INTER-COUNTRY COOPERATION CAN TRANSFORM PRECISION AGRICULTURE EDUCATION AND RESEARCH IN AFRICA

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ABSTRACT

The productivity and profitability of sub-Saharan (SSA) agriculture can be greatly enhanced by the adoption of precision agriculture technologies and tools. However, until 2020 when the African Plant Nutrition Institute (APNI) established the African Association for Precision Agriculture (AAPA), most SSA PA enthusiasts worked in isolation. The AAPA was formed to innovate Africa's agricultural industry by connecting PA science to its practice and disseminating PA tailored to the needs and aspirations of the African people. This paper highlights the leverage that intra-Africa cooperation such as the AAPA offers to transform PA education, research, and outreach in Africa. The paper further presents activities and milestones that the AAPA has chalked in the last two years. So far, the AAPA has provided opportunities for members to engage in research, extension, education, and training activities to promote the advancement and dissemination of PA tailored to the needs and aspirations of the African people and the furtherance of international collaborations. These opportunities include a Global Challenge Research Fund networking forum, and EU funding to promote leadership skills development, advocacy, and engagement among five African universities and a European partner. In conclusion, intra-Africa cooperation through AAPA has catalyzed the enthusiasm and willingness of universities in African countries to work together to develop and scale precision agriculture (PA) education, research, and outreach to reduce skill gaps and tackle food and nutritional security challenges in African countries.

INTRODUCTION

Precision agriculture (PA) has gained considerable recognition as a farm management strategy to improve resource economy, farm productivity, and profitability to enhance the sustainability of agricultural production systems (Wang et al., 2023; Ofori and El-Gayar, 2021). However, the application of PA technologies is yet to be widely adopted in smallholder farms in sub-Saharan Africa (SA). The World Bank (2021) estimated that agriculture employs 52% of the SSA adult population and contributes to about 17% of the region's gross domestic product (GDP). Despite the critical contribution of the agricultural sector to the economic development of the continent, the sector is inherently characterized by low productivity and low income for farmers (Abay et al., 2023; Marinus et al., 2022), and so the agriculture industry is unattractive for the youth. The burgeoning SSA population growth (World Bank, 2022b), and the impacts of climate change make it imperative for the adoption of innovative agricultural technologies to meet food and nutrition demands in the region. Adoption of precision agriculture is a promising pathway to transform agricultural productivity and profitability in SSA and incentivize the youth in the region to embrace agricultural production as a profitable livelihood option. Nyaga et al. (2021) contended that the low adoption rate of PA in SSA could be attributed to the lack of awareness and information among smallholder farmers and other agriculture stakeholders in SSA.

Therefore, there is a need to equip farmers, extension agents, and the youth in SSA with the relevant information and knowledge and provide the necessary tools to drive PA use for sustainable agriculture in the continent. Studies have been done on the potential for PA to improve farm productivity and profitability (Wang et al., 2023) adoption decisions (John et al., 2023; DeLay et al., 2022; Lowenberg-DeBoer and Erickson, 2019), the opportunities and challenges of precision agriculture for farmers (Khanna et al., 2022; Bosompem, 2021; Nyaga et al., 2021; Ofori and El-Gayar, 2021) and the role of data management for the deployment of precision agriculture (Gobezie and Biswas, 2023). However, there is a paucity of information about how African countries can leverage the power of collaboration and networking to transform agricultural production in their countries through inter-country collaboration. The objective of this paper was to highlight the potential of inter-country cooperation to transform precision agriculture education and research in Africa. Specifically, this paper provides practical examples of inter-country collaboration in the region, which have amply demonstrated that these collaborations can foster co-development and co-implementation of PA research, education, and outreach actions to increase awareness, motivate, and build the capacity of farmers, extension agents and students in the region.

MATERIALS AND METHODS

The paper presents an overview of three examples of inter-country collaborations – The African Association for Precision Agriculture (AAPA), the Global Challenge Research Fund (GCRF) networking forum, and the EU-funded 'Capacity Building of African Young Scientists in Precision Agriculture Through Cross-Regional Academic Mobility for Enhanced Climate-Smart Agri-Food System' (PATH) project, which have provided opportunities for faculty, postgraduate students, and staff of some African universities to engage in advocacy and networking fora to promote the advancement and dissemination of PA tailored to the needs and aspirations of the African people. The paper highlights some successes that the AAPA has achieved since its formation in 2020. The overview is supported by information from published and grey literature.

RESULTS AND DISCUSSION

The inter-country collaborations among African countries within the AAPA is a typical example of how such cooperation can promote PA education, research and outreach in the continent. The AAPA was formed by the African Plant Nutrition Institute (APNI) in 2020. The AAPA boasts of a membership of 628 registered members from 51 countries. The objectives, activities and board composition of the AAPPA are summarised in Table 1.

The AAPA have organised webinars and published newsletters, as well as supported the organization of the African Conference for Precision Agriculture in 2020 and 2022. Another example of inter-country collaboration is the GCRF-funded networking forum that was held at the University of Cape Coast in Ghana. The forum was a collaborative project between the Harper Adams University of the United Kingdom, the University of Cape Coast, and the University for Development Studies, both in Ghana, the University of Abomey Calavi in Benin, and the Institute of Agricultural Research and Training in Nigeria. The forum attracted participants from the Ministry of Food and Agriculture, Ghana, Non-governmental organizations, and agro-input dealers. An important outcome of the networking forum is the EU-funded PATH. Project, which is a collaborative project among four universities from West, East, and Southern Africa, a northern African associate partner, and a European technical partner, respectively, to promote leadership skills development, advocacy,

postgraduate education, and research. The partnering institutions, objectives, and target crops of the PATH project are presented in Table 2.

Table 1. Objectives, activities and board membership of the AAPA

Objectives	Activities	Board membership
The AAPA provides opportunities for members to engage in research, extension, education, and training activities to promote the advancement and dissemination of PA tailored to the needs and aspirations of the African people; the furtherance of international collaborations; leadership skills development; advocacy; and engagement with policymakers toward creating the enabling environment needed to advance the knowledge of the science and practice of PA in Africa.	Publishes a quarterly newsletter; leads professional community within the International Society of Precision Agriculture (ISPA); and organizes workshops and symposiums at the African Conference on Precision Agriculture (AfCPA), and the International Conference on Precision Agriculture (ICPA). AAPA also organizes and hosts webinars on various topics in precision agriculture.	• President (Nigeria) • Past President (Ghana) • President-elect (Benin): • Executive secretary (Morocco) • Regional Representatives North Africa (Tunisia), West Africa (Togo), Central Africa (Cameroon), East Africa (Tanzania), and Southern Africa (Zimbabwe): • Founder: Steve Phillips (APNI)

Table 2. Capacity Building of African Young Scientists in Precision Agriculture Through Cross-Regional Academic Mobility for Enhanced Climate-Smart Agri-Food System (PATH) Project

Objectives	Universities involved	Countries involved	Target crops
• Training 32 MSc and 12 PhD African scholars in Precision Agriculture (PA) to upgrade the continent's capability • Building the capacity of 10 young African trainees and 10 staff in PA and entrepreneurship • Improving PAAC and ICT4Ag curricula and research at the participating African Higher • Education Institutions (HEIs) to address more efficiently the current challenges of agriculture and climate change • Developing a network of HEIs in Africa involved in PAAC research and training	• University of Abomey Calavi • University of Cape Coast • University of Rwanda • University of Eswatini • University of Mohammed VI Polytechnic • Laboratoire Univers et Particules de Montpellier	• Benin (lead) • Ghana (Co-lead) • Rwanda (Co-lead) • Eswatini (Co-lead) • Morocco (Associate partner) • France (Technical partner)	• soybean, rice, tomato and pineapple between Ghana and Benin • groundnut between Benin and Eswatini • rice and potato between Benin and Rwanda • beans between Eswatini and Rwanda • taro and sweet potato between Ghana and Eswatini • sorghum and taro between Ghana and Rwanda

Potential benefits from Intra-Africa collaboration

African countries can harness available skills, expertise, and infrastructure in their countries to drive the PA agenda through knowledge sharing, and a culture of collaborative learning. Inter-country cooperation can also foster mutual deployment of digital technologies to enhance agricultural productivity, increase access to markets and finance, and improve food security. An analysis of the Baobab Insights companies' 2015 database showed that more than 40 innovative start-ups are established in Africa that provide various precision farming technologies and services with t 50% of these companies based in Nigeria, Kenya and South Africa. Universities, and other agricultural organizations in Africa can pool resources, coordinate their research efforts to avoid duplication of efforts and harmonize common research actions, and develop comprehensive training programs for farmers, extension workers, and students. The "Digital Transformation Strategy for Africa (2020-2030) of the African Union outlines the vision and objectives for Africa to leverage digital technologies for economic and social development (African Union, 2020). In June 2021, a high-level dialogue among Head of States of African countries on Feeding Africa pointed out the need for technology-led agriculture that can increase crop productivity, and improve product quality including post-harvest losses reduction while mitigating the negative effects of climate changes (drought, flooding, pest outbreak etc.

Challenges and the way forward

Intra-Africa cooperation in PA education, research and outreach is constrained by the lack of PA expertise, tools, and facilities in SSA education and research institutions, Further, there are limited financial commitments and enabling policies towards integrating PA into ongoing country-specific agricultural development programmes. Other challenges that inter-country cooperation face include the high costs of mobile technology and internet, which is exacerbated by unreliable electricity supply, low ICT literacy levels, and lack of financial resources to secure the use of ICTs.

CONCLUSION

Inter-country cooperation is crucial to support the farmers and other agriculture stakeholders in SSA. These cooperations can promote co-learning and sharing of scientific, technical, and market information. Thus, it is imperative to link universities and other agricultural institutions in Africa to tackle knowledge and skills gaps, while facilitating participatory research, and enhancing results dissemination. Inter-country cooperation can stimulate investment in digital infrastructure, technical capacity building, and policy support to unlock the potential of PA to improve the productivity and profitability of agriculture in Africa.

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