The need for a professional network of agricultural and biosystems engineers in Africa

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Abstract: Agricultural productivity in Africa remains the lowest in the world, but recent concerns about food insecurity, rising food prices and resource depletion have spurred world-wide interest about the role of African agriculture in feeding Africa and the world. Majority of world's uncultivated agricultural land is in Africa, yet the capacity to harness this resource remains limited due partly to very low application of innovative technologies which contribute to improved factor productivity. Postharvest loss remains high in Africa due to inadequate infrastructure, limited agro-processing and other value addition activities, and lack of favourable policies. These challenges present unique opportunities for agricultural and biosystems engineers in Africa and around the world to come together as a critical mass of educators, researchers and thought leaders to drive the change needed to transform African agriculture. AfroAgEng will stimulate, promote and shape the education, research, policy and practice of agricultural and biosystems engineering in Africa.

Keywords: agricultural engineering; biosystems engineering; mechanisation; irrigation; food security; postharvest losses; agro-processing; technological innovation; Africa.

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1 Introduction

Like many regions in the world, the African continent has undergone major geo-political and socio-economic transformations during the past century. After recent decades of political instability and economic stagnation, several African countries are now experiencing unprecedented and rapid economic growth, driven mainly by rising exports in the extractive industries. The dramatic and massive penetration of information and communication technologies (ICTs) across all sectors of the society has spurred the emergence of new industries that never existed before and is driving the transformation of existing ones such as banking, finance, health and transportation, including the democratisation of institutions. Consequently, Africa has leapfrogged straight into the mobile network and internet era without many parts of the continent experiencing 'land lines' for telephone and data transfer. Rural and resource-poor farmers that are still toiling the land and processing their harvest with the same hand tools and methods as our forebears are now able to communicate and also receive and transfer money anytime anywhere instantaneously using mobile phones without bank accounts. Many others in parts of rural and urban Africa can also access market information in real time about production inputs and demand for their products. While many communities still lack access to safe portable water and good sanitation and remain isolated by several kilometres away from good road networks, the number of airlines, passengers, airports and flights to and fro major African cities has skyrocketed during the past decade. The list goes on.

However, despite these signs of progress and favourable forecasts of economic growth, Africa still remains top on the list of major indices of underdevelopment such as widespread poverty, food insecurity, poor health and sanitation, high infant and maternal mortality, and low human development index. A large proportion of African children and mothers who depend on farming for their livelihood continue to die without seeing a doctor, and many children from such families are not able to get the education they need to participate in society even though they and their parents spend their lives as farmers. Notwithstanding Africa's diversity in geopolitics, culture, natural and human resources, agro-climate and food systems, agriculture and related activities still dominate the economies of most countries and the continent at large as the primary source of livelihood. And yet, agriculture remains the least developed and often neglected sector of the economy. While other industries such as communication, transport and healthcare are rapidly transforming the landscape of the continent, the potential of agriculture as the engine for job and wealth creation remains largely locked. Agriculture still remains largely the industry for the poorest of the poor who also lack access to off-farm sources of income, while the continent is now experiencing an urban sprawl of megacities fuelled by income from the extractive industries and related exports.

2 Transforming African agriculture for socio-economic development

Given its well acknowledged role as the main source of livelihood for the majority of people in Africa, it has long been recognised that successful transformation of agriculture into an engine for inclusive and sustainable economic growth is the key to breaking the vicious cycle of poverty, deprivation and underdevelopment in many parts of the continent. The African Union has responded to this challenge by conceptualising and

launching the Comprehensive African Agricultural Development Plan (CAADP) and its related Pillars and Compacts, which requires each member country to commit 10% of the national budget to agriculture. While each country seeks the right and workable strategies and policies needed to transform the agricultural sector, recent global events such as the food and financial crises have drawn the attention of investors, international food chains and even foreign governments in Asia and the Middle East to acquire very large portions of agricultural land in Sub-Saharan Africa for production of food and energy crops. These developments show that the need to increase agricultural production in Africa is now not only important to feed people living in the continent, but also to feed and supply biomaterials to meet global insatiable demands for food, feed and fuel. Certainly, agricultural engineering and related technologies have crucial roles to play in cultivating these large expanses of land, handling the products from farm to fork, and adding value along the chain. Furthermore, the smallholder farmers who currently produce most of the food consumed in Africa still lack access to innovative technologies needed to enhance their productivity and yields. For instance, it can be argued that given the ongoing rapid urbanisation of Africa and ageing of farmers in rural areas, successful mechanisation of smallholder agriculture is needed more than ever before to reduce drudgery and promote a new knowledge-intensive and productive agriculture to meet the food and fibre needs of a rising population. The reluctance of many African Governments, donors and policy makers to embrace, support and promote agricultural mechanisation must be overcome to tackle the longstanding problem of low factor productivity and lack of job opportunities for the youth in African agriculture.

Africa has sufficient areas of uncultivated agricultural land and other natural resources to adequately feed itself and the rest of the world. The majority of the world's uncultivated agricultural land (up to 60%) is in Africa, and in some countries such as Mozambique, it is estimated that less than 5% of available agricultural land is under cultivation. The African economy is also predicted to grow at an average rate of more than 7% over the next two decades, faster than China and other emerging and developed economies. In both current and future practice of agriculture, combined efforts to improve yields of crop and livestock and enhance the productivity of labour and other inputs are crucial to meet the food and raw material demands of a young and growing population in Africa. This presents enormous challenges and opportunities for agricultural engineers to make meaningful contributions to improve productivity and resource use efficiency at all stages of the food chain. With the right mix of impactful agricultural engineering and food technologies, skills, policies, and entrepreneurship deployed to harness its abundant natural resources, Africa can assure its own food and nutrition security and contribute to eliminate widespread incidence of poverty by 2030. Mechanising agriculture to reduce drudgery and enhance productivity, reducing the high incidence of postharvest food losses, and promoting value addition through preservation and agro-processing are concrete examples of key and urgent challenges (and opportunities) in African agriculture. Among engineering disciplines and professions, agricultural engineers are best equipped to lead this transformation process.

The much celebrated economic advancements achieved by emerging economies such as India, China and Brazil as well as developed countries was proceeded by successful transformation of agriculture and the food system, providing opportunities for co-existence of large, medium and small-scale agriculture. It is now self-evident that Africa is the only region in the world that has not experienced its own Green Revolution to usher in a *new and sustainable agriculture* for systemic economic development. The

Green Revolution that helped transform the rural economies of OECD countries in Europe, North America, Australasia and emerging economies such as Brazil, China and India into industrial powerhouses for job creation and pathway for long-term economic development depends on the use of high-yielding crop varieties, irrigation and mechanisation, backed by farmer-friendly policies to support access to inputs and markets. It is also true that the resource-intense agricultural practices of these Green Revolutions are now under greater public scrutiny because of the adverse impacts on the environment. Assuring food and nutrition security through sustainable agriculture therefore requires novel approaches to the education and practice of agriculture, including agricultural engineering. This requires new skills in emerging technologies and innovative leadership in agribusiness to cost-effectively grow, harvest, handle and process more with less. Agriculture and our food system must become more sustainable to meet the food and fibre needs of current and future generations. This is a challenge for agricultural engineering in Africa and elsewhere around the world.

3 AfroAgEng – the network of agricultural and biosystems engineers in Africa

Agricultural engineering is a well established academic discipline and engineering profession that has contributed to global advances in producing safe, quality and nutritious food and industrial agro-industrial raw materials. The education and training of skilled agricultural engineers played a critical role in this success. Records of historical and recent advances in agricultural, biosystems and biological engineering education and curriculum reform which underpinned this success have been documented in three special issues of the *International Journal of Engineering Education* initiated by Opara and co-edited with Cuello (http://www.ijee.ie). Historical evidence shows that advances in agricultural engineering have played and will continue to play crucial roles in addressing both the technological obstacles and emerging challenges facing global agriculture and environment. Success in this endeavour requires the development of highly skilled human resources who have relevant scientific and engineering knowledge, integrative skills and managerial expertise to work and lead at all levels in the agricultural value chain. It also requires concerted efforts to address the fundamental changes required to transform and improve the productivity and output of African agriculture: ranging from mechanisation of operations, irrigation, tillage, postharvest technology and agro-processing to recent advances in knowledge-intensive agriculture such as precision farming, conservation tillage, controlled environment agriculture and novel preservation and agro-processing of food and industrial raw materials. The Green Revolutions experienced and practised by industrialised and emerging economies have been characterised by massive expansion of agricultural land and input intensification. Lessons learned have shown that these practices are not sustainable in light of dwindling natural resources and the negative environmental impacts. Investments in new knowledge and partnerships (both local, regional and global) are required to adequately address these new and emerging 'sustainability' challenges facing Africa's Green Revolution and global agriculture at large. Both public and private sector institutions and professional organisations have critical roles to play. Knowledge institutions such as tertiary education institutions, research and development organisations and professional scientific/engineering organisations have crucial roles to play through human capacity development,

technological innovation, dissemination and application as well as formulation of evidence-based policy and investment strategies.

In Africa, many academic disciplines have formed continental professional networks to foster education and research collaboration, sharing and exchange of ideas and to provide a critical mass of educators, researchers, practitioners and policy makers, and platforms to shape and influence evidence-based policy and practice for Africa's economic development. These include the African Crop Science Society (http://www.acss.ws), and African Association of Agricultural Economists (http://www.aaae-africa.org), African Association for Public Administration and Management (http://www.aapam.org), African Association of Physiological Sciences (http://www.aapsnet.org), Federation of African Societies of Chemistry (http://www.faschem.org), African Association of Political Science (http://www.apsanet.org/content_8484.cfm), and the African Mathematical Union (http://www.math.buffalo.edu/mad/AMU).

Despite reported declines in undergraduate enrolments in agricultural engineering academic programmes in North America and Europe during the past couple of decades, agricultural engineering profession has continued to flourish and contribute to regional and global economic development through human capacity development and research to address the socio-economic needs of people. The oldest agricultural engineering professional society, the American Society of Agricultural and Biological Engineering (ASABE) was formed in 1907 (http://www.asabe.org) and the global umbrella organisation for the agricultural engineering profession, the International Commission of Agricultural and Biosystems Engineers (CIGR) was formed in 1930 (http://www.cigr.org). In 2011, the CIGR had active regional members from all continents except Africa. These include the European Society of Agricultural Engineers (http://www.eurageng.eu), Asian Association of Agricultural Engineers (http://www.aaae.org.cn) Euro Asian Association of Agricultural Engineers, Latin American and Caribbean Association of Agricultural Engineering (http://www.aliaweb.org), and the American Society of Agricultural and Biological Engineers. Successful reform of academic curricula, graduate attributes and strategic focus of research have enabled agricultural engineering to be repositioned to address the current and emerging complex challenges facing the agriculture, natural resources and the environment.

Historical experiences in developed countries such as the USA, UK and Japan and later in emerging countries like India and Brazil underscore the importance of engineering inputs in achieving successful agricultural transformation through human capacity development, research, development, dissemination, application and promotion of agricultural engineering and food technologies. In a speech delivered at the recent CIGR-EurAgEng International Agricultural Engineering Conference held in Valencia (2012), the immediate past president of the Indian Society of Agricultural Engineers (ISAE), Professor Gajendra Singh, highlighted the critical roles played by agricultural mechanisation and irrigation technologies in transforming Indian agriculture and averting the food crises faced by the country in the 1960–1970s. He also noted the crucial functions of advocacy and evidence-based policy advice played by ISAE in articulating and promoting the advancement of agricultural engineering education, research and practice to support India's much celebrated Green Revolution. For instance, Professor Singh highlighted the role played by ISAE in spearheading a government financed programme which established agricultural machinery testing stations within the

departments of agricultural engineering in some of the nation's land grant universities. Today, these machinery testing stations have been credited for their role in promoting and supporting the successful and widespread use of improved mechanical inputs in Indian agriculture, including small to large scale agriculture. There are numerous similar success stories around the world showing the influence of agricultural engineering profession in championing and influencing strategic policy directions and investment in economic development.

It is now time for agricultural engineers in Africa and others around the world interested in Africa's economic development to come together and work closely to develop a long-term strategy and agenda to promote education, research and practice of agricultural engineering for agricultural transformation and overall economic development in Africa. As part of the 7th CIGR International Technical Symposium 'Innovating the Food Value Chain' to be held at Stellenbosch University, South Africa, 25-29 November, 2012 (http://www.sun.ac.za/postharvest/cigr2012), a Special Forum on *"The Future of Agricultural Engineering Education and Profession in Africa"* will be held on Tuesday 27 November 2012. The objectives of this forum are to generate widespread consensus and support for a network of agricultural engineers in Africa and to inaugurate the network as the association of agricultural and biosystems engineers in Africa. As I have shown in the preceding sections of this article, Africa is the only continent or regional bloc without a functioning network of agricultural engineers. This Special Forum is therefore a landmark in the history of agricultural engineering education and profession in Africa and the organisers of the 7th CIGR International Technical Symposium are delighted to host this Special Forum as part of the scientific programme. Global literature is replete with research evidence showing that agricultural productivity is lowest in Africa, a continent that is also confronted with the highest incidence of food insecurity and economic underdevelopment. If Africa is to increase both agricultural productivity and total production of food necessary to feed its people and catalyse widespread socio-economic development, I would argue that the application of mechanisation and other engineering and technological inputs are necessary and these need to be pursued vigorously as crucial policy and investment actions. For too long, most African Governments, their development partners and the business sector have ignored the need (and opportunities there from) to promote agricultural mechanisation and other engineering inputs in African agriculture. As a consequence, African farmers and others in the agribusiness value chain have not benefited from the technological advancements that have enabled their counterparts in Europe, Asia and South America to increase productivity and lift them out of poverty. In the meantime, we continue to produce graduates (including agricultural engineers) from our tertiary education institutions whose education (both theory and practice) has little or no resemblance with the practice of agriculture in their communities. No wonder our bright minds and entrepreneurs shy away from agribusiness and we have not been successful in making agribusiness attractive as one of the pillars for sustainable employment of our youth. Surely, the investors and foreign governments that are now purchasing millions of hectares of agricultural land in Sub-Saharan Africa are not going to rely on the same simple hand tools and human muscle as the millions of Africa's subsistent and smallholder farmers for the cultivation, production, handling, processing and transportation of their crops. If these investors are not able to find the right engineering and technical skills locally, they would have to bring them from else to turn land into a productive resource.

4 Conclusions

The continent of Africa is at a major crossroads in its pursuit of sustainable socio-economic development. While agricultural productivity and total food production in Africa remains the lowest in the world, recent global concerns about widespread food insecurity, rising food prices and volatility have stimulated international interest and attention on Africa for two main reasons. First, can Africa feed its people, and second, how can Africa's abundant agricultural land and other natural resources be harnessed to meet the future food and energy needs the world? The majority of world's uncultivated agricultural land is in Africa, yet the capacity to bring this resource into food production remains limited due to, among other factors, very limited application of innovative engineering and technological inputs which contribute to improved factor productivity. The application of mechanical inputs, energy, and irrigation in agriculture remains the lowest in Africa compared with the rest of the world. Furthermore, incidence of postharvest losses of agri-food materials including grains, fish and horticultural produce remains highest in Africa, partly due to limited postharvest infrastructure, agro-processing and other value addition activities. Consequently, while agriculture remains the mainstay of most African economies, these countries remain net food importers to meet local demand.

These challenges present unique opportunities for agricultural and biosystems engineers in Africa and indeed around the world, to come together to create a critical mass of educators, researchers and thought leaders who can contribute to the change needed and necessary to transform agriculture into an engine for sustainable economic and social development in Africa. The network of agricultural and biosystems engineers in Africa (AfroAgEng) is envisioned to provide a platform for engineers, agribusiness leaders and civil society who are interested in the applications of engineering and related technologies in improve agriculture and rural development in Africa. For too long, Africa remains the only continent or region without a network of agricultural engineers to provide the much needed focal point and leadership to promote and shape the education, research, policy and practice of agricultural engineering in the continent. Africa needs it own Green Revolution and while engineering and technological innovations in agriculture alone are not sufficient to make this happen, Africa's Green Revolution cannot happen without these essential inputs. Among all the industrial sectors, such as telecommunication, mining and retail, agriculture remains the sleeping giant that continues to delay the dawn of Africa's economic renaissance. We must harness the power of agricultural engineering and technological innovations to awake this sleeping economic giant (agriculture) to free the millions of people locked into it in abject poverty to be able to unleash Africa's full economic and industrial potential. The time to act is now, for the actions we take today form the basis of history tomorrow.