system, overburdened extension agents, under-resourced farmer training centers, and poor research-extension linkages are found to be the main constraints facing the extension system. Regarding its contribution, our synthesis shows that access to the extension system increases adoption of modern inputs, including chemical fertilizers, improved seeds, herbicides, and irrigation. However, agricultural extension does not directly increase productivity levels other than through its indirect effects on increased adoption of these inputs. Use of modern inputs and row-planting are shown to contribute to productivity increases.

These findings are consistent with other recent evidence suggesting that agricultural productivity increases in Ethiopia are associated with expansion in cultivated area of land and increased use of chemical fertilizers. Adoption of such fundamental inputs has been crucial for productivity increases so far, as Ethiopia's agricultural production system starts from a rather low base. Indeed, our review strongly suggests that agricultural productivity increases in Ethiopia are not yet knowledge-driven. Achieving further productivity increases will be increasingly difficult without additional investments to improve the quality (not just the quantity) of the extension system, particularly given dwindling access to additional cultivable land due to increasing population pressure. Further gains in agricultural productivity will have to come from improvements to the existing input supply-focused extension system, changing it to become a more knowledge-driven and problem-solving system.

1. INTRODUCTION

Ethiopia has made enormous progress in terms of economic growth, agricultural development, and poverty reduction since the famines of the 1970s and 1980s (Hill et al. 2016; Bachewe et al. 2017; Dorosh and Rashid 2012). Sustained increases in agricultural productivity contributed to overall economic growth and poverty reduction in recent years (Bachewe et al. 2017; Hill et al. 2016). Ethiopia has witnessed rapid and sustained economic growth, averaging 11 percent between 2004 and 2014, pulling millions out of poverty and slashing headcount poverty from 44 percent in 2000 to 30 percent in 2011 (World Bank 2015). Land and labor use have expanded significantly, and total factor productivity grew by about 2.3 percent per year in the last decade, with modern input use more than doubling. The expansion in modern input use appears to have been driven by several factors including high public expenditures in the agriculture sector, especially on agricultural extension services (AES), an improved road network, higher levels of rural education, and favorable domestic and international price incentives (Bachewe et al. 2017).

Despite the rapid economic and agricultural growth of the past two decades, however, Ethiopia remains one of the poorest countries in Africa, with a significant proportion of its population still relying on traditional farming practices, which prevents rapid agricultural transformation and structural changes from taking place. Many constraints and bottlenecks remain, and the challenges that the country currently faces are how to build on the earlier successes and how to accelerate development to maintain rapid overall economic growth and enter into a sustainable structural transformation of the economy. Experts have highlighted the crucial role that AES will continue to play in this rural transformation (Bachewe et al. 2017).

This paper takes stock of the provision of AES in line with the country's development and suggests ways such services might contribute to accelerating agricultural growth and poverty reduction in the years ahead. Ethiopia has invested significantly in its AES system, in line with national policies that place a high priority on boosting agricultural production and productivity. Ethiopia is considered a leading country globally in the provision of extension services to farmers and has the highest extension agent-to-farmer ratio of any country.

Ethiopia presents an interesting case, as it is one of few African countries to have placed agriculture at the forefront of its economic development policies, having invested heavily in the sector in the last two decades. Unlike many countries where private sector AES expanded following drastic public funding cuts to their AES systems in the 1980s and 1990s (Zhou and Babu 2015), Ethiopia's AES system remains predominantly public.

A unique feature of Ethiopia's agriculture sector is that it has received unprecedented high-level political commitment since the current government assumed power in 1991. The Agriculture Development-Led Industrialization (ADLI) strategy was developed in the mid-1990s to serve as a roadmap to transform smallholder agriculture. Rural education, health, infrastructure, agricultural research, and AES were among its top priorities. Ethiopia is one of only four African countries to have implemented the Comprehensive Africa Agriculture Development Programme (CAADP) agreement of a 10 percent target of annual government expenditures earmarked for agriculture over the 2003–2013 period (Benin 2014). More recently, Ethiopia's transformation agenda elaborates its ambitious five-year Growth and Transformation Plan (GTP), placing significant importance on the agriculture sector in general, and on the AES system in particular.

While substantial progress has been made since the public official document that outlined the current AES model was issued in 2002 (FDRE 2002), Ethiopia's AES system faces several challenges, mainly relating to the way it is organized. The fact that it covers vast and scattered geographic areas implies that it is poorly resourced and has weak links with knowledge centers, hampering the quality of the extension services delivered. Evidence suggests a substantial increase in the number of farm households reached with AES (Bachewe et al. 2017); however, it is less clear whether or not productivity gains have been achieved and poverty has been reduced in consequence (Dercon et al. 2009; Davis, Swanson, and Amudavi 2009; Nisrane et al. 2011; Spielman, Kelemwork, and Alemu 2011; Krishnan and Patnam 2014; Abay et al. 2017; Berhane et al. 2017).

This paper reviews and provides evidence on the performance of the AES system in Ethiopia and the impact it has on productivity and other development outcomes. Data and information from various sources were analyzed to describe the enabling policies, landscape, organizational structure and management systems, capacities and incentives of different actors, approaches and tools to identify bottlenecks in the AES system, and areas for improvement.

2. DATA SOURCES

Three datasets are used in this study. The first is extracted from a large longitudinal dataset collected to evaluate Ethiopia's Agricultural Growth Program (AGP) between 2010 and 2015. The data were collected

collaboratively between the Central Statistical Agency (CSA) of Ethiopia and the International Food Policy Research Institute (IFPRI) and cover 7,500 farm households that were visited twice (2011 and 2013). For the survey, sixty-one districts were randomly selected from among the 83 AGP districts in the four main regions of the country: Amhara, Oromiya, Southern Nations, Nationalities and Peoples' (SNNP), and Tigray. In parallel, 32 districts were randomly selected from among non-AGP districts in the same regions. Three enumeration areas were randomly selected in each district, from which 26 households were similarly selected from each. The selection of survey households was carried out randomly using a fresh list of households within each selected enumeration area.

The second dataset originated from a unique survey of 237 Development Agents (DAs) selected from eight districts in seven regions: Amhara, Oromia, Tigray, SNNP, Gambela, Afar, and Benishangul-Gumuz. Data were collected in 2009 by IFPRI and the Ethiopian Economics Association. These data are uniquely designed to fathom the profiles and roles played by DAs in Ethiopia.

The third dataset was obtained from a survey conducted for an impact evaluation of a Digital Green pilot project in Ethiopia. A quantitative survey was administered to 896 DAs involved in the project. Digital Green is working with different partners in Ethiopia to introduce a community-centric participatory video approach to the provision of AES. The pilot project aims to improve the efficacy of the country's public AES system by broadening its reach through cost-effective information and communications technologies (ICT). Digital Green's survey of DAs provides information on characteristics of the human capital of DAs, their activities, their job satisfaction, and their overall motivation.

3. ENABLING ENVIRONMENT AND POLICIES

3.1. Context

The delivery of AES in Ethiopia takes place within a complex public bureaucratic structure that involves diverse interactions which, together with the distinct features of the agriculture sector, tend to be a challenge in terms of achieving effective AES provision. First, a substantial share of the Ethiopian population depends on agriculture for its livelihood, and this population consists mainly of smallholder farmers. Thus AES for the entire farming community would require extensive coverage across the country, placing considerable demand on public human and financial resources.

Second, given the wide geographic dispersion of activities, with farmers widely scattered, reaching them with AES through conventional means is time-consuming and would be a complex undertaking for DAs. For example, rainfall varies significantly between mountains and valleys, even across short distances. Large variations exist in altitude, rainfall, connectivity, and cropping patterns, and there is no single dominant crop for Ethiopia's food consumption (as is, for example, rice in Asia, maize in Latin America, and wheat in cooler climates). Thus five cereals are cultivated on a wide scale in Ethiopia: teff (an indigenous crop widely grown only in Ethiopia and Eritrea), wheat, maize, sorghum, and barley. Coffee, cultivated in the rainfall-sufficient southern highlands, is Ethiopia's major export crop. Livestock—mainly cattle, sheep, and goats—are the major sources of meat and livelihood for the pastoralist and agropastoralist populations.

Third, while major strides have been made in Ethiopia in expanding road infrastructure throughout the country, transport infrastructure within rural areas is still such that traversing space to contact a large number of farmers within a given area continues to be difficult for DAs. Throughout the country, the population is more concentrated along major road networks, although much of Ethiopia's population remains remote: 45 percent of the population lives more than five hours from a city of 50,000 (Schmidt and Kedir 2009). Furthermore, the rugged terrain in much of the highlands makes transport and communication difficult.

The above three features—large number of potential AES users, geographic dispersion, and infrastructure constraints—place a strain on public resources if AES is to reach a large segment of the agricultural population. It is also a challenge to monitor the quality and quantity of AES provided. One approach would be to manage the resource and quality control challenges by significantly standardizing the modality of delivery and content of AES to facilitate not only the provision of DA training at scale, but also the identification of objectives and standards against which agent performance can be measured.

A fourth essential aspect is the extent to which Ethiopian agriculture is suitable to such approaches, given its richly diverse agroecological conditions, including soil, climate, and altitude. As such, Ethiopia is a particularly unique case, exemplifying much of Africa in terms of ecological processes applied to agricultural production systems. The result is that Ethiopia produces even more diverse crop products than Asia.[1]

As such, AES delivery modalities, as well as the content of advisory services, are much harder to standardize in Ethiopia's diverse conditions than in countries with more homogenous agricultural settings. This diversity therefore calls for frontline AES providers to have a relatively large degree of discretion in tailoring agricultural advice to the agrophysical and socioeconomic peculiarities of the particular areas they serve, especially in view of their better knowledge compared to those at higher levels of the agricultural bureaucracy.

However, giving greater discretion to DAs complicates the effective monitoring of their performance, and may widen the gap between the skills they need and the skills they acquire in agricultural education and from standard training packages and guidelines. Moreover, greater discretion would require them to provide varied services which, in turn, requires a variety of knowledge centers to backstop AES.

Therefore, the choice between alternative designs of AES systems—in particular, extensive standardization versus delegation of content and modality to the frontline provider—constitutes a range of tradeoffs. Much of the literature on the design of AES systems, which heralds the benefits of giving frontline DAs a larger degree of flexibility in conducting their work, does not adequately discuss the operational challenges in conducting quality control. Similarly, the de facto substantial standardization of delivery mechanisms and content in many country policies does not necessarily account for the issues in matching advice to farmers' local conditions. Described below is Ethiopia's standardized delivery system, its evolution during the last two decades, and its challenges, despite the country's diverse agroecology.

Ethiopia's investment in agriculture mainly focuses on the provision of "advisory and training services" through a public AES structure that spans from the federal ministry to the regions and trickles down to *kebeles*[2] through frontline DAs. Over the last two decades, Ethiopia's AES system underwent a number of experiments in terms of delivery arrangements within the structure, as well as in the nature of AES provided (FDRE 2002; Gebremedhin, Hoekstra, and Tegegne 2006). With regard to delivery, the system has evolved from one that was largely top-down and managed by the federal ministry to one owned and operated by the regions and *woreda*s (districts),[3] within the general wave of decentralized public services.

While Ethiopia's AES system remains predominantly public and unimodal in terms of services provided, the government nevertheless has given special attention to the agriculture sector. With the

[1] Over the past several decades, this has meant that a set of agricultural technologies, such as improved varieties, developed to be suitable for one area in Asia has been applicable to much wider areas within that region, whereas technologies have had geographically much more circumscribed applicability in Africa (World Bank 2007, p. 55), including Ethiopia.

[2] A *kebele* is the lowest administration unit in Ethiopia. There are around 15,000 *kebeles* in Ethiopia.

[3] For example, starting from 2003, each *woreda* was required to identify its priority market-oriented commodity production, along with a detailed projection of input requirements to be delivered through the AES system (Gebremedhin, Hoekstra, and Tegegne 2006).

earlier launching of the ADLI strategy,[4] the Government of Ethiopia (GoE) placed agriculture and rural development at the core of its development policy agenda and committed a substantial share of the national budget to the sector. This emphasis on smallholder agriculture, based on the ADLI approach, continued with the addition of the Sustainable Poverty Reduction Strategy of 2002 (MoFED 2002) and the Plan for Accelerated and Sustained Development to End Poverty in 2006 (MoFED 2006).

Support from the private sector has come with the Ethiopian Commodity Exchange, launched in 2008 and designed to provide a transparent and efficient market for agricultural products (albeit it is currently unable to attract agricultural products other than exportable commodities (Rashid et al. 2010)). Despite the liberalization of Ethiopia's economy, the government did not completely withdraw from the market (Dorosh and Rashid 2012), given that when the fertilizer sector was liberalized, individually owned market shares dropped from 30 percent in 1995 to zero in 1999 (Dorosh and Rashid 2012). As a result, most fertilizer imports and land markets have remained under state control (Dorosh and Rashid 2012).

3.2. Past, present, and future policies

The history of AES in Ethiopia goes back to the introduction of the land grant AES system by the Imperial Ethiopian College of Agriculture and Mechanical Arts (IECAMA) in 1953 (Belay 2003).[5] It was followed by the Comprehensive Package Program (1967), Minimum Package Project I (1971–1979), Minimum Package Project II (1980–85), and Peasant Agricultural Development Program (PADEP) (1985–1995). Despite some variations, these early efforts had limited focus on the most accessible and high-potential areas of the country.[6] The evolution of Ethiopia's thinking on the provision of AES to the wider rural communities grew in the next two decades (1967–1985), albeit at a slower pace, and remained largely foreign-funded (Gebremedhin, Hoekstra, and Tegegne 2006; Davis et al. 2010). Table 3.1 provides the key historical milestones in the evolution of the AES system in the last six decades.

[4] Agricultural development, which set the pace not only for the industrial sector but also for other sectors, provided the blueprint for national development. An emphasis was placed on the provision of AES, rural education, and the strengthening of public agricultural research.

[5] The history of AES in Ethiopia before 1991 is well documented (Gebremedhin, Hoekstra, and Tegegne 2006; Davis et al. 2010; Spielman, Kelemwork, and Alemu 2011).

[6] For example, when it started, the college had only two DAs, increasing to 132 working in 77 AES locations (Gebremedhin, Hoekstra, and Tegegne 2006).

Table 3.1. Historical evolution of agricultural extension services in Ethiopia

Period	Program/Event	Objectives/Highlights	Remarks
1953–1963	Establishment of Imperial Ethiopian College of Agriculture and Mechanical Arts (IECAMA)	The establishment of the IECAMA, currently known as Haramaya University, is said to be the start of AES in Ethiopia. The college recruited graduates of the then Jimma and Ambo agricultural high schools as Development Agents (DAs) and concentrated its efforts around the areas where it had agricultural experimental stations.	Major constraints were limited manpower and outreach and lack of complementary services such as inputs and credit.
1963	Transfer of AES mandate to the Ministry of Agriculture	The mandate to provide AES was moved to the then Ministry of Agriculture (MoA), structured as a department at the national level and AES personnel assigned at the provincial level.	This new structure did not become active until 1968.
1967–1975	Comprehensive Integrated Package Projects	Several pilot comprehensive package AES programs were implemented: Chillalo Agricultural Development Unit (CADU), which later became Arsi Rural Development Unit (ARDU); Wolayita Agricultural Development Unit (WADU), 1970; Ada'a Woreda Development Project (ADDP), 1972; Tach Adiyabo and Hadekti Agricultural Development Unit (TAHADU); Southern Region Agricultural Development Project (SORADEP); and Humera Agricultural Development (HAD).	Since all of these programs and projects were operational in only small areas, the vast majority of the country was out of their reach. Evaluation studies suggest that this approach did not benefit smallholders and was too expensive to scale out and up, both financially and in terms of manpower requirements.
1971–1979	Minimum Package Project I (MPP-I)	The MPP-I coincided with the passing of the Third Five Year Development Plan (1971–74) aimed to modernize Ethiopia's agriculture sector through a comprehensive package approach to be initially implemented in selected pilot areas and eventually scaled up to cover about 90% of the farming community within 15–20 years. The MPP-I established minimum package areas within a 10-km radius of all-weather roads and within a 50–75 km distance designed to serve about 10,000 households each. Each minimum package area used 5 AES agents, about 5 input supply workers, and 1 AES supervisor. The project managed to establish 55 minimum package areas with 346 development centers in 280 *woredas* out of the total 580 *woredas* in the country by then. The military Derg regime that followed continued with this project (1974–1979).	The major drawbacks of the MMP-I included minimal attention given to the livestock sector, not benefiting smallholders, and not being able to reach the vast majority of farmers.
1980–1985	Minimum Package Project II (MPP-II)	A significant change from the MPP-I was that the AES responsibility was given to the commodity-based specialized departments in the Ministry. Regions also adopted a similar structure and *woredas* became the lowest structures where AES personnel were located. The development centers established under MPP-I were closed and AES personnel were reassigned to the *woreda* level.	The MPP-II failed to achieve its objectives due to shortage of AES personnel, and burdening AES agents with activities such as tax collection and organization of cooperatives.
1985–1994	Peasant Agricultural Development Extension Project (PADEP) using Training and Visit system	PADEP aimed to provide inputs, credit, and AES to smallholders organized into approximately 2,900 farmer service cooperatives using a Training and Visit AES 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.	By the end of the Derg regime (1971–1991), AES had been reduced to instruments of political control over the peasantry, while input and credit provision was largely focused on covering the inefficiencies of large state farms and peasant collectives (Wubneh 2007).

Period	Program/Event	Objectives/Highlights	Remarks
1993–1994	Sasakawa-Global 2000 pilot program (SG-2000)	The major objective of SG-2000 was to increase agricultural food production at the level of small-scale farmers and stimulate the linkage between research and AES so that agricultural technologies within the country could be made available to the AES system. During this time, available agricultural technologies were assessed; technology packages for maize, wheat, sorghum, and teff were developed; and about 1,600 farmers participated in farm demos in Oromiya, SNNP, Tigray, and Amhara Regions.	Major productivity increases were achieved, which convinced the GoE to adopt and expand it as a national agricultural AES intervention program (NAEIP) through the PADETES in 1995.
1995 to present	Participatory Demonstration and Training Extension System (PADETS or PADETES)	PADETS or PADETES is promoted as the national AES system and builds on the success of the SG-2000. It falls under the National Agricultural Extension Intervention Program (NAEIP). The goal of PADETES is to improve incomes via increasing productivity, ensure self-sufficiency in food production, establish farmers' organizations, increase production of export crops, conserve natural resources, and increase women's participation in development.	Limited evaluation and impact assessment. Available studies show mixed results (Dercon et al. 2009; Davis, Swanson, and Amudavi 2009; Nisrane et al. 2011; Elias et al. 2013; Krishnan and Patnam 2014; Abay et al. 2017; Berhane et al. 2017; Bachewe et al. 2017).
2004	Agricultural Technical and Vocational Education and Training colleges (ATVETs) and farmer training centers in each *kebele*	In line with decentralization processes, ATVETs were established to train a new cadre of AES workers and farmer training centers (FTCs) were established to become the focal point of AES support in every *kebele* in the country.	Limited evaluation and impact assessment. Available studies show mixed results. But a recent study by Bachewe et al. (2017) attributes agricultural productivity growth to investments in AES programs as a main driver.
2006–2012	Rural Capacity Building Project (RCBP)	The RCBP aimed to increase agricultural productivity, focusing on investments in building technical, physical, and managerial capacity of the AES system and its linkages with the research system.	Mixed results. Project was given overall moderately unsatisfactory rating in its Implementation and Completion Report (World Bank 2013). Unclear impact on agricultural productivity and quality of AES services based on project documents. Recent study shows some positive impacts (Buehren et al. 2017).
2010; 2016	Growth and Transformation Plan (GTP); GTP II	GTP I aimed for AES reach to 14.6 million beneficiaries by 2014/2015; GTP II aims to increase beneficiaries to 18.237 million by 2019/2020.	GTP reached 95% of target
2011	Farmer development groups and model farmers	Trainings and demonstration of improved technologies and best practices were carried out on model farmers' fields to advance their skills.	No evaluation yet.

Source: Authors' compilation from various sources.

3.3. From 1993 up to 2006

In 1993, a pilot AES program was initiated by Sasakawa Africa Association and Global 2000 of the Carter Center (SG-2000), a nongovernmental organization. The pilot program operated in collaboration with AES staff from the Ministry of Agriculture for two years and was tested in four regions: Oromiya, SNNP, Tigray, and Amhara. At program inception, there were 160 farmers, increasing to 1,600 in 1994. The program promoted the use of productivity-enhancing technologies by providing inputs and credit, and training using demonstration plots (0.25 to 0.50 hectares), supervised by researchers and DAs. SG-2000 demonstrated that with sufficient inputs, supervision, and management, farmers could double or triple their yields of maize and wheat (Davis et al. 2010; Gebremedhin, Hoekstra, and Tegegne 2006).

In 1995, the transitional government of Ethiopia adopted the SG-2000 pilot program as its national AES system, referred to as the Participatory Demonstration and Training Extension System (PADETES), later relabeled as National Agricultural Extension Intervention Program (NAEIP). PADETES/NAEIP was the first national AES program to be fully funded by the Ethiopian government.

The goal of PADETES/NAEIP is to improve incomes by increasing productivity, ensuring self-sufficiency in food production, establishing farmers' organizations, increasing production of export crops, conserving natural resources, and increasing women's participation in development. The program was initially implemented in seven regions with technology packages for wheat, maize, sorghum, and teff in high rainfall areas. The program later expanded its coverage and number of technology packages. Technology packages related to crop production for moisture-stressed areas, livestock, high-value crops, postharvest technology, and agroforestry, among others (Gebremedhin, Hoekstra, and Tegegne 2006) (Box 3.1). The aim of the program was to reach about 9 million farmers, using the adapted Training and Visit model, initially promoted by the World Bank in various countries.

PADETES/NAEIP, which remains the core program implemented today, follows a technology or AES package approach for agricultural development that incorporates information on agricultural technology, provision of inputs and credit, and communication methods. Farmers who agree to participate in the program make a 25–50 percent down payment on the inputs used, with the remainder to be paid following harvesting. The rates for advance payment vary according to the types of technologies to be used and the resource level of the farming communities. Loans for crop-based packages are repaid immediately after the harvest, whereas for other AES packages, various repayment options can be made depending on the types of development program undertaken.

To deliver knowledge, AES make use of: individual visits by DAs to farmers' homes or farms; group-based approaches by working with communities, farmers' organizations, and other groups; and mass media approaches including radio and print media. In some *woredas,* AES messages are transmitted at church/mosque gatherings during religious holidays or other occasional social gatherings, indicating the need to ensure the effectiveness of such fora in reaching the intended recipients.

The number of DAs increased from 2,500 in 1995 to 15,000 in 2002 and households covered by AES increased from 32,000 to 4.2 million in the same period. But the yield levels realized by farmers through the public AES program were not as high as the original demonstration plots of the SG-2000 pilot program, mainly due to the lack of sufficient supervision by AES staff (Gebremedhin, Hoekstra, and Tegegne 2006; Davis et al. 2010).

Box 3.1. Technology packages under the Participatory Demonstration and Training Extension System (PADETES) / National Agricultural Extension Intervention Program (NAEIP)

The dryland, cereal-based AES package covers Ethiopia's major staple food crops, such as maize, wheat, teff, and sorghum. The contents of the package are improved seeds, chemical fertilizers (500 kg DAP and 50 kg UREA per hectare), herbicides, and tied ridging for moisture conservation. Tied ridging is a technique to create embankments with regular spacing between ridges to prevent water runoff and to create basins of water into micro-catchments. This makes more water available for crop growth (Abesha, Waktola, and Aune 2000). Local seeds are also considered one of the options, together with improved technologies in areas where farmers believe that their own local varieties are superior to improved ones (Abesha, Waktola, and Aune 2000). The high-value crop extension package includes pulses, vegetables, and oil crops. The livestock development AES package includes items for dairying for milk production, fattening for meat production, poultry for egg production, and apiculture (beekeeping) for honey production. These last two packages are designed for risk management and income-generation for the household. Three types of packages are disseminated: integrated household, regular, and minimum.

Integrated household package AES programs: These are based on the selection of a package of technologies from a menu of package choices provided to farmers. The needs of households to increase overall farm productivity and household income are assessed and a set of complementary AES packages are identified and made available to the household. Therefore, more than one package is provided and implemented at a given household level. For example, in moisture-stressed areas, household packages are centered on the construction of water harvesting ponds, or shallow wells, ensuring access to different forms of irrigation such as river diversion or irrigation dams. The aim is to arrive at certain income levels per year, and to help eventually transform subsistence farmers to some form of specialization for market-oriented agricultural development. Hence, the adequate recording of farming household activities and income earnings was proposed as an important undertaking in the program. Household packages are aimed at raising the annual household income to Ethiopian Birr (ETB) 18,000 by 2006 (Gebremedhin, Hoekstra, and Tegegne 2006). The household package programs seem to be well integrated with the credit supply service in most *woredas* (Gebremedhin, Hoekstra, and Tegegne 2006).

The major components of the AES packages include: (i) crop production packages (of cereals, pulses, fruits, and vegetables) including crop protection and irrigation; (ii) livestock production technologies (feeds, dairy, fattening, animal health, fishery, poultry, apiculture); and (iii) natural resources management (agroforestry, soil conservation, and water harvesting).

Regular package AES programs: These are aimed at enabling farmers to adopt improved seeds with commercial fertilizer, improved management practices, and soil moisture conservation practices.

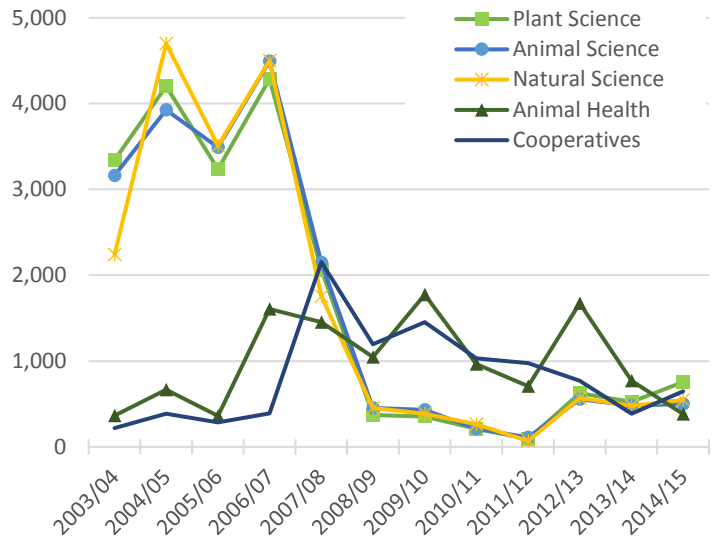
Minimum package AES programs: These stipulate that farmers adopt improved seeds with traditional soil fertility management (for example, application of compost and manure) and soil moisture conservation practices. The minimum package implements the recommended standard packages of a commodity without necessarily integrating different options or elements of other packages that a given household could profitably use. Most of the farmers involved in the AES package program were implemented this form of AES package.

Source: Authors' compilation from various sources.

3.4. From 2006 onwards

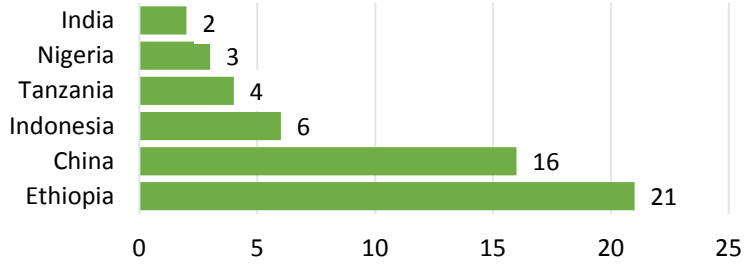
Based on PADETES/NAEIP assessments, the GoE realized the need for additional AES staff in the system. This was in line with the GoE's broader decentralization program. Therefore, Agricultural Technical and Vocational Education and Training (ATVETs) colleges were founded to increase the number of DAs assigned at the decentralized level (Davis et al. 2010). As shown in Figure 3.1, between 2003/04 and 2014/15, about 80,000 DAs were trained in different fields of studies in these ATVETs. Sixty percent of these DAs graduated over a four year period from 2003/04 to 2006/07; the number of graduates significantly dropped in 2008/09 and has continued to be low since. The decline suggests that the training of additional DAs and retraining of existing DAs did not continue as planned. That said, the in-service and continuing education program (that is, summer and distance education) to higher education levels could be an alternative explanation for the declining number of DA graduates in ATVETs in recent years. Anecdotal evidence suggests that the this program and the expanded opportunities it provided contributed to a high turnover of DAs, who often wanted to change fields as they moved higher in their studies.

Figure 3.1. Development agents graduated from Agricultural Technical and Vocational Education and Training colleges, by field of study, 2003/04 to 2014/15



Source: Authors' compilation based on secondary data obtained from the MoANR.

Figure 3.2. Number of agricultural extension agents per 10,000 farmers in selected countries



Source: Davis et al. (2010).
Note: For Ethiopia, figures in 2016/2017 show a higher ratio of 43 Development Agents per 10,000 farmers.

Estimates over the period 2010 to 2016 indicate that Ethiopia has one of the most extensive AES systems in the world in terms of its extension agent-to-farmer ratio. As shown in Figure 3.2, by 2010, Ethiopia's DA–farmer ratio was estimated at one DA per 476 farmers—that is, 21 DAs per 10,000 farmers. In comparison, figures for Tanzania stood at one DA per 2,500 farmers—that is, 4 DAs per 10,000 farmers (Figure 3.2). More recent data from the Ministry of Agriculture and Natural Resource (MoANR) show that

more than 72,000 DAs reportedly served about 16.7 million smallholder farmers in 2016/17 – that is, one DA per 230 farmers or 43 DAs per 10,000 farmers. This coverage is consistent with the Bachewe et al. (2017) study showing that about 80 percent of farm households have been reached by extension services.

In addition to the human capital, the GoE established more than 15,000 farmer training centers (FTCs) throughout the country (about one FTC at each *kebele*) during this period. These FTCs were designed as local-level focal points for farmers to receive information, training, demonstrations, and advice, and included classrooms and demonstration fields. How fully resourced and functional these FTC are has always been an issue and needs a standalone detailed study. Davis et al. (2010) estimated that only about 30 percent of these FTCs are functional. Anecdotal evidence and additional field visits suggest that many are poorly resourced or completely abandoned.

In addition to the DAs stationed in the *kebeles*, roughly 7,000 subject matter specialists (SMSs) and 4,000 supervisors are employed in the public AES system in the *woreda* and regional offices. On average, about 30 agricultural officers work in nine divisions or units within each *woreda* agriculture office, including ten or more SMSs, who are expected to provide technical support and training to the DA staff in the *kebeles*.

In 2011, a new AES delivery approach was designed to ensure more efficient delivery of extension services to farmers. In addition to the existing system of training through FTCs and DA visits to farmers, farmer development groups were created. These groups consist of 20 to 30 farmers. Each development group has sub-development groups organized with five members, led by a model farmer (otherwise known as *the one-to-five network or syndicate).* In addition to FTC training, demonstration of improved technologies and best practices are carried out on model farmers' fields to advance their skills. This is expected to help create a better learning process among farmers through group settings and facilitates a favorable environment for scaling up best practices.

The sub-development groups led by model farmers are expected to meet periodically to discuss key AES messages. Rather than one-to-one meetings with each farmer, the DA is subsequently expected to meet and convey AES messages through the group leaders. Given the amount of work DAs are expected to accomplish and the considerable transportation and communication challenges they face in their farm visits, it is believed that this new structure will eventually improve the efficacy of the AES system, although to what extent is yet unknown.

The GoE released its national five-year Growth and Transformation Plan (GTP) (2010–2015), aiming to further expand AES. By 2014/15, it was estimated that AES would reach 14.6 million beneficiaries (MoFED 2010). Accordingly, 13.95 million farmers were reached by the end of the plan period – 95 percent of the target set for 2014/15 (NPC 2016).

In the second Growth and Transformation Plan (GTP II), released in May 2016, the overall target was set to increase total AES beneficiaries from 13.95 million in 2014/15 to 18.237 million by 2019/20 (NPC 2016). Over the years, the human resources devoted to AES grew substantially, from approximately 200 DAs in the 1950s to almost 72,000 DAs in 2016/2017, reaching about 13 million beneficiaries with AES technology packages in 2014/2015 (Table 3.2).

As clearly stipulated in the GTP-II, the future of Ethiopia's AES system is focused on the provision of tailored AES that are market-oriented and context-specific. The plan's objectives are specifically to improve the quality of the AES system—a primary cause for the shortfall in productivity following GTP I—by mainstreaming approaches to agroecology and climate change, farming systems (for example, agropastoralists and pastoralists), and gender.

Table 3.2. Milestones in the evolution of Ethiopia's agricultural extension services since 1950

Year	AES posts/ FTCs	AES agents or DAs, number	Beneficiaries	Sources
1953	77	132	-	IPMS
1971	346	330	-	IPMS
1993/94	-		1,600	SG-2000
1995	-	2,500	32,000	IPMS
2002	-	15,000	4.2 million	IPMS, Davis et al. (2010)
2008	6,486	47,522	9 million	Spielman, Kelemwork, and Alemu (2011)
2014/15	11,000	-	13 million	GTP I
2016/17	>15,000	72,402	16.7 million	MoANR
Plan for 2019/20	18,000	-	18.2 million	GTP II

Source: Various project documents and reports.
Note: AES = agricultural extension service; FTC = Farmer training center; IPMS= Improving Productivity and Market Success; SG=Sasakawa Global; GTP=Growth and Transformation Project.

The GoE drafted a new AES strategy in collaboration with the Ethiopian Agricultural Transformation Agency (ATA), building around nine pillars: (i) strengthening and building the capacity of FTCs; (ii) enhancing agricultural knowledge and information systems; (iii) enhancing client-oriented and multi-actors' AES; (iv) facilitating market linkages; (v) mainstreaming gender, youth, and nutrition; (vi) enhancing environmental management and sustainability; (vii) enhancing institutional coordination and linkages among partners; (viii) enhancing the development and utilization of human resources; and (ix) establishing strong and dynamic result-based monitoring, evaluation, and learning systems. The strategy is yet to be implemented.

Ethiopia's AES system is also systematically testing the role of ICT to improve AES quality and coverage. The recently scaled-up Agricultural Information Hotline—Interactive Voice Response and a Short Message System—is one example; it provides real-time and immediate access to vital agronomic information. Farmers can call the hotline for free and receive information on a wide range of topics on all major crops grown in the country. It also sends customized content (in case of drought, pest, and disease) to callers based on crop and geography data captured upon registration. A community-centric video approach to AES provision is another ICT-based method the government is piloting with Digital Green. On the front end, the approach produces localized videos (that is, videos that feature local farmers and are tailored to local needs) on agricultural technologies and practices. AES agents facilitate the video dissemination or screening. On the back end, extensive monitoring data are collected and analyzed for course corrections and tracking performance.

4. ORGANIZATION AND MANAGEMENT

4.1. Overall structure

Ethiopia is a federal republic with five administrative tiers: federal level, regional, zone, *woredas*, and *kebeles*. In 1992, the GoE executed its first decentralization exercise, making the regions responsible for policy implementation and providing them with broad discretionary authority. In 2001 and 2002, the ambitious second wave took place, further devolving responsibility for many public goods and services, including AES, to district governments in the four most populous regions (Amhara, Oromia, Tigray, and SNNP, comprising 86 percent of Ethiopia's total population). The GoE directed the districts in these four regions to dynamically expand AES so that every *kebele* would have a team of at least three DAs providing training in crops, livestock, and natural resource management. Accordingly, DAs are based in the *kebeles*, rotating to new communities every few years. The AES team leader in the *kebele* serves as the agriculture portfolio holder in the *kebele* cabinet. In some cases, there are additional DAs, such as those who specialize

in beekeeping, veterinary health, cooperatives, or other areas; where they are present, they usually serve multiple *kebeles*. As indicated above, each *kebele* is to have an FTC.

Woreda offices are staffed with SMSs in the areas of AES communication, crop production and protection, livestock development and animal husbandry, natural resources, and irrigation agronomy. DA supervision is the responsibility of SMSs, each supervising at least three FTCs. *Kebeles* are divided into three sub-*kebeles*. Each DA is assigned one sub-*kebele*. DAs are responsible for AES activities in their sub-*kebele*. DAs are also members of a *kebele* task force. The task force, comprising 10 members including the DAs, is fully accountable to the administration of the *kebele*.

4.2. Capacity of Development Agents

Based on Digital Green's 2016 survey of 896 DAs in the four largest regions, all DAs have post-secondary education, and a random selection of DAs reveals a good mix of expertise on crops and livestock production and natural resource management. DAs are trained for 10 + 2 years, the last two years being provided at ATVETs (Table 4.1).

However, some areas of DA training, experience, or skills can be further improved:

- While most DAs (92 percent) have received AES-related training, 8 percent have not. Moreover, recent training has focused heavily on crop production; only 11 percent mentioned training on water and soil conservation and 6 percent mentioned animal production.
- Ten percent of DAs surveyed do not have any farming experience. Having farm demonstrations and/or extensive training for these DAs may be important.
- Less than half of DAs (46 percent) are computer literate. Training in computer literacy can help as can equipping FTCs with computers and Internet access.
- Less than half of DAs (42 percent) own a smartphone. Providing smartphones to DAs could assist them to be more efficient and to reach out to more farmers in remote areas.

4.3. Approaches used by agricultural extension service providers

Several AES methods are often applied and combined, including door-to-door AES, farm-to-farm AES, development group meetings, community meetings, field demonstrations, and FTC training. The results from the 2009 DA survey show that community and development group meetings were more prominent than other approaches. Also, in earlier surveys, contact with farmers via social events (for example, weddings, funerals, and other religious activities) was emphasized by 15 percent of DAs as essential in reaching farmers.

Almost all DAs in the 2008 and 2016 surveys stated they used model farmers. As shown in Table 4.1, in the 2016 survey, almost all DAs reported collaborating with development groups. However, the medium of delivery is dominated by word (speech, verbal), and only half use pictures or illustrations. Only 14 percent use an audio/sound system (including a radio) and only 7 percent use a video (sound and picture). A recent study by Bernard et al. (2016) shows significant potential for video in terms of technology adoption and productivity. The expansion and promotion of the use of low-cost ICT, including smartphones, instant messaging, radio, interactive voice response, and video, is an area that the AES system can improve on. A simple starting point would be to reimburse DAs' expenses for their use of mobile calls and text messages to farmers, an issue DAs routinely complain about when it comes to incentives.

Table 4.1. Incentives, work resources, and environment for Development Agents

	Tigray	Amhara	Oromia	SNNP	TOTAL
Fixed salary, monthly average in ETB	1988	2712	2151	2191	2280
Housing or housing allowance, % yes	81.5	56.4	29.5	18.7	40.9
Transport allowance, % yes	5.0	2.2	6.6	3.2	4.6
Health allowance, % yes	4.2	0.4	1.6	1.1	1.6
Annual leave taken in 2016, days on average	2.8	3.3	2.3	1.5	2.5
Is there a performance-related award or prize for DAs?, % yes	41.2	42.3	40.2	45.6	41.9
Received award or prize, % yes	57.1	37.5	39.0	32.9	39.6
Type of the main award received, % yes					
Financial (money)	39.3	50.0	3.5	17.9	24.1
Certificate (recognition)	28.6	13.9	57.9	35.7	37.6
Education opportunity	28.6	27.8	26.3	28.6	27.5
Promotion	3.5	0.0	3.5	7.1	3.4
Transfer to preferred location	0.0	8.3	8.8	10.7	7.4
Satisfied with the existing DA incentive structure, % yes	20.2	29.1	25.6	31.6	27.0
Access to bicycles, % yes	3.4	18.9	22.9	2.1	14.9
Access to motorbikes, % yes	9.2	3.5	4.1	1.1	4.0
Access to AES materials					
Leaflets, % yes	57.9	66.9	49.0	53.5	55.7
Slides, % yes	42.9	14.5	14.3	19.3	19.2
Package booklets, % yes	86.6	88.6	64.7	63.6	73.4
Annual reports, % yes	82.4	74.9	67.2	88.8	75.7
Have enough resource to fully carry out AES related work, % yes	10.1	8.4	3.3	9.1	6.7

Source: Digital Green DA Survey (2016). SNNP = Southern Nations, Nationalities, and Peoples' Region.

4.4. Target groups

In terms of target groups, 72 percent of DAs reported targeting the head and spouse within the same household, while 26 percent reported targeting only the head. This is worse in Oromia Region, in which only 66 percent of DAs interviewed targeted both senior adults in the household. Fifty-one percent and 60 percent of DAs reported organizing training specifically for women and youth, respectively. These efforts provide for greater gender inclusion, although attention to head and spouse together should be further improved, especially in Oromia (Table 4.1).

4.5. Incentives for Development Agents

In terms of incentives, only 27 percent of DAs interviewed said they are satisfied with the incentive structure within the public AES system (Table 4.1). Rewards and prizes are given for good performance, such as financial rewards, educational opportunities, certificates, and promotions. In fact, 40 percent of DAs said they have been promoted in the last three years. However, promotion, benefits, and allowances appear not to have been the same for all; most DAs receive a housing allowance (or rural housing facility) in Tigray, but only 19 percent do so in SNNP (Table 4.1). Across all regions, only 5 percent receive a travel allowance and only 2 percent a health allowance.

Sanctions for underperformance were reported by 62 percent of DAs. Sanctions are mostly warnings or decreased salary (2008 DA survey). The main issue may be the lack of resources to carry out AES work. Only 7 percent reported that they have enough resources to fully carry out their work. Only 14 percent have access to a bicycle and 4 percent have access to a motorcycle, while the majority deliver AES on foot (Table 4.1). This situation has not changed much since the 2008 DA survey. About 73 percent have access to at least AES materials/booklets, although this is lower in Oromia and SNNP regions (64 to

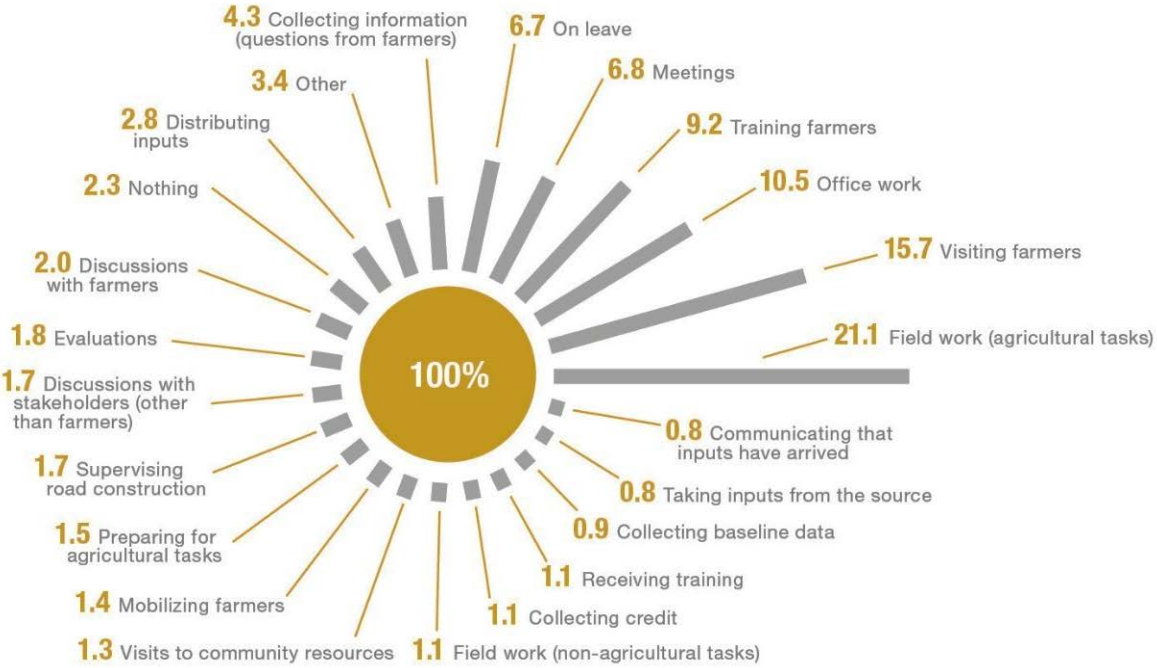
65 percent) – an improvement over the 2008 DA survey, in which only half of the DAs interviewed reported some access to AES materials.

When these data are combined with the information on the use of pictures or illustrations (only half of DAs interviewed use them), it appears that most AES materials are mainly text without illustrations. This implies that significant potential remains to improve methods of agricultural extension delivery and ensure message retention through more creative visual applications.

4.6. Workload

Despite recent efforts to clarify DAs' specific roles and tasks (MoA 2011), the amount and type of work they are expected to perform is daunting and increases with each intervention, leaving DAs overburdened and poorly prepared to do regular AES activities. Although AES has been decentralized to the administrative control of regional governments and *woreda* administrations, the continued imposition of targets at the national level and the lack of local capacity have prevented, so far, the emergence of a dynamic, demand-driven system (Spielman, Kelemwork, and Alemu 2011). DAs are positioned at the frontline and, as such, are at the very end of the government structure, where they are at the end of the receiving line in terms of workflow around activities that do not necessarily relate to their specific tasks. As can be seen in Figure 4.1, every intervention flowing to the *kebeles*, for example, programmatic interventions such as the Productive Safety Net Program (PSNP), AGP, Feed the Future (FtF), and other meso- and micro-interventions, involves engagement by the DA, including those from non-government actors. This leaves DAs overburdened and under-resourced to achieve their goals.

Figure 4.1. A typical work week for a Development Agent in Ethiopia

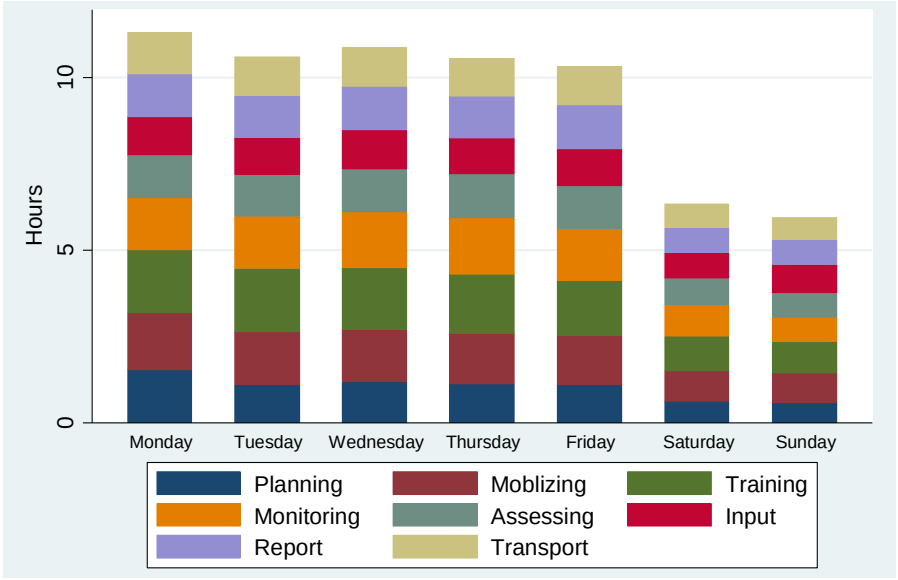


Source: Authors' calculation from IFPRI/EEA survey data (2009).

In terms of overall workload, only 62 percent of DAs reported that it is manageable, while the rest reported that their workload is too much. During planting season, DAs work 10 to 11 hours per weekday and 5 to 6 hours on weekends on average (Figure 4.2). A DA works with 19 development groups and with about 500 households on average. They are involved in many activities, which include visiting farmers, training farmers, receiving training and office work, administering farm taxes and credit repayments, collecting data, supplying inputs, and mobilizing community work (Figure 4.3). They are also involved in non-agriculture-related activities in the community. Moreover, DAs spend almost 8 hours per week

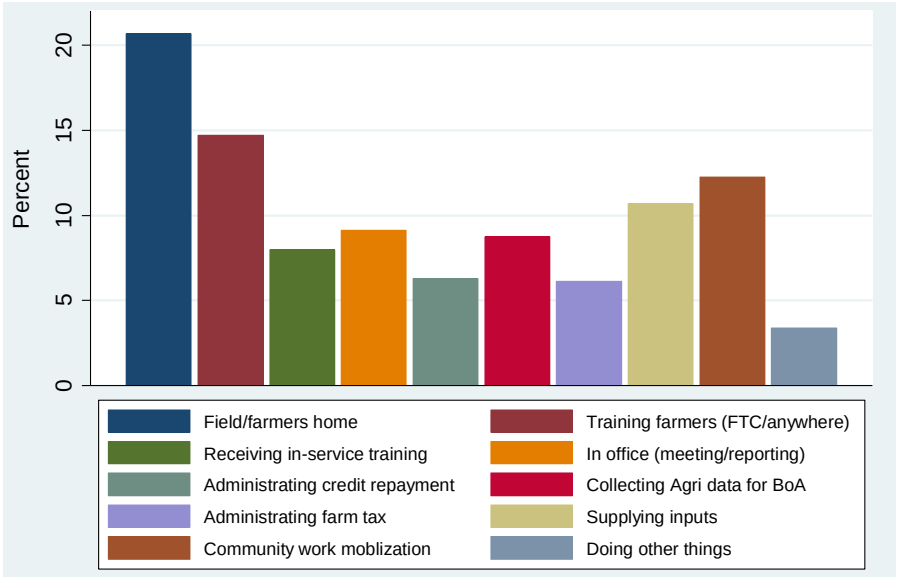
(10 percent of their work time) in the office preparing and writing reports. On average, a DA prepares 50 reports in a year, in addition to the hours spent on collecting data and monitoring farms according to indicators (approximately 10 to 20 percent of their work time). Therefore, the time devoted to working with and advising farmers was only approximately 35 percent in 2016 and 46 percent in 2009, if one adds up the time spent by DAs on field work, visiting farmers, and training farmers.

Figure 4.2. Number of hours a Development Agent spends on an activity in a typical week during the planting season



Source: Digital Green DA survey (2016).

Figure 4.3. Allocation of a Development Agent's work time



Source: Digital Green DA survey (2016).

The figures above indicate the heavy work burden that DAs carry and the need to balance the expectations placed on them with the support they are given. In particular, ways to ease transportation time through, for example, the provision of motorcycles or vehicles, and expanding the technologies and tools they use through, for example, expanding the use of radio, video, and smartphones, would make AES delivery more efficient and useful.

Given the amount of data that DAs collect and time spent on collecting data, monitoring, and report writing, these data can be used more systematically to improve or refine local AES strategies and approaches. Digital Green's "Connect Online— Connect Offline" (COCO) platform can be further tested as an alternative to the current data collection system (Bernard et al. 2016). COCO data are typically collected by DAs on paper, and later digitalized at the *woreda* level. Data are automatically synchronized with Digital Green's main database via Internet connection. All data are integrated under the COCO platform. At the *woreda* level, the COCO platform automatically computes relevant statistics on technology dissemination and farmers' adoption and presents them on a dedicated user-friendly dashboard.

4.7. Linkages with national agricultural research systems

An AES system is not only the most important vehicle to convey knowledge generated at research centers to farmers' fields, but can also bridge the reverse information flow gap from farmers to researchers (Birkhaeuser, Evenson, and Feder 1991). As such, it is important that AES are carefully synced with research centers. However, studies indicate that research–extension links are generally weak in many developing countries, partly due to poorly aligned incentive structures between researchers and extension managers, as each of them fall under separate management structures (Anderson and Feder 2004). In short, in such contexts, the priorities of national agricultural research centers are ill-aligned with those providing AES or the farmers themselves, leading to undesirable outcomes in many instances (Purcell and Anderson 1997). The Ethiopian context is no different. Table 4.2 provides a summary of the literature on the evolution of extension–research–farmer linkages in the recent history of Ethiopia. A key takeaway from this summary is that the link between research and extension (and its feedback loop to farmers) has been inadequate and ad hoc despite efforts made at several points in time to address this challenge.

The main observations are fourfold:

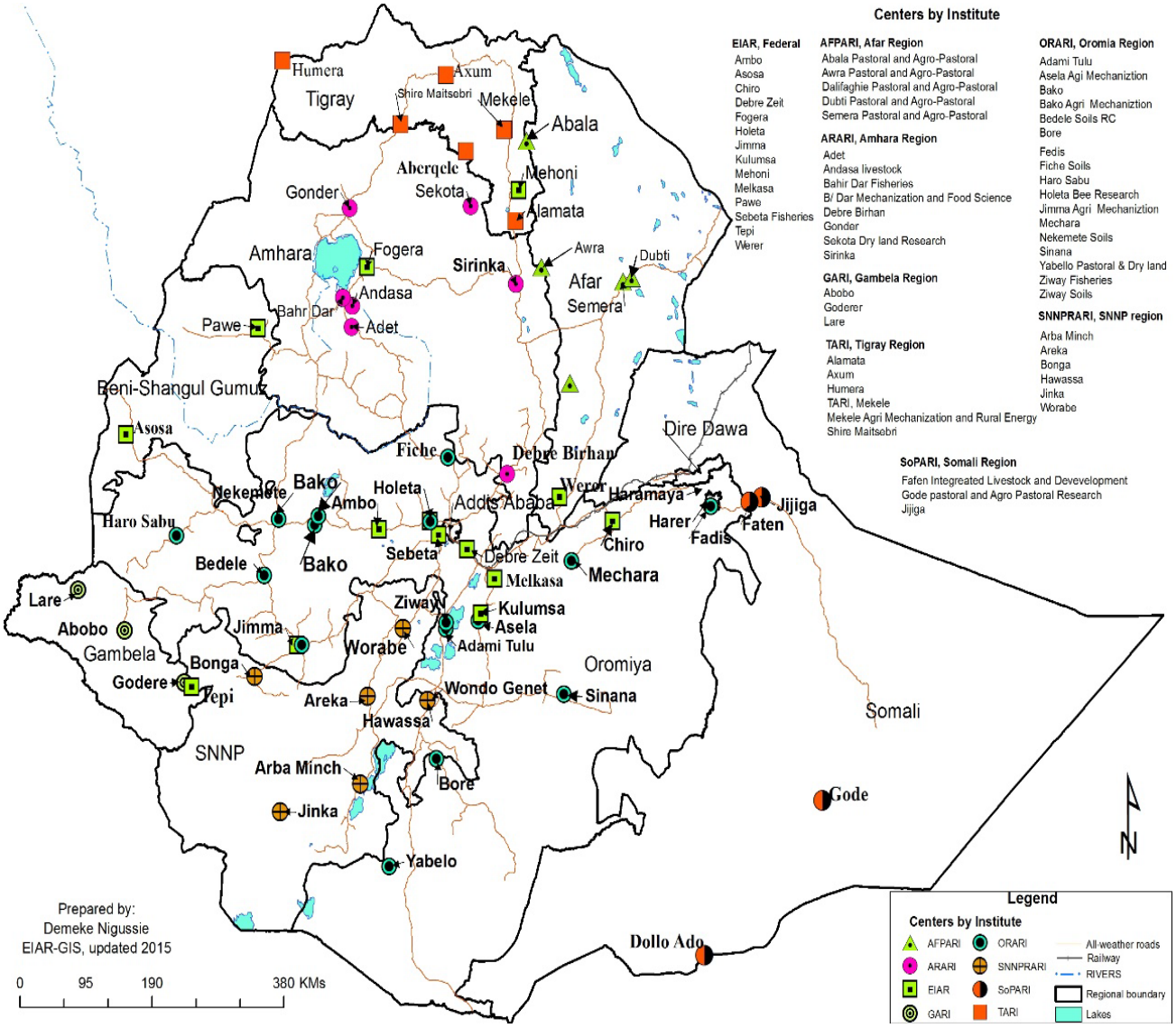
- Although the various efforts summarized in Table 4.2 aimed at interlinking research and extension, most of them continued to view research and extension as distinct processes. In some instances, this was even manifested by organizing research and extension in different organizations or institutional structures.
- Most of these efforts to integrate research and extension lacked proper legal status to align incentive structures between the two entities and facilitate decision-making processes. The bodies that facilitated the interlinkage were organized in the form of platforms or ad hoc committees that lacked proper institutionalization to convey research outcomes to the AES system or the required accountability to enforce the research-extension linkage. Instead, such committees focused on rather broader issues of planning and execution of activities outlined by AES providers. Relatedly, such initiatives heavily relied on project funds and often ceased to exist when projects phased out.
- More importantly, the end users of the technologies and extension services were not properly represented in most of such research–extension linkage platforms.
- Such efforts were also hampered by the limited capacities of national research centers to generate critical knowledge that addresses local conditions. Although rigorous studies evaluating the relevance and impacts of agricultural research investments in Ethiopia is yet to come, suggestive evidence indicates that research centers in Ethiopia, despite improvements, are highly under-resourced both financially and skill wise, and lack proper coordination among centers themselves (MoA 2014; Abate 2006; Belay and Degnet 2004). This is further discussed below.

Table 4.2. Historical evolution of research–extension–farmers linkages in Ethiopia

Period	Program/Event	Objectives/Highlights	Remarks
1952–1965	Integrating education, research, and extension	Formal research and extension service was started in 1952 when the Agricultural and Technical School at Jimma and the College of Agriculture and Mechanical Arts were established. Later, extension mandate was transferred to the MoA.	The system was modeled after the US land grant university system.
1966	Establishment of the Institute of Agricultural Research (IAR)	Following establishment of the IAR in 1966, research was divorced from education and extension without setting a mechanism for coordination of research and extension.	By compartmentalizing research and extension activities, a linear research–extension–farmer model was adopted.
1974–1977	Institute of Agricultural Research Extension Project Implementation Department of MoA (IAR/EPID)	The joint IAR/EPID program was mainly initiated for agricultural technology package testing and formulation of research recommendations.	The program was discontinued in 1977 due to budget problems and reinitiated in 1980/81 as IAR/ADD, albeit it was not successful for various reasons.
1980s	Farming System Research (FSR) research–extension linkage	Conducted multidisciplinary surveys and focused on providing feedback to researchers on the characteristics of technologies, conveying on farmers' problems, formulating recommendations appropriate to smallholder farmers, and generating useful recommendations for policy makers.	Followed the FSR model, but the program was found to be expensive and time-consuming and was phased out as project funds ran out.
1985–1986	Research-Extension Liaison Committee (RELC) was established under Research–Extension Division (RED) of IAR	The RELC was established at zonal and national levels: at zonal level to review and approve research proposals and extension recommendations, identify training needs for SMSs, and oversee research–extension and farmer linkages; at national level to give overall policy direction and capacity building.	RELC was largely ad hoc – that is, it did not have any legal status, which affected its decision-making power and institutionalizing accountability among members; farmers were passive participants.
Late 1990s	Research-Extension-Farmers Linkage Advisory Council (REFAC)	REFAC was organized at national, regional, and research center levels and was run by the RED of the Ethiopian Agricultural Research Organization (EARO). The main objective of REFAC was providing overall guidance to research and extension programs, and oversight of the linkage between the two activities. It was mainly funded by the World Bank Agricultural Research and Training Project (ARTP).	REFAC did not produce strong linkages as expected, mainly due to lack of clarity on actors' responsibilities.
2008–2009	Agriculture and Rural Development Partners Linkage Advisory Council (ARDPLAC)	ARDPLAC was organized at national, regional, zonal, and *woreda* levels and was run by the MoA or Bureau of Agriculture. Later the name was changed to Agriculture Development Partners Linkage Advisory Council (ADPLAC). Like REFAC, it was mainly funded by the World Bank.	ADPLAC can be considered as a first attempt to institutionalize the linkage through allocation of regular finance and accountable institutional setup within the MoA, even though there is still an ad hoc nature to the planning and execution of linkage activities.

Source: Authors' compilation from various sources (mainly from Deneke and Gulti (2016); Kassa and Alemu (2016); Demekech et al. (2010); and FDRE 1999).

Figure 4.4: Location of national and regional agricultural research centers in Ethiopia



Source: Ethiopian Institute of Agricultural Research (EIAR).

The Ethiopian agricultural research system has a decentralized structure that includes three types of institutes: (i) National Agricultural Research Centers; (ii) Regional Agricultural Research Centers; and (iii) Agricultural Research Centers in Higher Education Institutions (Kassa and Alemu 2016). Figure 4.4 presents the geographical locations of regional and national research centers in Ethiopia. Ethiopia has 62 federal and regional agricultural research centers, excluding university research institutes, well spread across the various agroecologies of the country. This geographic dispersion makes it possible to link these centers with AES located in each of these localities. However, recent studies indicate the absence of clear functional delineation and lack of formal or institutionalized mechanisms of collaboration among these three types of agricultural research centers. Cognizant of this, the Ethiopian Agricultural Research Council – an umbrella organization to coordinate national agricultural research – was established in 2014 (Deneke and Gulti 2016; Kassa and Alemu 2016). However, given the complexities to coordinate research nationally, this has remained rather nominal and is yet to function as planned.

In sum, as discussed earlier, poor research–extension–farmers linkages are cited as the main reason for limited impact of the agricultural research system (Deneke and Gulti 2016; Kassa and Alemu 2016; Davis et al. 2010). A recent study by Kassa and Alemu (2016) points out that: (i) the lack of integration

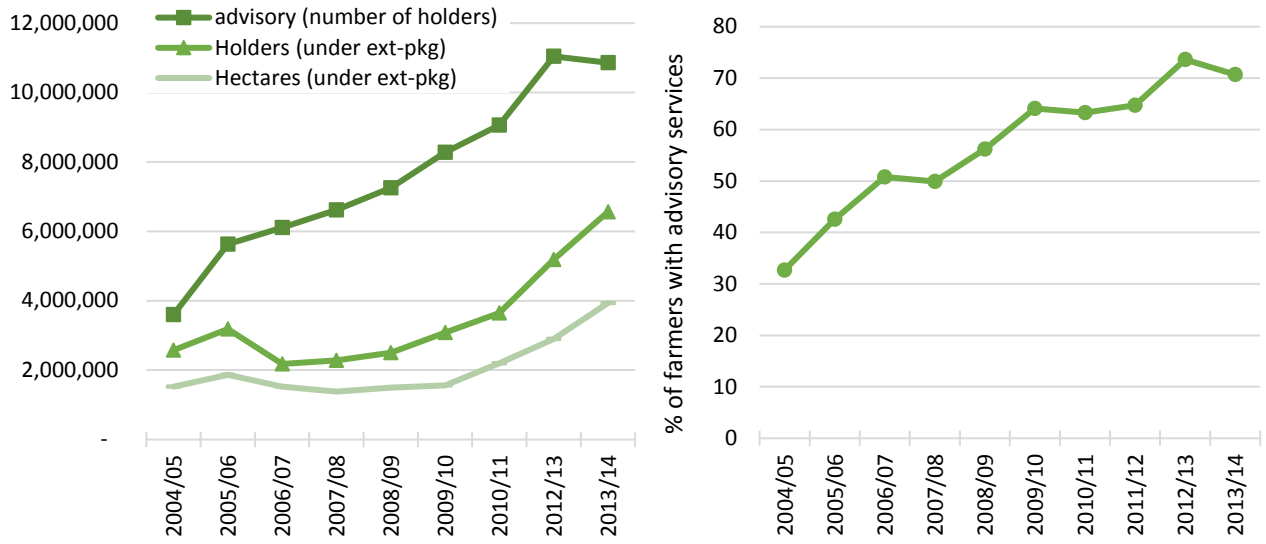
and coordination between research and extension has created ambiguity as to who should conduct pre-extension trials before making technologies available to farmers; and (ii) farmers and extension agents provide little or no feedback to research institutes about disseminated technologies, mainly due to the weak link between research and extension. Thus, given these challenges, the gains from the research and development investments made to run geographically spread national and regional agricultural research centers throughout the country would hardly be worth it.

5. EVIDENCE OF EFFECTIVENESS AND IMPACT

5.1. Access to the agricultural extension service system

Several improved technology sets and a great deal of modern inputs have been distributed to farmers through the AES system. According to the annual Agricultural Sample Survey of the CSA of Ethiopia, between 2004/05 and 2010/11 the proportion of farm households that had access to the AES system jumped from 33 percent to 71 percent. At the same time, the number of farm households with access to advisory services increased from 3.6 million to 10.8 million (Figure 5.1). Furthermore, the number of farm households covered by the AES package, including advisory services, increased from 2.5 million to 6.6 million, while coverage increased from 1.5 million to 3.9 million hectares. Note that farmers are considered covered if they have applied one or more of the elements of the AES package, including the use of fertilizers and improved seeds.

Figure 5.1: Number of farm households and area covered by the public agricultural extension system (left) & percentage of farm households receiving advisory services (right), 2004/05–2013/14



Source: Calculated using CSA data (CSA, 2005b–2014b).
Note: Ext-pkg=AES package.

5.2. Promoted technologies

According to the DAs interviewed, a wide range of technologies are being promoted in terms of land preparation, seed selections, row-planting, fertilizer applications, crop management, postharvest handling, and natural resource conservation. Many DAs (75 percent) reported having promoted market linkages, although one-quarter of DAs have yet to do so. It is also interesting to note that market linkages are among the top requests by farmers but are among the least promoted AES technology. Ayenew (2016) documented that the Improving Productivity and Market Success (IPMS) project, which integrated productivity-enhancing technological schemes with market information and the market access model, contributed to input and output market integration and/or market-oriented agricultural production.

The topics requested by farmers are several, with the major ones relating to seed selection, crop management, market linkages, fertilizer application, and land preparation. According to the 2008 DA survey, the most overwhelmingly requested topic is improved seed and planting materials. This demonstrates improvements in the diversity of knowledge and information provided by the AES system beyond modern inputs promotion. However, Table 4.3 shows that a major disconnect still exists, as well as an inconsistency in the focus of DAs to establish such needs.

Table 4.3. Technologies or practices promoted by Development Agents

Technology/practices	DAs who promoted technology in 2015/16, %	Topic or technology requested by farmers? (% yes)
Land preparation	98.6	57.0
Seed selection	97.0	60.0
Row-planting	98.0	53.0
Fertilizer application	98.2	57.4
Crop management	97.2	58.4
Postharvest handling	96.0	57.4
Natural resource conservation	96.4	49.2
Climate-smart practices	85.2	53.3
Market linkages	75.5	57.7

Source: Digital Green DA Survey (2016).

Table 4.4. Development Agent visits in the last main season and in the last 5 years

	Visited in the last season	Visited in the last 5 years
% yes	53.3	64.2
If yes, average number of visits	1.4	4.1
Type of visit (%)		
Helped in the introduction new inputs	33.9	34.4
Source of introduction to new methods of cultivation	30.0	22.9
Source of introduction to new crops	6.6	8.4
Assisted in obtaining fertilizer	15.1	17.0
Assisted in obtaining improved seeds	7.1	9.1
Assisted in obtaining credit	1.4	3.3
Other	5.9	4.9

Source: AGP survey (2011, 2013), two rounds. Observations: 7,381.

5.3. Satisfaction with agricultural extension services

In terms of satisfaction with the quality of the services provided, almost all households surveyed were satisfied (59 percent, strongly satisfied; 40 percent, satisfied) with the individual visits made by DAs (Table 5.1). Less than 2 percent indicated that they were not satisfied with the answers DAs provided or that the information given by DAs was incorrect or irrelevant. This shows overall high satisfaction with DA advice.

Table 5.1. Recipients' assessment of quality of agricultural extension services provided in the last 12 months, 2011 and 2013, percent

	2011	2013
The service provided by the DAs was satisfactory?		
Strongly agree	62.5	58.7
Agree	35.5	39.6
Disagree	1.1	1.3
Strongly disagree	0.7	0.4

Source: AGP survey (2011, 2013), two rounds. Observations: 7,381.

Another study by Elias et al. (2016), although with a small sample size (150 beneficiaries in northwest Ethiopia), paints a different picture. It shows that about 55 percent of interviewees were satisfied, whereas 45 percent of them were dissatisfied with the extension services received, implying that the program still has a lot of room for improvement. Focus group discussions conducted with farmers show that lack of quality and diversified improved seeds, limited technology choices, high price of inputs (chemical fertilizer), and an inconvenient loan system are the main reasons for dissatisfaction.

Farmers also indicated serious issues with the quality, diversity, and availability of improved seeds in the study area. They have experienced crop loss due to seed quality. In addition, while they have a great need to access different types of crop seeds, they are only able to access improved seeds for maize, wheat, and teff crops. Their opinion is consistent with previous literature (Spielman, Kelemwork, and Alemu 2011). While this may not relate to the quality of AES per se, these farmer responses highlight the inability of the AES system to communicate and respond to these constraints. In other words, supply-driven, instead of demand-driven, AES limits farmers' satisfaction. Therefore, it is important that packages provided farmers should be of a high standard, and be easily accessible, affordable, and needs-based to enhance overall satisfaction.

Yet other studies have highlighted caution in the interpretation of farmers' satisfaction due to overreporting and serious social desirability bias with responses obtained in some settings and country contexts (Ragasa and Niu 2017 in the case of Malawi). Moreover, satisfaction can be correlated with the promotion and provision of inputs, as highlighted by Elias et al. (2016) and Ragasa and Mazunda (2018). Therefore, one should exercise caution when interpreting such responses while, at the same time, learn from the insights. In addition to asking about farmers' satisfaction, it is often insightful and useful to ask farmers how the advice was used and how it changed their behavior and practices.

5.4. Agricultural extension services, technology adoption, and productivity growth: Empirical evidence

Several studies suggest that the success of AES programs in Ethiopia has been mixed. The most recent expansion of AES has yet to be evaluated, although Davis et al. (2010) provide a careful review of system operation prior to 2010 and identify a series of weaknesses. A study by Dercon et al. (2009) shows that receiving at least one visit from a DA increases consumption growth (a measure of income) by 7 percent and reduces poverty by 10 percent, based on a panel dataset from 1999 to 2004. The authors caution readers on the implications of the results for AES, as some of the effect may represent transfers of technology or knowledge, while some may reflect the influence that AES agents have on the increased use of fertilizer and other inputs.

Given the success of Ethiopia to put in place one of largest public AES systems in Africa, and the associated quality challenges thereof, Berhane et al. (2017) study: (i) the roles this system has played in the adoption of specific technologies; (ii) identify direct effects of the system in improving agricultural productivity; and (iii) infer and outline the challenges ahead to further improve agricultural productivity in Ethiopia. They control for many important sources of heterogeneity, including household wealth and weather-related factors. The following are the main findings.

- Access to the AES system significantly increases adoption of modern inputs (mainly chemical fertilizers, improved seeds, herbicides, and irrigation).
- AES does not directly increase the level of productivity other than through its indirect effect on increased adoption of these modern inputs (see Table 5.2). Use of modern inputs, including fertilizers, improved seeds, irrigation, and row-planting, contributes to productivity increases. This result is consistent across several indicators for AES and advisory services directly provided by DAs, as well as those provided through farmer-to-farmer interactions. These results are also in line with

recent evidence suggesting that agricultural productivity increases in Ethiopia in the last decade are mainly associated with expansion in cultivated area of land and increased use of chemical fertilizers (Bachewe et al. 2016). The results suggest that agricultural productivity increases in Ethiopia are not knowledge-driven as yet, and that achieving additional productivity increases will be difficult without investing in knowledge-based AES.

- Berhane et al. (2017) do not find significant adoption and productivity variances among younger and older farmers as a result of access to AES.
- There are variances in wealth, rainfall levels and agroecology, land, labor, and other critical farm inputs such as oxen, the last of which are associated with significant productivity growth. Both Berhane et al. (2017) and Ragasa et al. (2013) find that access to production-related information delivered by radio does raise productivity. Innovating on alternative methods for information dissemination such as radio and other mass media may prove to be a low-cost and effective way of increasing productivity and incomes.

These results show that the technical support currently provided through AES is not directly linked with increases in productivity (other than through channeling inputs) and is consistent with a recent assessment by the GoE, documented in GTP II. What is not clear is the mechanism that drives these low achievements in recent years.

Table 5.2. Productivity effects of Development Agents and use of agricultural technologies: Regression estimates based on a Correlated Random Effects approach

	Coefficient	Standard error
Agricultural extension services – Development Agent's advice		
Household gets advice on land preparation or planting (=1)	0.008	0.016
Household gets advice on how to use fertilizer (=1)	0.005	0.017
Household gets advice and assistance to use improved seed (=1)	0.000	0.017
Household believes DAs do their best to help farmers	0.011	0.009
Use of new agricultural technologies and modern inputs		
Household used fertilizer (=1)	0.031	0.013
Household used improved seed (=1)	0.023	0.014
Household used irrigation (=1)	0.061	0.036
Amount of pesticide used, liters	0.000	0.000
Amount of herbicide used, cubic meters ('000s of liters)	0.259	0.111
Household planted new crop (=1)	-0.002	0.013
Constant	-15.448	14.584
Observations	19,203	
Adjusted R^2	0.21	

Note: *p< 0.10, **p< 0.05, ***p< 0.01. Dependent variables: logarithmic expression of land productivity measured in tons of production per hectare; DA=Development Agent.

The explanation for this is simple. DAs, in practice, spend a substantial amount of their time on promoting and channeling fertilizer and improved seeds to farmers and increasingly less time on technical assistance (Figure 4.1). In fact, being at the receiving node of government parastatals involved with input supply, the DA is viewed more as the sole link to communities than an AES agent whose expertise is in need. Recent studies that link AES and productivity show a major effort to push for fertilizer and improved seed use (Abay et al. 2017; Berhane et al. 2017), considered the major contributors to rapid productivity growth and agricultural transformation in Ethiopia (Bachewe et al. 2017). Beyond this, studies show no other direct effects on productivity (Abay et al. 2017).

These results are largely consistent with an earlier study by Krishnan and Patnam (2014), which used a panel dataset from 1999 to 2009 to specifically review the adoption of fertilizer and improved seeds.

However, their study shows that the impact of DA extension wears off over time as farmers learn more from other farmers. It shows that adoption is mainly a result of knowledge shared by neighbors, thus spreading the technologies during this period. DAs had a significant impact on adoption in 1999; however, by 2004 and by 2009, their role had become almost irrelevant in this process, despite a vast increase in the number of DAs throughout rural Ethiopia. Learning from neighbors is significant and stable throughout the study: an increase of one standard deviation in the average adoption of improved seeds by neighbors (corresponding to local diffusion rates increasing by 22 percent) raises the probability of one's own adoption by 11 percentage points. For 1999, the results by Dercon et al. (2009) are confirmed by Krishnan and Patnam (2014) in that the role of AES does matter. Learning from AES ceases to be relevant after 1999, however, and despite further extensive public investment in AES in subsequent years, there is no evidence of return.

Another paper by Nisrane et al. (2011) provides further data that is consistent with the results of Krishnan and Patnam (2014); they find a significant impact of AES on output for the years 1994–1999 and 1999–2004, although no effect on output post-2004. These results are consistent with various studies showing that AES in 1999 had the largest bearing on adoption – and hence, potentially on output growth in the subsequent period – although this effect wears off in more recent years.

Ragasa et al. (2013) also find no significant direct effect of extension services on crop productivity beyond their impact on fertilizer and improved seed use. In addition, their study shows that the perceived usefulness of DA advice is statistically significant in the productivity models, implying that "quality" extension services matters. They also show that radio can contribute significantly to increasing productivity. These may reflect the situation in Ethiopia, where the large cadre of DAs is focused on fertilizer and improved seed promotion; and other information channels like radio are more likely to promote other forms of nonfertilizer soil fertility management practices (such as manure and other organic fertilizers, crop rotation, and soil conservation techniques) than DA visits (Ragasa et al. 2013). They highlight the need to pay close attention to women's access to extension services and which delivery methods can best reach them. Male heads are more likely to be visited by and to receive advice from development or extension agents than female heads (Ragasa et al. 2013). Female-headed households appear to have lower productivity; but when extension services and land access are given equally to them, they are as, if not more, productive as male-headed households (Ragasa et al. 2013).

These findings have several implications.

- There is a need for both dynamic processes of innovation and regular reviews of the technologies promoted. As farmers become aware of and try these technologies, the issue of low adoption becomes less an issue of weak extension and information systems and more an issue of the nature and relevance of the technology. This calls for an urgent need to review the usefulness of different technologies currently promoted.
- There is need to look at the quality of advice. Again, this can be a product of irrelevant technologies being promoted or a reflection of some DAs' incompetence.
- The capacities and specific tasks of DAs need to be reviewed to understand how they can best support farmers within the limits of their resources and time. Despite recent efforts to clarify the specific roles and tasks of DAs as AES agents (MoA 2011), the amount and type of work they are expected to perform is daunting and increasing with each intervention taking place, leaving them overburdened and poorly prepared to perform regular AES activities.

In addition, the poor technical training of DAs and the deficient quality of facilities at FTCs means that farmers are not tempted to spend time around FTCs. DAs are challenged to demonstrate to farmers whatever knowledge or experiences they hold. Added to this is the fact that DAs often need to traverse

difficult terrain to reach many farm communities, which are scattered over a wide geographical area, with poor infrastructure and (or even nonexistent) transportation facilities.

This suggests that further gains in agricultural productivity will have to come from institutional innovations in the existing input supply-led AES system, upgrading it to one that is more focused and knowledge-driven to address complex problems in scattered and heterogeneous geographical areas. DAs will need a more holistic knowledge base, with more facilitation and knowledge-brokering skills in addition to technical skills. A stronger engagement with research institutes and knowledge sources will need to be institutionally cultivated with an incentive system accordingly in place.

6. CONCLUSIONS AND RECOMMENDATIONS

AES is critical to promote improved farm technologies and increase productivity. Ethiopia has heavily invested in its massive public AES system, and has one of the highest agent-to-farmer ratios in the world. Ethiopia has also registered substantial economic progress in recent years, largely attributable to growth in agriculture. This paper has dealt with the extent of Ethiopia's investment in agriculture – particularly the AES system that is linked to this growth; the extent to which existing AES structures maintain current growth levels; and what needs to be done to sustain current growth levels. In addition, while drawing on diverse sources of primary and secondary data, this paper has documented the historical evolution and state of Ethiopia's AES system, providing suggestions on the way forward.

Results from data analyses at the household and DA levels indicate that access to the AES system increased the adoption of modern inputs such as chemical fertilizers (primarily), improved seeds, herbicides, and irrigation. Moreover, the use of these modern inputs, as well as row-planting, increased productivity levels significantly. However, AES does not directly increase productivity levels other than indirectly through its effects on the increased adoption of modern inputs. These results are plausible, given that Ethiopia's AES system is geared toward conveying these inputs to farmers and has limited capability to convey critical knowledge-based support to farmers.

Adoption of these fundamental inputs was instrumental to recent productivity increases and will continue to be important insofar as Ethiopia's agricultural production system starts from a rather low base. To that extent, the essential role that DAs place in channeling inputs to farmers will remain critical. However, further gains in agricultural productivity will have to come through significant improvement of the existing input supply-led AES system, upgrading it to one that is knowledge-driven and able to address some of the complex issues that arise due to, among others, the dynamics of farming systems that arise from heterogeneous agroecology, as well as soil nutrient deficiencies (in the face of population growth and climate change).

The analysis in this paper indicates three key constraints that play against the greater contributions of AES to productivity growth and agricultural transformation. First, with limited institutional innovations and poor coordination with research centers – hence the limited injection of new knowledge into the system – DAs are left with little leverage to convince lead and other farmers. DAs' operation under poorly resourced work conditions (given the amount and diversity of work they are tasked with) implies that the link between research and AES remains weak, which leads to diminishing returns to the technical support of DAs on technology adoption (Krishnan and Patnam 2014). Second, the fact that DAs are overburdened by activities beyond their regular mandates provides little time for them to search for additional knowledge and information. While the current system can be commended for having one of the highest DA-to-farmer ratios, it is overly standardized (one-size-fits-all) and lacks the flexibility to adapt to local conditions. Third, the efficacy of FTCs is also constrained because they are generally under-resourced and scattered, with little focus and scale. While evidence suggests that the number of farm households reached with AES has

substantially increased, these constraints negate sustaining future gains. It is unlikely, therefore, that the increased farmers' access to the system, as it is now, can be translated into productivity gains.

As such, significant reforms of the AES system are critical to Ethiopia's agricultural transformation. Reforms will need to extricate the system away from single-minded, top-down, package approaches of cereal intensification to more dynamic, responsive, and knowledge-based service provision. This will obviously require some major policy choices between a system that covers a wider area of the country with thinly spread resources (given Ethiopia's topography and limited resources) and a more focused but well-resourced system that is capable of addressing critical knowledge bottlenecks to proceed with transformation. These analyses also highlight the heavy work burden of DAs and the need to balance expectations against support they are provided with. In the short to medium term, ways to ease transportation time (such as providing more motorcycles or vehicles) and the facilitation of technologies and tools (such as radio, video, and smartphones) to make their AES delivery more efficient would be useful, given their heavy involvement in numerous other activities.

More importantly, institutional innovations require the channeling of new knowledge to AES agents, with a strong link between research and AES to remain country specific. Given the complexities associated with the size of farm communities to be served, and the physical and infrastructural constraints of Ethiopia, recasting the AES system as one that will be responsive to farmers' demands and to knowledge sources is the most pressing agenda for policy makers at this time.

Finally, AES is very much tied to access to productive inputs. Thus, there is a need not only to continue public investment to promote fertilizer, seed, credit, and AES, but also to support private sector development. These findings reinforce other studies conducted in the region relating to the need for complete, rather than half-hearted, liberalization of input supply markets to support smallholders to intensify cereal production. The findings recognize the necessity of continued public engagement in input markets and AES, while carving out new space for private investment by providing goods and services for smallholders in an efficient manner. By being more flexible in how inputs and services are provided and ensuring a greater degree of choice for smallholders, new market and technological opportunities will emerge in Ethiopia's agriculture sector.

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