#7464 JUST A MOMENT; THE NEED FOR STREAMLINING PRECISION AGRICULTURE DATA IN AFRICA

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ABSTRACT

Precision agriculture (PA) data sources in the era of digital agriculture are diverse in terms of the range of technology options and the types of data they generate. These include proximal sensors, unmanned aerial vehicle (UAV), satellites, farm machinery mounted sensors and robotics to generate static data or real time information (e.g., yield monitoring). Government institutions, scientists and private sectors take the lion's share in generating PA data at innovation, validation and dissemination phases. At scale-up and wider application phases, farmers also generate tremendous amount of data that might have privacy and ownership concerns. There are no one-size-fits-all approach in terms of PA technology applications, but there remains a question on better way of integrating PA data continent-wide in Africa. The data privacy and ownership concerns have to be addressed while maintaining the integration of PA data at continental scale. The objective of this paper is to review the existing opportunities and challenges of data harmonization in PA in Africa and discuss the existing technological advancements in PA data science and their applications in the other parts of the world. Finally, we proposed a new PA data sharing and rewarding model – 'PrecisionLink' to rationalize data network system through establishing strong institutions and self-sustaining business model for all of Africa. The model uses AI and blockchain technology to track and stamp PA data using unique dataset_IDs or PrecisionPrint (like a fingerprint), valuing credit amounts using 'pVouchers' (eVouchers) and distribute credits between PA data owner or 'PrecisionProprietor', data client or 'PrecisionClient' and funders or 'PrecisionPatron'. The system we propose lays the foundation for win-win PA data sharing and self-sustaining business models for smallholder farmers and technology solutions, while ensuring strong partnership between farmers' cooperatives, private sectors, scientists, government and financial institutions, and countries at high-level. Establishing and networking strong PA data-nodes in all of African countries is timely to ensure the future of PA big data application in Africa.

Keywords: precision agriculture, data, AI, blockchain, 'PrecisionLink', 'pVoucher', 'PrecisionPrint', 'PrecisionProprietor', 'PrecisionPatron', 'PrecisionClient'

INTRODUCTION

The sources of precision agriculture (PA) data include machine-generated, process-mediated or human-sourced data that are known to be highly heterogeneous (Wolfert et al., 2017). Most of the PA applications in Africa are related to improving water use efficiency and input costs reduction such as water-efficient and climate smart deciduous and fruit farming in South Africa, Mozambique, Tanzania and Zimbabwe (Ncube et al., 2018). In PA something that perfectly works for a given farm might not work for adjacent farm. This implicitly indicate that PA applications for the very fragmented pieces of lands of African smallholder farmers that are mainly characterised by high variabilities between and within farms require more tailored PA solutions. The diversity of PA data in terms of volume and variety can be considered as important driver of bigdata in the era of digital agriculture if there are high success rate of PA technology adoption. In such scenario, shortage of data might not be the question in the future, but sustainable way of integrating PA data from different sources continent-wide in Africa is one of the key issues. Various research results have shown that different data captured from variety of sources can be harmonized using data-fusion techniques for application of PA (Bendre et al., 2015; Ji et al., 2019, 2017; Xu et al., 2019). Data-fusion and other state-of-the-art methods address the technical layer that are very critical in the data value chain. However, the governance layer of such a big and very diverse data that might have privacy and ownership concerns is the elephant in the room. Data is merchantable good but key issues related to data marketing in PA are ownership, privacy and lack of sustainable business model (Pierce et al., 2019). Therefore, the objective of this paper is to review the existing opportunities and major challenges of PA data harmonization in Africa in relation to existing technological advancements in PA data science and their applications in the other parts of the world. For future application of PA data synchronisation, we proposed a new data sharing and rewarding model – 'PrecisionLink' to network several PA data-hubs for establishing self-sustaining business model that connects different actors in the PA data landscape for all member countries in Africa.

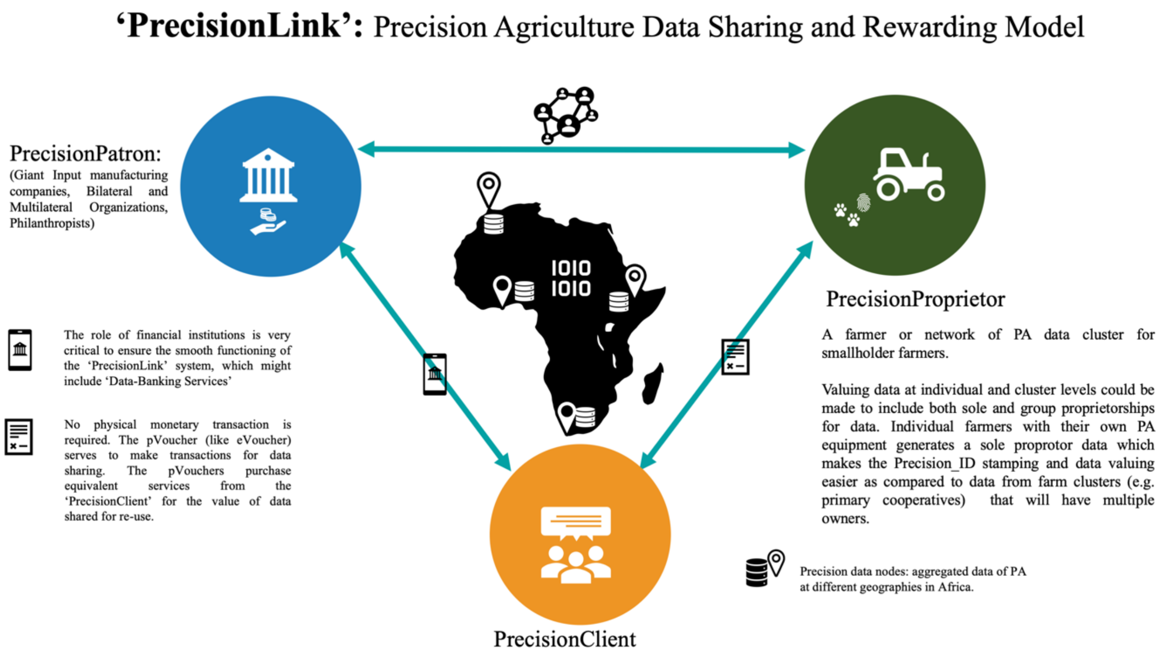
CHALLENGES AND OPPORTUNITIES

Looking at data as marketable good and as the new oil in the 21st century, PA data passes through different stages before reaching the final data marketing stage. Mostly data capture is the initial stage in the entire process of data value chain and the intermediary stages respectively include data storage, data transfer, data transformation and data analytics (Wolfert et al., 2017). Data governance issues, which are one of the major challenges of data sharing, become more complicated at the later stage due to privacy and ownership concerns that are in turn associated with lack of viable business model that motivates data holders to share their data. The other challenges in PA are related to the technical realm, especially decisions made at the data capture stage. Sanches et al. (2018) reported that number of samples usually collected to spatially represent soil attributes are denser for PA than ordinary field observation methods, however, sometimes outputs are reported similar for both approaches, e.g., application of apparent electrical conductivity (ECa) to formulate lime recommendation rate. This has a direct implication on the volume of data required for certain PA solutions and the ultimate adoption rate of the technologies.

The opportunities for PA to advance in Africa are enormous since some reports have shown that use of Internet of things (IOT) technologies using sensors-based computer visioning assisted PA have been tested for on-site fertilizer recommendations (OLIVEIRA-JR et al., 2020). Some of the initiatives like Agricultural Commercialization Cluster (ACC) in Ethiopia lay the foundation for PA applications on cluster of farms which otherwise could have been fragmented and remain challenging for smallholder farmers. In addition, there are several enablers that promote the PA use, which include: (1) the example of using drones and AI to estimate what yield (2) cloud computing and freely available high resolution imageries from google earth engine (3) handheld proximal sensors and breakthrough on automated farm inputs management system, (4) immerging high-resolution information on biophysical and agronomic advisories (e.g., the iSDA-Soil) and (5) use of planters in PA for weeding by fitting with tines to improve efficiencies in Semi-Arid part of Western Africa (Aune et al., 2017).

THE OUTLOOK

Conceptualizing PA data in an analogy to produce agricultural commodity for export that meet certain standards such as speciality coffee could help to streamline winning business model for data sharing. It is like treating PA data as 'speciality data' that fulfill traceability in the new framework of PA data sharing and rewarding model called 'PrecisionLink'. As proposed by Pierce et al. (2019) data will be tagged using unique identifiers that we designated as 'PrecisionPrint' (like a figure print) for the case of PA data. The origin and owner of such data could be multiple farmers or individual farmer - 'PrecisionProprietor', and do not have to be limited to a single source as AI and blockchain technology could be used to link the 'PrecisionPrint' and 'PrecisionProprietor' to track and stamp the data. As shown in the PA data sharing and rewarding model – 'PrecisionLink' (Figure 1), PrecisionPatron that representers funders such as giant input manufacturing companies, bi-lateral and multilateral organizations, philanthropists, etc. stimulates the PA that will help them to achieve their objectives in one or another way. PrecisionPatron mainly provide funding to data client or the 'PrecisionClient' that could be PA hardware and software developers using their analytical tools for better decision making. There could be cases where the PrecisionPatron channel funds to countries or umbrella institutions within countries such as farmers coops for their PA priorities through 'PrecisionProprietor' to promote PA for climate-smart agriculture and the data capture process.



To ensure the smooth functioning of the model, 'PrecisionProprietor' will have an agreement to share PA data with 'PrecisionClient' that will be valued using pVoucher (like eVoucher) and there could be no physical monitory transactions. The equivalent pVoucher of data shared by 'PrecisionProprietor' to 'PrecisionClient' will help the data owners to get equivalent services by the 'PrecisionClient'. In return to the funding channelled to 'PrecisionClient' by 'PrecisionPatron' the total values of the 'pVouchers' could be used to claim for fulfilment of agreement made with the 'PrecisionPatron'.

REFERENCES

Aune JB, Coulibaly A, Giller KE. 2017. Precision farming for increased land and labour productivity in semi-arid West Africa. A review. Agron. Sustain. Dev. 37: 16. https://doi.org/10.1007/s13593-017-0424-z

Bendre MR, Thool RC, Thool VR. 2015. Big data in precision agriculture: Weather forecasting for future farming, In: 1st International Conference on Next Generation Computing Technologies (NGCT). pp. 744–750. https://doi.org/10.1109/NGCT.2015.7375220

Ji W, Adamchuk V, Chen S, Biswas A, Leclerc M, Viscarra Rossel R. 2017. The use of proximal soil sensor data fusion and digital soil mapping for precision agriculture, In: Pedometrics 2017, Abstract Book Pedometrics 2017. Wageningen, Netherlands, p. 298 p.

Ji W, Adamchuk VI, Chen S, Mat Su AS, Ismail A, Gan Q, Shi Z, Biswas A. 2019. Simultaneous measurement of multiple soil properties through proximal sensor data fusion: A case study. Geoderma 341: 111–128. https://doi.org/10.1016/j.geoderma.2019.01.006

Ncube B, Mupangwa W, French A. 2018. Precision Agriculture and Food Security in Africa, In: Mensah P, Katerere D, Hachigonta S, Roodt A. (Eds.), Systems Analysis Approach for Complex Global Challenges. Springer International Publishing, Cham, pp. 159–178. https://doi.org/10.1007/978-3-319-71486-8_9

Oliveira-Jr A, Resende C, Gonçalves J, Soares F, Moreira W. 2020. IoT Sensing Platform for e-Agriculture in Africa, in: 2020 IST-Africa Conference (IST-Africa). Presented at the 2020 IST-Africa Conference (IST-Africa), pp. 1–8.

Pierce HH, Dev A, Statham E, Bierer BE, 2019. Credit data generators for data reuse. Nature 570: 30–32. https://doi.org/10.1038/d41586-019-01715-4

Sanches GM, Magalhães PSG, Remacre AZ, Franco HCJ. 2018. Potential of apparent soil electrical conductivity to describe the soil pH and improve lime application in a clayey soil. Soil and Tillage Research 175: 217–225. https://doi.org/10.1016/j.still.2017.09.010

Wolfert S, Ge L, Verdouw C, Bogaardt M-J. 2017. Big Data in Smart Farming – A review. Agricultural Systems 153: 69–80. https://doi.org/10.1016/j.agsy.2017.01.023

Xu D, Chen S, Viscarra Rossel RA, Biswas A, Li S, Zhou Y, Shi Z. 2019. X-ray fluorescence and visible near infrared sensor fusion for predicting soil chromium content. Geoderma 352: 61–69. https://doi.org/10.1016/j.geoderma.2019.05.036