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Development Brief

Promoting ICT based agricultural knowledge management

to increase production and productivity of smallholder farmers in Ethiopia

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Abstract

The Agricultural sector has the greatest potential for improving rural livelihood and eradicating poverty, and is a cornerstone of Ethiopia's medium term strategy—the Growth and Transformation Plan (GTP). By the end of the GTP period, the government seeks to double yields of smallholder farmers largely by scaling-up best practices, producing high value crops, expanding irrigation development and promoting natural resource conservation. A substantial increase in agricultural yield and output is expected to be realized by implementing interventions aimed at speeding-up the assimilation and adoption of improved agricultural technology and management practices of the most productive "model farmer" to less productive smallholder farmers. The impact of these strategies on productivity and production are analyzed to determine their adequacy in meeting the GTP production targets. The analysis shows that while production and productivity targets are generally achievable, the country needs to adopt more cost-effective, innovative and modern approaches to agricultural knowledge management and reform and modernize its agricultural extension system. These new approaches, concepts and tools for effective knowledge management in the agricultural sector are presented. Case studies on how these approaches have been designed and implemented in selected countries in Africa and Asia to increase production and productivity of smallholder farmers are presented. Ethiopia can draw on these experiences to develop and utilize ICT-based knowledge management techniques to implement robust strategies and intervention to transform its agricultural sector and double production and productivity of smallholder farmers as envisaged in the GTP.

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1. Introduction

Knowledge management can play a pivotal role in enhancing agricultural productivity and addressing the problem of food insecurity. If properly managed, it enables appropriate knowledge and information to reach knowledge intermediaries and smallholder farmers in a timely manner. Such delivery of knowledge and information undoubtedly minimizes the risk and uncertainty smallholder farmers face from production to marketing of their produce. But, to effectively engage in agricultural knowledge management, adequate mechanisms are needed for generating, capturing, and disseminating knowledge and information through the use of effective processes and institutional arrangements.

Sources of agricultural knowledge include scientific research and indigenous knowledge. After the creation, sourcing or accumulation of knowledge, the knowledge has to be disseminated to users to support the innovation process. Information and communication technology (ICT) can play a critical role in facilitating rapid, efficient, and cost effective knowledge management. However, ICT application in Ethiopia remains low in comparison with several African countries. For instance, in a number of Sub-Saharan African countries, smallholder farmers get technology-related advice as well as location-specific market information on inputs and outputs through ICT kiosks. Furthermore, mobile telephone service is being used to deliver agricultural information to users.

To speed up technology adoption, the government of Ethiopia needs to quickly review and modernize its public extension service delivery system and particularly the agricultural extension system and provide an enabling framework for utilizing advances in information and communication technology to deliver agricultural extension services. Using available ICTs will not only improve information and knowledge management for extension workers and farmers but optimize and rationalize public resources devoted to agricultural extension services. Illustrative case studies on how modern ICT systems have been utilized to deliver effective public extension service in the agricultural sector will be reviewed and recommendations codified for policy consideration.

This paper also analyzes the government's medium-term vision and strategy for doubling agriculture production and identifies innovative approaches that the country can utilize to design and implement cost-effective interventions in the smallholder segment of the agricultural sector. The analysis begins with a review of agricultural productivity in Ethiopia from a comparative perspective and examines

the potential improvements that can be realized by improving technology adoption and use by smallholder farmers. This assessment provides a basis for analyzing strategies for attaining productivity targets in the smallholder farm segment which substantially underpins the country's food security goals.

Streamlining public extension service has been identified as one of the critical interventions that will drive technology adoption and use by smallholder farmers. In this regard, reviewing the country's agricultural extension system will be critical in identifying gaps and areas where strategic improvements needs to be made to enable improved information management to contribute to raising agriculture productivity and ensuring food security in the country. Such strategies will focus, among others, on innovative approaches for embracing modern ICT-based agricultural extension to speed up agricultural technology and market information dissemination to farmers and other stakeholders in the agricultural sector.

2. Background and policy framework

Agriculture is the mainstay of the Ethiopian economy and underpins its development process. It is a sector with great potential for stimulating growth and employment and eradicating poverty. Because of its importance to national food security and poverty reduction, the government has, within the Growth and Transformation Plan (GTP), articulated a clear vision for the sector, placing it at the center of the country's transformation agenda. The initiatives that underlie the agriculture policy and plan aim to stimulate investment and productivity of the sector to promote household and national food security and to rally development partners to deliver effective development aid to the sector. Transformation of Ethiopia's agricultural sector requires scaling up efforts to increase agricultural production and productivity by among others promoting domestic and foreign investment through agricultural commercialization, increasing public investment in agricultural infrastructure, promoting technology transfer and adoption, ensuring efficient use of land, labor, technology and other inputs, and specifically raising the productivity of smallholder farmers (GTP, 2010).

During the GTP period, government aims to double the production of smallholder farmers by implementing measures to raise and sustain high agricultural productivity. The scope to increase production through area expansion is continuously diminishing as land for agriculture gets exhausted,

making this approach less sustainable in the long term. There are about 12.6 million smallholder farmers with an average farm size of only 1.2 hectares whose production accounts for 85 percent of the country's agricultural output, valued at Birr 221 billion (or US$13 billion) in 2011 (Access Capital, 2012). In addition to the fact that agricultural productivity among smallholder farmers is as low as 1.25 tonnes per hectare for teff, there is also great variability in productivity across farmers with the most productive farmer producing 3.66 tonnes per hectare compared to the average yield of 1.83 per hectare for cereals (Access capital, 2012).

This shows that there is great potential to increase production by raising yields per hectare for all smallholder farmers to that of the most productive (model) farmer. Significant productivity differences also exist across agro-ecological zones. These differences provide additional prospects for increasing production and productivity by providing incentives that induce farmers to optimally exploit regional specific advantages to enhance returns from agricultural investment.[1] Doing so will not only increase agricultural production through specialization and commercialization of agricultural production but will help to raise agricultural household income and employment, and ultimately contribute to poverty reduction in the rural sector.

In view of these opportunities, the Ethiopian government aims to double agricultural production and food production in particular by implementing key initiatives in the following three strategic areas that will involve:

a) Scaling up best-practices: Under this pillar, government recognizes that the productivity of a typical smallholder farmer is two to three times lower than that of the most productive farmer in this segment. Interventions to move less productive farmers to the production frontier of the "most productive farmer" will enable the country to double agricultural output in the medium term. Among others, technology development and diffusion, and adoption of sound farm management practices by small holder farmers have been identified as being strategic to the realization of this objective. In the immediate term, government should focus on

[1] For example, Afar region produces 40 quintiles of maize per ha, while the second highest Oromia produces 25 quintile per hectares and lower Dire Dawa and Somalia only 15 quintiles per hectare. Bridging these gaps would almost double maize production.

streamlining agricultural extension services, scaling- up proven interventions, and testing of new technologies for future productivity enhancement and catch-up.

b) Expanding land under irrigation: Irrigation development and natural resources conservation, with great focus on irrigation and surface and underground water development, utilization and management to support agricultural activities especially in arid or drought prone areas; and

c) Promoting cultivation of high value crops: Gradually and according to regional specific comparative advantage move farmers from producing low value to high value crops in order to enhance their productivity and income from agriculture. This precisely entails changing the mindset of smallholder farmers so that they can look at farming as business and not simply as a way of life.

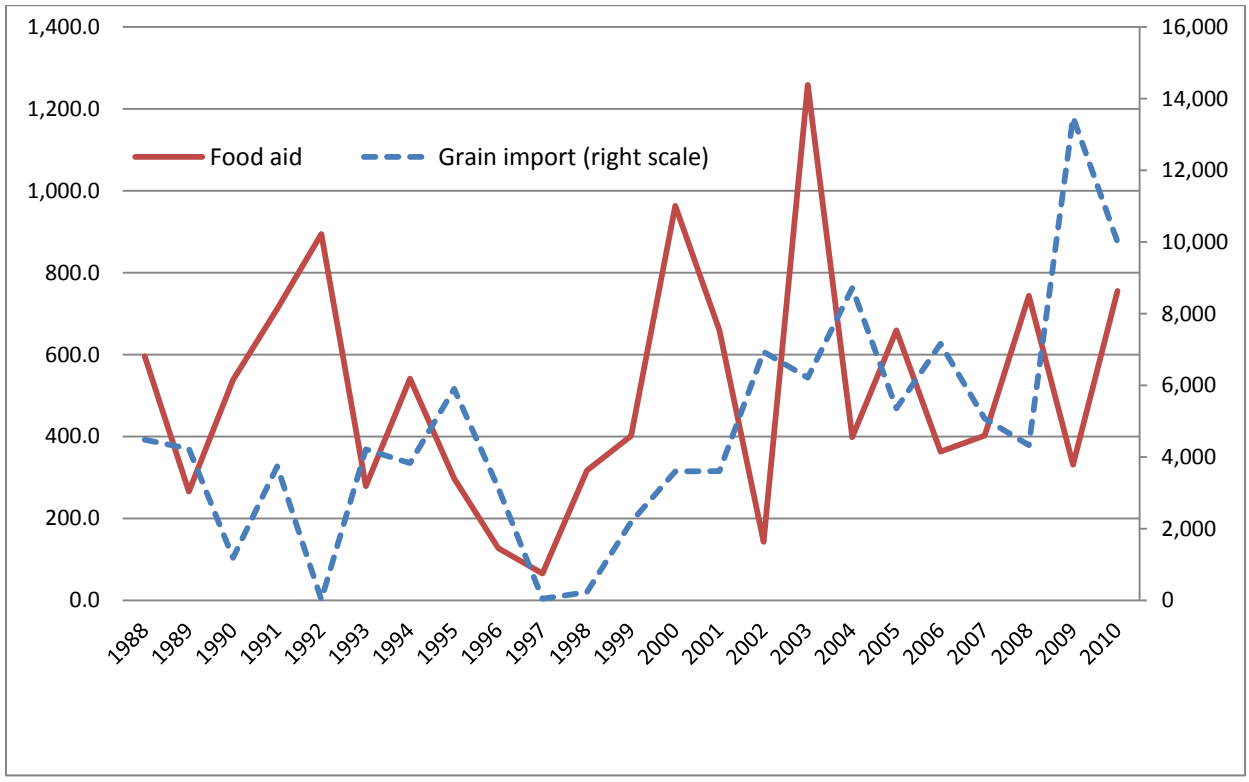
These three strategic directions are underpinned by interventions aimed at enhancing agricultural extension systems and adoption and efficient use of existing technologies to raise productivity on small holder farms. Development, testing, and diffusion of new technologies are emphasized in order to ensure continuous innovation and growth of the sector as well as to promote resilience and adaptation to changing agro-ecological environment. The problem of low productivity on smallholder farms is not much the lack of agricultural technologies but rather of inadequate knowledge, skills and resources (inputs such as fertilizer, labor, equipment, seeds and water) to enable them adopt and efficiently utilize existing technologies to enhance production and earning from farming. While government has identified low productivity as one of the major hindrances to raising agriculture productivity and food security, it should also focus policy towards speeding up the rate of technology adoption and dissemination of market information to support decision-making at the farm-level and indeed along the agricultural value chain.

Agricultural production and food security in Ethiopia

The agricultural sector accounts for 41.6 percent of GDP (Birr 474.5 billion in 2011) and employs 85 percent of the country's labor force. The sector generates about 70 percent of the country's export earnings currently valued at US$2.7 billion. While real agricultural GDP has steadily increased from Birr 31.1 billion (US$3.73 billion) in 1999/00 to Birr 64.7 billion (US$ 3.65billion) in 2010/11, its contribution to GDP has fallen by 10 percentage points to 41 percent of GDP between 1999/00 and 2010/11. In

terms of food production, the country produced 22.5 million tonnes of crop, of which 95 percent is from small holder farms and the remainder from commercial farms. As a major source of calories, cereal production is critical to both household and national food security in Ethiopia. In 2010/11, over 96 percent of cereals were produced by smallholder farmers and 65 percent of this production was consumed within the farm-household and only 16 percent was sold for cash or bartered. Taking the average per-capita calorie requirement of 2.16 quintiles for 2,100 daily calories, the country needs to produce 18.4 million tonnes of cereals to feed its population of about 85 million people. Since 16 percent of the cereals are produced as seed, 15.5 million tonnes of the production is consumable within the farm household. This implies a deficit in cereal production of approximately three million tonnes in 2010/11. This deficit is expected to be much higher when cereal production is converted to wheat calorie equivalence, which is the standard calorie measure. Using these estimates, the number of people that were food insecure in 2010/11 is estimated at 13.3 million people.[2] This number is likely to increase when crops fail due to either adverse weather conditions or conflicts.

Figure 1. Trends in food aid and grain imports (in right scale) in metric tons



Source: WFP (2011)

[2] This is estimated by multiplying the population by cereal deficit of three million and divided by the country's food requirement (18.5 million tonnes).

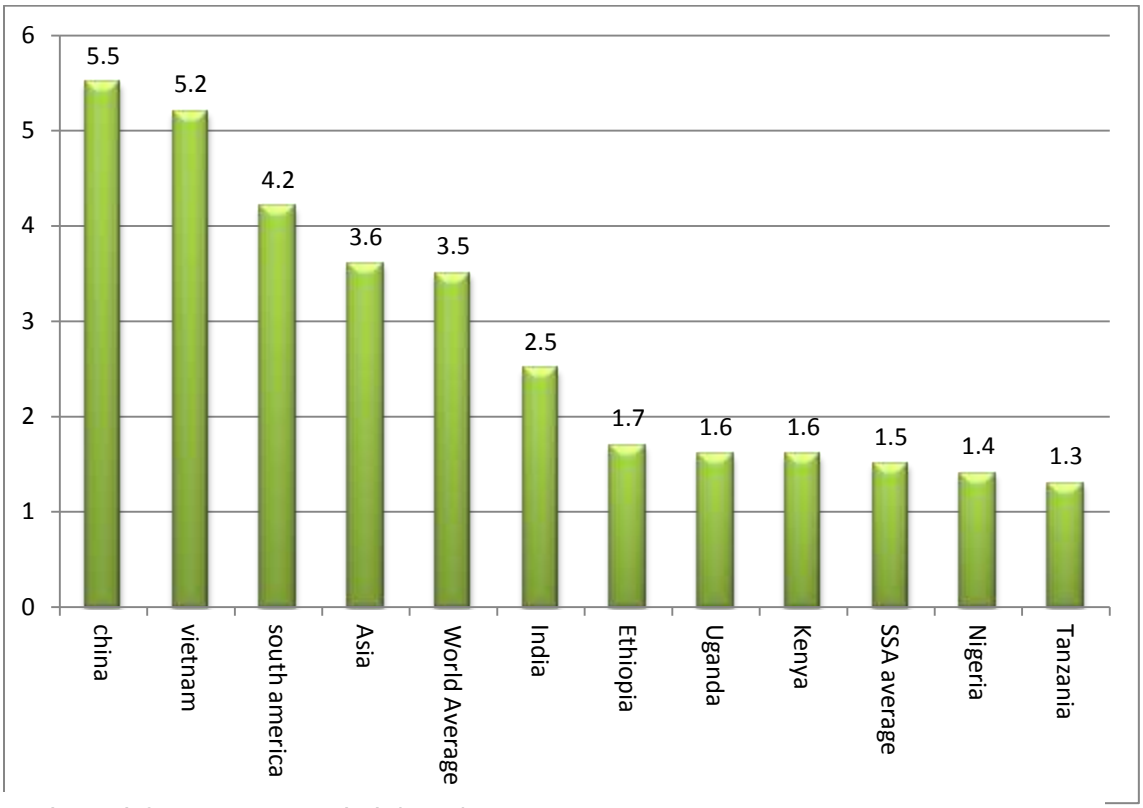
Ethiopia is dependent on food imports and food aid especially in times of high food deficits. In 2010/11, about 10,000 metric tonnes of grains, which accounts for 74 percent of total food imports, were imported into the country and an additional 755,540 tonnes of cereals was received as food aid in 2010. Food aid amounted to 1.25 million tonnes in 2003 when the country had a drought which led to crop failure and high food deficits.[3] The Productive Safety Net Program (PSNP) initiative provides cash and food transfers to chronically food insecure households covering 8 million beneficiaries. PSNP also provides assistance to households facing transitory food shortages especially in areas prone to frequent droughts estimated at 3.5 to 5 million people. This means that the PSNP, which is probably the largest social security program in Africa covers approximately 13.3 million people categorized as food insecure. The need to ensure national food security puts food production at the center of the country's agricultural policy and investment in Ethiopia.

Trends in agriculture and crop productivity

Ethiopia has ample scope to substantially increase agricultural production and achieve household and national food security by increasing the productivity of smallholder farmers. This can be achieved by promoting technology transfer and adoption, boosting commercial production, deepening agricultural markets, and improving infrastructure and agricultural policies. Some progress in rising productivity has been made in the last decade, but these changes are far from being transformative. While agricultural yields per hectare is 1.7 tonnes of cereals and just above the Sub-Saharan Africa average of 1.5 tonnes, agricultural production systems are largely agrarian and subsistence with over 65 percent of the production consumed within the farm household. Agricultural systems should rapidly be transformed in order to double productivity levels to reach 3.5 tonnes per hectare recorded in Asia (figure 2).

[3] Food aid receipt are quite high, averaging 610,000 metric tonnes annually since 2000, and the food import bill rose to US$1004 million in 2010 from an annual average of US$366 between 2002 and 2007.

Figure 2. Comparison of yield per hectare for cereals in selected countries in 2010



Adopted from Access Capital, (2012).

In addition to implementing measures to double physical quantities of the agricultural produce by increasing agricultural productivity, government should equally be concerned about maximizing the nutritional value of the output as well as marginal value of land devoted to agriculture and other land competing uses. Figure 3 shows trends in the value of crop and total agricultural output per hectare between 2004/5 and 2010/11. The data shows that value of output per hectare, which has been increasing since 2004/5, declined significantly in 2010/11 largely due to the sharp increase in inflation. While the nominal value of agricultural and crop output increased by approximately 43 percent and 50 percent over the six-year period since 2004/5, the corresponding increase in real terms was only 8.2 percent and 7.3 percent respectively. The value of crop output per hectare which had been rising at 7.3 percent annually between 2004/5 and 2009/10 posted a sharp decline of 13 percent in 2010/11. The fall in the value of output per hectare was even more pronounced for the whole agriculture sector, which posted a decline of 21 percent in 2010/11 when headline inflation and food inflation rose to 38 and 45 percent respectively and the local currency was devalued by 20 percent.

Figure 3. Real value of crop and agricultural output per hectare (2004/5—2010/11)

Source: CSA (various issues)

It is important that the government does not solely focus on increasing the physical output per hectare but also ensures that the value of output produced is maximized in real terms. This will help to enhance efficiency in agricultural land use and land allocation across the different land uses in the economy. To achieve this, the government needs to maintain macroeconomic stability and gravitate towards a competitive exchange rate. Slippages in macroeconomic stability, which have adversely impacted agriculture production and income should be addressed and where possible avoided in future in order to create and sustain a vibrant and internationally competitive agricultural sector. Providing incentives to farmers to shift from production of low value crops to high value crops can help to increase yields and returns on land devoted to small holder agriculture in the country. Measures to increase the nutritional value of food crops will help to enhance food security at the household level.

Increasing agricultural productivity of smallholder farmers

In order to double output, government can pursue at least three strategies: first, it can raise agricultural yield per hectare from 1.7 tonnes to 3.5 tonnes—which is the average for Asia, by benchmarking on agricultural technologies in Asian countries. While rapid agricultural commercialization can help to raise total factor productivity, it should not leave smallholder farmers who currently produce over 95 percent of the food crop behind the technology frontier. In this context, a more sustainable transformation of the agricultural sector should ultimately involve measures to boost production and productivity of small holder farmers on the one hand and targeted interventions to support agricultural commercialization on the other. Since productivity is widely dispersed across small holders, closing these disparities by raising productivity of marginal farmers to that of the most productive farmers in this segment would enable the country to double production and achieve the target envisioned in the GTP. This can be achieved by also inculcating the spirit of entrepreneurship in small holder farmers so that they can take up farming as business ventures.

Lastly, much of the increase in agricultural output in the last decade was achieved by expanding land under crop cultivation. The increase in real agricultural output and crop production of 43 percent and 33 percent respectively has been attributed to the increases in land under cultivation, which invariably grew by 30 percent compared to less than 20 percent growth in productivity over the same period. This strategy of raising food production is not sustainable in the long term as the scope for further growth in output will soon reach a natural limit as land available for agricultural expansion gets exhausted. Therefore, merely expanding land under crop cultivation will not guarantee national food self-sufficiency in the long-term. In the coming years, the contribution of productivity growth to output should be farther enhanced in order to increase food production and achieve food security. As indicated in the GTP, land under crop cultivation among smallholder farmers will only be increased by 8.1 percent, and land under irrigation will be more than double to reach 1,850,000 ha by the end of the GTP period from 850,000 ha in 2009. This will bring about 20 percent of the land cultivated by smallholder farmers under irrigation, and yields are expected to increase as production will not depend solely on rainfall.

Table 1 shows differences in productivity between smallholder and commercial farmers in 2010/11 and projections of the potential output that can be produced by pushing smallholder farmers towards the production frontier of commercial farmers for all crops, except for rice where yields on smallholder farms are reported to be higher than that on commercial farms. Column two and three show the amount of land under crop cultivation and corresponding output produced by crop. Columns four and five show productivity by crop for smallholder farmers as well as commercial framers, while column six shows productivity difference between smallholder farmers and commercial farmers.

Crop productivity on smallholder farms is on average 1.83 tonnes per hectare for cereals, which is 83 percent lower than yields on commercial farms (3.36 tonnes/ha for cereals). Clearly, the greatest differences in productivity are in maize, wheat and barley. This means that raising the productivity of smallholder farmers in these three crops will have the greatest impact on overall grain production in the country. Productivity differences in teff and sorghum is only 15 percent, suggesting that raising productivity on both smallholder and commercial farmers is required in order to double yields and enhance national and household food security.

Table 1. Cereal productivity among small and commercial farmers in 2010/11

Crops	ha	tonnes	smallholders	commercial	productivity diff.	close gap by 50%	close the gap 100%
teff	2,764,669	3,483,483	1.26	1.45	15.1%	3,691,930	4,008,770
barley	1,044,998	1,703,347	1.63	2.48	52.1%	1,975,816	2,591,595
wheat	1,552,001	2,855,682	1.84	3.3	79.3%	3,471,422	5,121,604
maize	1,963,041	4,986,125	2.54	4.81	89.4%	5,863,311	9,442,229
sorghum	1,894,688	3,959,897	2.09	2.41	15.3%	4,104,945	4,566,197
finger	406,940	634,826	1.56	1.64	5.1%	645,260	667,381
oats	30,886	47,565	1.54	1.54	0.0%	47,565	47,565
rice	29,839	90,412	3.03	2.33	-23.1%	108,494	108,494
cereals	9,687,062	17,761,337	1.83	3.36	83.6%	19,908,743	26,553,836

Source: Own computations based on statistics from CSA (2011) and Access Capital (2012).

Raising crop productivity on smallholder farms to that of commercial farms will only increase output by 50 percent to 26.6 million tonnes from 17.8 million tonnes in 2010/11, with 87 percent of the increase in output resulting from productivity enhancement in maize, wheat and barley. Attaining national food security will also require increasing productivity and output of the stable crop, teff in this case. For teff production, new technologies in the area of seed and improvements in reducing post-harvest losses which are currently as high as 30 percent will help to increase output. When we add 8.1 percent expansion in land under smallholder crop production, total crop output increases to 28.7 million tonnes, which is about 62 percent of the GTP target. This target is achievable in five years as long as technology and farm management practices of commercial farmers can be diffused, assimilated and employed by smallholder farmers to raise productivity.

The second approach envisioned in the GTP is to reduce disparities in output and productivity among smallholder farmers by pushing laggards towards the frontier of the best-model farmer in each crop segment. Diffusing the model farmer's technology to the rest of the group is the strategy the government intends to pursue during the GTP implementation period. This will be complimented by expansion in irrigation facilities to increase land under irrigation in this segment by 117 percent to 1,850,000 ha by the end of the GTP period. This will increase land under irrigation from the current 9 percent to 20 percent of the total land cultivated. This combined with 8.1percent expansion in land under crop cultivation is expected to double productivity from 1.83 tonnes per ha to about 3.6 tonnes per hectare. It is expected that this will enable smallholder farmers to produce 35.5 million tonnes of cereals per annum by the end of the GTP period and achieve the objective of doubling the 17.8 million tonnes recorded in the 2010 baseline period.

Finally, increasing agricultural productivity from the current 1.7 tonnes to 3.5 tonnes and join the ranks of Asian countries in term of yields per hectare calls for major transformation of the agricultural sector. Private investment in commercial agriculture will need to be promoted over the period and FDI will certainly have to play a key role in this transformation. This will be enhanced by implementing strategies aimed at changing the mindset of smallholder farmers so that they can undertake farming as a business and not merely as a source of traditional livelihoods so that they can gradually transition towards small-scale but efficient commercial farming. These strategies matched by strong commitment by government to promote technology diffusion, adoption and effective utilization is required to translate these bold ambitions into reality and ultimately stir the agricultural sector on a

sustainable and transformative path. It is true that additional research and knowledge is needed, especially in the present era of climate change to enable farmers to adapt and also mitigate climate change impacts.

Agricultural technical-knowhow and market information to some extent is available to support decision-making at the farm-level and along the value chain. The major challenge lies in transmitting this knowledge and information to farmers in a manner that they are able to assimilate the technology and use it to improve yields and livelihoods. To gain in depth insight on this challenge, the country's agricultural extension systems is reviewed and major challenges and innovative solutions for streamlining knowledge and information management to increase agricultural productivity and output of smallholder farmers are discussed and recommendations highlighted for policy consideration.

Knowledge Management in the agricultural sector in Ethiopia

6.1 An overview of agricultural extension

In Ethiopia, public agricultural extension services have been in action for about half a century. Studies show that Ethiopia has the largest agricultural extension system in Sub-Saharan Africa, and third largest in the world after China and India (Swanson and Rajalahti, 2010). According to the Bill and Melinda Gates Foundation (BMGF 2010), a total of 8,500 farmer training centers (FTCs) have been established and 63,000 field extension workers (known as development agents-DAs) have been trained. The current extension approach, therefore, follows FTC-based extension system. The FTCs are positioned to facilitate agricultural knowledge and information exchange among researchers, extension workers and farmers. Woreda level agricultural offices are responsible for managing the operation of FTCs with the support of zonal and regional agriculture bureaus and are the frontline administrative structure for implementing agricultural extension services in the country. The experts (called subject matter specialists-SMS) in each woreda provide technical support and training to DAs. Most of the FTCs have at least three development agents—one for crops, livestock, and natural resource management. These development agents hold at least a diploma in agricultural (natural resource) sciences from one of the country's technical and vocational training colleges.

Despite the potential role that FTCs and DAs can play in knowledge and information dissemination, a number of factors pose limits to the proper implementation and success of the program. In this regard, inadequate infrastructure and localized technical information, as well as budgetary shortfalls are some of the major constraints that inhibit effective agricultural knowledge management and delivery of agricultural extension services in Ethiopia (Davis et al, 2010 and BMFG, 2010). Most FTCs have no access to electricity and do not have electronic equipments such as TVs and computers that they need to effectively discharge their work. In addition, only very few FTCs have advanced teaching equipment such as computers and access to the internet. Even when access and equipment are available to development agents, there is need to train and upgrade their skills. This upgrade is necessary because most of the development agents and extensions workers have limited ICT skills to optimally utilize them in their daily agricultural extension work with smallholder farmers.

Ethiopian Institute of Agricultural Research (EIAR) and regional agricultural research centers deliver agricultural research activities to farmers mostly through SMS, development agents and FTCs. EIAR also oversees the work of federal research centers and coordinates all agricultural research activities in the country. On the other hand, Regional Agricultural Research Centers (RARCs) are run by the respective regional governments within their regional bureaus of agriculture. Both EIAR and the RARCs have research-extension coordination departments, which tries to link research activities to agricultural extension. These linkages are currently weak and need to be improved in order to use them as a vehicle for generating, transmitting and updating agricultural knowledge and practices of smallholder farmers (Davis 2010). This is important in making agricultural research and extensions services play a key role in raising output and productivity of smallholder farmers and thereby contribute to doubling of production and productivity of smallholder farmers by the end of the GTP period in 2015.

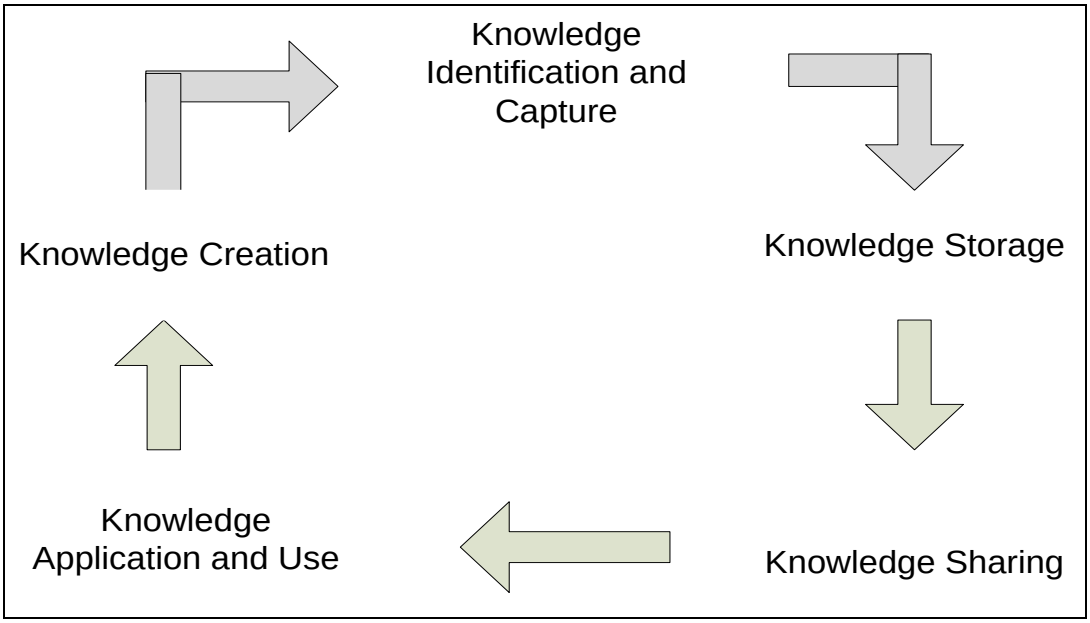
6.2 Knowledge management: concepts, processes and tools

Knowledge management can be defined as the fact or condition of knowing something with a considerable degree of familiarity acquired through experience, association or contact. Knowledge consists of the attitudes, cumulative experiences, and developed skills that enable a person to consistently, systematically and effectively perform a function (William and Michael, 2005). It is an integration of explicit and tacit knowledge. Explicit knowledge refers to all aspects of formal, systematic, recorded, communicated and shared knowledge that is made accessible through a variety

of information delivery systems. Tacit knowledge on the other hand is highly personal, created by doing, trial, error, reflection and revision.

Knowledge management encompasses processes and practices concerned with the creation, acquisition, sharing and use of knowledge, skills and expertise and follow a circular flow and a nonstop process that continuously updates itself (see figure 4).

Figure 4. Knowledge management process



Source: Adopted from Cong et al. (2007)

Knowledge management deals with the process of capturing, sharing and using of knowledge and techniques .For the circular flow of knowledge management to take place both knowledge, that is sufficiently better than the existing knowledge, and means for transmitting it must be both available. In addition, the consumers of knowledge must be willing and able to use the better knowledge that is now available.

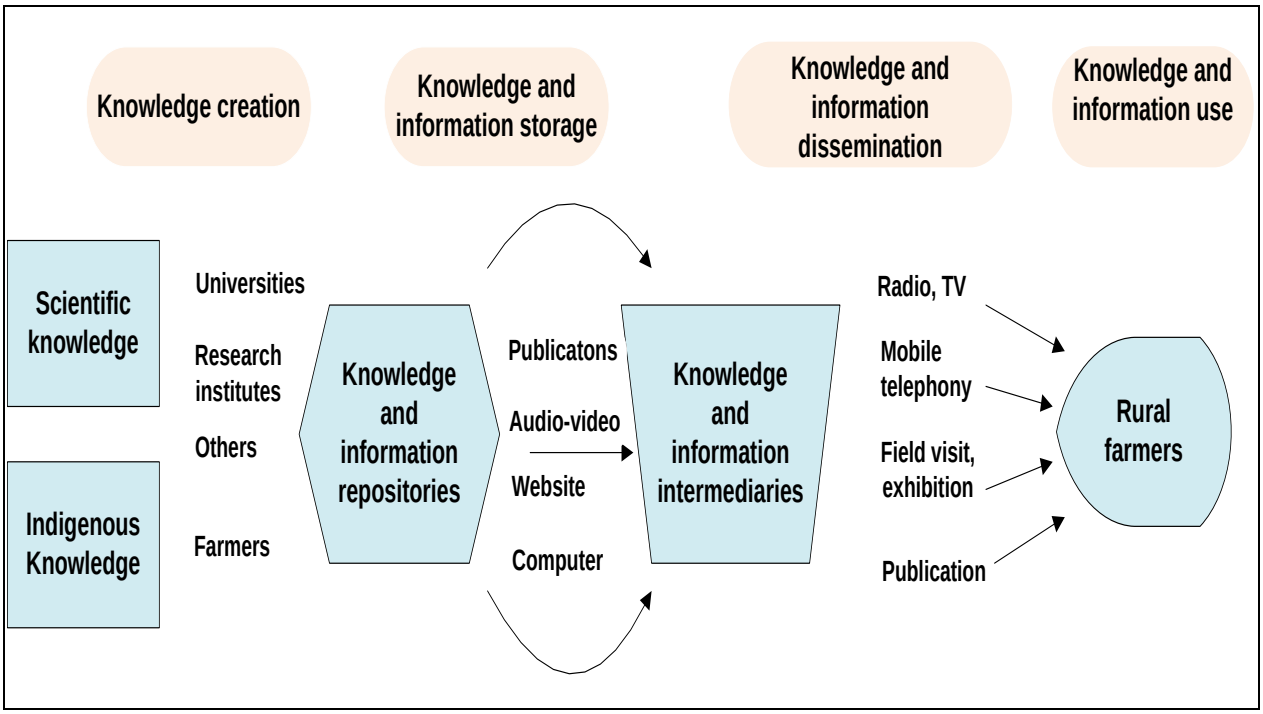
Knowledge is considered as the fourth production factor after labor, land and capital (AFAAS, 2011) and is particularly critical in the agricultural sector. Making relevant knowledge accessible to the farming community helps improve production, productivity and brings higher returns. If the agricultural practice of smallholders is not backed up by modern agricultural knowledge and information, agricultural households are likely to remain trapped in low productivity, food insecurity

and poverty. In the context of Ethiopia, generating new agricultural knowledge and information and making it available for use by smallholder farmers is important in promoting sustainable livelihoods and reducing rural poverty.

Various entities are engaged in the creation and development of information and knowledge. Likewise, several repositories and intermediaries play their role to bring the information and knowledge to the ultimate users. Agricultural knowledge is created from modern and indigenous sources. The modern knowledge is created through scientific research (and therefore it is explicit knowledge) by universities and research institutes. Indigenous knowledge or tacit knowledge, on the other hand, refers to traditional knowledge, innovations and practices of local communities and is developed outside the formal education system.

Agricultural information and knowledge created from these sources is stored in various forms before it is disseminated for use. The main repositories of such knowledge include publications, audio visuals, and websites. The stored knowledge and information is then disseminated to users, such as rural farmers, through intermediaries notably during trainings, field visits, exhibitions, publications, and using traditional forms of ICT (TV and radio), modern forms of ICT (internet, mobile phone, etc), and others. Figure 5 shows the flow of agricultural knowledge and information from creation to end use.

Figure 5. Tools of knowledge and information management in agriculture



Effective knowledge management is achieved when the right knowledge and information is delivered to the right person at the right time in a user friendly and accessible manner that helps the recipients to perform their jobs efficiently (Islam 2010). The outcome of effective knowledge management includes improved productivity and performance of the agricultural sector.

The attainment of effective knowledge management in the agriculture sector requires the systematic and continuous interaction of stakeholders that include farmers, farmer organizations, research scientists, policy makers, extension agents and the private sector among others (ASARECA, 2010). Therefore, to be effective, knowledge management in agriculture must embrace the following four issues: (i) comprehensive knowledge of what needs to be done to solve the sector's problems or to exploit its potentials (ii) identifying how the problem can be solved or opportunities can be exploited (iii) the source of knowledge required for success; and (iv) determination of who would be responsible for taking the actions needed to solve the problem or exploit the identified opportunities.

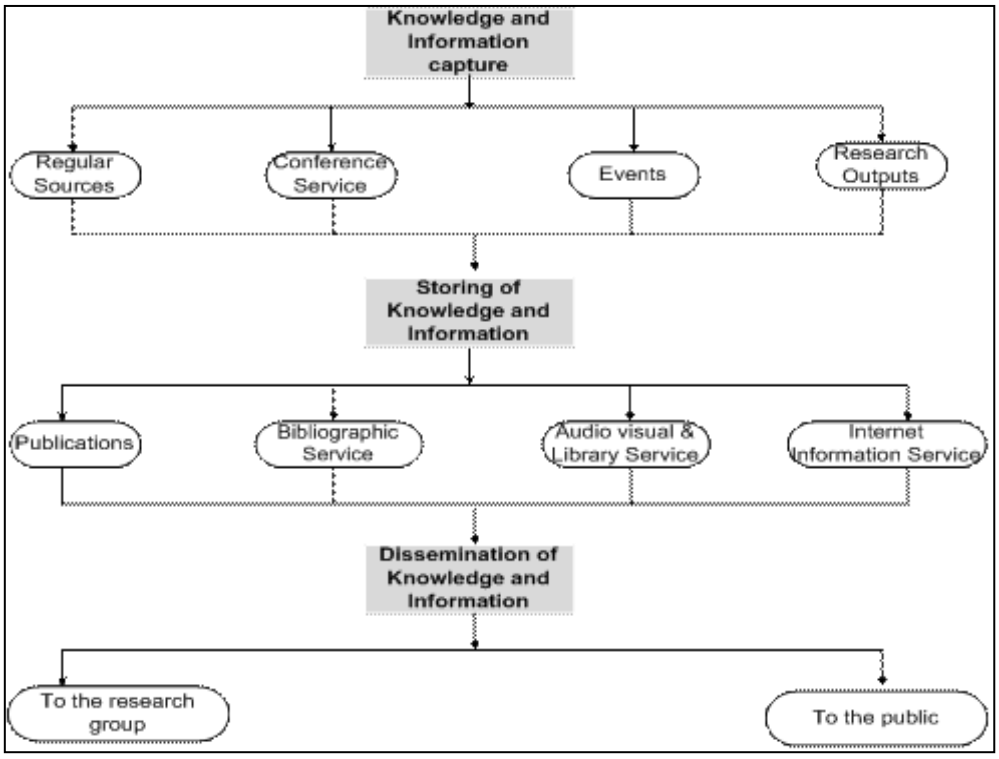
In Africa, this process of ensuring the effectiveness of knowledge management in agriculture is bested by a range of constraints such as inadequate mechanisms for capturing, systematizing and sharing available knowledge; inadequate analysis of agricultural sector communication stakeholders, their knowledge needs, attitudes and practices to knowledge management; use of less effective media and

channels for communicating with different stakeholders; and weak monitoring and evaluation of knowledge management systems (ASARECA, 2010). In order to obtain satisfactory results out of knowledge and information management, farmers need to be engaged in the whole knowledge management process. This is crucial because it will enable better integration of tacit and explicit knowledge. The knowledge and information created out of this process is also more likely to be accepted by the farmers as it would have incorporated knowledge and practices developed and passed on to them through generations. Farmers can also improve and enrich their existing indigenous (tacit) knowledge not only through the interaction with modern knowledge, but also by sharing experience with other farmers. However, in order to scale up knowledge to other farmers, the knowledge and information needs to be codified, made explicit, and upgraded or modernized with research-based evidence.

Creation, accumulation and dissemination of agricultural knowledge and information

Smallholder farmers in Ethiopia as well as elsewhere in the developing world require up to date knowledge and information in order to effectively and efficiently perform their farming practices. The knowledge and information that farmers demand ranges from accessibility of new farming methods, availability of weather forecast and supply as well as price of inputs and outputs, among others. In Ethiopia, various institutions and organizations are engaged in the creation, collection, storing, and dissemination of agricultural knowledge and information. The most notable ones, in terms of having direct linkage with the farmers, are institutes of agricultural research and the Ministry of Agriculture. Agricultural research institutes are the prime source for the creation of agricultural knowledge and information in the country.

Figure 6. Information and knowledge management process in EIAR



Source: EIAR: Information, communication and public relations new process operation manual (2007)

The creation of information and knowledge management by these institutes begins with identification of information and knowledge needs or gaps, and the capturing, storage, and sharing/dissemination of the knowledge to the users. Identification of the demand for knowledge and information is conducted through a participatory approach with the involvement of stakeholders, namely: farmers, researchers, extension experts, among others. The major sources for capturing knowledge and information are publications, conferences, events (field day, exhibitions, visits, etc), and research reports, and germplasm management (see figure 6). Whatever is obtained in this way is stored in various forms, including in publications, audio visuals, library services, and websites among others. The knowledge and information is then disseminated to researchers, extension experts, farmers, and the public at largethrough publications, mass media (radio and television), internet, field day, exhibitions, and interviews. In practice, however, field days, radio, and TV programs were the major tools usually used to share the knowledge and information to the smallholder farmers while internet and other modern ICT tools were seldom found to be used.

ICT for the Dissemination of Agricultural Knowledge and Information

ICT can play a crucial role in benefiting the resource-strapped farmers with up to date knowledge and information on agricultural technologies, best practices, markets, price trends, and weather conditions. The experiences of most countries indicate that rapid development of ICT, which facilitates the flow of data and information, has tremendously enhanced the knowledge management practice in agriculture.

However, in Ethiopia the use of ICT for the accumulation and dissemination of knowledge and information is still low. Currently, among the various ICT related initiatives, radio is widely used to share and inform users on agricultural issues, including new and upgraded farming techniques, production management, market information, and other issues. Due to its strategic importance in reaching the majority of the smallholders, attempts are being made to strengthen the delivery of knowledge and information through radio programs.

The initiative of Farm Radio International (FRI) is one best case in the use of ICT for agriculture. FRI, a Canadian based not-for-profit organization, started its operation in Ethiopia in June 2011. It operates in direct partnership with some local radio broadcasters where it supports them to build the necessary skills to develop content that responds to the needs of local small-scale farmers. In order to provide the radio broadcasters with news and resources that help meet the needs of small-scale farmers, FRI produces a weekly publication called Farm Radio Weekly that is delivered to e-mail inboxes every week with free subscription. FRI also prepares and collects agriculture related knowledge and information and produce radio script that is used by the partner broadcasters.

Apart from such traditional ICT tools (i.e., radio and TV), the use of modern ICT (computer, internet, mobile telephony, etc) remains very low in the country. However, some activities that make use of ICT tools in agricultural knowledge and information management are underway and are worth mentioning.

A project on Improving Productivity and Market Success (IPMS) of Ethiopian Farmers was implemented[4] with the objective of assisting the Ministry of Agriculture to develop a knowledge management system. This IPMS project has developed web-based portal and also established knowledge centers. The Ethiopian Agriculture Portal aggregates information from diverse national and international sources. It contains technology, market related as well as extension packages for a wide range of crops, forest products, and livestock. In addition, it deploys agricultural research outputs drawn from national and international research institutes, and higher education institutions. In response to the unavailability or poor internet network in many rural areas, the project has also developed an offline version of the portal that provides access to most of the features of the online version.

In addition, woreda knowledge centers are established in each of the pilot learning woredas, where it operates. Each center is equipped with computers, a printer, a TV set, DVD player, and telephone line and access to internet connection among others. These centers provide the respective woreda extension personnel easier access to agricultural information and thus empower them to be better prepared to discharge their duties. At present the IPMS project only operates in the ten pilot learning woredas. Any attempt to scale up the activity to other woredas and FTCs has been hampered by lack of electricity, internet connection, computer skills, and budget among others.

The Ethiopian Commodity Exchange (ECX) is yet another notable organization that has embarked on some modern types of ICT-based information management system. It carries out trading of the agricultural commodities on its trading floor located in Addis Ababa and disseminates price information in real time to producers, consumers, and traders using electronic price tickers as well as its website. At present, there are 30 price tickers installed in towns across the country and it is projected to reach 150 by the end of 2012. The price tickers are also used to transmit any change of price information directly in real time to the users. In addition, ECX has developed a prototype for data dissemination using short message services (SMS) and interactive voice response (IVR). There are currently about 200 thousand users of the SMS service, and about 50 thousand IVR users per day of which, the majority (65 percent), are from outside Addis Ababa.

[4] It is a project funded by the Canadian International Development Agency and implemented by International Livestock Research Institute on behalf of the Ethiopian Ministry of Agriculture

Although progress is being made in using ICT to provide a wide range of knowledge and information that reaches the rural majority, other countries' experiences show that the practice in Ethiopia is comparatively low. Innovative approaches such as ICT kiosks that serve as centers for providing a range of knowledge and information are not yet widely available in the country. In rural parts of Ethiopia, where access to information on individual basis may be costly and also unavailable, such arrangements are believed to have the potential to bring the required information to the rural community in the most cost effective way.

Box 1. ICT and agricultural commodity exchange in Kenya

The Kenyan Agricultural Commodity Exchange (KACE) collects, updates, analyses and provides reliable and timely marketing information and intelligence on a wide range of crop and livestock commodities, targeting actors in commodity value chains, with particular attention to smallholder farmers and small scale agribusinesses (KACE, 2011). The KACE marketing information and linkage system (MILS) involves harnessing the power and advantages of modern ICT for information collection, processing and delivery. The components of the KACE MILS are: Market Resource Centers (MRCs), Mobile Phone SMS, IVRS, Internet Database System (IDS), National Radio, Rural FM Radio and the KACE Headquarters Central Hub (KCH) in Nairobi.

MRCs are information kiosks located in rural markets and serve as sources of KACE market information for farmers and agribusinesses, as well as providing market linkage through matching commodity offers and bids. SMS service applies mobile telephone for market information delivery to users. The market information currently available through SMS includes daily wholesale buying prices for about 20 commodities, as well as offers to sell and bids to buy. IVRS uses voice mail for delivery of market price information. In this platform, a user dials a special phone number to access the information through simple menu steps, with a choice of language between the local Kiswahili and English. IDS is a system where updated market information is sent daily to subscribers in the database as email messages. The KCH in Nairobi receives processes, manages, updates, disseminates and coordinates market information services through the MILS, using the channels described above (KACE, 2011).

In countries like Ethiopia where social networks are important factors in disseminating knowledge and information within the rural community, ICT kiosks can play a facilitating role and can also be used as a place where farmers can buy various goods and services. In India, this has been applied effectively with the involvement of the private sector (see Box 2).

Box 2. ICT kiosks: success story in India

eChoupal is an initiative of ITC Limited (a large multi business conglomerate in India) to link directly with rural farmers for procurement of agricultural produce like soybeans, wheat, coffee, and prawns. eChoupal was conceived to tackle the challenges of Indian agriculture, characterized by fragmented farms, weak infrastructure, and the involvement of numerous intermediaries.

The company has already established over 10,000 eChoupal kiosks (centers), across several agricultural regions of the country each with a computer and Internet access where the farmers can directly negotiate the sale of their produce online with ITC Limited. These eChoupal centers also enable farmers to obtain online information and recommendations on good farming practices. In addition, they can place orders for agricultural inputs like seeds and fertilizers. This helps farmers to improve the quality of their produce and realize better prices. Each ITC Limited kiosk is run by a trained farmer. The computer housed in the farmer's house serves farmers in the surrounding villages, generally within about a 5 km radius. These farmers bear some operating cost but, in return, earn a service fee for each e-transaction done through their eChoupal.

The foregoing discussion points out that in Ethiopia various institutions and organizations are engaged in the creation, accumulation, and dissemination of agricultural knowledge. Nevertheless, the use of ICT in knowledge and information management is so far not only low but also dominated by traditional ICT tools- radio and TV. The use of modern ICT (internet, mobile phones, etc) in storing and disseminating knowledge and information remains very low, despite their huge potential. In this knowledge and information age, it is important to address the challenges that limit the use of such tools and identify the opportunities that should be tapped to assist Ethiopian smallholder farmers in their endeavor to improve production and contribute to national food security.

The challenges and opportunities for using ICT for dissemination of agricultural knowledge and information in Ethiopia

The role of ICT in enhancing food security and supporting rural livelihoods is increasingly being recognized and was officially endorsed at the World Summit on the Information Society (2003-2005). Several countries in Africa and Asia are now using ICT for the dissemination of agricultural knowledge and information and a number of success stories have been registered that can be replicated and scaled up in Ethiopia. A few of the ICT-based interventions are provided below to illustrate the extent of the progress that has been made in the agricultural sector in selected countries (see box 3 below).

Box 3. Selected success stories[5]

In Philippines the Nutrient Manager for Rice Mobile program provides rice farmers with advice via their mobile phone on the optimal timing, amount, and type of fertilizer to apply to their rice crop to maximize production and profit, and reduce waste. The farmers and extension workers are able to dial a toll-free number and hear a voice instruction in their preferred local language, which will prompt them to use their keypad to answer 12 to 15 questions about their rice crop.

In Ghana, Esoko, a local company, implemented Cocoalink, a pilot program that provides cocoa farmers with useful information about improving farming practices, farm safety, crop disease prevention, post-harvest production, and crop marketing. In this program farmers receive information and specific answers to questions at no charge through voice and SMS messages in their local language or English.

In India, Reuters Market Light (RML) sends four SMS messages a day to its subscribers. Farmers who subscribe to the system receive information about the weather, crops, current and projected commodity prices at different markets.

In Kenya farmers are provided with agricultural insurance products through mobile phones. A product developed by UAP Insurance, the Syngenta Foundation for Sustainable Agriculture and mobile operator Safaricom, is a 'pay as you plant' type insurance which enables smallholder farmers to insure their agricultural inputs against adverse weather conditions, such as drought or too much rain. To be covered

[5] The discussion is taken from Asenso-Okyere and Ayalew, (2011).

under the scheme, farmers only need to pay an extra 5% for a bag of seed, fertilizer or other inputs.

In Mozambique, Agricultural Marketing Service (SIMA) collects and disseminates nation-wide and provincial data on market prices, product processing and availability through a variety of media including text messages, email, internet, national and rural radios, television and newspapers.

A study conducted in selected countries in Sub-Saharan Africa (Tanzania, Malawi, Mali, Mozambique, Ghana, and South Africa) showed that rural radios with innovative programs, including dramas and radio forums tailored to local communities, are an effective way of communicating agricultural messages.

The above brief presentation of selected success stories shows that ICT can serve as a critical vehicle for agricultural development. The impact of these interventions on farmers' revenue was substantial. According to Carvalho et. al (2011), eChoupal has brought 10 percent increase in farmers revenue, 5 to 25 percent by RML, and up to by 40 percent for Esoko. The question therefore is what are the challenges that deter the replication of these and other successes stories in Ethiopia? Furthermore, what opportunities exist that can be exploited to strengthen ICT-based knowledge and information dissemination for the agriculture sector in this country?

Challenges: The challenges of access to ICT can be divided into two: (i) access to ICT infrastructure and (ii) access to ICT services. The access to ICT infrastructure in Ethiopia is still very low despite some noticeable improvements registered in recent years. According to the country diagnostic report of the World Bank issued in March 2010, the coverage of ICT in Ethiopia is one of the lowest in Africa. For instance, the coverage of GSM signal is about 10 percent of the population compared to the 48 percent benchmark for low income countries. Similarly, at the time of assessment, the Internet bandwidth benchmark for low income countries is about 20 times higher than that of Ethiopia. Studies have argued that the monopolistic market structure that exists in Ethiopia's fixed, Internet and mobile markets is one of the major factors behind the slow development of its ICT sector (Adam, 2010).

Thus, despite the fact that ICT has immense potential in disseminating agricultural knowledge and information, the low level of ICT infrastructure in Ethiopia is believed to have hindered the sector from

realizing its potential. This has inhibited the effectiveness of FTCs in creating and delivering agricultural knowledge for use by rural farmers to increase productivity and production and to enhance efficiency. In most places, FTCs are not connected to modern ICT infrastructure and services. As a result, research-extension-farmer linkages are weak and costly as such linkages have to be fostered through physical contact such as training, field demonstration, field day program and visits. The low level of access to ICT infrastructure is also believed to have slowed the sharing and exchange of knowledge and information generated from research centers at national and regional levels. Relatedly, electricity infrastructure coverage in the rural parts of the country remains low despite recent efforts to extend the electricity grid to rural areas through the rural electrification program. The low level of electricity coverage has in turn inhibited the expansion of ICT services to rural areas.

In spite of being a necessary condition, access to ICT infrastructure by itself is not sufficient for the dissemination of knowledge and information to occur through it. Access to ICT infrastructure must be accompanied by access to ICT services. In this respect, the other challenge is how to make ICT services both affordable and available in venues or modes that are convenient to smallholder farmers. Availability of venues refers to the presence of various access points particularly information kiosks, tele-centers, call-centers, and so on in a manner that is accessible to the majority of the farmers. These services are not adequately available and accessible to farmers in Ethiopia. A recent study has pointed out that there are only three public tele-centers per 10 thousand people and even existing service centers are unlikely to be sustainable, and extension to rural areas is a challenge due to lack of funds (Chekol, 2009). Furthermore, affordability poses a great challenge to accessibility of ICT service, especially among subsistent farmers. Moreover, although the tariff for modern ICT services such as mobile phone, internet, and fixed lines in Ethiopia is one of the lowest in Africa, prices are not that low in purchasing power parity terms when one takes into account the low levels of household per-capita income (Adam, 2010). Other countries circumvent the problem of affordability by implementing a range of measures aimed at making these services more affordable. In the case of Ghana and the Philippines this includes the provision of free access to ICT services (see the experience of Philippines and Ghana in box 3).

Opportunities: Ethiopia has some ICT related opportunities that can be utilized in the dissemination of agricultural knowledge and information to the users. The most notable opportunity is the presence of ICT infrastructure called the Woredanet that can be easily extended to reach most of

the rural farmers and to further strengthen the research-extension-farmer linkage. At present, almost all woredas have the infrastructure that enabled them to be connected to the network and have access to internet, telecommunication, video conference and databases at national level. In addition, more than half of the kebeles in the country were linked to the network by the time of the assessment by Adam (2010). Thus, the presence of such modern ICT initiatives can be considered to be a good opportunity to enhance the flow of agricultural knowledge and information in the country. It is also an important medium to expand and effectively provide a wide range of other extension services including health and nutrition extension services and conducting civic education programs.

Furthermore, radio transmission covers over 80 percent of the country and about half of the Ethiopian households own a radio. This makes radio programs one of the most cost-effective channels for conveying agricultural knowledge and information to the rural community. There is potential to strengthen the use radio to enhance research-extension-farmer linkages in Ethiopia.

Policy and investment priorities for effective knowledge management in agriculture

A review of experiences on the use of ICT for agricultural knowledge management indicates that leveraging ICT for agricultural development can generate tremendous development outcomes and impacts. These could be in terms of improving productivity, access to market, returns as a result of price information and other benefits.

But in order to realize such benefits of ICT, the service must be available and accessible, demand-driven, affordable, and its application should be within the capacity of the majority of the farmers. ICT should serve as a repository of knowledge created by researchers and farmers; and also a platform for experience sharing so that more smallholders can benefit from it. In Ethiopia the application of ICT in this way is very limited except for few programs and initiatives whose coverage is currently very low to generate the desired agricultural production and productivity outcomes. As a result, the following policy and investment priorities are identified and recommended to help make smallholder farmers benefit from ICT based agricultural knowledge and information management.

Extend the existing ICT infrastructure to FTCs and woreda agriculture offices: FTCs are the prime channels through which agricultural knowledge and information reach farmers. They are focal points

for farmers to receive information, training, demonstration, and advice. Hence, strengthening the service delivery capacity and capability of FTCs by availing them with modern ICT services and infrastructure is paramount. The feasible option in this respect is to utilize and expand the existing infrastructure particularly the Woredanet link.

Realizing this would undoubtedly strengthen the research-extension-farmer linkage and also enable the flow of up to date information among the stakeholders. For instance, it will enable extension workers to access and utilize a wide range of knowledge and information such as those available in the Ethiopian Agriculture Portal. In addition, the importance of this arrangement in exchanging location specific knowledge and information is believed to be substantial. An occurrence of a certain type of crop or livestock disease in a given location can be communicated to concerned specialists using the Woredanet networks provide prompt advice and actions. The specialist without going to the field can examine the audiovisual information prepared by the extension workers in the field ans prescribe immediate interventions to be taken by field staff. Apart from solving the problem in the field, it will also upgrade the knowledge of farmers and extension workers, and other knowledge intermediaries.

Thus, the role of the extension worker would be improved from transferring technology packages to that of transferring knowledge and information packages. Extension activity of this kind will be more knowledge intensive and more effective as it meets the timely knowledge and information needs of farmers. Furthermore, such access to ICT service will enable extension workers to engage in the full knowledge management activity and be in the position to gather, store, and disseminate knowledge and information that are demanded by the farmers. This however, requires the operators to be well trained in the application of ICT.

Establish and expand rural ICT kiosks: The rural community in Ethiopia is mostly characterized by low levels of literacy, income, and awareness of the benefits of ICT. Coupled with the cost of technology ownership, most farmers may be unable to access the technology hardware even if the service was available and affordable to them.

In such a scenario the feasible approach includes engaging intermediaries between the technology and the farmers. This will bring rural ICT kiosks into the picture and as a tool that farmers can use to

obtain information more cheaply as they do not have to personally investing in owning the ICT devices. As operators of the kiosks are trained with computer application, they will help bridge the knowledge and skill gap of the farmers by providing personally tailored knowledge and information to their clients.

The growth and sound performance of ICT kiosks witnessed in many parts of Africa affirm its potential in narrowing the information and knowledge divide that smallholder farmers face. Thus, the introduction and promotion of such services in the rural parts of Ethiopia is believed to benefit farmers in many respect, particularly by providing market price information and weather forecasts. In Africa and Asia ICT kiosks are known for their role in providing information on the prevailing prices of various crops in different markets. Adopting this approach in Ethiopia will enable farmers to increase production and productivity and thereby significantly enhance their returns from farming. Such information will provide them with what price they would get for their produce in the markets, before they even start the journey to the marketplace. This will help farmers to use the information and decide as to when and where to sell their produce. Further, the sharing of information on location specific weather is expected to be demanded by the farmers as it will enable them to prepare and deal better with the situation.

The kiosks can be formed in different ways. It may totally remain as a public center under the local administration, or controlled by farmers cooperatives in the area. Other possible forms of ownership include private as well as public-private partnership. In whatever form the kiosk is established its sustainability depends on its ability to finance the activity and provide credible knowledge and information. To finance the operation, awareness creation on the benefits afforded by kiosks needs to be made. In addition, it requires providing content that are demanded by the users so that they will be encouraged to pay for the service. Credibility of the service provided by the kiosk is the other important aspects that influence its sustainability. Following the successful experience of other countries (such as eChoupal of India), it is advised that the management be composed of trusted local farmers. In addition to its core service, the kiosk can also serve as an internet cafe where users access additional knowledge and information thereby diversifying the center's revenue base as part of its sustainability strategy. The project, however, may start as a pilot program in selected places where electricity, internet and mobile connections are available and later scaled up to other places based on the experiences obtained therein.

Strengthening community radio services: The coverage of radio transmission in Ethiopia is quite high, currently covering 80 percent of the country and over half of the households have a radio. This is a good opportunity that needs to be utilized to enhance agricultural knowledge and information dissemination. In this regard, the role of community radio stations is important as it provides a cost-effective vehicle for knowledge and information sharing in local languages and at community level. It allows community members to gain from the program and also create opportunities for increased participation. Thus, establishing and strengthening community radios needs immediate attention as it can provide rural farmers with quick access to relevant knowledge and information. However, to attain its potential, program developers should be well trained and have ample background knowledge about agriculture. Further, they should cooperate with farmers in content generation improve the involvement of farmers and encourage live discussions with farmers, extension workers, and researchers.

Expand ICT training and make ICT hardware more affordable: The effectiveness of ICT-based agricultural knowledge and information management equally depends on the availability of well trained human resource in ICT, among others. ICT training needs to be well integrated into the education system from primary to tertiary level. In addition, tailor made short term training should be given to upgrade and refresh ICT knowledge of those already engaged in agricultural extension service.

The cost of ICT equipments particularly computers and related ones should be affordable to enable the expansion of ICT-based agricultural knowledge and information management. It is recommended that the government provides incentives to promote access and use of ICT services by the majority of the people, thereby opening new avenues for cost-effective delivery of agricultural extension services especially to smallholder farmers. These incentives could take different forms including, among others, reductions in duty and taxes on ICT equipment and services and increasing public investment in ICT infrastructure across the country. In addition, attractive incentive packages can be designed to encourage the private sector to establish ICT equipment manufacturing facilities and assembly plants in the country. This would help to reduce the cost of ICT equipment, stabilize supply, promote technology and skills transfer, and generate income and employment in the economy.

Conclusion

Agriculture is a sector with great potential for improving rural livelihood and eradicating poverty. Resting on this potential, the government seeks to double agricultural production during the GTP period by scaling up best practices, incentivizing production of high value crops, and expanding irrigation development and natural resource conservation. This will be supported by interventions aimed at transforming the agricultural system so that it facilitates the doubling of agricultural productivity of smallholder farmers by end of the GTP in 2015. This goal is achievable with the strategies government has identified. The challenge, however, lies in implementing these strategies to enable smallholder farmers to scale-up productivity and increase production almost two-fold by the end of the GTP period. Since the underlying strategy is to diffuse agricultural best-best practices from the "model farmer" to the rest of the farmers, the role of agricultural extension services is critical in realizing this goal. It calls for cost-effective and innovative approaches to the way the agricultural sector generates and disseminates new knowledge and information to smallholder farmers. New approaches, concepts and tools for effective knowledge management are presented backed by a review of global case studies on how these approaches have be designed and implemented to support effective creation and dissemination of new agricultural knowledge and information to farmers. The review indicates that access and utilization of knowledge and information plays a significant role in increasing production, productivity and incomes of smallholder farmers. Ethiopia can draw upon these experiences to develop and utilize existing ICT-based knowledge management techniques to implement robust strategies and intervention to transform its agricultural sector.

Effective knowledge and information management in the agricultural sector will be achieved when the right knowledge and information is delivered to the farmers and other stakeholders at the right time in a user-friendly and accessible manner. To realize this, farmers should be involved in the knowledge management process as knowledge generated in a participatory manner has a greater likelihood of being accepted and acted upon by the farmers. This participatory approach will also enable the integration of traditional or tacit knowledge of farmers with the modern forms of knowledge, and further enhance the utilization of knowledge disseminated to smallholder farmers.

Implementing modern approaches to knowledge management in the Ethiopian agriculture sector will not be without challenge. While recognizing that the country has several institutions and organizations engaged in the creation and dissemination of agricultural knowledge and information,

effectiveness is inhibited by the coverage and inadequate usage of ICT. Ethiopia is currently far behind several African countries in the coverage and usage of ICT services, and efforts are needed to scale-up investments in physical ICT infrastructure and services across the country. At present, radio stands out as the most utilized medium among the various ICT platforms. In the many countries reviewed, however, other modern and innovative ICT-based knowledge management systems have been fully embraced to generate and disseminate agricultural information to stakeholders along the agricultural value chain. Some initiatives aimed at using modern ICT tools such as web portal are underway albeit at small-scale. Government should capitalize on the potential role that ICT can play in improving the productivity and output of smallholder farmers and should implement bold measures to harness and turn the potentials into real development benefits.

The major challenges inhibiting the use ICT in disseminating agricultural knowledge and information, which includes the low level of access to ICT infrastructure and services, need to be addressed. The existing potential for extending the current ICT infrastructure to reach rural farmers, coupled by the presence of wide area radio service coverage across the country, should be exploited to implement ICT-based knowledge and information dissemination in the short-term. Policy and investment priorities that government and its partners should consider in order to promote cost-effective knowledge management in agriculture have been highlighted. Priorities include extending the existing ICT infrastructure to reach FTCs and woreda agricultural offices, establishing rural ICT kiosks, establishing and strengthening community radios, integrating ICT at all levels of education, and making ICT hardware affordable to the users. Mobile phone platforms offer good opportunity for reaching farmers and knowledge intermediaries, and their use for disseminating knowledge and information should be explored and enhanced and design of interventions should benefit from existing lessons and experiences of many countries in Africa and Asia. These initiatives, we believe, will assist the government to rationalize its expenditures in the sector, streamline the agricultural extension system, speed up agricultural transformation and attain the objective of doubling agricultural production and productivity by the end of the GTP period in 2015.

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[6] IFPRI was established in 1975 to identify and analyze national and international strategies and policies for meeting the food needs of the developing world on a sustainable basis, with particular emphasis on low-income countries and on the poorer groups in those countries. IFPRI ((www.ifpri.org) is one of 15 CGIAR consortium agricultural research centers.

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