Background Paper for
African Transformation Report 2016: Transforming Africa's Agriculture

Overall Review

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Contents

ACET's Vision for a transformed agriculture in Africa

A modern, competitive, and environmentally sustainable agricultural sector that ensures food security, supports a middle-class lifestyle for most farmers, and supports overall economic transformation.

1. Introduction and background

As stated in the concept note submitted to JICA-RI in July 2015, the recent high growth in GDP on the continent has not been accompanied by a modernization of agriculture; the sector continues to be based primarily on peasant farmers who operate with traditional methods that generate low productivity, who focus mainly on a narrow range of traditional products for the domestic and export markets, and whose activities and products have limited linkages to the rest of the economy, particularly manufacturing. As we discuss in The African Center for Economic Transformation (ACET)'s 2014 African Transformation Report (ATR 2014), the upswing in growth on the continent is welcome, but it is not enough. What Africa needs is economic transformation, or growth with depth; that is growth with diversification of the economy, export competitiveness, substantially higher productivity, upgraded technology, and noticeably improved human well-being through, in particular, higher employment and income levels (see ATR 2014). Transforming agriculture by modernizing it is a necessary and critical part of this agenda. [1]

The concept note submitted to JICA-RI in July 2015 also stressed that agricultural productivity in Africa will have to rise significantly if we are to achieve mass poverty reduction and improve food security.[2] A transforming agricultural sector will also help spur manufacturing sector growth in African countries by: providing cheap raw materials for processing, helping moderate food price inflation and thereby industrial wage increases (which helps keep manufacturing internationally competitive), providing an expanded domestic market (arising from higher rural incomes) for manufactured goods, and providing higher levels of foreign exchange earnings and fiscal revenues to help finance imported inputs and public goods necessary for manufacturing and other sectors of the economy (ATR 2014, and Breisinger et al., 2011).[3]

Numerous studies have documented the important role of agriculture as an engine of growth and overall economic transformation and as a powerful instrument for poverty reduction (Johnston and Mellor, 1961; Schultz, 1964; Christiaensen et al., 2011)[4], with causality, in most cases, running from agricultural growth to economy-wide growth at the early stages of transformation. Evidence from developed countries and the Green Revolution in Asia and Latin America clearly supports these

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1 While agriculture-led rural transformation may not be a priority everywhere in Africa because of regional heterogeneity of rural situations across and within countries (Dercon and Gollin, 2014), it does apply in the case of many regions or countries in Sub-Saharan Africa with large share of agricultural production and employment.

2 The 2008 World Development Report on agriculture cites several studies, which show that welfare gains from growth originating in agriculture are substantially larger for households in the poorer five expenditure deciles. For example a cross-country study of 42 developing countries over 1981–2003, showed that a 1% GDP growth originating in agriculture increased the expenditures of the three poorest deciles at least 2.5 times as much as growth originating in the rest of the economy (Ligon, Ethan, and Elisabeth Sadoulet, 2007, Estimating the Effects of Aggregate Agricultural Growth on the Distribution of Expenditures. Background paper for the WDR 2008.)

3 Breisinger, C., Diao, X., Kolavalli, S., Al Hassan, R, Thurlow, J. (2011). A New Era of Transformation in Ghana - Lessons from the Past and Scenarios for the Future. IFPRI Research Monograph, Washington, DC: International Food Policy Research Institute.

4 Johnston, B., Mellor, J. (1961). The Role of Agriculture in Economic Development. *American Economic Review* 4, 566–593.
Schultz, T.W. (1964). *Transforming Traditional Agriculture*. Yale University Press, New Haven, Connecticut.
Christiaensen Luc, Demery, L., Kuhl, J. (2011). The (Evolving) Role of Agriculture in Poverty Reduction—An Empirical Perspective. *Journal of Development Economics* 96 (2011) 239–254.

findings; agricultural transformation and growth has been the precursor to the acceleration of industrial growth in such countries as Japan, South Korea, and Taiwan (Studwell, 2013)[5], and more recently in emerging markets such as China and Brazil. In Africa, agricultural productivity remains low and the reinforcing linkages between agriculture and manufacturing are yet to emerge.

In seeking to transform its agriculture, Africa must leverage the great opportunities offered by developments in the continent as well as in global markets. However, Africa's agriculture faces a number of overarching challenges that specific strategies and policy instruments will have to confront. Chief among these challenges is low agricultural productivity.

2. Low productivity levels: A major challenge

There is ample evidence in the literature of productivity-led agricultural transformation playing an active role in economic transformation in general and making agriculture an important driver of growth. The experience of Asian countries such as South Korea, China, and Taiwan shows that land reforms and increases in farmers' productivity were the springboard for their economic transformation. Indeed, in his 2013 book *'How Asia Works: success and failure in the world's most dynamic region'*, Joe Studwell argues that Japan, Korea, Taiwan (and more recently China) succeeded because the first major and successfully implemented intervention the government used to speed up economic development in each country focused on enabling the transformation in agriculture. Studwell notes that this intervention was to maximize output from agriculture which, in poor countries, is a significantly labor-intensive sector, employing most of the labor force.

At the farm level, African agriculture is generally characterized by low productivity in most countries, relying mainly on subsistence farming with low mechanization and low use of good quality inputs (e.g., seeds and fertilizers). However, there are large disparities between a small group of countries (such as Egypt, South Africa, and Mauritius) with productivity, based on cereal yield, relatively high (compared to the average in Africa) and the majority of countries where productivity is very low.
A number of factors account for the low productivity observed in African agriculture, including weak land security and tenure systems; low use of mechanization, irrigation, and modern inputs; weak use of research and extension; absence in many countries of well-functioning input and output markets that generate proper price incentives; and limited access to credit.

In addressing the factors that constrain the rise agricultural productivity, and hence constitute a barrier to agricultural transformation in Africa, ACET is conducting a number of studies that will feed into the ATR2. Six of these studies are being supported by JICA.

3. Studies commissioned as part of JICA-ACET collaboration: Motivation

With the generous support of JICA, ACET commissioned six studies to produce papers that will feed into the chapters of ATR2. These six studies are part of a larger set of studies and analyses that ACET in conducting, in line with the concept note submitted to JICA-RI in July 2015, in order to produce the report (ATR2) on transforming Africa's agriculture.

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5 Studwell, J. (2013.) *How Asia Works: Success and Failure in the World's Most Dynamic Region*. New York: Grove Press.

The first study, titled 'Securing Land Tenure and Easing Access to Land', reviews the state of land tenure and governance and examines land reform in Africa with the view to articulate a package of investments and policy actions that can contribute to enriching the agricultural transformation agenda. If Africa can address the issue of land tenure, its vast land endowment will clearly be a significant asset for agricultural transformation. Land tenure systems in Africa have been associated with a predominantly traditional agriculture and low agricultural productivity. Transforming Africa's agriculture will therefore require reforms and investments to secure land tenure and to ease access to land.

While large parts of Africa have abundant uncultivated land, scarcity of farmland is becoming an issue in a larger proportion of the continent (Headey and Jayne 2014), and hence increasing overall agricultural production in Africa and transforming agriculture must also involve agricultural intensification. The latter also requires increased investment just as much, if not more, than is required to put Africa's abundant uncultivated land under production. The required investment also necessitates land reform to increase land tenure security to efficiently and equitably allocate the scarce land among fast growing farming populations and to provide incentives to invest in land improvements and productivity. It is therefore clear that, both in areas of Africa with abundant land and in others where land is scarce, investments and policy actions are necessary to increase land tenure security and to ease access to land in a socially and environmentally sustainable way.

Land reform must be part of Africa's agriculture transformation agenda. And the good news is that technologies are now available to enable key land reforms to be undertaken fast and cost effectively. For example, recently new technologies based on satellites and ICT were used to undertake national programs of regularization of land tenure in Rwanda and Ethiopia at a pace and cost that are globally impressive, and empirical studies have established that these programs have had positive and significant impacts on land tenure security and investment in land improvements. The experiences gained from these successful national land tenure regularization programs and lessons that have been drawn from extensive piloting of land tenure regularization programs elsewhere in Africa (Byamugisha 2013) provide a solid springboard from which land reforms can be scaled up continent-wide to secure Africa's land for shared prosperity and transformation of African agriculture.

The second study, titled 'Agricultural Mechanization and Agricultural Transformation in Africa' examines the current state of agricultural mechanization in Africa and its potential contribution to agricultural and broader economic transformation. The study reviews the factors likely to influence farmer demand for mechanization in Africa and details different existing and potential mechanization supply models.

Overall, recent reports indicate that between 1980 and 2003, the use of tractors more than doubled in Asia and Latin America but it declined in Sub-Saharan Africa. This issue will be examined systematically in the background paper. The effort to promote agricultural mechanization has increased in recent years. For instance in 2013, FAO published a report entitled "Agricultural Mechanization in Sub-Saharan Africa: Guidelines for preparing a strategy (FAO, 2013). The document outlines why and how a strategy on agricultural mechanization can make a major contribution to the achievement of the goal of increasing the levels of agricultural production and improving the livelihoods of farmers. In particular, to inform the development and implementation of strategies for agricultural mechanization, FAO reviewed the literature as it relates to agricultural

mechanization including the technologies for processing agricultural products, building on-farm storage facilities, and facilitating the delivery of irrigation water.
The contributions of agricultural mechanization to higher labor and land productivity and reduced drudgery are well documented. In addition, agricultural mechanization increases food supply and enhances food security by reducing pervasive problems such as post-harvest losses thus increasing farm incomes and improving the well-being of farmers and rural populations. The specific aims of agricultural mechanization are to[6] (i) increase productivity per unit area due to improved timeliness of farm operations, (ii) expand the area under cultivation where there is available land, (iii) accomplish tasks that are difficult to perform without agricultural machinery, (iv) improve the quality of work and agricultural products, and (iv) reduce the drudgery in farming activities thus making farm work attractive, especially for the educated youth (both men and women).

In general, farmers and their families find agricultural activities time consuming. In fact, this is a major constraint not only for increasing agricultural production but also for attracting young people to consider agriculture as a rewarding economic activity. Thus, the potential for increasing agricultural mechanization in Africa is very high. The background paper documents the prospects for increasing the use of engine power in carrying out agricultural activities. In particular, it reviews the literature on the rate of use and effectiveness of tractors; mechanical harvesters; and agricultural mechanization-relevant information and communication technology.

The third study, a background paper titled 'Irrigation for Agricultural Transformation', reviews the current state and trends of water resource management and irrigation sectors in Africa, according to agro-ecological typology (FAO, Aquastat 2005) and assesses the potentialities for irrigation development and management. The paper proposes some lines of action based on evidence from successful experiences and identifies externalities and their impacts on the contribution of irrigation to agricultural transformation in Africa. The paper notes, in particular, that some major areas need to be focused on if irrigation systems are to make a significant contribution to agricultural transformation. These include climatic uncertainties and change; water and land resources scarcity, soil fertility and the sustainability in use; cultural, socio-economic factors; technical skills, institutional capacities, irrigation backed by value chain activities, market accessibility and services; and capacities of countries to undertake heavy investments for irrigation sector.

The heavy reliance on rainfall and the limited development of irrigation systems have contributed to the persistence of low levels of agricultural productivity, notable variability/volatility in production, limited range of agricultural products which reflects inadequate diversification in production, and frequent episodes of food insecurity. In turn, the low agricultural productivity, high variability/ volatility in production, and limited range of products that result from reliance on rain-fed agriculture exert a direct impact on the persistence of poverty in rural Africa. It is important to note that social and economic indicators such as health, education, gender equality, and food security can be influenced by the availability of water and that women and children involved in agricultural activities are particularly affected by proximity to water supply systems.

In many African countries, concerns about the development of cost- effective agricultural water

6 For a good summary of the issues and challenges to the adoption of different forms of mechanization by small farmers in Africa see "Farm power and mechanization for small farms in Sub-Saharan Africa (FAO, 2006).

resource management systems (especially irrigation) and efforts to strengthen water-related institutions both at the national and international levels have become integral parts of comprehensive agricultural transformation and rural development strategies[7] .

The fourth study, titled "Transforming African Agriculture by Promoting Improved Technology and Management Practices", focuses on modern agricultural inputs, including in particular high-yielding seed varieties and fertilizers, and improved farm management practices to promote a Green Revolution in Africa.

There exists strong evidence suggesting that the use of modern agricultural inputs raises productivity substantially and that such inputs are essential for sustaining intensive agriculture in the long term without depleting soil fertility. SSA lags in terms of fertilizer use. For example, the average use of fertilizer is 13 kg per hectare whereas in the Middle East and North Africa it is 73 kg per hectare. Africa's rate of agricultural mechanization is low (at 28 tractors per 1000 ha compared to 241 tractors for 9 countries in Asia), and the proportion of irrigated cultivable land averages only 5 percent and the rate of expansion is slow.

An important feature of the green revolution in Asia in the 1960s and the 1970 was the intensive and widespread use of modern intermediate inputs such as fertilizers and improved seeds. In Africa, the use of such inputs lags behind other regions of the world. As a result, the prospects for the realization of a green revolution in Africa do not look as promising as they did for the Asian countries when they embarked on transforming their agricultural sectors five decades ago. In particular, the knowledge base for understanding the opportunities and constraints for using modern agricultural inputs with the view to promote green revolution in Africa is limited.

This paper on modern agricultural inputs will be incorporated in the chapter on 'Capital. Knowledge, and Intermediate Inputs in Farm Production', which explores effective approaches for maximizing the contributions of increased and cost-effective use of modern agricultural inputs in transforming African agriculture and in achieving the goals of overall economic transformation. The chapter will also be informed by the background papers agricultural mechanization and on water resources and irrigation discussed earlier.

The fifth study, a background paper titled 'Index Insurance for Agricultural Transformation in Africa', will inform the chapter on 'Insurance, Risk Mitigation, and Safety Nets for Farmer: Public and Private'. The main purpose of this background paper is to examine the state of weather insurance as currently used in Africa and its contributions to agricultural transformation and document the challenges and opportunities for developing policies and strengthening institutions that facilitate the effective use of weather insurance with the view to enhance the implementation of the agricultural transformation agenda for Africa.

Weather-based insurance has been identified as a potential new tool that can help smallholder farmers mitigate the growing agricultural risks. Weather based insurance for agriculture is a contract that pays for losses based on an index, an independent and objective measure that is highly correlated with losses such as those caused by extreme weather. Weather insurance contracts, such

7 For the details of the existing policy and institutional framework influencing the development of agricultural water management in Sub-Saharan Africa, see Pillar 1 on the Framework for Sustainable Land and Water Management of the Comprehensive Africa Agricultural Development Program (CAADP) of the New Partnership for Africa's Development.

as rainfall insurance, are highly attractive because they circumvent the moral hazard and adverse selection problems that plague traditional insurance[8] . Moral hazard is suppressed since farmers' indemnification is independent of their individual losses; and adverse selection is suppressed because every farmer faces the same insured risks. For this reason, weather insurance is considered by many development agencies as well as academics as an important life changer especially for farmers who face increasingly erratic weather due to a changing climate.

One of the key components of agricultural transformation is the resilience of the sector to risks, including extreme weather events. Weather insurance has been identified as a prospective tool for increasing the resilience of agriculture and reducing the risks of technology adoption. However, recent experience with weather insurance, both in Africa and in other developing regions, have left many skeptical. Issues related to its low take-up, basis risks, and subsidized premia have undermined its potential welfare impact and sustainability. However, new models for using weather insurance are being explored. These new models aim to address the limitations of the conventional index insurance approach by (1) introducing new indices that reduce the basis risks, (2) targeting risk aggregators such as farmer groups, outgrowers, and rural banks as opposed to individual farmers to increase take-up and reduce the need of subsidy, (3) using information and communication technologies (ICT) to reduce transactions cost, and (4) selling insurance during the harvest period when farmers are expected to have more cash on hand as opposed to the planting period. It is therefore important to learn about them and rethink the current approaches used by government and development agencies in Africa for developing and using weather insurance in light of the new models.

The sixth study, a background paper titled 'Integrated Rural Development in Africa; Back to the Future?' will inform the overview chapter as well as Part B of ATR2, which will outline a vision and a strategy for agricultural transformation in Africa. This background paper aims to answer the following questions: (a) what is the general approach followed by Governments and donors currently to support African agriculture and rural development; (b) why did donors and development practitioners move away from the integrated rural development approaches of the 1970s and early 80s; (c) what lessons have been learned and incorporated in the design and implementation of new rural development programs and what impact are these having on African agriculture; and (d) how can the concept and implementation of integrated rural development (IRD) be updated to ensure a holistic transformation of agriculture?

Most of the development partners that once put large amounts of money to support integrated rural development projects are no longer keen to support such projects especially in the form in which they evolved in the 1970s and early 80s. While there are still projects and programs that follow the approach in one form or other, a large number of development practitioners have toned down the original excitement they had that the IRD approach could transform undeveloped rural areas. There are however new and interesting integrated rural development programs, an important and interesting example being the ProSAVANA in Mozambique supported by the Mozambican government, Japan (JICA) and Brazil.

As Africa continues to search for ways of transforming its agriculture and its rural areas, it remains

8 Skees, J.R. 2008. "Innovations in Index Insurance for the Poor in Lower Income Countries." Agricultural and Resource Economics Review 37 (1): 1-15.

true that a coordinated development approach would still be required. There may therefore be a strong case for revisiting the idea of integrated development in rural areas, taking into account the post-evaluation reports of the original IRDs, evaluating how rural development is being financed currently, and looking at the design and performance of the interesting new examples (such as ProSAVANA and the Cerrado, both supported by JICA) and how such integrated projects can help the agricultural transformation process in Africa.

4. Highlights of the completed drafts of commissioned papers

4.1 Securing land tenure and easing access to land

This chapter first reviews the state of land tenure and administration in Africa and identifies nine (9) factors that could explain the problems faced by Africa's land sector. These factors include:

(i) only a small proportion (about 10 percent) of Africa's land has its ownership legally recognized and documented;
(ii) rising scarcity of farmland for a larger proportion of African smallholder farmers amidst abundant land on the continent;
(iii) high rural land ownership inequality and landlessness in former colonial settlements and growing elsewhere in Africa;
(iv) limited land ownership and access for women and youth;
(v) underutilization of state land;
(vi) poor functioning of land sales and rental markets;
(vii) high levels of land disputes;
(viii) high land transaction costs; and
(ix) climate change and the associated production risk.

The chapter argues that securing land tenure is necessary in both land-abundant and land-constrained areas to promote investment and productivity through land expansion and agricultural intensification, respectively. In the land-abundant areas, most of the land is under customary tenure and held in common; the immediate need is delimitation or demarcation of boundaries and registration of community land which can be more cost-effective and appropriate than registration of individually owned land. On the other hand, land-constrained and densely populated areas require community-based systematic land titling to register individual rights. Even after registering land, enhanced land tenure security will require the strengthening of formal and informal land dispute resolution institutions to resolve land disputes fast and cheaply if and when they arise in both land-abundant and land-constrained areas. Many African countries have already made legal provisions recognizing customary tenure and communal land rights although implementation in terms of organizing local communities into legal entities and registering their land rights has been progressing slowly.

The following three key lessons learnt from the African experience are highlighted.

(1) Demarcation of communal land boundaries is not merely a technical surveying exercise, but a process that requires time and financial resources to resolve disputes and agree on boundaries before fieldwork begins;
(2) Even without a legal requirement for a detailed survey of boundaries, registration of communal lands can be a very slow process if community owners of land are not clearly defined, such as established traditional authorities (as in Ghana) or statutory ones (as in Tanzania), and if new

formal entities have to be developed as in Mozambique; and

(3) Registration of communal land needs to be followed up with resources to plan for communal and individual land use within the community and to delineate common-property resources such as grazing land.

The chapter notes that a recent project to watch which seems to be putting all the three lessons to work is ProSAVANA in Mozambique. The project supports: (a) organizing local communities into legal entities and registering their community land rights through community DUATs; (b) registering land rights for smallholders within the communities through an estimated 660,000 individual DUATs; and (c) institutionalizing government's district land use plans in all the 19 districts.

The chapter argues that at least three sets of reforms are needed to improve land markets so as to enhance productivity and transform Africa's agriculture. The first is to increase land tenure security. Studies conducted in Ethiopia found that land certification programs in 1998-99 and 2003-05 resulted in higher rental market activities. The second is to avoid or eliminate controls and restrictions on land markets. Experience in Uganda and Ethiopia show that where and when there were less restrictions on land rental markets, land rental activities went up and eased land access for the land poor and impacted significantly on productivity at least in Ethiopia. The third is to scale up the integration of customary tenure into statutory law and to develop representative formal institutions to strengthen land tenure security and to enable formal land transaction to be conducted with non-community members, building on the experiences of at least ten African countries and others outside Africa such as in Mexico. African countries have to scale up efforts to organize traditional customary institutions into legal entities, as Mozambique, Uganda and Liberia have been piloting, to enable them enter into formal contracts of land transactions with non-community members as has been done successfully with the ejidos in Mexico.

While strengthening land tenure security is key to achieving efficient land allocation among farmers, additional interventions must be made to overcome lack of and imperfections in land markets so as to make land easily accessible to all farming households including the land-poor, women and the youth to maximize their contribution to agricultural transformation. These Interventions must involve strengthening land markets, allocating unused agricultural state land to investors and the land-poor, redistributing to the land-poor underused private land using market-oriented approaches, and eliminating the gap between men and women in accessing land. In addition, protecting land rights of smallholders and communities is critical to ensuring that the investments are economically, socially and environmentally viable.

The challenges to reforming agricultural land tenure and land administration include:

- The escalation of "land grabs" in some African countries with weak land governance;
- High vulnerability of agricultural lands in Africa (compared to other continents) to land grabbing and expropriation without adequate compensation as less than 10 percent of agricultural land is registered;
- Highly inefficient land administration, as it takes twice as long and costs twice as high to transfer land in Africa compared to OECD countries;
- High levels of corruption and lack of transparency; and
- Low capacity and demand for professionals as indicated by Ghana, Kenya and Uganda each having fewer than 10 land professional surveyors per 1 million people while Malaysia and Sri

Lanka have 197 and 150, respectively.

Major emerging opportunities to reforming agricultural land tenure include (i) better commodity prices and increased foreign direct investment with potential to increase agricultural yields and markets thereby raising returns to investing in reforming land tenure and land administration; (ii) availability of new technologies such as satellite and ICT with potential to reduce costs of land administration; (iii) basic land laws are in place in many African countries recognizing customary land rights and gender equality which are key to improving land tenure security and equitable access to land; and (iv) the existence of important global and regional initiatives in place, including the *Voluntary Guidelines on Responsible Tenure of Land* and the African Union's *Framework and Guidelines for Land Policy*, which should make it easier for African countries to design and implement land reforms.

4.2 Agricultural mechanization and agricultural transformation in Africa

The paper discusses the current state of agricultural mechanization in Africa and its potential contribution to agricultural and broader economic transformation. It reviews the factors likely to influence farmer demand for mechanization in Africa and details different existing and potential mechanization supply models. Although an empirical analysis of mechanization demand and the effectiveness of supply chains is beyond the scope of this paper, in part due to data limitations, this paper suggests that demand for mechanization may be emerging in some parts of Africa. It also suggests that private sector-driven supply models are better positioned to meet this demand than direct government involvement and certain types of subsidized programs. The paper then identifies possible areas for government support to complement private sector leadership in developing mechanization supply chains.

A renewed focus on agriculture's potential contribution to economic transformation in Africa has resulted in increased attention paid to agricultural mechanization. Nevertheless, African agriculture still relies predominantly on human muscle power, in contrast to other developing regions that have experienced rapid increases in agricultural mechanization over the past few decades. Efforts to promote mechanization in previous decades largely consisted of state-led interventions, which failed due to the lack of demand for mechanization among farmers (Pingali et al 1987).
This paper attempts to overcome some of the misconceptions that drove these programs by reviewing definitions of agricultural mechanization and its role in agricultural intensification processes. The paper draws on Boserup (1965) and Ruthenberg's (1980) theory of agricultural intensification and Hayami and Ruttan's (1970, 1985) induced innovation theory. According to this framework, agricultural intensification is driven by increased population pressure and rising demand for agricultural products, which prompt the need for the adoption of existing and the development of new labor-saving technologies, in the form of mechanization. Thus, mechanization can be expected to be adopted by farmers when the appropriate conditions arise and would not be profitable in the absence of such conditions.

The paper discusses the effects of farm size, labor saving, market demand, the availability of complementary technologies, and demonstration on developing demand. It also describes the sequential nature of mechanization demand as postulated by Pingali et al. (1987) in which power-intensive operations (plowing, threshing and harvesting) are mechanized before control-intensive ones (planting, weeding, winnowing) and animal power (where feasible) is adopted before the transition to mechanized power. As a result of the components and sequences of demand, it predicts

that demand for mechanization in Africa is expected to exhibit significant spatial variation, meaning that existing national surveys and other data may fail to accurately capture patterns of demand.

The analysis in this paper suggests that where demand has emerged, the private sector has been relatively responsive to meet this demand. Private dealers tend to import the types of machinery demanded by farmers, for which markets for spare parts and repairs may be relatively developed, while governments tend to import the brands of machinery accessed through concessional loans, which do not possess these advantages. The paper however shows that, government importation and subsidization of machines may produce distortionary effects on the private importation and distribution channels. Similarly, individual machine owner-operators appear to have an advantage over government-subsidized service-provision enterprises, as they are usually able to achieve higher utilization rates in addition to obtaining benefits from using machines on their own farmers.

Despite the apparent advantages for the private sector in machine distribution and service provision, there are significant roles for African governments to play in promoting mechanization. Perhaps the most significant of these roles is providing public goods, including infrastructure, technical R&D, and economic research. Other potential roles include capacity building, removing distortionary policies, facilitating access to credit and formulating viable strategies. However, the private sector is still better positioned to drive mechanization in areas where demand has emerged and government policies should aim to play a facilitative and supportive role.

Despite a history of disappointment, agricultural mechanization may finally be in position to contribute to agricultural transformation in some parts of Africa. Demand for mechanization appears to have emerged in certain systems and, where it has, the private sector has often demonstrated its potential to efficiently supply machines and hiring services. However, the evidence base surrounding mechanization in Africa is still quite limited. Significant further research is required to better understand the changing nature of mechanization demand in Africa and the extent and effectiveness of different supply models in meeting it.

4.3 Irrigation for agricultural transformation

This paper discusses irrigation as a major contributor to the transformation of African agriculture in order to address the challenges of ending hunger, reducing poverty and vulnerability, improving livelihood and resilience to extreme events and climate change as underlined in the main official documents like CAADP (AU, NEPAD), African water vision 2025 and AU agenda 2063; and countries' strategies and plans.

The paper argues that, to ensure the contribution of irrigation to African agricultural transformation, several challenges need to be taken into consideration:

- Climatic uncertainties and change; water and land resources scarcity, soil fertility and the sustainability in use; cultural, socio-economic factors; technical skills, institutional capacities, irrigation backed by value chain activities, market accessibility and services;
- Capacities of countries to undertake heavy investments in the irrigation sector.

The paper examines the current situation and future developments of the irrigation sector in Africa and the trends according to agro-ecological typology and according to the main factors and issues:

(i) Increase of imbalance between food production and demand.

(ii) Water supply scarcity and strategy: It categorizes water scarcity into three dimensions: scarcity

of water quantity and quality, scarcity of water infrastructures and scarcity of services and capacities.

(iii) Since transboundary water resources require agreements at different levels, water supply plans from inland water resources could be strengthened for irrigation development. Geographical water transfer (temporal and spatial) needs to be studied.

(iv) Competition for water accessibility between economic sectors will increase in a context of water scarcity.

(v) It is obvious that because agriculture is still the main employer in Africa and the development of irrigation oriented to markets and services is a promising option to sustain employment and to stop rural-to-urban migration, the competition between irrigation and other water uses will take into account social and economic effects and require massive investments in the irrigation sector.

(vi) Total water allocation for irrigation may continue to increase, but production needs will increase faster. For irrigation, this means water allocation per unit (per ha) will decrease, so water use efficiency will have to increase.

(vii) To cultivate year-round and to stabilize production, irrigation needs to be accompanied by smart agriculture measures (soil fertilization, crop rotation and adapted/selected seeds).

(viii) Small farm size will call for special strategies oriented to small farmers. Organization and capacity building of users will be required for efficient operation and maintenance.

(ix) In terms of policy, a Master Plan for Irrigation is required at national and basin levels.

(x) In Africa, more than 78 percent of irrigation land is irrigated from surface water, against almost 20 percent of water from groundwater. Developing ground water knowledge and its use in conjunction with surface water will be required to address droughts.

(xi) Extension, capacity building of smallholders and their access to investment in farm-level irrigation (despite land tenure constraints), and support for access to irrigation technological packages at farm level will be needed to address the low development and preparation of land for irrigation.

(xii) Since around 80 percent of farmers are smallholders, commitment of governments to heavy investments in modern irrigation equipment will be needed (drip and sprinkler irrigation systems are subsidized in many countries with public-private partnerships). Financial and technical empowerment of farmers is needed to enhance ownership of operation and maintenance and to ensure cost recovery of irrigation investments and services.

(xii) Based on areas that are economically viable for irrigation, the World Bank (Africa Infrastructure Country Diagnostic, 2008) estimates that the total irrigation investment needed in Africa comes to more than USD 40 billion (large and small scale plus rehabilitation of existing systems).

(xiii) Like in East Asia (1970s and 1980s) and North Africa (1970s and 2000s), if up to 50 percent of agricultural expenditures are diverted to agricultural water management (Horizon 2063), then Sub- Saharan Africa's full irrigation potential could be realized over a 50-year time horizon (Ref: Liang Zhi, World Bank, 2008).

(xiv) Heavy investment in irrigation requires involvement of potential stakeholders and partnerships with the private sector. Currently, most investment in large scale irrigation systems is from the public sector. For small scale irrigation, it is essential to have individual or community level financing with public subsidies for main infrastructures and heavy maintenance (water storage reservoirs, deep wells, main water supply scheme).

(xv) Every irrigation system once in operation has positive and negative consequences, which require accompanying measures (salinization and pollution, water logging and drainage,

diseases, inequity etc).

Africa has great opportunities to overcome the current challenges hunger and food insecurity by transforming agriculture through irrigation development. This will require, in particular:

- ➢ Road Map for water supply strategy as a part of national development planning, entailing multi-purpose water infrastructure systems for inter-annual management at the national and trans-boundary levels;
- ➢ An Irrigation Sector Policy and a Master Plan that respond to the agricultural transformation objectives and aligned to National Investment Plans;
- ➢ National and Sub-regional capacity building programs focusing on irrigation on institutions (public and non-public) to enable effective policy implementation; create or reorient at sub-regional levels centers for irrigation experiments and equipment homologation, linked to research and experimentation institutions;
- ➢ Creation, rehabilitation and modernization of irrigation systems constitute the main components for irrigation investment strategy, including mechanisms for participatory irrigation management, transfer of maintenance and operation and partnership with private sector;
- ➢ Promote a program of water demand management and water saving and accounting, to stimulate private sector involvement, enhance step-by-step cost recovery, and integrate environmental component and gender mainstreaming.

4.4 Transforming African Agriculture by Promoting Improved Technology and Management Practices

The purpose of this study is to design the strategy to transform agriculture in SSA by means of generation and diffusion of modern agricultural technology. Following new statistical evidence and a critical review of the empirical literature, the study also attempts to identify the promising crops, required technologies to realize major productivity gains, and desirable government policies.

In this the paper, the fundamental source of agricultural transformation is technological change or innovation, which accompanies the introduction of modern agricultural technology and improved cultivation practices in the context of developing countries, such as countries in sub-Saharan Africa (SSA). Usually markets fail to generate and disseminate modern agricultural technology in a socially optimum manner because technological knowledge is often a public good. Thus, appropriate government intervention is necessary to achieve desirable technological change in agriculture.

According to the paper, while there can be many possible explanations for the failure to realize a Green Revolution in SSA, the following three are potentially most important:

1. Lack of superior variety: Available improved variety is not sufficiently fertilizer-responsive and high-yielding, so that most farmers are largely indifferent between improved and traditional varieties. Furthermore, the demand for fertilizer is inexistent or small, as the marginal product of fertilizer is low.
2. Ignorance about improved management practices: While improved rice production requires not only improved high-yielding varieties and ample application of chemical fertilizer but also the adoption of improved agronomic practices, such as bunding, leveling, and straight-row planting (Otsuka and Larson 2016), improved maize and other upland crop production requires rotation of crops including leguminous crops with capacity to fix nitrogen and application of manure, compost, and crop residues as well as improved variety and modern inputs (Kajisa and

Palanichamy 2013; Otsuka and Muraoka 2015). The yield function shifts upward with the introduction of the improved management practices, as is illustrated by the upper curve in Figure 1. Since marginal product of modern input is high, its application will also increase, e.g., from point A or B to point C.

3. Exorbitant prices of fertilizer and other modern inputs and low product prices: Prices of chemical fertilizer and other chemical inputs are much higher than the value of marginal product of fertilizer, particularly when traditional variety is adopted, so that it is perfectly rational for farmers not to apply any fertilizer, as is indicated by point A in Figure 1. Even if farmers know that crop production can be increased by increased fertilizer application, they do not want to do so because the product market is so underdeveloped that the product price is low and increased outputs cannot be easily sold (Matsumoto and Yamano 2011).

The paper goes argues that to identify which crops are promising to realize a Green Revolution in SSA, it will be instructive to (1) confirm the extent to which the Green Revolution has taken place in the production of various grains in tropical Asia (focus on India in this paper), (2) measure the yield gap per hectare between tropical Asia and SSA, and (3) inquire if the Green Revolution has already taken place in the advanced regions in SSA, including South Africa. If Green Revolution did not take place in the production of certain crops in Asia, which is endowed with much better infrastructure and research and extension systems and more favorable policy environments than in SSA, it is probably difficult to realize a Green Revolution in such crops. Furthermore, if we do not observe significant yield gap between the two continents, the opportunity for technology transfer from Asia to SSA will be limited. If Green Revolution already took place in some crops in some advanced regions in SSA, such crops are likely to be promising. In this case, there is a possibility of scaling up Green Revolution by inter-regional technology transfer within SSA. Similarly, to the extent that South Africa is technologically advanced, we should consider technology transfer from this country to the rest of countries in SSA.

This paper examined the yields of five major grains; paddy rice, maize, wheat, millet, and sorghum. Except for wheat, these crops are grown mainly by smallholders, in which the inverse relationship between crop yield and farm size is observed, indicating that smallholders are not inefficient producers (Larson et al. 2014; Njagi et al. 2016; Sheahan and Barrett 2014). To represent tropical Asia, the paper uses India, as its climate is not far different from SSA (Tsusaka and Otsuka 2013). In fact, millet and sorghum, which are widely grown in SSA, are grown primarily in India in tropical Asia. To represent advanced regions in SSA, the top 10 countries in terms of average yield for each crop from 1961 to 2012, as well as South Africa selected.[9] Apart from grains, the paper also contains a short discussion of high-value crops within the context of contract farming.

After analysis of data from the crops above, the paper concluded that rice was a promising crop for a Green Revolution in SSA. Unfortunately judging from the relatively stagnant yield, realizing a maize Green Revolution in SSA may look a daunting task, even though transfer of technology from South Africa is an option. Interestingly, unlike rice and maize, cultivators of wheat are not smallholders but large-scale farmers. Yet, there is no question that wheat Green Revolution has taken place in many parts of SSA, if we follow the definition of Green Revolution as the adoption of semi-dwarf varieties coupled with the increased application of chemical fertilizer. Limitation of wheat in SSA is that it is primarily grown in highlands endowed with cool climate, which are not abundant.

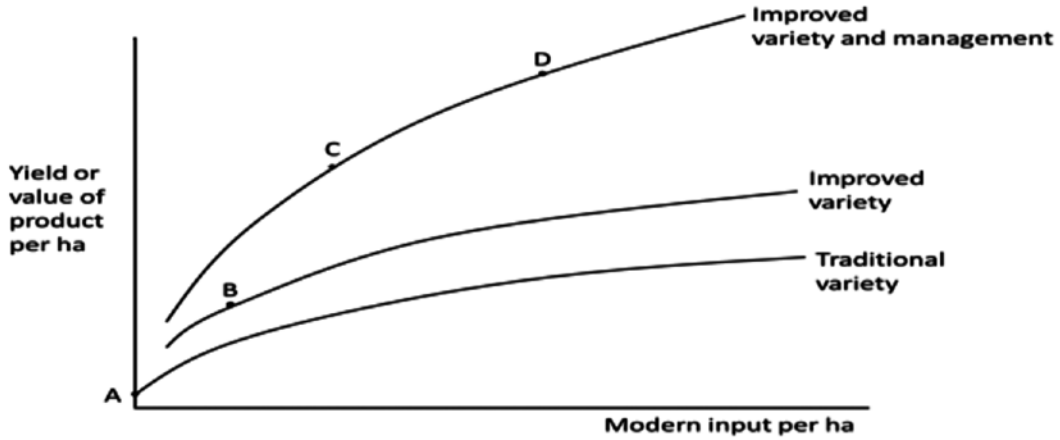
9 South Africa is not included in the top 10 countries.

The paper notes that Green Revolution in millet and sorghum did not take place in India, as evidenced by slow yield growth and low yield level as of now. It seems that it is scientifically difficult to develop high-yielding varieties of these crops even in India. Another important observation is that the average yield of these crops in SSA is comparable to, and the average of top 10 countries is even higher than the yield in India, which indicates that there is not much room for transfer of technology from India to SSA. Yet, as far as sorghum is concerned, the yield in South Africa is distinctively high, so that some of its technology may be transferred to other countries in SSA. The tentative conclusion is that major research efforts are required to develop yield-enhancing technologies for these crops particularly suitable for agro-climate in many regions in SSA.

Theodore W. Schultz (1964) noted, just on the eve of the Green Revolution in Asia, that "farmers are efficient but poor," because of the lack of technological change or innovation to use a preferred term. While the paper believes that Schultz' thesis is valid in SSA, it argues that "appropriate innovations" are different for different crops and, hence, they need to be identified before designing effective strategy to transform African agriculture. For this purpose, it is useful to distinguish among new technology (e.g., new high-yielding varieties), improved management practices, and improved marketing (e.g., branding, establishment of reputation of high-quality producers, and direct sales from farmers or farmers' groups to retailers and consumers). In identifying the critically important innovation, it is important to recognize that the three types of innovations are complementary: the productivity impact of new variety is limited without proper management (as is illustrated by Figure 1 in the paper and reproduced below), whereas marketing becomes more important when both the demand for modern inputs and supply of outputs increase owing to the improvements in technology and management practices. This implies that productive technology and improved management practices must be developed first, which should be followed by extension activities and improvements in marketing.

According to this paper, with the use of improved high-yielding seed varieties, correct application of fertilizer, and improved management practices (such as bunding), and farmer education rice yields in Africa can approach those of Asia. The paper therefore argues for investment in capacity building for the extension of modern rice technology and management practices to realize the rice green revolution. The paper argues, the rice green revolution could then provide a model that could be refined to promote green revolutions in other crops. Regarding maize, along with rice two of the most important food staples, the paper identifies a promising intensive intercropping farming system involving maize, legumes, and dairy on smallholder farms in Kenya, but proposes more research to refine and optimize it before promoting it through extension. Regarding high-value products in the context of contract farming, the paper identifies the real issues as neither technological nor managerial, as the contractor seems to know improved technology, management practices, and useful inputs. In order to expand contract farming, it seems best to reduce transaction costs in contracting between contractors and farmers. For this purpose, it is likely that improvement of entrepreneurial human capital of farmers is critically important. In reiterated the observation by Schultz (1975) that, "poor small farmers cannot move out of poverty, unless they acquire the ability to deal with disequilibria or to make appropriate production, marketing, and technology decisions in a dynamic setting". Promoting the acquisition of such ability by farmers ought to be the fundamental strategy to expand the production of high-value products by smallholders in SSA.

Figure 1. Illustrated relationship between the application of modern input and yield or value of product per hectare



4.5 Index insurance for agricultural transformation in Africa

The paper discusses the renewed focus in using index insurance to manage risks in agricultural production in order to promote technical transformation of agriculture. It then demonstrates that unlike conventional agricultural insurance, which indemnifies policyholders for verifiable production losses arising from multiple perils, index insurance pays policyholders based on the observed value of a specified "index" variable, such as rainfall, that is highly correlated with losses. Index insurance is less susceptible to the structural problems that have rendered conventional agricultural insurance too expensive and financially unsustainable for the developing world. Index insurance, however, offers less effective individual risk protection than conventional insurance and faces non-trivial challenges for sustainable implementation. Most early index insurance products were micro products designed for farmers, who would receive the payouts provided by the contract. However, given uniformly disappointing results with micro insurance products, researchers are now paying increased attention to offering index insurance to lenders, input suppliers, processors, farmer based-organizations, and exporters to strengthen the agricultural value chain in general, with farmers benefiting indirectly. In general, the paper summarizes lessons learned from index insurance projects undertaken in sub-Saharan Africa since 2000.

According to the paper, the best way forward with index insurance is to use it to strategically to manage the portfolio risks borne by lenders, processors, and exporters. Only then can the basis-risk reduction benefits promised by meso index insurance products be fully realized. Index insurance has the potential to reduce loan defaults (or losses from such defaults) across many farmers simultaneously in the event of a widespread drought, flood, or other natural disaster. Thus, if properly integrated into a lender's portfolio risk management and loan policies, index insurance could dramatically reduce the lender's exposure to catastrophic risk and promote the expansion of credit supply to subsistence farmers at lower interest rates, which in turn should spur increased adoption of higher-yielding agricultural technologies.

However, proper use of index insurance by lenders in holistic portfolio risk management requires a deeper understanding of the cash-flow risks faced by lenders and the debt restructuring policies they employ to manage such risks. Although lenders arguably are more sophisticated than farmers and thus better able to implement complex risk management practices, it is also true that many rural lenders in developing countries lack a culture of active risk management practices that employ

insurance, reinsurance, and derivative products. Operational cash-flow models and risk management practices can be intricate and opaque and can vary from one lender to the next. Efforts to develop lender portfolio risk management strategies that incorporate index insurance can encounter difficulties if lenders are reluctant to openly discuss their trade and internal cash-flow management practices with index insurance specialists. For meso index insurance products to gain wide acceptance from donors and international agencies, there is a very practical need to demonstrate that they can generate tangible benefits to poor farmers, either through lower interest rates on loans or through significant expansion of services offered to such farmers.

The paper also shows that most pilot projects have been developed around a specific crop or farmer group and typically with the involvement of one or a very small number of lenders or processors. Although many lessons have been learned from these efforts, questions remain as to whether index insurance can take root in Africa and support its agricultural transformation. These questions, however, can only be answered by attempting expansion of the most promising pilot programs so as to (1) include a larger number of poor farmers on the fringes of the agricultural marketing chain; (2) span a greater variety of crops and production practices over a wider geographical scope; (3) develop alternative institutional frameworks that includes wider stakeholder representation, including a combination of banks, input suppliers, processors, and exporters; and 4) promote chances in lender, processor, and exporter risk management strategies.

4.6 Integrated rural development in Africa: Back to the future?

This paper reviews the general approach followed by governments and donors to support African agriculture and rural development over the last several decades. It focuses in particular on evaluating the integrated rural development (IRD) approach that was used in the decades of the 1970s and 1980s. The paper then looks at the difficulties that the approach encountered and what lessons came out of the extensive evaluation of projects using the IRD approach. The paper further discusses the different approaches that have evolved since around 1990 to support African agriculture and rural development including how the lessons learned from the implementation of the IRDs have been incorporated in the design and implementation of these new rural development programs. Finally it tries to answer the question of whether there may be better approaches to designing programs and projects to support agricultural growth and development than the IRD approach or whether this approach needs to be revisited as a means of putting agriculture at the center of processes to transform rural Africa and promote growth and development of the rural sector.

Starting in the 1950s, the key ideas informing approaches to rural development revolved around the need to modernize rural areas with the idea that the traditional small scale subsistence sector had little potential for improved productivity or growth.

In the 1960s there were high expectations of the promise of technology with a focus on technology transfer targeting large scale, input intensive agriculture based on packages of higher yielding hybrid seeds, fertilizers, pesticides, mechanization and post-harvest technologies, which came to be known as the Green Revolution in Asia.

In the decade of 1970s, development practitioners concluded that despite more than a decade of rapid growth in underdeveloped countries, there had been of little or no benefit to most of the poor who were being bypassed. This resulted in the introduction of several IRD projects, which the World

Bank vigorously supported. Sadly, many of these of projects failed due to serious institutional weaknesses, and progress was slowest where most needed—in Sub-Saharan Africa.

The 1980s saw the introduction of the structural adjustments programs which had a devastating impact on the state-financed IRD programs

The period starting around the year 2000 had a strong focus on the millennium development goals (MDG) with introduction of sustainable livelihoods (SL) approaches. Another major evolution in the new millennium is the introduction of the notion of Sector Wide development approaches (SWAp) to rural development.

The paper shows that in all the approaches adopted for rural development, agriculture has remained at the center of rural development programs. Unfortunately for many governments, the term 'rural development' is used to mean any development initiative undertaken in rural areas. In this sense, a rural development strategy often simply means little more than a greater resource commitment to rural areas. While others have seen it as a set of functions that require administrative co-ordination at the central government level or the regional level.

This paper highlights the point that the general expectation was that through IRD projects governments could initiate a process that would lead to sustainable improvements in the quality of life for rural people, especially the poor, and would help transform undeveloped rural settings into cohesive communities with profitable productive opportunities where members enjoyed basic public and social services. Under IRD, a national program of rural development should include a mix of activities, including projects to raise agricultural output, create new employment, improve health and education, expand communications, and improve housing.

An assessment of the IRD indicate that some 60 percent of the completed projects had satisfactory results. There were, however, variations in satisfactory rates according to project type and/or subsector. This was due to several reasons including (1) design issues, (2) unfavorable macro-economic and/or political environments, (3) rigidities and staffing of development agencies for IRD, and (4) misunderstanding of farming systems and technological packages.

It is evident from the paper that the IRD approach of the 1970s was well-intended, given the alarming situation of the absolute poor in the developing world as described by the World Bank president in 1973. While there were issues about the design and implementation of the IRD projects, there were some successes and the projects attempted to respond to a real need to address poverty in rural areas. More importantly, the decades of implementation covering several countries and projects involved have afforded many lessons learned, offering policymakers and government officials better tools and methods to design projects with a more realistic, seasoned approach to reach the poor. In addition, the lessons from the past suggest that there is much to be gained using a coordinated approach to rural development. While we may not necessarily go back to the integrated rural development model of the 1970s, lessons learned could inform the design and implementation of coordinated support to the agricultural sector. In particular, these lessons could be help in the sector-wide approach and also the emerging value-chain approach to agricultural development.

4.7 Conclusion—the role of the six papers in agricultural transformation

As mentioned above, these six studies are part of a larger set of studies that ACET is conducting on

how to transform Africa's agriculture, in line with the Concept Note submitted to JICA-RI in July 2015. The topics dealt by the six papers constitute key building blocks to bringing a modern commercial orientation to farming in Africa, raising productivity on farms, and encouraging farmers to adopt improved technologies.

The paper on land is addressing one of the most fundamental constraints to introducing a more modern and commercial orientation to agriculture in Africa. Modern commercial agriculture requires investments in capital inputs (e.g. modern farm implements and simple power tools, on-farm irrigation systems…etc.) and modern inputs (e.g. high-yielding seed varieties, fertilizers ...etc.). These require financial resources that farmers may not have, and therefore have to borrow. Without security of tenure on their land they cannot use it as collateral and therefore their access to loans is curtailed. Even if a farmer has the financial resources required, without security of tenure to ensure he can reap the results of his investments, he would be very hesitant in investing his money. And efficient land markets allows new and more dynamic people without access to inherited land to enter into agriculture. One of the main reasons for low productivity and lack of resilience on African farms is the fact that they rely primarily on rainfall. The paper on increasing access to and improving the performance of irrigation systems aims at helping to address these problems and also making it possible for farmers to diversify into a greater variety of crops. Increased mechanization will clearly complement farm labor and help raise labor productivity and expand production as has happened in most parts of the world, and the paper on mechanization explores how this could be made to happen in Africa. The Green Revolution in Asia was based on largely a combination of high-yielding varieties, correct application of fertilizers, and training of farmers on good farm management practices. Where are the good prospects for a Green Revolution in Africa, and how do we bring an African version of the combination that worked so well in Asia? This is the focus of the paper "Transforming African Agriculture by Promoting Improved Technology and Management Practices". Lastly, adoption of new and unfamiliar technology, which often also entails higher financial investments requiring borrowing expose farmers to increased risks. Having effective mechanisms to cushion farmers against these risks, therefore, incentivizes them to adopt new technology. It also helps reduce volatility in their farm incomes and so makes farming more attractive.

The six papers financed by JICA-RI in this joint collaborative research therefore goes to the heart of modernizing and raising productivity in African agriculture. They are very helpful as stand-alone reports, and their findings will also be combined with those of the other studies being conducted by ACET in order to produce a report (ATR2) addressing the issues raised in the Concept Note submitted to JICA-RI and laying out a strategy for transforming Africa's agriculture in ways that also drive overall economic transformation. We expect the report to be out in the last quarter of 2016.