American Society of
Agricultural and Biological Engineers

Conference Report

Modernizing African Agriculture

A Special Session of the ASABE Virtual 2020 Annual International Meeting

July 13, 2020

Organizing Committee

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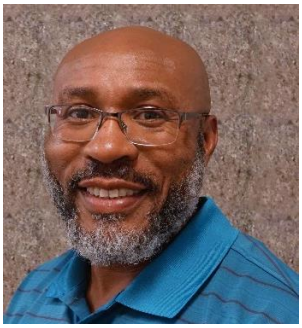

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Welcome Remarks

Agriculture is vital to economic development and the overall quality of life. Over the last five decades, agricultural productivity has significantly increased in North America, Europe and Asia but Africa has not seen these large increases in productivity. Africa's population is expected to grow from 1 billion to 2 billion by 2050, a 100% increase. Therefore, increasing agricultural productivity and developing the food value chain are crucial for food security, economic development, and poverty alleviation. African agriculture faces many challenges. A large majority of farms are small and most farm work is performed manually or by draft animals. To modernize African agriculture, we must think of technology that is appropriate and sustainable in the African context. The American Society of Agricultural and Biological Engineers (ASABE) has a long tradition of working collaboratively with our international partners to address global problems. I applaud the African Network Group of the ASABE (ANGASABE) undertaking this initiative. The American Society of Agricultural and Biological Engineers (ASABE) is delighted to be part of this highly worthwhile and potentially transformational event.

Thank you,

Sue E. Nokes

Sue Nokes, PhD, PE
President, American Society of Agricultural and Biological Engineers (2019-2020)
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Overview of the Modernizing African Agriculture Initiative

Ajit Srivastava, PhD, P.E., Professor, Biosystems and Agricultural Engineering, Michigan State University

Vision – A modern, productive, and profitable agri-food system in Africa that ensures food security, provides economic growth, and improves quality of life in a sustainable, equitable, and responsible manner.

Foundational Pillars – While the ASABE's strength and focus is on Technology and Innovation which is one of the pillars of this initiative, technology and innovation alone cannot sustain an initiative of this nature. Entrepreneurship and Business Development, Capacity-Building and Workforce Development, and Infrastructure and Policy Framework are equally important to support a modern African agriculture.

Salient Points – The agri-food system in Africa, like any other place, is a complex multifaceted system that faces many unique social, political, environmental, and economic challenges. Megatrends such as population growth, rapid urbanization, climate change, and pressure on resources such as land, water, and energy will continue to impact the food system. Over the last 50 years, significant progress has been made to overcome many of these challenges and to lay the groundwork for an intentional, transformational change in the African food system to take place. There is an ongoing rapid development of technological innovations with applications in agri-food systems in other parts of the developing world. It will take a coordinated, concerted, and collaborative effort to realize the vision of a modern African agriculture. The Modernizing African Agriculture initiative (MAA) is a long-term initiative and will require continued effort and perseverance to be successful.

Activities and Milestones

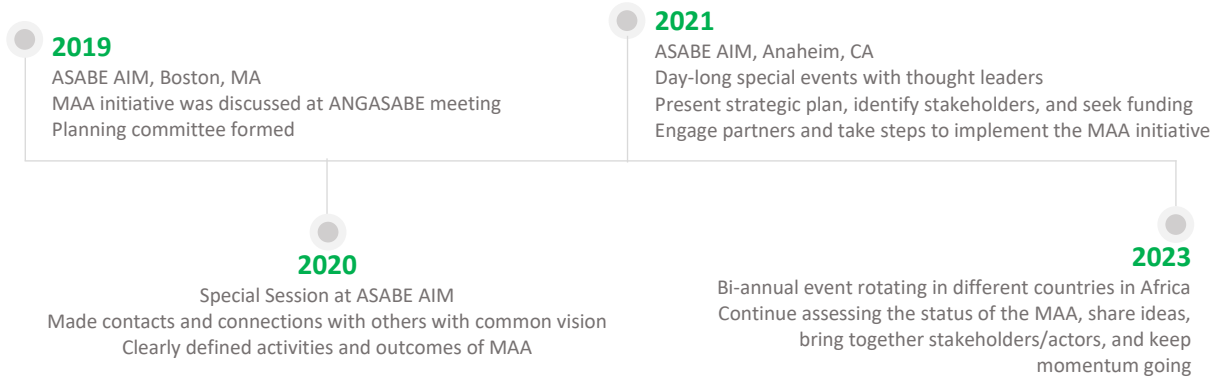

Figure 1: Timelines, activities, and milestones of the Modernizing African Agriculture Initiative

Keynote Address

Adesoji Adelaja, PhD
John A. Hannah Distinguished Professor in Land Policy
Department of Agricultural, Food, and Resource Economics
Michigan State University

Path to Sustainable Agriculture in Africa

Strong evidence supports the understanding that labor productive growth (LPG) drives gross domestic product (GDP). There are two schools of thought on how to grow an economy through increased labor productivity. McMillan et al. (2014), highlights these two different sources of aggregate LPG. One is to increase labor productivity in all sectors. By raising the general level of productivity in an economy, people earn better wages and prosperity grows over time. The second is for labor productivity to increase in a high labor productivity sector like manufacturing and then over time as this sector creates opportunities, people move from low productivity sectors such as agriculture into the higher productivity sectors.

Most of the growth that has occurred in African countries has been organic, meaning all sectors have been growing - option 1 (Badiani and Makombe, 2014). The situation where labor (as a proportion of the population) moves from agriculture into manufacturing (option 2) has been limited. The special challenge faced in Africa is that there are millions of people living in poverty (particularly for rural populations) who do not have access to developing the skills needed to engage in manufacturing and thereby move upward from a lower productivity sector.

As long as China and India continue to flood the African market with low-cost manufactured products, Africa is not likely to become an export manufacturing hub (at least in the next 20 years). For example, China's exports of manufactured goods to Africa rose from $4.4 billion to $86.7 billion between 2004 and 2013. This is equivalent to a 28% increase per year. Reasons why African countries generally cannot compete with India, China or South Korea include: poor business environment and poor infrastructure; high transportation costs and inadequate/costly port facilities; unreliable power supply and inadequate access to finance; land acquisition difficulties and rising labor costs; and shortage of skilled labor. Agriculture will thus be the engine of Africa's economic transformation for the next 20 years or more. As agriculture's contributions to society fully mature, then the transition may begin to happen into other sectors. It will not be surprising that Africa will leapfrog into service industries.

Due to labor and other constraints, agriculture, rather than high productivity sectors such as manufacturing, will be the engine of Africa's economic transformation.

McMillan M., D. Rodrik, Í. Verduzco-Gallo. 2014. Globalization, Structural Change, and Productivity Growth, with an Update on Africa. World Development. 63: 11-32

Badiani, O. and T. Makombe. 2014. The Theory and Practice of Agriculture, Growth, and Development in Africa. No wp-2014-061, WIDER Working Paper Series, World Institute for Development Economic Research (UNU-WIDER).

African Agriculture Today

Eighty percent of Africa's fifty-one million farms (41 million farms) are small holders (< 2 hectares each in size). In terms of relative contributions, small farms produce 30% of the total agricultural output, medium-scale farms (2 - 20 hectares in size) produce about 50%, and large farms (> 20 hectares) produce 20%. Although the percentages vary among countries, farming is essentially a smallholder activity in Africa (Lowder et al., 2016). All farm sizes, small, medium, and large are growing across the continent.

It is important to note that smallholder farmers produce 70% of the food eaten in Africa. Medium and large-sized farms are more involved in export production; therefore, smallholder farmers are at the very heart of food security in Africa. Larson et al. (2014) indicated that smallholder farms are efficient low-cost producers. It can be argued that they are not efficient enough but certainly have higher yields per hectare than larger farms. This is interesting from the perspective of economies of scale, but in Africa in general (situations may vary among countries), smallholder farmers have very decent yields compared to larger farms. Another way to look at it is that the problems that plague smallholder farms are also faced by larger farms.

Agriculture is a major employer in Africa. Seventy percent of the African population are smallholder farmers. Smallholder farmers, if they employ mixed cropping, will have higher capacity to create jobs than large mechanized monocultures, according to the Food and Agriculture Organization. Increased productivity will lead to increased job creation.

Agriculture is key to food security and the 2050 food gap challenge cannot be met without smallholder farmers. As a significant portion of the population are involved in smallholder farming, to alleviate poverty or eliminate hunger in Africa, the smallholder farmers need to be involved. Any other strategy is unlikely to work.

Most African governments are not putting adequate resources into agriculture. For example, very few countries contribute up to 4% of their annual budgets, although up to 10% is expected or has been promised. This is largely because farmers lack a voice and have been unable to convince policymakers that agriculture is the key to economic development in Africa.

Key to bringing strategic and important change in Africa will be technologies focused on bringing efficiency and enhanced productivity to smallholder farmers (Herrero et al., 2017). Larger farms already have access to technology and may not need help from this kind of initiative (MAA) but the benefits could spillover.

Smallholder farmers are at the heart of food security in Africa, producing 70% of the food consumed on the continent.

Increased productivity among smallholder farmers will lead to increased job creation.

Key to transforming African agriculture are technologies focused on efficiency and enhanced productivity among smallholder farmers.

Larson, D.F., K. Otsuka, T. Matsumoto, T. Kilic. 2014. Should African Rural Development Strategies Depend on Smallholder Farms? An Exploration of the Inverse-Productivity Hypothesis Agricultural Economics, 45 (3) (2014), pp. 355-367

Lowder, S. K., J. Skoet, T. Raney. 2014. The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. World Development, (87):16-19

Herrero M., P. K. Thornton, B. Power et al., 2017. Farming and the Geography of Nutrient Production for Human Use: A Transdisciplinary Analysis. The Lancet Planetary Health 1(1)

To be stressed also are the three solution sets proposed by Keating et al. (2014) for moving agriculture forward (Figure 2). First is reducing net farm product demand per capita (that is, what is actually produced versus what is consumed in the market) and this includes reducing harvest losses and increasing shelf life. Secondly, target-fill production gap and that involves shifting product mix and engaging in new markets. Lastly, avoiding losses in production which comprises increasing productivity and improving energy efficiency. A transformational change in African agriculture involving technology must, at least, keep these three areas in mind. As a technology-based profession, agricultural engineering is the key profession that could be most transformational through innovation, strategic focus on an agenda or topic of modernization, and partnering with the right professions, as well as through effective communication with policymakers.

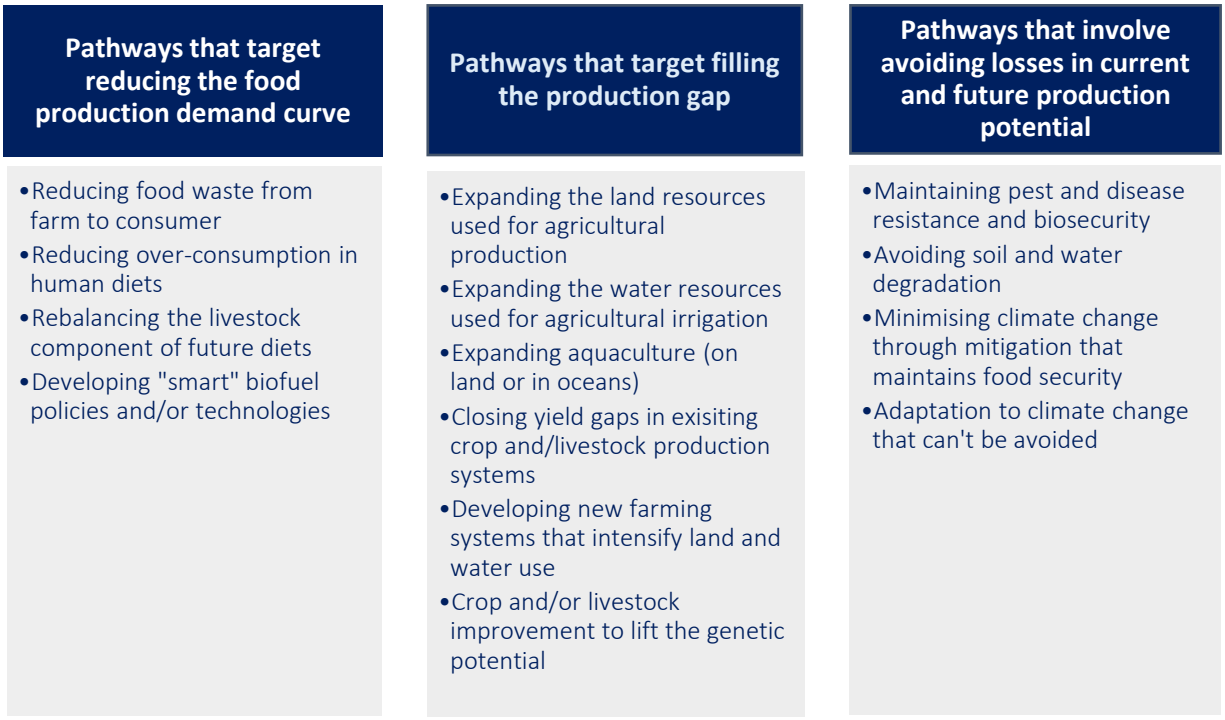

Figure 2: Pathways to meet world food demand by 2050 (Keating et al., 2014)

Challenges with governance, policy, markets, institutions, land tenure, and finance are examples of the variety of constraints African agriculture faces. Technology is therefore, not the only challenge, but it can help address many of these other constraints. A few are listed below.

Land expansion	Market intelligence	Standardization
Land tenure	Access to markets	Simple Mechanical Technology
Power and energy	Unlocking Small to Medium Enterprises opportunities	Appropriate Information & Communications Technology
Farm logistics		Extension access
Harvest losses		
Value addition (on farm)		

Agriculture's Role in Africa's Transformation

If the challenges facing African agriculture are successfully addressed, estimates are that, intensely farmed lands could produce 100 million tons of grain equivalent per year (similar to adding another U.S. corn belt). This will meet the rapidly growing demand for food.

The population of Africa is slated to more than double by 2050. Additionally, growing incomes, increasing urbanization resulting in changing diets (more fruits and vegetables consumption) will cause demand for non-traditional food staples to increase substantially. As most farmers are poor smallholders, a strategy to transform agriculture should be able to increase productivity while keeping prices low. This will best serve the broader interest of society. A 1% increase in productivity is estimated to result in 0.72% reduction in number of poor people in Africa, better than 0.48% in Asia (Thirtle et al., 2003).

A gap in agricultural land productivity exists between Africa and Asia and other parts of the world. Although productivity is increasing over time in sub-Saharan Africa, it is not growing fast enough to create competitiveness with major agricultural producers (Figure 3). Furthermore, while output per hectare is increasing in Africa, output per worker is not, compared to trends in other regions (Figure 4). Output per hectare could be increased in Africa but land will eventually limit growth. Tremendous opportunity lies in increasing labor productivity through technology as done in other regions of the world.

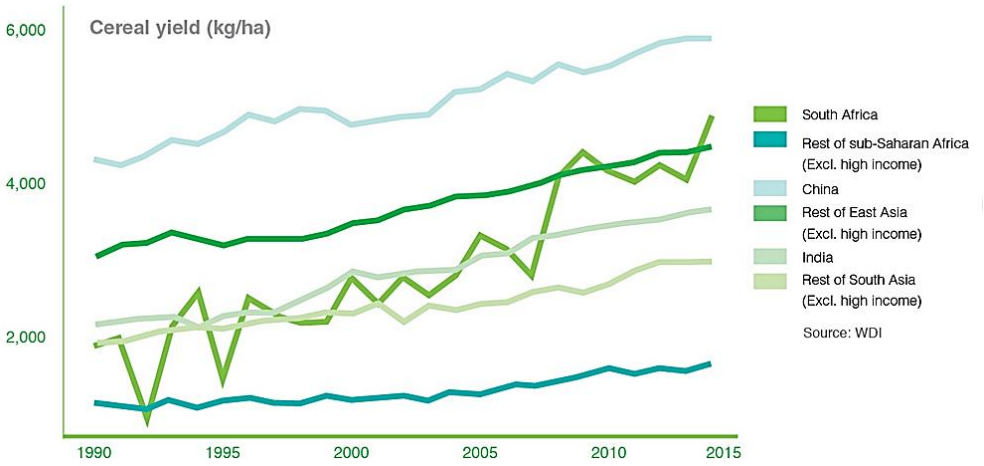

Figure 3: Trends in cereal yields in Africa and Asia.

Source: Hazell, P.B.R. 2017. Why Agriculture is still Critical for Africa's Economic Transformation. In AGRA (2017). Africa Agriculture Status Report: The Business of Smallholder Agriculture in Sub-Saharan Africa (Issue 5). Pgs. 1-19. Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA). Issue No. 5

To serve the broader interest of society, a strategy to transform agriculture should increase productivity at low costs.

As done in other regions of the world, great opportunity lies in increasing labor productivity through technology.

A 1% increase in productivity is estimated to result in 0.72% reduction in number of poor people in Africa, better than 0.48% in Asia (Thirtle et al., 2003)

Keating, A.B. M. Herrero, P. S. Carberry, J. Gardner, and M. B. Cole. 2014. Food Wedges: Framing The Global Food Demand And Supply Challenge Towards 2050. Global Food Security: 3 (3–4)

Thirtle, C., L. Lin and J. Piesse. 2003. The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America. *World Development*, 31(12)

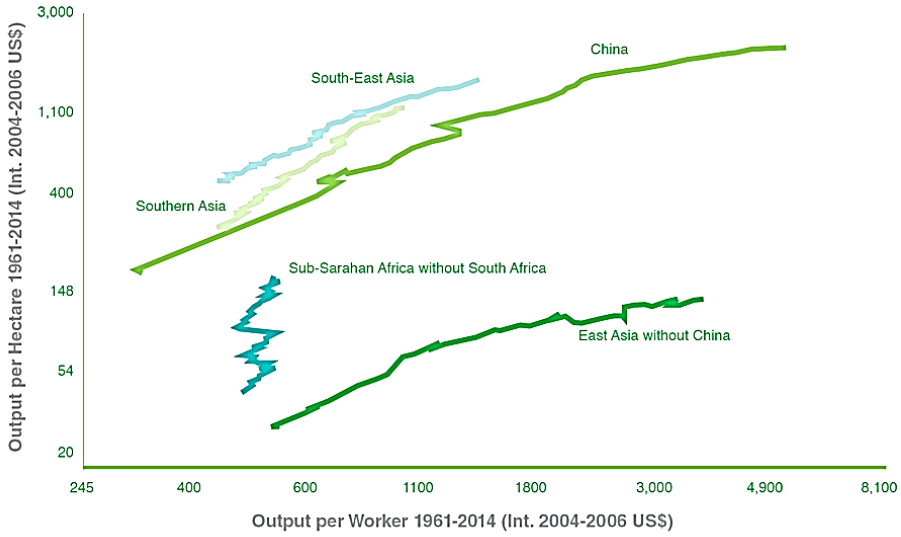

Figure 4: Regional trends in land and labor productivity in world regions (2000 – 2014).

Source: Hazell, P.B.R. 2017. Why Agriculture is still Critical for Africa's Economic Transformation. In AGRA (2017). Africa Agriculture Status Report: The Business of Smallholder Agriculture in Sub-Saharan Africa (Issue 5). Pgs. 1-19. Nairobi, Kenya: Alliance for a Green Revolution in Africa (AGRA). Issue No. 5

Technology Timeframes

Technology timeframes can be delineated into short-term (less than 5 years), medium-term (from 5 to 15 years) and long-term (greater than 15 years) time dimensions. Because the short-term is too limited a timeframe for a research-based technology program to manifest, technology benefits mostly accrue in the medium to long-term (5+ years). The short-term goals of a research-based technology initiative for Africa should be to increase productivity or income by maximizing access to existing information and technology while eliminating short-term constraints. Medium-term timeframe is the sphere of influence that is most compelling for scientists and funders; it is short enough to excite beneficiaries and long enough to inspire scholars. The critical focus of technology development in Africa should be on the medium-term. The long-term timeframe can focus on transformational technologies and offer the opportunity for global solutions to convergence. Donors will only fund long-term projects if convinced about a mega-sized impact.

The critical focus of technology development in Africa should be on the medium-term timeframe. It is short enough to excite beneficiaries and long enough to inspire scholars.

Short-term Technology Needs of Africa

The short-term goal should be sustainable increase in land use intensity and increase in labor productivity. One of the ways that this can be accomplished is through the rapid adaptation of transformational domestic low-cost shelf-ready technologies.

The recommendation to agricultural engineers is to do a triage of existing technologies from Africa and Asia that can easily be deployed in the short-term. Key is to look for ways to keep costs low. Examples of such technologies for possible adaptation that the ASABE should brainstorm on are;

- Solar-powered small tractor rapid demonstration and adoption
- Rapidly deployable rechargeable power assist hoes
- Tillers adapted from India and far-east countries
- Efficient solar equipment (drying, washing, tilling, handling, etc.)
- Intensive mixed-use technologies (affordable water pumps, water filtration systems, hydroponics, urban container farms, micro-greenhouses, etc.).

Funding can come from foundations and public private sector participants (public private partnerships (PPP)). A good model is a pilot program between a government and a foundation.

Long-term Technology Needs of Africa

The long-term goal should be threefold; support Africa's readiness to utilize relevant advanced technologies, help build long-term capacity through education, and build long-term partnership for convergence technology

solutions. Convergence technology refers to technology developed for technologically advanced countries that can be used in Africa given that the necessary developmental steps (related to medium-term goals) have already been taken. The long-term focus should be on the adaptation of technologies from more advanced regions to African settings, and to extend the shelf life of these technology products. This will resonate well with manufacturers and foundations in the more technologically advanced economies. Key will be keeping costs down.

Medium-term Technology Needs of Africa

The medium-term is the timeframe that is most relevant to ASABE in its Modernizing African Agriculture initiative. The recommendations being presented are guided by the assumptions that agriculture:

- remains important and will be a leading industry;
- will be a glue-point for Africa's economy and engine of the industrial revolution;
- will provide raw materials to industry;
- will remain key to food security and nutrition; and
- will stem the growth of small and medium enterprises.

If human capital and policy issues are addressed, then technology will be the key barrier in Africa.

Technologies critical to medium-term transformation of African agriculture include, mechanical, post-harvest, on-farm logistics, extension technology, and market and information technology

The goals of medium-term technology development program should be to:

- improve farmers' skills and capabilities;
- increase farmer productivity and value added and reduce poverty;
- supply quality raw material to industry and food value chain;
- release skilled labor from agriculture to industry/services;
- increase self-reliance and reduce fragility; and
- introduce farmers to markets.

General areas of medium-term technology development program include;

Mechanical technology – An area critically in need of mechanization is land clearing for acreage expansion which currently, is expensive. Equipment that ASABE targets should be adaptable to smallholder farmers by not bulky and unaffordable and must be energy efficient.

Post-harvest processing technology – Food losses from spoilage amount to 30% of production output in Africa. Most existing preservation technologies are for large scale farmers and are unaffordable and too bulky for smallholders. Examples of affordable preservation technologies are:

- low cost non-electricity dependent refrigeration;
- changing the primary form of produce to increase shelf life (for example, tomatoes and plantain drying equipment, and cassava flour processors). These will also reduce price for consumers.

On-farm logistics – Rural roads in Africa are bad, hampering farm connectivity and farm-to-market movement of products. Affordable, motorized small vehicles are needed that are energy efficient (powered by solar, gas, etc.). Examples include;

- three-wheelers that can navigate rough terrain;
- flexible motorcycles that can carry loads; and
- reconditioning standards for expired equipment

Extension Technology – Technology is the only thing that can revive and transform extension in Africa today. There are fewer extension agents available than 50 years ago due to non-replacement, fewer entering the workforce, scattered farmers, bad roads, and lack of funds for trips. This slows down technology transfer, farmer education, and agricultural modernization. Technologies are needed to ease communication, support farmer education, and transfer knowledge. For example, mapping and GIS-based software for knowing farmers' locations, monitoring farms, delivering programs, etc., will prove to be impactful.

Market Information & Information Technology – The top market information problems for farmers include: locating raw materials and farm inputs, knowing the market price of commodities produced, and finding major off-takers. Many farmers own smart phones. Mobile phone applications can decrease search cost and transportation time. Jobs can be created for young technology savvy graduates especially those in rural areas. Africa can become a hub for rural information and communications technology.

The agricultural engineering profession is poised more than any other to create jobs for and attract young people to agriculture

Employment Impacts

An ASABE initiative must improve productivity while creating platforms that provide jobs for the unemployed. The majority, 70% to 80%, of agricultural graduates are underemployed in other sectors or unemployed due to lack of agricultural opportunities. Technology can make agriculture attractive to young people while improving productivity and incomes.

Suggestions for the Structure of an ASABE Initiatives

1. Branding is important. Consider the name, "Initiative to Modernize African Agriculture through Technology" for the initiative.
2. The initiative should be formalized and led by major ASABE universities and through them, reach out to potential partners.

3. An interdisciplinary approach should be utilized - involving economists, agronomists, animal scientists, and policymakers, for example, will be beneficial.
4. Discussions on how to transform African Agriculture are underway among potential partners and donors. Thus, execution should be done quickly by starting to sell ideas to funders and building funding partnerships rather than waiting for calls for proposal. The initiative should have an "Agricultural Innovation Fund Component".
5. The initiative must involve African professionals, governments, and funders such as the USAID, World Bank, and African Development Bank
6. A powerful feasibility study and impact assessment will be needed.
7. Clear funding targets need to be set.

Suggested Initiative Elements

- Audacious Goal: *Modernizing African Agriculture*
- Scope: Solid contribution to transformation
- Clear agenda
- Clear delineations of technologies
- Clear timeframes
- Show how technology will define the future
- Clear technology transfer program
- Well-designed initiative management structure
- Clear delineation of PPP partners and other professions more attuned to the policy and legal frameworks that need to be involved in the initiative
- Norman Borlaug style – that is, mission-oriented scholarship.
- Accompanying policies: e.g. laws to compel governments of Africa to devote 5% of their budgets to agriculture as a condition for aid

Agricultural is key to transforming Africa and the agricultural engineering profession has much to offer. The focus should be on rapidly increasing land and labor productivity within the medium-time frame of 5 to 15 years.

Conclusions

Agriculture is key to transforming Africa. Although there are other areas of concern, agriculture is at the center of Africa's transformation. Agricultural engineering is a powerful profession that has much to offer African agriculture. The land grant mission makes mission-oriented intervention easy for Africa-focused ASABE engineers. There is a need to focus on increasing land and labor productivity. The focus should be on medium-term technological transformations. A powerful vision is needed that will drive a 10-year plus initiative budget. The Initiative needs to be fast-tracked, as key decisions about Africa's agricultural future are underway.

Note: This presentation draws from the 2017 African Agriculture Status Report (AASR 2017) published by AGRA. The presenter is one of the authors of AASR 2017. The presentation also benefited from discussions by the presenter with key agricultural sector opinion leaders from higher education, state and federal government, and international institutions in Africa.

Breakout Sessions

I. Taking Stock of the Current Agricultural Landscape in Africa

(*Facilitators: Margaret Gitau, Purdue University; Kifle Gebremedhin, Cornell University*)

We have identified the following categories of major challenges which hinder the modernization of agriculture and the food system in sub-Saharan Africa: Food insecurity and inadequate nutrition; Climate change, desertification, vulnerability of communities, and lack of adaptive capacity; Land availability and access; Water availability and access; Inadequate availability of energy; Post-harvest losses; Lack of on-farm processing technology; and, Adding value to farm products.

This session assumes three key guiding principles:
Agricultural producers (small-holder farmers) are central in the process of modernizing agriculture.

1. Innovations (technologies, methodologies, policies and organizations) should be relevant, transformational, sustainable, and cost effective.
2. Innovations should foster environmental protection, economic growth and human-capital empowerment.

Discussion Topics and Contributions

Staying with the broad categories outlined above, have we missed any other broad category of challenges? Our next step will be to discuss each of these categories in more detail. Identify specific issues under each of the broad categories as outlined.

1. Access to appropriate **input** (mechanization, fertilizer, organic fertilizer, pest and weed control, draught resisting seeds, etc.)
2. Lack of **capacity** and training on the part of farmers and growers, especially women who play a major role in agricultural and food chain.
3. Access to **finance or credit** that is affordable to small-scale farmers
4. Access to **information** – farmers are not aware of information, price of produce in the market, available data, etc.
5. Farmers have no information on where/how to **maintain and service** equipment
6. Lack of adequate water and energy for irrigation technology, etc.
7. On-farm capacity to **process** agricultural products to **add value** (coffee, cheese, canning tomatoes, etc.).
8. Access to **market** to sell products worsened by lack of transportation and bad rural roads
9. Problem with **preservation** of produce to increase shelf life and maintain quality for export
10. Small land ownership and **land tenure** not conducive for mechanization
11. **Youth** not attracted to agricultural production (low pay and not a sexy occupation)
12. Inadequate **government subsidies** to small-holder farmers and growers
13. Lack of **commitment and priority** on the part of the government towards agriculture (low budget, minimal or no research, non-vibrant research centers)
14. Lack of access to agricultural **extension and outreach** activities and programs
15. Lack of **research/training collaboration** across the continent
16. Inconsistency in government policies
17. Nomadic way of life does not lend itself to modernization.

Identify/propose potential innovative solutions that will lead us towards modernizing African agriculture. In each category, please propose, potential innovative technologies or solutions that will lead us to accelerate the modernization of African agriculture.

1. Vertical farming for plants, animals, vegetables, and ornamental flowers
2. Collective community farming that lends itself to mechanization and crop storage facilities
3. Use of solar and geothermal energy sources
4. Sensor technology to enable precision agriculture (precision farming, irrigation, pest control, etc.)
5. Employ advanced water conservation, storage, reuse, and multiple use factors
6. Diversification of crops, vegetables, flowers, etc.
7. On-farm processing to add value to harvested products
8. Information systems to get around lack of extension and outreach services
9. Development of exchange market for agricultural products so farmers could directly sell their produce at reasonable price
10. Cross-country agricultural research and outreach centers with information sharing across countries
11. Ocean farming for crops and vegetables.

Concerns Expressed:

1. The focus should not be only on agricultural production but also the food chain – a wholistic approach is suggested.
2. Africa should not mimic western technology and methods but need to integrate them with indigenous technologies, practices, and approaches.
3. There was concern regarding lack of access to different kinds of information including financing, services, etc.
4. There was need to consider impacts on the environment, which is often overlooked.

II. Cultivating Entrepreneurship and Fostering Private Investment

(Facilitators: Klein Ileleji, Purdue University; Terry Howell, University of Nebraska Lincoln)

In the context of sub-Sahara Africa, improving the investment climate to support technology development and adoption is an important objective. Cultivating entrepreneurship and fostering private investments has been identified as an important issue. Following are some factors to participants were asked to consider in preparation for the discussion.

How is Africa Investing? Addressing Africa's agricultural challenges has the potential to unlock inclusive economic growth, benefit smallholder farmers, boost food production and end hunger. The Maputo Declaration, signed by African Heads of State and Government, called for a pan-African flagship program to enhance agricultural production and bring about food security on the continent. As a result, the Comprehensive Africa Agriculture Development Program (CAADP) was born with the aim to increase public investment in agriculture by a minimum of 10 per cent of national budgets, and to raise agricultural productivity by at least 6 per cent. To this date, 44 African countries have signed the CAADP Compact to allocate 10 per cent of their national budgets to agriculture, and 39 countries have formulated national agriculture and food security investment plans.

Overarching themes:
Food security, nutrition, and health; Economic and rural development; Sustainability and environmental stewardship; Women and youth empowerment; and Using technology to target local needs

Discussion Topics and Contributions

*How would you **rate the extent of entrepreneurship**, vis a vis the optimal level? Identify key (product, service, technology) areas where entrepreneurial and FDI gaps exist.*

1. The extent of entrepreneurship and investment across Africa is low. The talent level of people is high, but there is a historical focus on subsistence farming, so a culture of innovative entrepreneurship is not present.
2. Gap: there is a worldview that Agricultural investment is risky
3. Youth lack resources.
4. Agriculture is a noble profession, but access to credit, capital, and good policies are lacking.
5. Small-scale farming and technology continue to be a challenged (and an opportunity)
6. Tradition: a commercial mindset is missing.

*List **new strategies** that should be pursued to: a. encourage entrepreneurship in the agri-food system b. encourage foreign direct investment in the agri-food system*

1. Identify the major imports to Africa and find ways to produce them on the continent
2. Improve the marketing of high-value exports
3. Communication: we must find a way to convey the value of agriculture as a positive, profitable profession in order to attract investments

*What is the current **enabling environment for entrepreneurs and private investment** to thrive? How can the role of women and youth be integrated? How much are African governments doing?*

Forming farmer groups have been successful in addresing these areas.

III. Appropriate Capacity Building and Workforce Development

(Facilitators: Senorpe Asem-Hiablie, Penn State University; Daniel Uyeh, Kyungpook National University)

The Modernizing African Agriculture initiative, using a holistic approach, seeks to explore and introduce modern technologies to improve the food value chain in African leading to improved food security and poverty reduction. To serve as an engine for sustainable economic growth, modern African agriculture needs to be productive, efficient, and resilient. The right skill set is vital to driving and maintaining this transformation and growth. This session sought to identify priorities for appropriate capacity building and workforce development systems fit for African agriculture and included:

1. Assessing the current status of capacity (knowledge-based, infrastructural and capital, and social) for modernization across Africa and identifying gaps.
2. Identifying priority areas and stakeholders for the development of a roadmap towards short-, medium- and long-term transformation and relevant indicators along the way.
3. Capacity building and workforce development over the long-term.

In the context of education and training, workforce development and capacity building are important issues that must be addressed. We define capacity as encompassing knowledge-based capacity (including education and training, research, extension and outreach programs, as well as cross-country collaborations), infrastructural support, capital capacity (including tuition and technology support), and social capacity (opportunities and barriers based on perceived norms). Workforce is defined as including farmers, growers, and pastoralists, and agricultural support occupations.

Discussion Topics and Contributions

Keeping in mind the presentation by our keynote speaker about the future of Africa's agri-food system, identify specific areas where there are significant gaps in capacity building and workforce development.

1. Lack of training Infrastructure
2. Poor road infrastructure, especially in rural areas, could be extremely limiting for transportation to centralized training locations even if training was free
3. Decreasing numbers of extension personnel
4. Attitude towards work
5. Lack of the availability of technical workforce (for example, tractor drivers, mechanics, etc.)
6. Unwillingness to take up jobs in agriculture
7. Lack of simple bookkeeping and recordkeeping skills among smallholder farmers especially female farmers
8. Lack of training for high-productivity jobs

For each of the areas as identified, provide specific examples of activities and programs which if implemented will be transformational.

1. Research and training targeted towards solving identified problems (e.g. Technologies for African Agricultural Transformation (TAAT) initiative of the CGIAR and AfDB)
2. Training locals instead of importing skills
3. Training targeted to women
4. International training partnerships primarily within Africa where countries trade expertise
5. More innovative platform for value chain development
6. Training policy makers to understand the current agricultural dispensation and how to craft relevant policies to fit the changing needs

7. Foreign partners should design projects as an opportunity to empower national partners
8. Farmer field schools
9. Feed the Future Innovation Labs, such as the Post-Harvest Loss Innovation Lab, BecA Hub
10. Metal fabricators' annual workshop and expo to expose technicians to our new designs as done by the Federal Institute of Industrial Research Oshodi (FIIRO), Nigeria in collaboration with International Center for Tropical Agriculture (CIAT), The International Institute of Tropical Agriculture (IITA), and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Nigeria
11. Center for sustainable agriculture mechanization: Sharing strength with other countries on the continent
12. AU-NEPAD Biosciences Eastern and Central Africa Hub (ILRI)

Name main considerations for implementing long-term capacity building and workforce development plans

1. Synergy should be increased among agricultural engineers, extension workers, and farmers
2. Integration of research and training. Knowledge passed to farmers must be research-based. Research institutions and universities to be more active in this space.
3. Developing supply chain expertise
4. Overcoming language barriers
5. Sourcing funding for capacity building
6. Increasing investments in research and extension
7. African experts abroad should be engaging more with those on the continent
8. Development of appropriate renewable energy within an integrated cooperative framework of community engagement

IV. Public and Private Partnerships and Policy (4P) Needs to Support Agricultural Development

(Facilitators: Michael Ngadi, McGill University; Kumar Mallikarjunan, University of Minnesota)

The challenge of meeting the food security and nutrition needs of over 237 million people suffering from chronic undernutrition in sub-Saharan Africa remains stark. Appropriate strategy must address the root causes of hunger, poverty, and dependency by focusing on inclusive economic growth and inequality reduction. It has been recognized that public-private partnerships and an enabling policy environment are key areas where innovations are needed to advance the agri-food system. Partnerships could be on provision of agribusiness services, market infrastructure, innovation and technology transfer and value chain enhancements. This session will explore the impact of engineering focused 4P on agricultural development; the success and failure stories; best practices; and which sectors might benefit most from 4P strategies.

Suggested Reference Materials

1. Camagni M., and Kherallah M. 2016. How to do: Public-Private-Producer Partnerships (4Ps) in Agricultural Value Chains. IFAD Policy and Technical Advisory Division, IFAD, Rome. Weblink: https://www.ifad.org/documents/38714170/40314128/Public-Private-Producer+Partnerships+%284Ps%29+in+Agricultural+Value+Chains/853d82f8-45c9-4493-b2da-b509112cc0b3
2. Hartwich, F., J. Tola, A. Engler, et al. (2007). Building Public–Private Partnerships for Agricultural Innovation. Food Security in Practice technical guide series. Washington, D.C.: International Food Policy Research Institute.
3. Rankin, M., E. Gálvez Nogales, P. Santacoloma, N. Mhlanga and C. Rizzo. 2016. Public–private partnerships for agribusiness development – A review of international experiences. FAO,
4. Rome, Italy. Weblink: http://www.fao.org/3/a-i5699e.pdf
5. Ferroni, M., and Castle P. 2011. Public-private partnerships and sustainable agricultural development. Sustainability 3: 1064 – 1073

Discussion Topics and Contributions

These questions discussed during the session:

1. How do 4P work in Africa and what are their impacts? Provide specific examples
2. Identify how development, evaluation, transfer, and adoption of existing or new technologies are integrated in each of the identified areas of partnership. Provide specific examples
3. Discuss what you would consider as best practices with respect to 4P. What are the best (or worse) 4P models that you are aware of
4. What would you consider as a possible creative destructive 4P model in Africa?

Responses are as follows:

Example from Nigeria include the involvement of Nestle with the help from USAID for helping farmers in the North. This was initiated by Nestle. Another example is partnership between Hershey and USAID in Ghana for producing ready to use therapeutic supplements. Senegal has involvement from Windrock International and local NGOs. However, the session participants mentioned a lack of coordinated efforts and not a lot of clarity for policy goals from local governments.

A farmer from Nigeria in the session mentioned about land consolidation efforts that are critical to improving land productivity. Similarly farm inputs like solar powered farm machinery, rechargeable hoes, solar powered drying, affordable water pumps, water filtration were identified as technologies needed for modernizing African agriculture by the participants.

The role of private sector is profit driven. Some of the crops grown in the region (e.g. cassava) are one cycle crop and private sector does not want to invest. Small farms are considered as no profit. There is a need for infrastructure development and processing facilities near the farm to make farming sustainable. The participants agreed on the role of technology to increase farm profit.

A member from FAO mentioned about developing machinery services and also emphasized the importance of partnership with tech developers, banks and government to train and support the entrepreneurs to provide such machinery services.

A participant talked about AgCo in Zambia and emphasized the need for developing value chain. Increasing yield without access to market is not helpful in increasing profit from agriculture. She also talked about the role of mobile services and ICT services. Another aspect is to incorporate data collection aspects through mobile phones, GPS from farm machinery (tractor) for automated data collection.

A farmer from Nigeria mentioned about the cost of land clearing. A group of youngsters were involved in such activities and funded through central bank of Nigeria.

Similarly, farm inputs and training young farmers and also expanding the crop agriculture to include dairy and meat production.

As for impactful PPPP, Nigerian farmer mentioned about AgriCity and circular economy. Another aspect is to develop value addition at the farm level. FAO person mentioned about support services and mobile refrigeration to reduce post-harvest losses. The person from AfDB also mentioned about the role of local African universities for research and development toward modernizing agriculture.

Roundtable Working Group

Moderators: Ajit, Srivastava and Margaret Gitau

This session's purpose was to plan how to move forward. Participants' perspectives were sought.

Building a team:

1. Identify key players (names and contact information) who should be a part of this initiative and are willing to make a long-term commitment with a sincere effort to the MAA vision and investment of time
   - A total of thirty-five names of individuals belonging to a variety of institutions including higher education, governments, and non-governmental international bodies were listed.

2. Identify key organization that we should be connecting in regard to the MAA initiative. Please indicate if you would be willing to make the connection with them.
   - Close to fifty organizations were listed and included higher education institutions, regional bodies (e.g., Economic Community of West African States (ECOWAS); The Forum for Agricultural Research in Africa (FARA)), development agencies (e.g., the USAID), members of the Consortium of International Agricultural Research Centers (e.g., ICRISAT; IITA), professional bodies (e.g., The Nigerian Institution of Agricultural Engineers), and funding institutions (e.g. The World Bank and the African Development Bank) and private businesses.

Situational awareness: Are you aware of similar initiatives or projects in play that we should be aware of and connect with?

Forty initiatives were listed. These included the following:

- AGCO Demonstration Farm Lusaka, Zambia
- The Agro Processing Productivity Enhancement and Livelihood Support (APPEALS) Project
- Agricultural Machinery Manufacturers Association (AMMA)-India
- Appropriate Scale Mechanization Consortium of the Sustainable Intensification Innovation Lab
- Center for Sustainable Agricultural Mechanization (CSAM), UN-ESCAP, Beijing
- FAO/AUC Framework for Sustainable Agricultural Mechanization in Africa (SAMA)
- Feed the Future – Post-harvest Loss Reduction
- Green Belt Initiative in the Sahel Region (African Union Initiative)
- Landmark University Greenhouse and Hydroponics Technology (LUGHTEC)
- Low Cost Mobile Cooling Technologies for Fruit and Vegetables-Suitable for Small Scale Farmers in arid and semi-arid zone of Africa
- National Startups Centre for Performance in West African States (funded by UNIDO)

- Nigerian Stored Product Research Institute (NSPRI)
- Roadmap of the Nigerian Institution of Agricultural Engineers and Pan African Society for Agricultural Engineering
- The Songhai Centre in Porto Novo, Republic of Benin
- West African Trade and Investment Hub (WATIH; funded by the USAID)
- World Bank Irrigation Initiative in the Sahel

Foundational Pillars: Which of the four foundational pillars do you most identify with, if any?

Of the 40 responses received, majority identified with **Technology and Innovation** only or in combination with **Capacity Building and Workforce Development**. All respondents who identified **with Infrastructure and Policy Framework** also indicated interest in **Technology and Innovation**. Generally, shared interests were identified among the various pillars as shown in Figure 5 below.

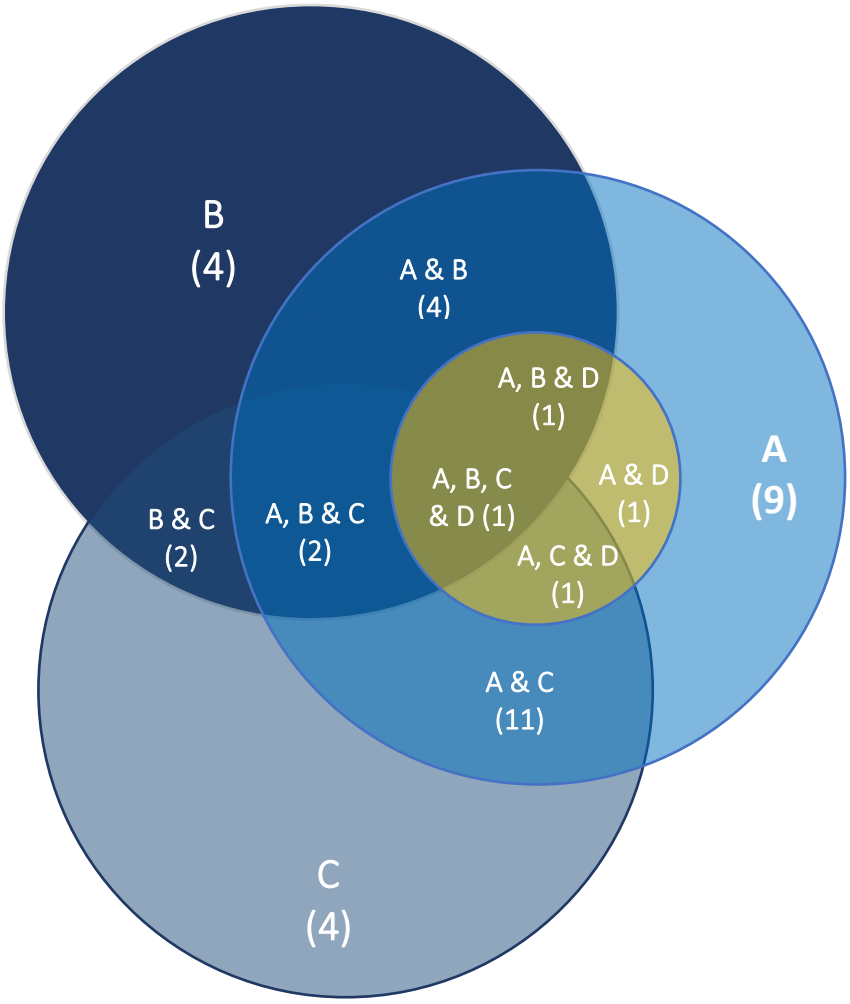

Figure 5: A diagram showing the numbers of respondents identifying with the foundational pillars of the Modernizing African Agriculture Initiative. Where, A is Technology and Innovation, B is Entrepreneurship and Business Development, C is Capacity Building and Workforce Development, and D is Infrastructure and Policy Framework.

Vision: The keynote speaker talked about a powerful vision that will drive a 10-year initiative budget. Please articulate your thoughts as to what should be the key elements of this initiative. (Points mentioned earlier have not been repeated in this compilation)

Summary of responses:

- Establish regionally centered innovation and development hubs
- Create a regional network of Agricultural Engineering for Africa to share knowledge and appropriate technologies
- Establish cooperatives to share in capital costs such as mechanization and ensure availability of inputs
- Empower women and youth through cultural reforms and access to capital
- Develop infrastructure to create market opportunities and provide access to markets
- Implement capacity building in agro-entrepreneurship through farm business model centers and well-trained extension workers
- Adopt a Total Factor Productivity approach – that is, significant increases in the use of technologies that increase productivity of all factors of production individually and collectively
- Develop a culture of intellectual development from the research institutes
- The Sustainable Development Goals should be central
- Water conservation and control of deforestation should be focused on
- To modernize agriculture in Africa, move beyond smallholder farmers

Open ended response: Please share other thoughts you may have
(Points mentioned earlier have not been repeated in this compilation)

- Integrate African indigenous practices and native philosophies into agricultural systems towards the evolution of an appropriate technology that is purely African
- Promote local production to reduce costs and create employment while designing for local requirements
- Provision of equipment servicing and maintenance as well as spare parts (after-sales support) would be vital
- Approaches to designing low-cost finance models like pay-as-you-go and reliable payment systems can make technologies available to the poor (e.g. MPESA and M-KOPA in Kenya)
- A finance model for mechanization might be the financing from equipment dealers as done in other parts of the world. Equipment sold to government agencies have been generally prone to fall into disrepair in short time frames
- Repair of piles of broken-down machinery (reconditioning) might offer lower economic options versus new buys
- Support and develop sustainable mechanization of custom hire services provision in Africa including promoting the use of information and communications technologies (ICT) to make these services readily available to more small-scale farmers/entrepreneurs
- Small-pilot projects need to be able to scale up
- Transformation should be based on science. Example, the Technologies for African Agricultural Transformation for the Savannahs Initiative)

Concluding Remarks

Klein Ileleji, Professor and Extension Engineer, Department of Agricultural & Biological Engineering, Purdue University

Summary:

- Agriculture employs a significant portion of the African population and is the primary producer of food eaten on the continent. It therefore must be the major means of economic growth.
- A strategic plan should outline short-, medium-, and long- term goals.
- Technology will be key to modernize African Agriculture therefore ideas need to be socialized and marketed to key stakeholders.
- Africans need to be involved in this process. Mind-sets need to be changed and solutions encouraged from within.
- The problem is huge; therefore, the initiative has to be audacious.
- The time is now! If not us, whom? If not now, when?

Special thanks to Dr. Adesoji Adelaja for his engagement in the session's planning in addition to giving the keynote as well as to the ASABE Foundation and Headquarters for supporting attendee participant. At its peak (during the keynote), attendance was about 87 people.