IITA 50th Anniversary Science Conference on Food Security Challenge for the Next 50 Year Cycle

Introductory Statement

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Dr Kwesi Atta-Krah

Transforming African Agriculture – From Past to Future

Introduction

This conference "Towards Food and Nutrition Security for the next Half Century" is being organized as the concluding part of the celebration of the 50th Anniversary of IITA. The Conference provides an opportunity to exchange ideas among experts on food and nutrition security futures – strategies and opportunities, while mapping a roadmap for future research and delivery for IITA and its partners.

Agriculture is central to the development of the African continent, currently contributing 40% to 80% to the Gross Domestic Product (GDP) in several countries. In recent years, it has been put back on to the development agenda of most African governments. In Nigeria, for instance, the agricultural policy document of the current government, builds on the Agricultural Transformation Agenda of the previous government, and is tagged "The Green Alternative", signifying the importance of agriculture (green) as alternative engine for economic development in the country. Agriculture does indeed have the potential to drive economic development and wealth creation. IITA positions itself as a key partner for the realization of this vision for African Agriculture.

The Birth of IITA

IITA was created through the joint initiative of Ford Foundation and Rockefeller Foundation in July 1967, as the first Africa link in a network of international agricultural research centers. As a research-for-development center IITA has three strategic objectives: (1) increasing food security and availability, (2) increasing profitability of foods, feeds, and other agricultural products, and (3) sustainable management of natural resources. Its research is organized around several core themes: (1) improving crops, (2) making healthy crops, (3) managing natural resources, (4) improving livelihoods, and (5) enhancing nutrition. The Institute also works on special initiatives such as youth engagement in agribusiness, commercialization of technologies, business incubation for developed technologies, protecting and conserving biodiversity, among many others.

Accomplishments

Presently, IITA has become the largest international agriculture research center in tropical Africa, with notable contributions to food and nutrition security in the region. Its research has produced many improved varieties in most of the major staples in the continent that include banana/plantain, cassava, cowpea, maize, soybean, and yam, that have improved overall agricultural productivity, and created wealth for farmers and value chain actors. Major accomplishments have also been made in seed systems enhancement, integrated

pest and disease management, technologies for rapid multiplication of clean planting material for both vegetative and sexually propagated crops, integrated soil fertility management, nutrition enhancement and food systems, and processing and commercialization of agricultural crop commodities. Working in partnership with national agricultural research systems, these research and delivery accomplishments are making significant contributions to national economic development in several African countries through agriculture.

Physically, IITA has spread from its original location in Ibadan, with Regional Hubs created in Dar Es Salaam, Tanzania, for East Africa; Bukavu, DR Congo, for Central Africa; Lusaka, Zambia, for Southern Africa, and the Ibadan Headquarters also presently doubling as West Africa Hub headquaters. Each Hub, like Ibadan, is equipped with research facilities and fields, with operations engaging countries within the Hub in a spectrum of research and delivery activities.

Future Orientation

In the next 50 years IITA will continue undertaking research and delivery in its key mandate domains, while intensifying efforts in four particular areas:

(i) The transformation focus of its research, which aims through massive scaling out efforts, to impact on changing livelihoods of farmers and in the economies of African countries. This includes pursuing a value chain approach in research as well as linking research to markets and development. The African Development Bank program on Technologies for African Agricultural Transformation (TAAT), which is coordinated by IITA, will be a key instrument in this component of work. The program is also supported by the World Bank, the BMGF and USAID.

(ii) Youth in agriculture and agribusiness, which provides solutions to the issue of youth unemployment and unearthing opportunities for youth in agriculture and agribusiness. IITA, through the Youth Agripreneurship Program has demonstrated how this can be done and has developed a model for out-scaling of this initiative to African countries. The African Development Bank has initiated a program known as ENABLE-Youth, based on the IITA IYA model, and aimed at supporting African countries to initiate Youth Agripreneurship incubation programs in countries. IITA provides technical direction in this initiative.

(iii) Strengthening research to address direct and indirect impacts of climate change. Emphasis will be placed on the indirect impacts such as the effect of climate change on new pests and diseases. A current threat being experienced in Africa is the rapid spread of the pest, fall armyworm, throughout the continent. Based on previous successes of managing large biocontrol and IPM projects, IITA and partners have spearheaded the initiative of establishing, a Biorisk Management Facility (BIMAF), to be housed in its research campus in Cotonou, Republic of Benin, under the umbrella of CORAF/WECARD, and with political support of the President of Benin, H.E. Patrice Talon, who championed this initiative at COP22 in Morocco.

(iv) Finally, IITA will strengthen efforts in aligning its research and delivery operations with the strategic goals and targets of priority countries. This will also include alignment to continental policy and political processes such as the African Union Commission, CAADP and NEPAD-PCA.

Partnerships

Partnerships will continue to be a key mechanism through which IITA conducts its programs. Emphasis will be given to strategic, value-added partnerships spanning research to delivery, and oriented towards achievement of impacts in food and nutrition security, livelihoods enhancement and economic development. NARS and other national agencies, other CGIAR Centers and international Agriculture Research Institutions will be central in this.

Conclusion

The above will be done in parallel with the historical mandate of IITA, as CGIAR Center, of developing International Public Goods for the enhancement of science and agricultural productivity. IITA will continue to be a key player in science and technology based research for assuring the food and nutrition security of the continent as well as making contributions through agriculture to the economic development of African countries. For the expanded transformation agenda to work most appropriately there is the need to create a link between the technical research and development agenda of IITA and partners, with the regional and continental policy and political level frameworks, such as the Comprehensive Africa Agriculture Development Program (CAADP), of the Africa Union. This will be a priority domain in our partnership development for the coming years.

Extended Summaries of Keynote Presentations

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Prof Ken Giller

The Renaissance of Farming Systems Research in Africa

Abstract

Agricultural research in Africa suffers from trends and fashions that often distract from the central goal of enhancing the livelihoods of smallholder farmers. Farming systems research (FSR) played a central role in the late 1980s in revealing the constraints faced by farmers in implementing technologies such as alley cropping. Yet with the advent of participatory research in the 1990s, the spotlight swung away and attention to FSR dwindled.

Over the past 15 years research on farming systems in Africa has experienced a renaissance. Regular and repeating patterns of soil fertility accumulation and depletion across different farming systems were observed and described. Detailed research explained the processes that led to such patterns, which were linked to resource scarcity and poverty. Field experimentation revealed that patterns of soil fertility were over-riding in determining crop yields and returns to investment in new technologies. The efficiency of resource use was strongly influenced by these patterns. The huge diversity of smallholder farms and farming systems was revealed. Field and farm scale modeling allowed exploration of benefits of technologies and new configurations of farms and farming systems. We refer to this approach, which builds on FSR as farming systems *analysis*.

IITA and partners have played a central role in the evolution of these approaches to research on farming systems. I will reflect on the need for greater attention to the rapid changes in African farming systems and the major demographic and economic and environmental threats and opportunities. Future-orientated analyses can play a central role in steering research to support farmers to anticipate and adapt to changing circumstances. This can be achieved by building on the renaissance of research on farming systems.

Extended Summary

When I first visited the IITA HQ in Ibadan in 1990 I had the privilege to be shown around experiments on Alley Cropping by a young upcoming scientist – Dr Nteranya Sanginga. Little did I know that I would visit over 25 years later with him as Director General of an institute that has grown from strength to strength under his leadership. I visited the Kano and Ibadan research stations in the context of a conference of the *African Association of Biological Nitrogen Fixation (AABNF)* – a group that Dr Sanginga and I continued to support over the intervening years.

I can remember heated discussions in the evening at IITA about recent on-farm research where farmers were clearly not interested in adoption of alley cropping – and yet massive promotion of the technology by researchers was continuing. This was the heyday of Farming Systems Research. A major focus was placed on understanding how farms and farming systems functioned and why farmers farmed as they did. Such research helped to reveal problems of labour constraints that farmers faced when implementing alley cropping that had not been taken into account in the experiments conducted on experimental stations.

Farming Systems Research, at least in the early years, was dominated by agricultural economists although scientists from many disciplines were soon working in teams (Collinson, 2000; Mutsaers, 2007). Rather too soon in my view, Farming Systems Research was muscled out of the way by the advent of "Farmer First" and the drive for participatory research (Chambers *et al.*, 1989). I recognise this is an over-simplified caricature of research trends, but with the benefit of hindsight I think that the pendulum swung too far away from the detailed study of farming systems. We certainly learned a lot about methodology for learning from and experimenting with farmers (e.g. Defoer, 2002), but in my view we did not reap the full rewards of the insights gleaned through Farming Systems Research.

Parallel to these developments a lot of research on soil biology and fertility was going on (Vanlauwe *et al.*, 2017). Mike Swift left IITA in the early 1990s to lead the Tropical Soil Biology and Fertility Programme (TSBF) from Nairobi which had a major influence on the soils agenda. The limitations of on-station research were particularly apparent when studying problems related to soil fertility. All of the research I was involved in was conducted on farmers' fields. During the 1990s, I worked extensively with colleagues in Malawi and Zimbabwe and we had the opportunity to run trials across many regions and on many farms. We quickly learned that most of the technologies we had to ameliorate soil fertility problems simply did not work in the degraded soils farmers gave us to experiment on. When chairing an external review at IITA in 2000 I had the opportunity to visit field experiments with Bernard Vanlauwe in the Northern Guinea savanna we realised we were facing similar problems. Much of our work focused on the quality and management of organic resources for managing soil fertility. When it came to testing these technologies in the context of farms and farming systems we encountered similar patterns and results across a wide variety of agroecologies across sub-Saharan Africa. We soon realised that the organic resources (i.e. cattle manure, crop residues and other plant biomass) were in critically short supply. Many of the approaches we proposed to address soil fertility did not work in the fields allocated to us by farmers, often because the soils were too degraded. Approaches to grow biomass *in situ* for soil amendment through green manures or agroforestry were consistently rejected by smallholders who needed to meet their immediate food and cash needs and did not have the luxury to invest in enhancing soil fertility for the long term.

Since I joined Wageningen University in 2001, we been able to use the tools of systems analysis to characterise and understand smallholder farming in Africa (Giller *et al.*, 2006; Giller *et al.*, 2011). We use a combination of field surveys and observations, participatory experiments and modelling to probe the constraints faced by farmers, to evaluate technologies and to explore possible development pathways (see http://www.africanuances.nl). The outcomes of such research are several. We aim to identify broad 'baskets of options' that can meet the needs of the diverse farming communities – poor and better-resourced farmers, women and men through a 'tailoring-of-technologies' approach. We encounter institutional barriers and opportunities, particularly relating to markets and knowledge sharing and work with partners to address these. Our research explores the boundaries of what is possible in terms of addressing poverty and wealth creation through agriculture on small farms. This generates important insights that can help to shape agricultural policy and future interventions.

These approaches have been used extensively in the project - N2Africa: Putting Nitrogen Fixation to Work for Smallholder Farmers in Africa - http://www.n2africa.org/. N2Africa works to scale promising grain legume technologies through >90 public-private partnerships in eleven countries of sub-Saharan Africa. I will draw on examples from this project in my talk.

I believe that changes in our scientific approach over the past 25 years can provide useful insights when thinking about likely trends for the future. In an editorial published a few years ago (Giller, 2013) I provided a definition of farming systems:

"*A farming system is defined as a population of individual farm systems that may have widely differing resource bases, enterprise patterns, household livelihoods and constraints.*"

This definition moves us away from seeing farming systems as single recommendation domains as is implied in earlier writings, because:

"The farm systems exhibit varying degrees of interdependency and interact in use of common property resources. The diversity of farm enterprises requires that development strategies, interventions and policies need to be tailored to their different needs and opportunities."

In my talk I'll explore how field-based agronomy, big data and what we refer to as *Farming Systems Analysis* can be combined to understand and to guide future research and development of smallholder agriculture.

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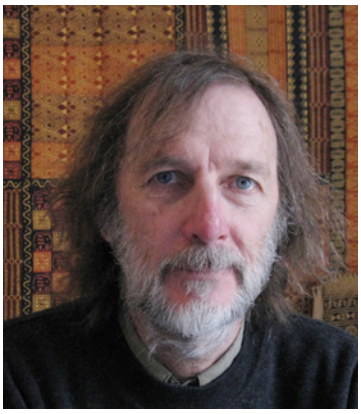

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Dr Bruce Campbell

Transforming African Agriculture in the face of climate change

Abstract

Climate change in Africa is likely to have far-reaching impacts, as temperatures warm, and extreme weather events increase in strength and frequency. Adaptation actions will need to be transformative if Africa is to be put on a trajectory to a more prosperous future, requiring changes from farm to country to regional levels; including shifts from current farming systems. In addition to adaptation, agriculture will also need to reduce emissions from business-as-usual agricultural development. While new and improved technologies are one part of the solution, as important if not more so, will be financial, market, information and governance solutions, because adaptation is largely about improving the capacity to deal with change, not shifting to a new state. Digital solutions, peer-to-peer learning using social networks, and the private sector will likely become increasingly important in driving change. Additional attention will need to be given to seasonal and other climate forecasts, and the forecasting of extreme events; with close linkages between on-farm agricultural actions (less extreme events) and those of national food security agencies and emergency services (more extreme events). Examples of good practices are emerging throughout the developing world, but these will need to be significantly scaled up. If agricultural research agencies are to maintain relevance, they will need significant re-orientating to become partners in change processes.

Extended Summary

Climate change in Africa is likely to have far-reaching impacts, as temperatures warm, and extreme weather events increase in strength and frequency. Adaptation actions will need to be transformative if Africa is to be put on a trajectory to a more prosperous future, requiring changes from farm to country to regional levels; including shifts from current farming systems.

In addition to adaptation, agriculture will also need to reduce greenhouse gas (GHG) emissions from business-as-usual agricultural development. Fortunately, many agricultural innovations are synergistic across food security, adaptation and mitigation, if not in absolute emissions then in emissions efficiency (GHG emissions per unit output).

While new and improved technologies are one part of the solution, as important if not more so, will be financial, market, information and governance solutions, because adaptation is largely about improving the capacity to deal with change, not shifting to a new state. We capture the vision for agriculture under climate change in Figure 1.

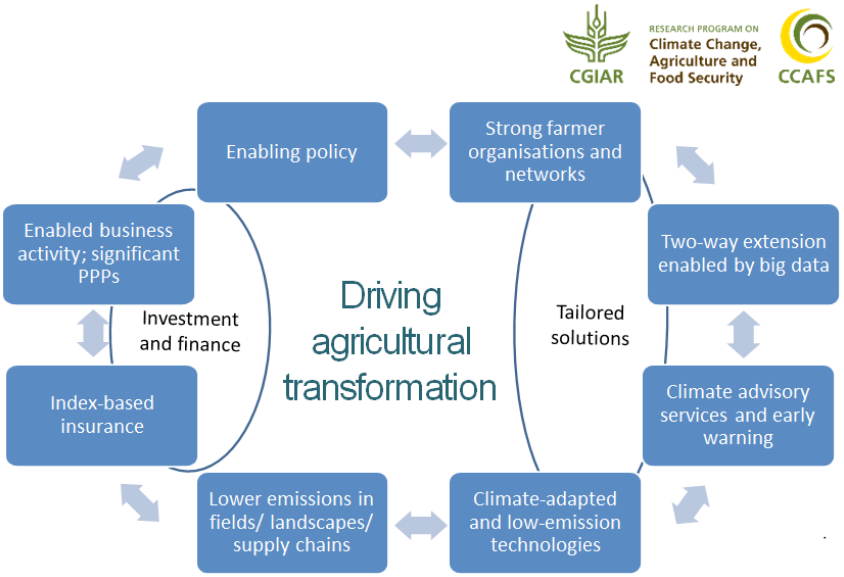

Figure 1. Cornerstones of an agricultural revolution under climate change

Agricultural development can be slow and uneven, often not reaching the people who are most vulnerable and in pockets of deep, entrenched poverty. We need to go beyond business-as-usual if we are to widely transform agriculture and lift people out of poverty and achieve food security, especially in the face of the new threat of climate change. Piecemeal, short-term projects following past conventions will not do that. The Green Climate Fund has the vision of driving a paradigm shift towards resilient and low emissions agriculture. Many other agencies are embracing a transformative agenda.

We suggest that if agricultural development is to succeed it will need to embrace a comprehensive approach that includes a number of closely-linked elements. A key assumption is that the private sector will be crucial. With continuing urbanization, wealthier populations and changing consumer demands the food sector is going to continue to be dynamic, with the private sector – both small and large enterprises – ready to rise to the challenge of the changing demands. The finance the private sector brings to development of the agriculture and food sector will be key to drive change. This will include the insurance sector, important for reducing risk, but also for stimulating entrepreneurship, innovation and credit provision.

Strong farmer, producer or women's groups can greatly facilitate local development, through bulking and reduced input prices and higher commodity prices, through reduced transport costs for goods and services and through information exchange. Farmers are, in general, faced by very poor extension, and here one needs two-way extension, not the delivery of generalized extension messages top-down. Big data, cloud computing and machine learning are likely to revolutionize two-way communication; thus facilitating access and connectivity to smart phones could be a key innovation that drives agricultural change.

One aspect of communication concerns weather data – seasonal, 10-day forecasts and daily forecasts, so farmers can select varieties and plan for planting, field management operations and harvesting. By close collaboration between meteorological agencies, agricultural ministries and farmers themselves (so that farmers get the advisories they need) climate-informed advisories can stimulate production and even reduce emissions (the latter through better timing of fertilizer applications, for example).

Then there are agricultural innovations that need to be part of the transformational agenda. While all must enhance resilience, many also include emission reduction co-benefits. These include:

- Agroforestry, that diversifies livelihoods and landscapes and builds carbon stocks.
- Aquaculture, that meets the rising demand for animal protein and has the ability to diversify incomes, enhance resilience and provide high quality nutrition.
- Solar irrigation, which tackles agricultural and energy needs – diversifying and expanding agriculture and where feasible selling electricity back to the national grid.

- Stress tolerant varieties (e.g. heat, drought and flood tolerant crops, heat-adapted breeds), giving greater stability in yields to farmers.
- Improving smallholder dairy, which enhances animal resilience and health, diversifies livelihoods and can reduce emission intensities due to better feed.
- Alternate wetting and drying in rice – with rice production still expanding and being a major contributor to emissions, this technology reduces emissions and water use, without compromising yields.

Each of the elements of a transformational agenda is ultimately dependent on an enabling policy environment; policy that helps businesses to expand and invest, greatly expands connectivity and availability of mobile devices, incentivizes the uptake of insurance and credit, fosters strong farmer and other local groups, expands markets and availability of inputs, and greatly expands extension.

A transformational agenda to stimulate agriculture will inevitably have winners and losers, given the strong differentiation already in rural areas. And a private sector approach will inevitably favour those farmers that can rise to the challenges posed by markets and consumers. The hope is that a rapidly expanding rural economy will also provide benefits to those not directly benefiting from a transformed agriculture, but various types of farming households need to be recognised, with some groups being dealt with through social protection programs.

If agricultural research agencies are to maintain relevance, they will need significant re-orientating to become partners in change processes. They also need transformation. Some elements of success in this new research environment are captured in Figure 2, based on an analysis of outcomes achieved in climate change research and action.

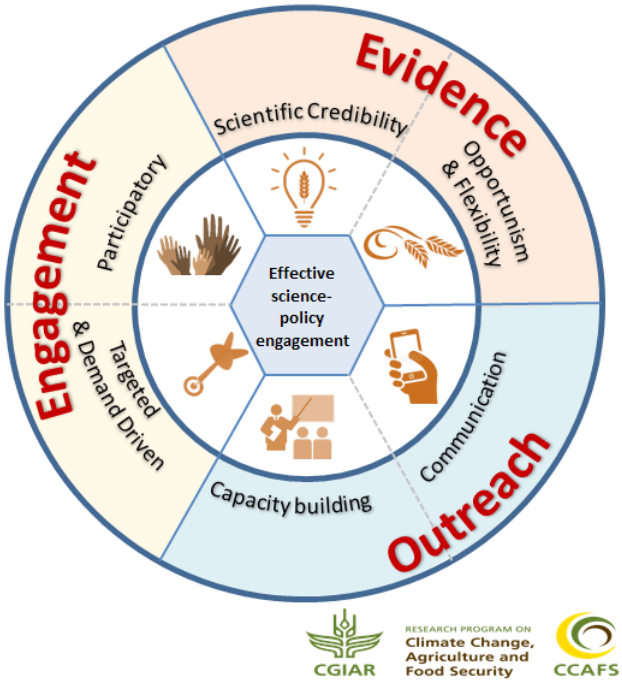

Figure 2. Elements of a successful AR4D program

Dr Ousmane Badiane and Dr Julie Collins

The rise of the processing sector in African agriculture: Economic Recovery, urbanization, and transformation of traditional staple value chains.

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Abstract

The most fundamental changes in the African agricultural sector today are not taking place within high-value export products, but rather within traditional staples such as millet, sorghum, cassava, and white maize. Over the last decade, fueled by increasing incomes, changing dietary habits in urban areas, and modernizing distribution chains, a vibrant processing sector has emerged across Africa to meet the needs of a changing consumer community. Higher spending on local staples and growing demand for greater convenience and storability have spurred innovation by the private sector and led to a multiplicity of new brands and products, such as ready-to-eat millet meals in Senegal and processed cassava products in Nigeria. The emerging processing sector creates considerable opportunities for smallholders to reach the rapidly expanding urban market, as well as great potential for employment creation for youth and women and ultimately for income generation and poverty reduction. However, the breadth and sustainability of these developments, and their potential to contribute to economic growth, will depend on the ability of microenterprises in the processing sector to grow and mature, increasing productivity and profitability. Identifying opportunities for enterprises to access finance, skill development, and technology and to learn to innovate in terms of products and processes will allow them to avoid the obstacles that have hampered enterprise growth and maturation in other sectors of the economy.

Extended Summary

Fundamental changes are taking place in African agricultural value chains in response to rising demand fueled by increased incomes and urbanization. Increased spending on staples and new demand for convenience have led to the emergence of a vibrant processing sector producing new products based on traditional staples. The 2014 Malabo Declaration recognizes the potential of agriculture and emerging agri-business to contribute to poverty reduction. The commitment to halving poverty by 2025 includes pledges to sustain agricultural growth of 6 percent per year, invest and create job opportunities for youth in value chains, and support women's and youth's participation in agri-business. The transformation of staples value chains and growth in processing and other off-farm value chain segments indeed offers powerful potential for employment growth and poverty reduction, but the extent to which this potential is fulfilled will depend on the ability of firms to access finance, skills development, and technology and learn to innovate with regard to products and processes.

Changing food demand

It is well-known that Africa is urbanizing rapidly. 38.3 percent of the population of Africa south of the Sahara lived in urban areas in 2016 (World Bank 2017); this share is projected to rise to 45.4 percent by 2030 and 54.8 percent by 2050 (UNPD 2014). Africa's past two decades of growth recovery are also well-documented. After falling GDP per capita in the 1980s and 1990s, GDP per capita grew at 3.3 percent annually during 2000-2010. Growth slowed somewhat in the current decade to 1.0 percent between 2010 and 2016, but is still higher than the three decades preceding the recovery (World Bank 2017). After stagnant or rising poverty rates in the 1990s, the economic growth of the 2000s was able to reduce poverty from 56.1 percent in 2002 to 41 percent in 2013. Although millions remain in poverty, the continent's middle class has doubled between 1990 and 2010 (Reardon et al. 2015).

Increasing incomes and urbanization have led to rapid changes in the composition of food demand. In addition to growing overall per capita food consumption, rising incomes have led to increased demand for purchased and processed food, as well as more high-value food such as meat, dairy, and fruits and vegetables. Urbanization is associated with increased time pressures for consumers due to long work hours and congestion, leading to higher demand for more convenient forms of processed food and food away from home (Hollinger and Staatz 2015).

Although more pronounced by urbanization and rising incomes, similar changes are taking place across a broad spectrum of consumers. A study of dietary changes in Eastern and Southern Africa found that purchased and processed food shares rise with income but are high even among the poor; expenditure elasticities of demand for processed and perishable foods are high in both urban and rural areas (Tschirley et al. 2015a). In Ethiopia, the share of processed cereals in food expenditures increased between 2000 and 2011 even as the overall share of cereals in food expenditures declined (Hassen et al. 2016).

Tschirley et al. (2015a) and Zhou and Staatz (2016) project changes in food demand to 2040 for Eastern and Southern Africa countries and West Africa countries, respectively. Both studies foresee increased expenditure shares for higher-value foods. Tschirley et al. suggest that the share of processed foods in purchased food, already high at 70 percent, will increase to 79 percent by 2040 under the Business as Usual growth scenario; the processed food category includes low-value added products such as maize meal as well as higher-value added products such as vegetable oils and dairy. Zhou and Staatz predict sharp growth in overall food expenditures, by as much as seven times for Ghana and Nigeria; projected demand will exceed supply for all commodities examined. Ensuring that these gaps are filled through domestic production rather than imports will require increased investments in marketing infrastructure and human resources in midstream value chain segments.

Transformation of staples value chains and increase in agro-processing

Economic growth and urbanization in Asia have led to a series of changes in the structure and conduct of value chains documented by Reardon (2015): the geographical lengthening of value chains and declining importance of seasonality; initially rising numbers of intermediaries followed by declines in intermediation; consolidation of firms; increased use of capital-intensive rather than labor-intensive production technologies; changing financial relationships between value chain actors; and more widespread use of contracts, brands and private food quality standards. Some of these changes are just beginning to appear in Africa, triggered by the changes in demand outlined above.

Value chain transformation in Africa is difficult to document due the lack of disaggregated data on economic activities. However, retail inventories carried out in several African countries demonstrate the significant presence of processed food products based on traditional staples as well as non-traditional commodities. An inventory conducted by Thériault et al. (2007) of processed cereal and dairy products in Mali found that about one quarter of the processed products available were already then domestically produced. While most processed food products were modern (e.g. cookies, yogurt), some locally-produced traditional processed products (e.g. fermented milk, traditional grain products) were noted. Andam et al.'s (2015) inventory of processed foods in Accra, Ghana similarly found that 27 percent of the surveyed products were domestically produced. The category with the largest representation of Ghanaian products was starchy staples (e.g. fufu flour, gari, plantain chips), with 51 percent of products domestically produced.

An inventory of three cities in Tanzania conducted by Snyder et al. (2015), in contrast, found that Tanzanian products accounted for the majority of processed products inventories (at 61 percent in Dar es Salaam, 56 percent in Arusha, and 69 percent in Mwanza). Intraregional imports from Ethiopia, Kenya and Uganda accounted for a further 7-17 percent of products. In particular, Tanzanian firms were strongly represented in the milled grains product category. The authors identified over 60 Tanzanian brands of maize flour and 50 Tanzanian brands of mixed flour in Dar es Salaam alone. These retail inventories do not provide evidence on market shares of processed domestic staples, but do demonstrate that traditional and modern products and domestic and imported brands coexist for some food categories, with domestic firms likely predominating in some categories.

Other signs of transformation in African value chains are widely observed, although difficult to quantify. Reardon et al. 2015 note that African value chains have rapidly increased the volume of food handled during the past several decades, and that large numbers of small firms are active in midstream segments. The authors describe rapid growth and transformation in teff value chains culminating in the sale of teff flour and ready-to-eat injera in Addis Ababa, as well the development of branded ready-to-cook millet or millet and dairy products in Senegal. Hollinger and Staatz (2015) describe rapid growth in artisanal, micro and small enterprises processing staples and other domestic crops in West Africa. For example, both farm production and small-scale processing of cassava have grown significantly in the past several decades, and processed cassava products such as gari and attiéké are increasingly produced for urban consumers.

The convenience foods increasingly being consumed in urban areas include processed, ready-to-cook forms of traditional staples as well as nontraditional products such as cookies, pasta and other wheat-based products, either imported or manufactured locally with imported wheat. Focus group interviews in Lagos and Accra described in Hollinger and Staatz (2015) suggested that urban consumers preferred traditional foods but chose non-traditional products based on their greater convenience. Some available processed traditional products, such as gari and yam products, do not seem to be widely purchased due to quality concerns. Clear opportunities exist to expand processed versions of traditional foods, but efforts must be made to improve product quality and marketing to effectively capture urban demand.

Potential for employment and income generation

Growth and transformation in food processing in Africa offers great potential for employment and income generation in the future. Food manufacturing may be particularly effective at reducing poverty, given its high labor intensity and high spatial dispersion relative to other types of manufacturing (Cazzuffi et al. 2017), as well as its strong forward and backward linkages (Proctor and Berdegué 2016). Growth in food manufacturing as well as other off-farm value chain segments, including commerce, distribution, and food away from home, are likely to be an important source of new jobs.

A study of recent employment changes in nine African countries found that non-farm agri-food employment is growing rapidly, from a low base (Yeboah and Jayne 2016). Tshirley et al. 2015b project sectoral employment changes to 2040 for a group of six Eastern and Southern African countries; they predict rapid growth in employment in off-farm segments of the agrifood system, with an employment share rising from 8.0 percent in 2010 to 11.2 percent in 2025 and 13.5 percent in 2040. Food away from home will show the strongest growth among off-farm agrifood sectors, followed by food manufacturing.

In their study of youth employment opportunities in three countries, Allen et al. 2017 estimate that off-farm agrifood jobs will account for 18-22 percent of new jobs over the next five years in Tanzania, 18 percent in Nigeria, and 11 percent in Rwanda. Food away from home, a sector with majority female employment, will account for a large share of these new jobs in Tanzania and Nigeria; food manufacturing will also create significant employment in Tanzania, as will produce and dairy in Rwanda.

Farming will remain the dominant source of employment in the medium term in many countries. The rise of processing and strengthening of linkages along value chains will create opportunities for smallholders to increase incomes by producing for high-value urban markets. Off-farm segments of transforming value chains also offer potential for future employment, particularly for women, who are overrepresented in many food processing activities. However, the extent to which this potential is realized will depend on the ability of domestic producers and firms to grow and mature, increasing productivity and profitability.

Africa's food processing sector, like the manufacturing sector overall, is characterized by the existence of a small number of large firms and a profusion of micro and small firms (Hollinger and Staatz 2015, Snyder et al. 2015, Soderbom 2011). Large firms have significantly higher labor productivity than small firms; Soderbom (2011) finds that Ethiopian manufacturers with over 50 employees produced ten times the value added per worker than firms with fewer than 10 employees. Low-productivity micro agro-processing firms in West Africa examined by Hollinger and Staatz (2015) rarely grow and formalize due to barriers including lack of skills, high costs, limited access to land and capital, and a "social network economy" of reliance on friends and family that produces disincentives for growth. Constraints facing agro-processors of all sizes include poor infrastructure and electricity; limited access to finance; and lack of skills and human resources. The authors suggest that the most important constraint limiting agro-processors is the lack of reliable access to quality raw materials; large firms tend to be those that rely on imported inputs such as wheat, rice, milk powder and fruit juice concentrate.

The African agro-processing sector would seem to be in what Otsuka and Sonobe (2011) termed the "quantity expansion phase," in which small firms proliferate and average profits are low. In order for the sector to enter the more productive quality improvement phase, leading firms must develop the capacity to differentiate their products by increasing quality in order to restore profitability. Beyond the agro-processing sector, overall economic development depends on the ability of firms to innovate and produce more high-value products (Hausmann and Rodrik 2003).

How do we see the future?

Midstream value chain firms will contribute to employment and poverty reduction to the extent that microenterprises are able to grow and mature, increasing productivity and profitability. The challenge for governments and partners is to facilitate microenterprises' access to finance, skill development, and technology and promote innovation. Three priority areas for policy and investments are 1) process and product innovation; 2) market development; and 3) cost of services and infrastructure access.

Under the first area, governments should expand and improve vocational training and form strategies to promote technology acquisition. Skills upgrading opportunities must be provided for smallholder farmers as well as for midstream value chain actors, who require skills and knowledge in processing technology, packaging and distribution, and food quality and safety, as well as process and product innovations and management skills. Research has demonstrated the positive effects of good management practices on firm profitability and productivity; vocational training programs that are relatively intensive seem more likely to affect business practices and contribute to firm profitability (McKenzie and Woodruff 2015). Governments can help enterprises to access knowledge and technology from international firms by promoting vocational training systems that integrate such knowledge and by adaptive research and dissemination of technologies as described in Otsuka and Sonobe (2011).

Under market development, efforts are needed to improve linkages between farmers and processors in order to facilitate access to raw materials, which is often a binding constraint on agro-processing enterprise growth (Hollinger and Staatz 2015). Regional trade policy can also help to better connect producers with wider output markets as well as, potentially, broader sources of inputs for certain products. Simulation results of Badiane et al. 2014 suggest that the removal of cross-border trade barriers would increase intra-regional exports of staple crops of different Regional Economic Communities (RECs) by around 10 to 30 percent. To facilitate both regional trade and domestic commerce, governments and partners can also play a coordinating role in establishing and facilitating the use of grades and standards to improve transparency related to food quality for processors and consumers.

Finally, high costs of services and limited infrastructure pose severe obstacles to enterprise growth. Poor transport infrastructure limits the ability of firms to obtain sufficient raw inputs for processing, while unreliable availability of electricity raises their costs significantly (Hollinger and Staatz 2015). Increased investments in transport infrastructure and power will clearly be required to lessen the constraints on agro-processors. Telecommunication infrastructure is a relative bright spot, where Africa's gaps are less severe (Torero 2014); in some cases, modern information and communication technologies (ICTs) can help to mitigate some of the barriers presented by poor physical infrastructure. For example, mobile phones can help extension and other service providers to reach the millions of dispersed smallholders; facilitate distance learning and peer-to-peer training; and link smallholders with processors and traders.

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New opportunities from molecular science for removing constraints to sustainable farming

Abstract

We have developed the highly successful push-pull system for raising dramatically the food production on small-holder cereal farms. However, we have a long way to go to ensure take up by the range of particularly small-holder farms that would benefit. The generic term push-pull refers to the original approach of using companion plants to push insect pests to the pull of trap plants and to pull in beneficials to attack the pests. However, the system employs a specific genus of livestock forage legumes *Desmodium* as the intercrop also to remove completely the parasitic weed *Striga hermonthica* from the farm. The perennial push-pull companion plants with no further inputs provide, in addition, ground cover, fixed nitrogen, help scavenge phosphorus and control plant pathogens. However, some funding agents and practitioners find the prospect of such a knowledge intensive system, in spite of its sustainability, potentially difficult to transfer into the 300 million farms that could be targeted. Recent development of climate smart push-pull including drought tolerant *Desmodium* spp. and trap species in the *Brachiaria* genus demonstrate the application to degraded and aridified land. However, the wider application could be facilitated by delivering all of the push-pull companion plant traits by using GM approaches on the crop plants. This talk will explain the routes by which this can be achieved.

Extended Summary

Because of the relatively low uptake of technologies developed as part of the green revolution and in order to meet the, now overarching, need for substantially increased food production, particularly for sub-Saharan Africa, while attempting to advance the tenets of sustainable production, molecular science will need to be substantially advanced in order to remove constraints to farming in the region. The FAO recently reviewed approaches to sustainable smallholder production specifically of maize, rice and wheat. However, some funding agents and practitioners find the prospect of such knowledge intensive systems, in spite of their sustainability, potentially difficult to transfer into the 300 million farms that could potentially benefit. Thus, we should look to such systems, particularly where there is evidence of high levels of effectiveness, to provide targets for new GM crops and even GM enhanced ecosystem services that can be more readily transferred to smallholder farmers. In the latter interests we must provide the new technologies via open pollenated varieties allowing for culturally favoured practices of seed saving after harvest. From a pioneering initiative, established originally by the Gatsby Charitable Foundation in the early 1990's, we have developed a sustainable intensive smallholder farming system called push-pull for raising dramatically food production on smallholder cereal farms. Although we have a long way to go to ensure take up by the range of particularly small-holder farms that would benefit, there are now attempts to achieve this. However, additionally the work could be developed potentially more rapidly by the creation of related GM crops and companion crops

The generic term push-pull refers to the original approach of using companion plants to push insect pests towards the pull of trap plants and to pull in beneficials to attack the pests. However, the system employs a specific genus of livestock forage legumes *Desmodium* as the intercrop also to remove completely the parasitic weed *Striga hermonthica* from the farm. The perennial push-pull companion plants with no further inputs provide, in addition, ground cover, fixed nitrogen, help scavenge phosphorus and control some plant pathogens. Recent development of climate smart push-pull including drought tolerant *Desmodium* spp. and trap species in the *Brachiaria* genus demonstrate the application to degraded and aridified land. The fall armyworm *Spodoptera frugiperda*, as an invasive species, is causing tremendous damage to crops and particularly those of smallholder farmers in the region currently, whereas farms practising the push-pull are free of this plague. In addition to the nitrogen fixation provided by the *Desmodium* intercrops and the obvious value to water and soil retention there is now evidence that these intercrops scavenge phosphorus. In terms of direct effects on human health there is also growing evidence of reduced aflatoxins in the harvestable crop. The push-pull is now currently adopted by 152,000+ smallholder farmsteads including the drought tolerant or climate smart push-pull system in which continually rising female farmer participation is observed.

Two immediate opportunities arise for development of the technologies underpinning the push-pull system by GM, one against insect pests which also enhances ecosystem services

and one on parasitic weed control which could have further impacts on plant nutrition and crop health. For insect control in maize it has been observed that, excluding regular commercial hybrids maize but particularly for certain OPVs, and landraces, the plants respond to egg laying by stemborer pests by a signalling process that causes increased foraging by beneficial insects attacking the pests. This trait can now be enhanced by breeding programmes based on the use of the egg elicitor now identified for the first time. This elicitor can also be used in next generation sequencing by the RNA-Seq approach to identify the inducible defence genes involved for enhancement by GM in cereal crop plants and also in companion crops. A series of *C*-glycosalated flavonoids have been identified as antagonistic to parasitic weed development. Three genes are required to convert normal legume secondary metabolism so as to produce the weed controlling trait. Two of these genes have been characterised and the third identified at the protein level. This trait could therefore be transferred to a GM legume producing human edible beans for simultaneous control of parasitic weeds or could even be expressed in cereals for this purpose but with the need for some further genetic engineering. It is also likely that the chemistry involved in weed control relates to the other beneficial properties or *Desmodium*.

How Do We See The Future?

We see the future as involving all of the opportunities offered here, from extensive use of targeted companion planting through to the development of GM enhanced crops and ecosystem services. In the immediate future we encourage further consideration be given to the push-pull and its embodied technological advances because, by providing sustainable cereal yields on smallholder farms of three to four times farmer's current practice, the rural population can be stabilised while other social changes occur. This will allow for wider industrialisation of agriculture employing the GM technologies proposed and those from the other numerous state sector and industry based efforts though perhaps throughout with a greater emphasis on exploiting natural processes.

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Hon. Minister (Prof.) Monty Jones,

The Future Prospects for Nerica rice in Food Security over the next 50 years

Abstract

The New Rice for Africa "NERICA" is a result of an interspecific breeding between the Asian indigenous rice species, Oriza sativa and the African species, Oriza glaberrima. The NERICA was developed by West Africa Rice development Association (WARDA) now the AfricaRice and it combines the high yield potential of the Asian rice and the adaptation of the African rice which has the ability to suppress weeds and higher levels of resistance/tolerance to stresses encountered in the spectrum of rice growing systems in Africa.

Majority of West Africans which account for about 240 million people rely heavily on rice as the primary source of food energy and protein in their diet, thus leading to about $1bn in importation.

The new NERICA varieties are suitable for dry lands, rain fed and irrigated systems.

If 25% of rice farmers in Guinea, Ivory Coast and Sierra Leone adopt this new variety, it's estimated that $20m will be saved each year.

The capacity of small-holder farms could account for large production improvements because farmers have the tendency to shift from one production system to another and the capacity to modernize.

Also, the dissemination of high yield varieties to rural poor increases production, thereby providing opportunities to increase income.

Self-sufficiency in rice production would improve food security and economic development in west African growth.

Extended Summary

Rice is important to Africa because of its position as the 3rd largest staple food crop particularly in West Africa where the rice sector is the most important. While rice production has been expanding at the rate of 6% per annum, domestic consumption has been increasing at 8% per annum creating a need to supplement with imported rice. The share of imports in consumption rose from an average of 43% from 1991 to 2000, to an average 57% by 2002 - 2004. [i] Currently, Africa accounts for 32% of global rice imports losing over $4 billion per annum which is a heavy burden on the continent which still has over 200 million people living under the poverty line. The growing demand for rice is mainly due to population growth, rising incomes and consumer preferences while the inability of supply to meet demand is due to low yields caused by myriads of factors such as water control, diseases, pests, market access, soil fertility, land degradation, input availability, access to finance, post-harvest loss, technology dissemination and adoption.

For example, in West Africa where most of the continent's rice is produced, production is on a small scale about 1 or 2 acres per farmer. About 75% of the total production of rice is from upland, hydromorphic and lowland rain fed ecosystems. In recent years average rice yields in SSA exhibited a highly variable trend, positive or negative across sub regions and countries. The overall rice production increase in recent years was mainly due to the expansion of rice production into marginal areas in West Africa where most production occurs. Additionally, the quality of domestic rice vis a vis imported rice; is of low quality, with impurities, and sold at 30-50% below the price of imported rice. The policy and institutional environment for the development of rice production also poses a major challenge for rice productivity. While CAADP helped push governments to make a change, the lack of effective restrictions on importation continues to allow the proliferation of foreign rice in the African market.

WARDA's breakthrough in producing the 'New Rice for Africa' ;NERICA , based on crossings between African rice species (*Oryza glaberrima* Steud) and Asian rice species (*O. sativa* L.), brought new hope for Africa presenting the much-needed relief and opportunity for sustainable agricultural development in the rainfed environments where most of Africa's rice farmers earn a living. The NERICA Project, which is funded by the African Development Bank, the Japanese government, and the United Nations Development Programme, saw the development of NERICA 1-11 including, the WAB450 progenies, from crosses of the released variety of CG14 (*O. glaberrima* steud.) and WAB5G-104 which belongs to the sub

species of *Japonica O. sativa* L. while NERICA 12-18 stems from crosses from different O. sativa and O. glaberrima parents.

The high yield (about 3-5 tonnes per hectare and 250 to 400 grains per panicle), short growth cycle, drought and infertile soil resistant, pest and disease resistant NERICA varieties which are rich in amino acids and has high protein content is profitable to the continent's millions of small-holder rice farmers and consumers[ii]. Since it began to be disseminated in 1997 it has reached over 20 million farmers sparking new hope for Africa's dreams to be self-sufficient in rice production and has helped bridge some of the gap between demand and supply. Though this represents a major advancement in food and nutrition security, it is still projected to fall short of meeting the growing demand for rice as a food staple.

The presentation concludes that there is urgent need to improve NERICA dissemination, increase the area under cultivation, intensify, increase the area under irrigation, commercialize small farms particularly in West Africa where rice consumption is very high, promote effective policies to mitigate foreign exchange loss due to importation of rice and invest in rice processing and value addition.

[i] (WARDA, Rice Trends in Sub-Saharan Africa, Third Edition, Cotonou, 2005, p. 31 and FAOStat; IRRI, Rice Almanac, 3rd Edition, Los Banos, 2002, p. 79)
[ii] (JONES et al., 1997; DINGKUHN et al. ,
1998; AUDEBERT et al. , 1998; JOHNSON et al. , 1998; DINGKUHN et al. , 1999; WOPEREIS
Impact of Improved Rice Technology (NERICA varieties) on Income and Poverty 2G9
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Building sustainable food systems for the 21st Century: the potential of diversified agroecological farming.

Abstract

Today's dominant model of farming has succeeded in supplying large volumes of foods to global markets, but is generating significant negative outcomes on multiple fronts, from widespread degradation of land and biodiversity losses to pervasive malnutrition and livelihood stresses for farmers around the world. The presentation provides a comprehensive view of how alternative food systems, based around fundamentally different agricultural models, can deliver on economic, environmental, social, cultural, as well as nutrition and health fronts. It identifies a number of lock-ins that maintain the current unsustainable systems in place and highlights positive developments in policies and concrete actions on the ground. It then maps out the pathways of transition towards sustainable food systems through seven general recommendations. It also highlights the crucial role of farmers in the management, conservation and exchange of the genetic diversity that today is more important than ever in the face of climate change.

The presentation is based on the recent IPES-Food report "From Uniformity to Diversity: a paradigm shift from industrial agriculture to diversified agroecological systems" and the report on "Strategic opportunities to strengthen community based approaches to seed agrobiodiversity" published by the Global Alliance for the Future of Food.

Extended Summary

Today's food and farming systems have succeeded in supplying large volumes of foods to global markets, but are now generating negative outcomes on multiple fronts. Many of these problems can be linked specifically to 'industrial agriculture', i.e. the industrial-scale feedlots and uniform crop monocultures that dominate agricultural landscapes, and rely on chemical fertilizers and pesticides as a means of managing agro-ecosystems.. This form of agriculture is associated with widespread degradation of land, water and ecosystems; high GHG emissions; biodiversity losses; persistent hunger and micro-nutrient deficiencies alongside the rapid rise of obesity and diet-related diseases; and livelihood stresses for farmers around the world.

What is keeping industrial agriculture in place.

Eight 'lock-ins' can be identified, referring to the key feedback loops that characterize modern food systems and keep industrial agriculture in place:

Lock-in 1: Path Dependency
Industrial agriculture requires significant up-front investments, in terms of equipment, training, networks and retail relationships, and often requires farmers to scale up. Once these investments and structural shifts have been made, it is increasingly difficult for farmers to change course ('path dependency').

Lock-in 2: Export Orientation
As industrial agriculture has spread, generating abundant supplies of uniform, tradable crop commodities, trade has taken on disproportionate political importance. Specific supply chains (e.g. for animal feed, for processed food ingredients) have become increasingly export-oriented and export-dependent. Supporting these chains has often been prioritized over other interests (e.g. ensuring resources for local food production) and in spite of the risks and problems associated with export orientation and regional monocultures (e.g. price volatility, environmental degradation, competition for land) various policy measures have incentivized export orientation.

Lock-in 3: The expectation of cheap food
Industrial agriculture and shifting consumer habits have helped to facilitate the emergence of mass food retailing, characterized by the abundance of relatively cheap highly-processed foods, and the year-round availability of a wide variety of foods. In many countries, consumers have become accustomed to spending less on food. In this context, farmers have received clear signals to industrialize their production in order to respond to the increasing demand for large volumes of undifferentiated commodities.

Lock-in 4: Compartmentalized thinking
Highly compartmentalized structures continue to govern the setting of priorities in politics, education, research and business, allowing the solutions offered by industrial agriculture to remain at centre stage. Agricultural ministries, committees and lobbies retain a privileged position relative to other constituencies (e.g. environment, health) in setting priorities and allocating budgets for food systems. Increasingly privatized agricultural R&D programmes remain focused on the handful of commodities for which there is a large enough market to secure significant returns. Educational silos remain in place, and sectoral 'value chain' organizations share knowledge vertically (by product) rather than encouraging food systems approaches.

Lock-in 5: Short-term thinking
Diversified agroecological systems offer major benefits for farmers and for society, however, the advantages will not be immediately visible, given the time needed to rebuild soil health and fertility, to increase biodiversity in production systems, and to reap the benefits of enhanced resilience. Unfortunately, key players in food systems are often required to deliver short-term results. Politicians are locked into short-term electoral cycles that encourage and reward policies that deliver immediate returns and publicly-traded agribusiness firms are required to deliver rapid returns to shareholders.

Lock-in 6: 'Feed the world' narratives
Despite the fact that food security is recognized primarily as a distributional question tied to poverty and access to food, achieving food security continues to be framed by many prominent actors as a question of how to 'feed the world', or in other words, how to produce sufficient calories at the global level. These narratives and approaches have been particularly prominent in the wake of the 2007-2008 food price spikes.

Lock-in 7: Measures of success
The criteria against which farming is typically measured - e.g. yields of specific crops, productivity per worker – tend to favour large-scale industrial monocultures. Evidence in recent long-duration studies, suggest that diversified agroecological systems can compete well on productivity grounds. However, they are still disadvantaged by such comparisons. Diversified systems are by definition geared towards producing diverse outputs, while delivering a range of environmental and social benefits on and off the farm. Narrowly-defined indicators of agricultural performance fail to capture many of these benefits. Current systems will be held in place insofar as they continue to be measured in terms of what industrial agriculture is designed to deliver, at the expense of the many other outcomes that really matter to society.

Lock-in 8: Concentration of power
The way food systems are currently structured allows value to accrue mainly to a limited number of actors, reinforcing their economic and political dominance, and thus their ability to influence the governance of those systems and the interests of these powerful actors converge around supporting industrial agriculture.

The potential of diversified agroecological systems

In contrast to industrial agriculture, diversified agroecological farming can deliver simultaneous and mutually-reinforcing benefits for productivity, the environment and society. These alternative systems deliver strong and stable yields over time by building healthy ecosystems where different species interact in ways that improve soil fertility and water retention. They perform particularly strongly under environmental stress and deliver production increases in the places where additional food is most needed. These systems have major potential to keep carbon in the ground, increase resource efficiency and restore degraded land, turning agriculture from a major contributor to climate change to one of the key solutions. Diversified agriculture also holds the key to increasing dietary diversity at the local level, as well as reducing the multiple health risks from industrial agriculture (e.g. pesticide exposure, antibiotic resistance).

Recommendations: How to shift the centre of gravity in food systems

The IPES-Food report identifies a set of coherent steps that strengthen the emerging opportunities while simultaneously breaking the vicious cycles that keep industrial agriculture in place. Together, these steps must shift the centre of gravity in food systems, allowing harmful dependencies to be cut, the agents of change to be empowered, and alliances to be forged in favour of change.

Recommendation 1: Develop new indicators for sustainable food systems.
It is essential to adopt a broader range of indicators, covering long-term ecosystem health; total resource flows; sustainable interactions between agriculture and the wider economy; the sustainability of outputs; nutrition and health outcomes; livelihood resilience; and the economic viability of farms with respect to debt, climate shocks etc.

Recommendation 2: Shift public support towards diversified agroecological production systems.
Governments must shift public support away from industrial production systems, while rewarding the array of positive outcomes in diversified agroecological systems. Governments must implement measures that allow farms to diversify and transition towards agroecology. In particular, they must support young people to enter agriculture and adopt agroecological farming – before they are locked into the cycles of industrial agriculture.

Recommendation 3: Support short supply chains & alternative retail infrastructures
Governments should support and promote short circuits in order to make them a viable, accessible and affordable alternative to mass retail outlets, e.g. by repurposing infrastructure in cities to favour farmers' markets. More attention should also be paid to the role of informal markets and policy measures must be put in place that empower emerging initiatives linking farmers to consumers.

Recommendation 4: Use public procurement to support local agroecological produce
Public procurement should be used with increasing ambition in order to ensure sales outlets for diversified agroecological farms, while providing fresh, nutritious food and diversified diets for the users of public canteens, particularly schoolchildren.

Recommendation 5: Strengthen movements that unify diverse constituencies around agroecology.
Governments can support farmers' groups, community-based organizations and social movements which encourage the spread of agroecological practices and advocate for sustainable food systems, and ensure the participation of diverse civil society groups from the global North and South in global governance processes and forums.

Recommendation 6: Mainstream agroecology and holistic food systems approaches into education and research agendas.
Public research agendas must be redefined around different priorities. Investments but must be redirected towards equipping farmers to shift their production. The mission of university research should be redefined around the delivery of public goods. FAO and other international agencies should mainstream agroecology into all of their work, in order to

spread existing knowledge and plug the remaining gaps in our understandings. Research conducted by the CGIAR Centres should be refocused around diversified agroecological systems and farmer participatory research.

Recommendation 7: Develop food planning processes and 'joined-up food policies' at multiple levels.
It is crucial to implement joined-up policymaking for food systems. Long-term, inter-ministerial planning– reaching across political boundaries and transcending electoral cycles - should be supported, building on landscape management and territorial planning initiatives, where food security can be meaningfully targeted and understood in terms other than 'feeding the world'. Crucially, food systems planning must be based on broad participation of various constituencies and groups with a stake in food systems reform. At the global level, the Committee on World Food Security (CFS) should advocate for coherent food policies and contribute to strengthening diversified agroecological food systems.

For references, see: http://www.ipes-food.org/images/Reports/UniformityToDiversity_FullReport.pdf

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Young people and rural transformation in Africa: Looking back to look forward

Abstract

This paper engages with current debates about young people, food systems and employment in rural Africa. It situates these debates in relation to broader understandings of historical and on-going processes of rural transformation. The argument is that how rural transformation plays out in different kinds of settings will have important implications for the number and types of economic opportunities that will be generated, and who – including different categories of young people – will be able to take advantage of these opportunities. Entrepreneurial activity will certainly be important, but it would be a mistake to assume that rural entrepreneurship can solve Africa's rural youth employment challenge. Historically and contextually informed international agricultural research has an important part to play in generating new knowledge about young peoples' current and potential future engagements with agriculture and the rural economy more broadly.

Extended Summary

Over the last decade there has been an explosion of interest in Africa's youth employment challenge, and the role that agriculture and the food industry might play in addressing it.

This new focus of youth employment has been associated with demographic factors like the so-called youth bulge, and the potential it creates for a demographic dividend; economic factors like the phenomenon of "jobless economic growth"; politics like the Arab Spring, and links that some have seen – although existence of this relationship is contested – between unemployment among young men and civil unrest; as well as rising levels of education; concerns about internal and international migration; and so on… The specific link with agriculture and food is made through reference to the fact that a significant proportion of young people currently – and will likely continue to live in rural areas, and have at least some engagement in agriculture. Also with reference to an aging farm population; and the need that some see, to inject new attitudes, energy and dynamism into agriculture in order to address food security.

From this rich mix has emerged a now widely held conviction, that by making the link between agriculture and youth more explicit, and by targeting, indeed privileging young people as rural development actors, there is potential to simultaneously address both the youth employment AND rural transformation or food security challenges. Indeed, it is now commonly – and confidently – stated that young people are driving (or could be put into a position to drive) the transformation of Africa's agriculture. Critically, this conviction is part of the bedrock upon which policies and investment programmes throughout SSA are now

being built. These policies and programmes deliberately target youth; they address what are assumed to be youth specific issues; and they privilege the provision of training, and access to land and financial resources.

I suggest that there are two ways we might look at this…

Either… that finally, a long neglected problem (or opportunity or constituency) has been recognised, and is now getting the attention from researchers, policy makers and others that it deserves. And a good thing too! **Or**… that the new interest in youth and agriculture is yet another example of a great flurry of activity, around a new development flavour of the month… another example of something being plucked out of context, grossly simplified, promoted as having great promise, but which will soon enough be forgotten when this promise is left unfulfilled. Either way, we should be cautions because much of the discourse around agriculture and youth in Africa, is constructed, and the investment rationalised, at a very high level of generalisation, and reflects what I think is a dangerous degree of essentialist thinking. Phrases like "Agriculture in Africa is…" and "Youth in Africa are…" should have no place in framing research, policy or interventions.

Let's now return to the proposition that young people will drive agricultural transformation in Africa. I would imagine that I could assert this repeatedly, and there would be few if any in this room who would disagree. And yet, if I were to just as confidently assert that young people will drive the development of Nigeria's petroleum industry, or that young people will drive the development of Germany's automobile industry… I am sure there would be an immediate flood of objections, questions and demands for qualifications. Youth driving the development of Nigeria's petroleum industry? But what about international climate change agreements and the changing global market for energy? What about new exploration and extraction technology? What about the petroleum companies' long-term strategies and investment priorities? What about national and state-level policy, and politics?

It seems to me that faced with questions like these, it would be very difficult, if not impossible, to defend the idea that youth are, or will be in the driver's seat. And is this not perfectly analogous to the proposition that youth will drive Africa's agricultural transformation? Should we not immediately ask: **But what about…**

- Changing global and national food consumption patterns, production trends and market dynamics?
- Processes of urbanisation and economic change?
- National agricultural and rural policy?
- **What about** new agricultural technology?
- Local land dynamics?
- And infrastructure development?

I want to make two important points. First, that we need to be honest, with ourselves and with everyone else: young people are not driving the bus of agricultural transformation. But neither are they simply along for the ride. It is certainly true that young people will be – as they have always been – a part of the story of agricultural and rural transformation, and as such they must certainly be within the gaze of both researchers and policy makers.

Second, in understanding where, how and who amongst the youth will be part of the this story of agricultural transformation, it is critically important that we remember that young people are deeply embedded – in families, peer groups, and communities, in social relations – and that they live and act in context… historical, social, political and policy, spatial, environmental, and so on. Social embeddedness and context both enable and constrain, they circumscribe what is possible. It is, I believe, a major mistake to conceive of young people as free-floating economic agents, who, when introduced to new mindsets and skills, and given access to productive resources, can march forth and boldly re-fashion the rural economy.

So what is the role for agricultural research institutes like IITA in all of this, particularly in an era of "research for development"? I want to highlight two areas, which represent, in my view, very significant gaps in our knowledge, and therefore constraint our ability to affect positive change through policy and associated interventions. But let me first introduce the idea of agricultural commercialisation "hot spots". These are areas where commercialisation is already well developed or in the process of developing. From the perspective of rural transformation, what is particularly interesting about these hot spots is that we can expect that good land will be scarce and difficult and/or expensive to access; labour may be scarce and expensive; and while marketing channels are likely to be well developed, they may also be demanding in terms of quality, timeliness and so forth. In other words, in relation to

primary production of crops and livestock, commercialisation hot spots are likely to have significantly higher barriers to entry than other, less commercialised areas. And it is young men and women, those just starting out, who we can expect to be most affected by these barriers.

This is why, in addition to the traditional farm-level measures, indicators and indices of commercialisation, it is critical that we take a "local economy" approach to understanding how these hot spots work. This is because a significant proportion of the employment opportunities generated for young people through agricultural commercialisation will be off-farm, either in agriculture-related enterprises or in other enterprises – like small shops, bars, and many others – that directly or indirectly feed off the revenue generated by agricultural commercialisation. These enterprises will provide young people with opportunities for both wage employment and entrepreneurship. What I am saying is that the young man or woman serving cold drinks in a local bar, is as important a part of the story of youth, agricultural commercialisation and rural transformation, as the farmer, farm labourer or input dealer.

With this in mind, let's turn to the gaps in our knowledge. The first gap relates to our understanding – or rather are lack of understanding – of how young people currently engage with agriculture and the rural economy more broadly, particularly in agricultural commercialisation hot spots. Who engages? How do they engage? How do they get started, and what do their subsequent trajectories look like? What impacts do different crops or livestock, different production systems, and different economic geographies have on the answers to these questions? Give the focus of Sustainable Development Goal 8 on "decent work for all", it is also important to understand how rural young people themselves see the notion of decent work, and how the different kinds of work open to them in commercialisation hot spots stack up against their own as well as the internationally recognised standards of decent work. In order to strengthen the knowledge base upon which policy and investment can be based, research to address this first gap will need to be interdisciplinary, historically informed, and placed within a broader framework of agrarian transformation, that takes explicit account of differences in context, and also of social relations, as well as the interplay of structure and agency as young people seek to establish their livelihoods. Working with colleagues at CIMMYT we recently proposed such a framework.

The second knowledge gap relates to our limited understanding of whether and how different kinds of rural investments and programmes – be they youth-specific or not – serve the interests of young people, and critically, of which young people. Here the call is for a more action-oriented or action-research approach. These programmes represent important research and learning opportunities, and this potential for learning cannot simply be left to mid-term or final evaluations.

Let me finish by reflecting on what all this might mean for the future – so, can the use of a foresight lens help us to frame research relating to youth and agriculture? Even without doing formal foresight work it seems to me impossible to escape the conclusion that over the coming decades the transformation of agriculture in Africa is likely to be characterised by consolidation, by changes in and greater use of technology, and by increasing mechanisation. These processes will be linked to the growth of urban markets, and changes in where food is purchased, prepared and consumed, and an increasing priority given to food safety, uniformity, and standards more generally. Of course, we should not forget that these developments will unfold in different ways and at different speeds, in different areas, so within this overall scenario, the lived experience of and the opportunity sets available to young people may differ very significantly. Nevertheless, a number of implications arise that are directly relevant to our interest in young people from an agricultural research perspective.

First, it should be expected that agricultural and rural transformation along these lines will result in a decline in the demand for labour at farm level. In other words, there will be fewer and fewer on-farm employment opportunities for young people – in other words, from an employment perspective, the part of the agricultural system that institutes like IITA have traditionally focused on will progressively shrink. For the jobs that remain, the balance will shift from independent farm operators to wage labour. And if what we have seen in other parts of the world is any indication, the quality of many of the agriculture-related jobs that remain in rural areas may fall well short of any decent work standard. On the other hand, there will certainly be growth in other parts of the food system – but many if not most of the associated employment opportunities are unlikely to be in rural areas. Here we must also be concerned about the quality of these new jobs – catering, fast food and food retail are notorious for poor terms and conditions of work. Are these the kinds of jobs upon which

future generations of increasingly educated young people will build their careers? But you might ask, what about the ancillary jobs in the rural economy that I mentioned earlier? Again, with a reduced agricultural workforce we well might expect to see the kinds of hollow-out rural areas and economies that have emerged in other parts of the world.

There is of course and alternative scenario, which is built around concerns with food sovereignty, local food and local control, the reduction of food miles, an emphasis on provenance, quality and so on. If taken seriously, the food sovereignty scenario would have important implications for farm structure, technology use, labour demand, the nature of rural economies and the shape of urban food systems. Should radical alternatives like this be part of the youth and agriculture research agenda? For me, a big question is how agriculture and food might fit into a future where economic and social policy really is driven by the vision of decent work for all, and how what we might think of as a "decent work" rural economy might serve the needs and interests of young people, and others. Institutes like IITA have, I believe, an extremely important role to play in exploring along these lines.

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Mrs Charlotte Lusty

Developing world-class genebanks to keep pace with users

Abstract

Since its first beginnings, CGIAR has managed international collections of crop and tree diversity for use in implementing its program of work and specifically in breeding improved varieties now grown worldwide. Since 2006, CGIAR has been fulfilling this role under the International Treaty on Plant Genetic Resources for Food and Agriculture. Over this time period, IITA and other Centres have witnessed many changes. Managing a collection in those early years is very different from operating a world-class genebank now. Conservation remains a high priority but the capacity to use diversity has radically changed. The present day revolution in genomics based technologies and bioinformatics provide potentially powerful tools for managing collections and for vastly extending the selection and use of diversity. Developing the capacity to exploit such advances is a major issue.

Extended Summary

There are some certainties about the decades ahead of us. We will face massive challenges. Difficult trade-offs will be navigated. Technological progress will be made. New findings in genomics, proteomics and epigenomics will push new scientific and ethical boundaries. Artificial intelligence, big data and concerns over individual and state privacy will bring changes to our daily lives. Many different scenarios of our future can and will be convincingly portrayed. None of them will be entirely correct, but we do know that all of them will be dependent on the resources that we inherit, safeguard and pass down to the next generation.

One of the vital resources that we benefit from today are the plant genetic resources that have been passed down to us by more than 40,000 generations of farmers and cultivators, a century of scientific breeding and 50 years of collecting and genebanking by IITA and its sister CGIAR Centres. While some may fantasize about the possibility of disinvesting ourselves of the need for physical seeds or germplasm (all we need is the DNA code inside them), we mismanage such resources at our peril. Genebanks conserve genetic resources for the uncertain tomorrow but that does not render them irrelevant today. In fact, genebanks are becoming more and more relevant for every day.

The 11 CGIAR genebanks manage 750,000 accessions in 35 collections, as seed, as plants in the field or screenhouse, in tissue culture, in cryopreservation and as DNA samples. These collections include tree species, forages, crop wild relatives, root and tuber crops, and bananas, as well as a wide range of cereals and grain legumes. CGIAR genebanks conserve, by far, the world's most genetically diverse and widely disseminated collection of germplasm available under the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). The associated germplasm health units (GHUs) provide an essential and unique service to ensure germplasm is distributed around the world without phytosanitary risk.

A much clearer picture of the status of these collections has been developing through the work of the Global Crop Diversity Trust working together with the CGIAR in the past 5 years. Every genebank has worked hard to eliminate backlogs and deal with unprocessed seeds or little known historic collections so that they can reach high performance targets that will ensure that no less than 90% of the accessions in the collection are immediately available for distribution, are adequately safety duplicated and documented with sufficient information to determine their identity and promote use. A major effort has been made to develop and strengthen individual quality management systems (QMS) based on the disciplines and practices of ISO but centred around the FAO genebank standards and the International Plant Protection Convention's International Standards for Phytosanitary Measures. Through the documentation and external auditing of standard operating procedures (SOPs) as part of each genebank's QMS, a new level of transparency has been created, as well as supporting capacity building and staff succession.

Moving forward in the new Genebank Platform, the genebanks are focussing on improving conservation through mainstreaming cryopreservation and improved practices to understand and extend seed longevity in storage. A firmly collaborative approach is also leading to more strategic conservation and curation of costly-to-conserve taxa – as an example, ILRI and CIAT are moving to jointly manage and rationalize their forage collections. Our determined aim is to increase efficiency and improve operations while controlling costs.

What about the needs of users? It remains difficult for researchers and breeders to identify and determine the values and potential applications of individual accessions – it is much more complicated than scientists might have thought 50 years ago. The interaction between genes and genes and environment is considerably more complex than perhaps once imagined. Each crop species has around 30,000 genes, producing thousands of biochemical compounds upon a multitude of different developmental and environmental triggers. We have still only touched the surface of understanding how they interact with each other over time to control the growth and performance of the plant, how they respond to pests, diseases, weeds, plant nutrients, extremes of temperature and moisture, soil microbes, soil structure and toxic compounds in the soil.

Nevertheless, we have perhaps reached a critical watershed today whereby mass genotyping is mainstreamed and phenotyping is following. The genebanks are doing what they can to support and use vastly increasing datasets. As part of the Use Module, the genebanks are fostering stronger flows of information, tools and skills between genebanks and genebank users. Eight Centres are adopting a shared data management system in the form of GRIN-Global, the system used by USDA and an increasing number of other national partners. For the first time, Digital Object Identifiers (DOIs) are being assigned to individual accessions. CIP received the first minted DOI from the ITPGRFA Secretariat last month and IITA followed fast behind. DOIs will be able to provide traceability of germplasm from collection to eventual use in released varieties. The genebanks are also building on new and more mature tools and methods for exploring diversity: mini-cores at ICRISAT; focused Identification of Germplasm Strategy (FIGS) subsets at ICARDA; molecular atlas at CIMMYT; whole-genome sequencing at IRRI. With improved data, and improved data standardization, the genebanks will be able to scale up and develop germplasm selections for specific users, traits, taxonomies or geographies.

All activities are carried out within the context of a rational global system made up of the vast network of genebanks and users worldwide. The partnership with national genebanks and breeding programs is profoundly consequential. CGIAR will sustain and expand its partnership within crop communities and address capacity building priorities, renew institute roles and continue to strengthen collective actions. A global gap analysis will also be undertaken to develop an objective indication of the representation of diversity conserved ex situ and to direct strategic joint collecting missions targeting under-represented genetic diversity and traits to address climate change challenges.

The signs are that genebanks are being called upon more and more. Between 2012 and 2016, the genebanks distributed 600,000 samples in response to requests, of which more than a third was received by non-CGIAR users in more than 120 countries. So far, CGIAR has been responsible for 94% of the reported distributions of germplasm under the ITPGRFA. The annual rate of distribution since 2012 for nine CGIAR genebanks has increased more than two fold compared to rates prior to 2009. The CGIAR genebanks are providing the raw resources to support fundamental research, gene discovery and crop improvement today and the investment we are making in improving both the conservation and our knowledge of these resources will ensure they are readily accessible tomorrow.