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The Role of Digital Platforms in Disrupting Agricultural Value Chains in Developing Countries

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Abstract. Mobile devices and the platforms they support are increasingly being mainstreamed into agricultural value chains. While the extant literature on the use of mobile devices for agriculture has focused on their use for the provision of m-services through short messaging services (SMS), unstructured supplementary service data (USSD) and voice calls, there is growing evidence of the adoption and use of a new wave of digital platforms (mobile apps, web apps and on-line databases) in agricultural value chains in developing regions. As debates on the disruptive potential of digital platforms in agriculture are still at a nascent stage, this scoping review investigates the current research landscape on the use of digital platforms in agricultural value chains in developing regions. An assessment of the 26 digital platforms identified through the review show their potential to cause change in a number of value chain processes. However, the review reveals certain methodological shortcomings and a dearth of empirical evidence to support claims of significant disruptive impact.

Keywords: *Digital platforms, Disruption, Agricultural Value Chains, Agricultural Development.*

1. Introduction

Digital platforms are currently re-shaping business and socio-economic structures globally (de Reuver et al., 2018) giving rise to debates on the digital economy and decent work; data rights and privacy; the emergence of innovation platform ecosystems in resource constrained environments; frugal innovations and digital entrepreneurship (Heeks, 2018; Mann, 2018). Digital platforms provide affordance (both enabling and constraining) which has the potential to change, re-structure or even destruct systems into which they are introduced, due to inherent characteristics which make them differ from their non-digital alternatives (Kazan et al., 2014; Koskinen et al., 2018). Moreover, the governance of these platforms goes a long way in determining their openness, accessibility and degree to which they are inclusive which has broader implications for development.

The GSMA (2017) reports that agriculture in developing countries is experiencing an extended use of mobile devices beyond conventional voice and short message service (SMS) functions. Mobile devices, especially smartphones, provide functionalities that enable users to access digital platforms (mobile and web applications) which facilitate a variety of economic activities in agricultural value chains (see: Fig 1). In addition, innovators and platform users in developing regions have become key participants in the innovation ecosystem, engaging more actively with the platform economy as opposed to being passive recipients of innovation (Yoo et al., 2012; Sedera et al., 2016; Graham et al., 2017).

This review seeks to investigate the current use of digital platforms, beyond the conventional SMS and voice services, to understand the influence of these emerging digital platforms on agricultural value chains in developing regions. The remaining sections of this review is structured as follows: section 2 describes the methodology adopted for the scoping review; section 3 provides a conceptual background on digital platforms, disruptive innovation and agricultural value chains; section 4 is a summary of key findings and thematic analysis of the literature surveyed; section 5 discusses the empirical evidence; and section 6 concludes the review with suggested areas for future research.

2. Review Methodology

Systematic and scoping literature reviews are underpinned by a step-wise methodology which entails detailed planning; justification of literature search and selection criteria; and a thorough documentation of the review process (Okoli and Schabram, 2010; Arksey and O'Malley, 2005). However, a scoping review

differs as it adopts an iterative methodology which allows redefinition of the literature search criteria as the researcher becomes more conversant with the extant literature (Arksey and O'Malley, 2005; Levac et al., 2010). Consequently, this review adopts a scoping review methodology as it is less restrictive and permits the researcher to engage with a wider breath of literature on the subject area. The five-step scoping methodology framework developed by Arksey and O'Malley (2005) and the Preferred Reporting of Items for Systematic Review and Meta-Analysis (PRISMA) methodology (Liberati et al., 2009) served as guides to structure this review process.

2.1 Step 1: Identifying the Research Question

Specifically, our overarching research question is: *what is known from existing literature about the current use of digital platforms (beyond voice and SMS) on agricultural value chains in developing regions? And how can we understand the (potential) disruptiveness of these digital platforms on agricultural value chains in developing countries?* The review also seeks to: a) identify digital platforms which are mainstreamed into agricultural processes and map out aspects of the agricultural value chain where these digital platforms are being applied; b) identify methodologies used for research on digital platforms on agricultural value chains; c) summarise and analyse findings from research on digital platforms in agricultural value chains; d) identify future research questions.

2.2 Step 2: Identifying Relevant Studies

To ensure we comprehensively capture publications relating to our research query, an iterative methodology was adopted by cross-referencing keywords related to the review topic - agri* digital* innovation* platform* app* ICT*, smartphone*, m-agri*, e-agri*, m-service*. Keyword search was performed using the following bibliographic databases: Scopus, JSTOR, Science Direct and Google scholar. Purposive handsearching for grey literature was also carried out by cross-referencing keywords using Google search engine to identify relevant practitioner reports.

2.3 Step 3: Study Selection

Search results from databases and search engines were further narrowed down to studies relevant to our research query. The review adopted an exclusion and inclusion criteria to screen articles based on title, sector, geographic coverage, language, duration, scope and content. The criteria are outlined in Table 1.

Table 1. Inclusion and exclusion criteria

Criteria	Include	Exclude
Title	Articles with titles that included keywords outlined in step 2	Titles with 'SMS' and/or Voice and/or USSD
Sector	Digital platforms used in agriculture	Digital platforms used in other non-agriculture SME's
Geographic coverage	Developing regions	Developed regions
Time-frame	2008-2018 ¹	Before 2008
Language	English publications	Non-English publications
Scope	Open access peer reviewed articles, book chapters and grey literature (practitioner reports, blogs, new articles were also included)	Publications which is not open access
Content	Must discuss at least one digital platform currently being adopted in one or more value chain activity outlined (Fig 1)	Digital platforms in development (prototype) stage not yet tested or used; platforms used for agricultural education

¹ We assume that papers before 2008 will focus on voice and SMS platforms

Based on the inclusion and exclusion criteria outlined above, the Preferred Reporting of Items for Systematic Review and Meta-Analysis (PRISMA) methodology proposed by Liberati et al. (2009) was used in selecting the 20 publications used for this review.

2.4 Step 4: Charting the Data

Using the 'reference function' of the NVivo data analysis software, data was extracted from each publication to map the research landscape. Data extracted includes: author, year; keywords; name of digital platform discussed; type of platform (Trading Platforms, Finance Platforms, Information Repositories, Social Networking Platforms, Farm Management Platforms, Crowdsourcing Platforms); value chain function used (based on Fig 1); description; platform owner; launch year, country, research methodology; and key findings.

2.5 Step 5: Collating, Summarising and Reporting

Using data extracted through the charting process in step 4 a thematic analysis of articles was carried out based on a framework for identifying potential disruptive innovation proposed by Nagy et al. (2016), discussed in the following section of this review. To iterate, these thematic categories are:

- a) Identification of value chain segments where digital platforms are being applied.
- b) Identification of the digital platforms and their characteristics based in their functionality, technicality and ownership.

3. Conceptual Background

3.1 Agricultural Value Chains

In developing country agriculture, the use of ICTs, such as mobile platforms, has been largely driven by inefficiencies in agricultural value chains, relating to high transaction cost and information asymmetries (Aker, 2011; Deichmann et al., 2016; Baumüller, 2018). A value chain represents the full range of activities and actors required to bring a product or service from inception to final consumption (Porter, 1990). The value chain, as an analytical framework, allows for the systematic mapping of chain actors, their functions and activities (Kaplinsky and Morris, 2001) and comprises a series of stages or 'links' which are made up of a broad range of (primary and secondary) actors, functions and activities which add value to an agricultural commodity as it moves along the chain (Gereffi et al., 2005; Trienekens, 2011). This systematic mapping could serve as a useful approach in identifying who, where and how digital platforms are being mainstreamed into value chain activities and also provide a starting point for understanding the disruptive potential of digital platforms on value chain actors and processes.

3.2 Digital Platforms

The term 'platform' is commonly conceptualised from two different disciplinary positions: first, the engineering and economics perspective. In engineering, platforms are defined as '*technological architectures*' (Gawer, 2014) which serve as a foundation for the development of other innovations. For instance, Google's android and Apple's iOS are digital platforms that support the development of mobile applications (apps) and other web platforms. Second, economists conceptualise platforms as '*two-sided markets*' or '*multi-sided markets*' that facilitate interactions between two or more group of users (Gawer, 2014). Evans and Gawer (2016) describe these two platform perspectives (typologies) as *innovation platforms* and *transaction platforms* respectively. Uniting both perspectives, a platform can be conceptualised as a foundation that supports further innovation and facilitates interactions between two or more users with common interests (Gawer, 2014; Tiwana, 2014; Deichmann et al., 2016; Evans and Gawer, 2016; Parker, et al., 2016).

In developing countries where digital platforms have been adopted, transaction platforms (mobile and web applications) constitute the most widely adopted typology of platforms while innovation platforms are increasingly being adopted by resource-constrained innovators as the basis for further innovation (GSMA 2017; Koskinen et al., 2018). These transaction platforms fall into the following sub-groups:

1) *Digital finance platforms* which facilitate financial transactions such as input purchase and agricultural product sales, for instance, Safaricom's MPesa (Jack and Suri, 2011) and PayStack².

2) *Online Trading Platforms* which bring buyers and sellers of agricultural commodities together reducing both spatial and temporal barriers to trade as well as transaction costs. For instance, the Indian Tobacco Company's (ITC) e-choupal which brings coffee farmers and buyers together giving farmers better bargaining power as a result of the elimination of middle men (Chen et al., 2013).

3) *Digital social networking platforms* such as WhatsApp and Facebook are increasingly being used as a channel to advertise products and connect with users that share similar interests (Irungu et al; 2015).

4) *Digital crowdsourcing platforms* such as 'ushaurilimo' which is used to gather agricultural information from a variety of experts to address the poor extension service delivery in Tanzania (Sanga et al., 2016).

5) *Digital information repositories* such as the Plantwise Knowledge Bank, although not transaction platforms *per se*, are platforms used by extension agents to provide scientifically informed recommendations to farmers (Leach and Hobbs, 2013).

3.2 Disruption due to Digital Platforms

Digital platforms have been described as '*disruptive information technology (IT) artefacts that erode conventional business logic associated with traditional market structures*' (Kazan et al., 2014). As with all other innovations, the potential or likelihood for a digital platform to transform (disrupt) agricultural value chains depends on innovation characteristics and the nature of the market or system where the innovation is being introduced (Rogers, 1995; Nagy et al., 2016). As a result, de Reuver et al. (2018) suggest that studying digital platforms (and their potential to disrupt) should be tailored to a specific academic discipline or industries to provide deeper conceptual clarity.

In discussing disruption within the context of developing country agriculture, there is yet to be a robust understanding of what constitutes a disrupted agricultural market or value chain or how a disruptive innovation interacts with pre-existing actors and functions within these traditional markets. Disruption has mainly focused on western industrialised markets, such as Kazan et al. (2014) who point out that despite their increased adoption in all economic sectors, there is a dearth of studies which describe how digital platform disruption occurs and its implication to existing market players. The most concerted effort to propose a framework for identifying potentially disruptive innovation along a value chain was done by Nagy et al. (2016) who describe disruptive innovation as '*an innovation with radical functionality, discontinuous technical standards, and/or new forms of ownership that redefines marketplace expectations*'. They argue that a potentially disruptive innovation is one which provides better *functionalities, technical standards and ownership models*, comparing the (potentially) disruptive innovation with incumbent innovations currently used for the same functions on the value chain. As a starting point, this review adopts Nagy's criteria which are used to assess the digital platforms identified in the review: according to

a) *Functionality* - which enables users to perform new tasks or results in behaviour changes that were previously impossible with the use of other innovations, and whether the disruption is to primary functions (such as production) or secondary (such as supporting services for the value chain) (Nagy et al. 2016).

b) *Technicality* - in terms of the level of complexity of the disruptive innovation and its compatibility with users existing technical knowledge. Disruptiveness suggests innovation characteristics which are *complex* if they possess new technical standards that pose knowledge barriers for users (Attewell, 1992).

c) *Ownership* - which influences how the innovation interacts with the market, how it is priced, and how it is perceived by users (Merges & Reynolds, 2000), who controls the innovation and how it is developed (Joyce and Patterson, 2003).

Digital platform disruption in agriculture is a nascent debate, and the thematic review is a starting point for an on-going analysis. Our review focuses on digital transaction platforms, as digital innovation platforms (technological architectures) are beyond the remit of this paper. Therefore, the following section 4 is limited to platform disruptions due to functionality, technicality and ownership, but we appreciate that a broader analysis is also required relating to disruption of existing production networks and the livelihoods of value chain actors, as well as changes in the way that agricultural development initiatives are implemented, and whether there have been agricultural intervention policy changes that reflect these

² PayStack is an online third party payment platform used in Africa. See: <https://paystack.com/>

developments. These broader disruptions are not the focus of this paper, but are elaborated upon in the discussion section 5 with regard to what was evidenced in the sample of papers reviewed.

4. Thematic Review

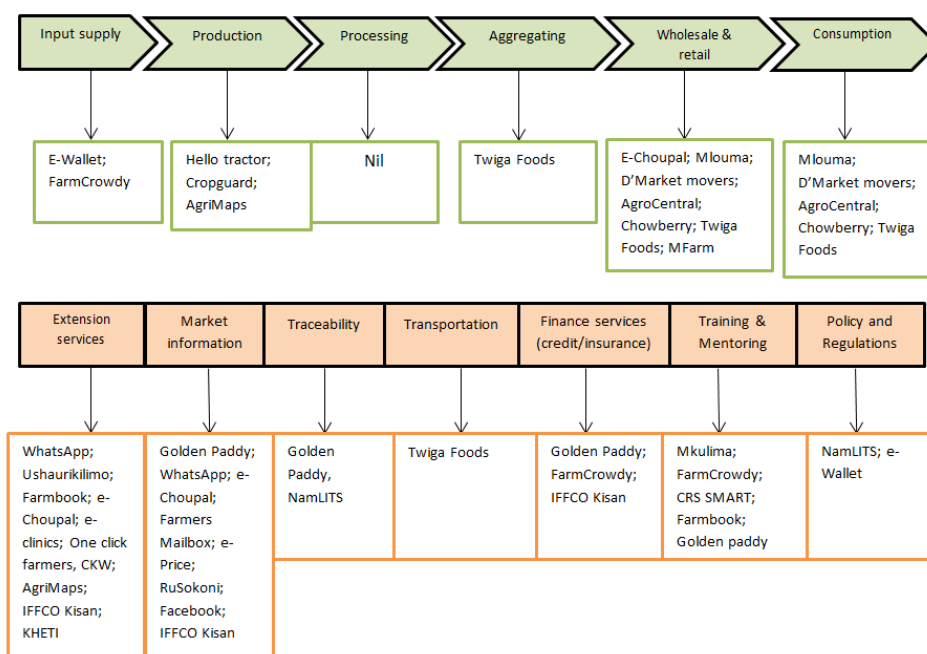
The thematic analysis entails identification of the digital platforms and their characteristics based on value chain mapping, functionality, technicality and ownership models. From the publications included in this review, 26 digital platforms are identified (including: mobile apps, web apps and databases). These include; mobile apps (10); web platforms (12) and databases (4). It should be noted that some of these digital platforms have both mobile apps and web platforms (e.g., Farmcrowdy); databases and mobile apps (e.g., e-clinics) and mobile apps supported by SMS functions (e.g., Agrocentral; Tiwga foods).

4.1 Value Chain Mapping

The review reveals that the digital platforms identified support secondary value chain activities such as extension service delivery (9); market information (7); financial services (4) and training/mentoring (5). While for primary value chain activities trading platforms which support wholesale/ retail (7) and consumption functions (6) account for the larger share of digital platforms adopted. Some platforms are used on more than one link in the chain to facilitate both primary and secondary activities (for instance: e-Choupal; FarmCrowdy; IFFCO Kisan; Tiwga foods); three platforms provide bespoke support on a single link (Hello tractor, Crop guard and Agrimaps); and no platform supporting processing activities was identified (see: Fig 1).

Fig 1: Identified digital platforms adopted on agricultural value chains in developing countries.

Source: Author's compilation



4.2 Functionality of Digital Platforms

Based on their functionality, the review identifies four types of digital platform used in agricultural value chains. These are:

a) *Crowdsourcing platforms*: These platforms are used in place of one-on-one fund raising and information sourcing providing a platform to obtain funds and information from larger numbers of individual investors. Examples identified include *Farmcrowdy* for crowdfunding (Ajadi et al. (2018), *RuSokoni* for

crowdsourcing market price information (Rahman and Fong, 2016) and *Ushaurikilimo* for crowdsourcing responses to farmers questions (Sanga et al., 2016).

b)) *Trading platforms*: This category brings together sellers and buyers of agricultural commodities to interact in a virtual marketplace, and are used as platforms to support trading activities through providing price information and product advertisement. These include *e-Choupal* (Banker et al., 2011; Ali and Kumar, 2011; Jain, 2016); *IFFCO Kisan* (Darabian, 2016); *AgroCentral*, *TiwgaFoods*, *Mlouma*, *Chowberry* and *D'Market Movers* (Rahman and Fong, 2016); and *MFarm* (Baumüller, 2015); In addition, the *e-Price* app (Zhang et al., 2016); *Facebook* (Rahman and Fong, 2016; Irungu et al., 2015) and *WhatsApp* (Thakur and Chander, 2016; Naruka, et al., 2017)

c) *Extension advisory platforms*: Digital platforms for extension services (e-extension) are identified as providing two forms of functionality. First, digital platform used by *farmers* to remotely connect with extension agents (e-extension). For example, *Ushaurikilimo* (Sanga et al., 2016); and *one click farmers' service* (Zhang et al., 2016). These e-extension platforms are adopted in place of physical contact between farmers and extension personnel and have become especially useful in regions with poor transportation networks which tend to limit extension service delivery (Aker, 2011). Second, digital platforms used by extension agents to facilitate extension service delivery: These include the *Plantwise Knowledge Bank* (Wright et al., 2016); the *Community Knowledge Worker (CKW) mobile platform* (Nakato et al., 2016); *KHETI* (Fu and Aker, 2011); and *Farmbook* (Tata and McNamara, 2018). These platforms usually support extension service delivery by providing information, training and data collection which help extension agents make more informed recommendations to farmers.

d) *Farm management platforms*: These are digital platforms that enable farmers make more informed farm management decisions such as *Hello tractor*, *Crop guard* (Rahman and Fong, 2016); *AgriMap* (Jordan et al., 2016); *IFFCO Kisan* (Darabian, 2016) and *E-wallet* (Godson-Ibeji et al., 2016; Demenongu et al., 2017). These platforms have functionalities that provide tailored information based on the site-specific realities including location, soil type and the type of farm enterprise (Jordan et al., 2016; Darabian, 2016).

4.3 Technicality of Digital Platforms

The evidence suggests that the degree of disruptiveness is influenced by technicality. To illustrate, as a result of the complexity of the *AgriMap* mobile app, Jordan et al. (2016) report that there has been a low level of adoption and use of the app in Trinidad and Tobago. They add that its low adoption is also due to the aging farmer population who engage in agriculture, most of whom still use feature phones (Jordan et al., 2016). Darabian (2016) explains that the slower rate of adoption of the IFFCO's mobile app, compared to their previous 'green SIM' SMS and voice model, is because most new users find it difficult to navigate the preliminary stages of registration and profile creation after the app was downloaded. As a result, users who could not overcome the challenging registration stage were unlikely to adopt mobile app (Darabian, 2016).

In contrast, among Nigerian farmers, the *e-wallet* platform has been widely adopted due to its relatively low-level of complexity and its compatibility with both smart and feature phones. However, its adoption and use is constrained by poor Internet connectivity and poor electricity supply in rural Nigeria which has resulted in untimely receipt of e-vouchers and slow disbursement of agricultural inputs (Godson-Ibeji et al., 2016; Demenongu et al., 2017). Zhang et al. (2016) reveals that the wide spread Internet coverage coupled with the high level smartphone usage among old and young farmers have driven the rapid adoption and usage of the *one click farmer service* platform, *farmers mailbox* and *E-Price app* in rural Zhengjiang and Shanghai, China. They describe farmers in this region as 'tech savvy' and willing to adopt new digital platforms. As a result of farmer's behaviour towards digital innovations in these regions, more local government support has been provided in developing and maintaining these platforms (Zhang et al., 2016).

Besides technical issues relating to digital platform navigation, the complexity of the content hosted or sourced through these platforms tends to serve as an impediment to their wide spread adoption. Digital platforms such as *AgriMap* and *CropGuard* described by Jordan et al. (2016) and Rahman and Fong (2016) require medium to high level specialist knowledge in Geographic Information System (GIS), and knowledge on pest and disease identification for users to be able to make meaningful inferences from information derived through these platforms. Furthermore, the user research carried out on the *IFFCO mobile app* reveals that the new pull service model which requires users to understand what exactly to search

for and interpret this information for themselves is also a challenge to uneducated users who tend to prefer the previous (green SIM) push model of receiving simple daily short messages (Darabian, 2016).

Finally, in terms of ease-of-use and multi-functionality, Rahman and Fong (2016) and Irungu et al. (2015) describe the use of *Facebook* by the Mkuima Youth group in Kenya as a platform for engaging with several agricultural value chains, information sourcing and peer-to-peer mentorship. Thakur and Chander (2016) and Naruka, et al. (2017) also provide evidence of *WhatsApp* usage by farmer groups in India for information sharing and trading. They posit that the relatively low level of technicality; multi-functional use of these platforms for both non-agricultural and agricultural purposes; and more specifically, the group chat functionality of both social networking platforms provide a space for crowdsourcing of information from a wide audience and peer-to-peer problem solving.

4.4 Ownership Models of Digital Platforms

Our review identifies a preliminary model of ownership of digital platforms introduced to developing country agricultural value chains: These are as follows.

a) *Sole-ownership models*: Private business start-ups account for the largest share of solely-owned digital platforms. Although they are privately owned and should be mainly profit-driven, the nine start-up agro-digital platforms identified have either benefitted from international funding and business incubation programmes such as provided by GSM Association (GSMA) and Technical Centre for Agriculture and Rural Cooperation (CTA) (Rahman and Fong, 2017; Ajadi et al., 2018). Consequently, these start-ups tend to also function as social enterprises whereby their platforms are used for agricultural development purposes as they extend information, financial and agricultural marketing support to marginalised groups (farmers) on the value chain.

b) *Jointly owned (partnerships)*: The three NGO-owned digital platforms identified were developed to achieve programme goals of agricultural development initiatives. These platforms are: the e-clinic platform by CABI in Kenya; FarmBook by CRS in Uganda; CKW mobile platform by Grameen foundation in Uganda; and KHETI in India funded by the EPSRC, are digital platforms developed to support the extension of agricultural advisory services as part of the goals of agricultural development programmes initiated by international organisations. As a result, the use, functionality and access to these platforms are shaped by programme goals and requirements of funding agencies.

c) *Government-owned*: As well as the partnership model, two exclusively government-owned digital platforms were identified, developed to support the implementation of national policy. For example, the E-wallet platform in Nigeria was developed under the Growth Enhancement Support (GES) scheme, a policy implemented by the Federal Ministry of Agriculture and Rural Development aimed at improving farmer's access to subsidised agricultural inputs (Godson-Ibeji et al., 2016; Demenongu et al., 2017). Zhang et al (2016) observed through their review on government-owned digital platforms such as Farmers mailbox that although these platforms tend to be managed using a top-down approach, their introduction into agricultural value chains tend to be incentive-based and at no cost to adopters thereby driving their wide spread adoption.

d) *Communal ownership*: Digital platforms owned by cooperatives enterprise also include platforms developed by cooperatives such IFFCO Kisan (Darabian, 2016).

5. Research Findings and Discussion

5.1 Disruptiveness along Value Chains

The quantitative approach adopted by Demenongu et al. (2017) used descriptive statistics and chi square to evaluate the effectiveness of the *e-wallet* platform in supporting the provision of timely inputs to 120 purposively selected e-wallet users. They found that 75% of e-wallet users were satisfied with the improved access to fertilizers provided through the platform while 25% did not trust that the system was transparent in its operation. Redemption code mismatch between registered farmers and input suppliers was also a major challenge to timely input acquisition. Godson-Ibeji et al. (2016) also sampled 180 *e-wallet* users and found that poor mobile network coupled with low numbers of certified agro-dealers within rural communities resulted in poor and untimely access to inputs through the *e-wallet* platform. In both studies, respondents indicated lack of trust in agro-dealers input disbursement through the platform.

In assessing the impact of the *e-Choupal* platform for decision making along the agricultural value chain in India, Ali and Kunal (2011) comparatively analysed data from 152 users and 151 non-users (the control group) of the platform. Using structured questionnaires, they investigated the usage of the *e-Choupal* platform for decision making in three segments of the value chain: i) production planning; (ii) cultivation practices; and (iii) post-harvest management and marketing; and analyse results using Analysis of Variance (ANOVA) technique. They find that both users and non-users with some form of education, generally made better decisions than uneducated users and non-users on the three stages of the value chain investigated. Other factors such as social class, income and farm ownership model (owned or rented) influenced the ability of both users and non-users to make better decisions on the value chain. They also observe that the use of *e-Choupal* is more likely to result in individual user's behaviour change in farming practices such as crop rotation; use of certified seeds; sorting and grading techniques; and market engagement. Jain (2016) also analysed the usefulness of the *e-Choupal* platform in making informed decision by comparing users and non-users of the platform. Using 160 women and 160 men users and 40 women and 40 men non-users of *e-Choupal*, the research finds that users of the platform make more informed decisions than non-users. It however does not show how these decisions translate to increase income or improved livelihoods of users.

Banker et al. (2011) however compared transactional (price) data from three coffee trading platforms: ITC's *e-Choupal* platform; physical auctions managed by the Indian Coffee Traders Association (ICTA³); and farm gate transactions, to determine which of these platforms provides higher prices for farmers - for various coffee grades. They find that generally, the advantage of the digital trading platform over physical auction was the lower transactions cost. However, coffee grades with higher price volatility tend to be cheaper on digital platforms meaning farmers sold at lower prices than at physical auctions where physical inspection by buyers meant farmers could earn more for a similar grade sold on the digital platform.

5.2 Digital Platforms in Resource Poor Environments

The three NGO-owned digital platforms identified were developed to achieve the programme goals of agricultural development initiatives. These platforms are: the *e-clinic* platform by CABI in Kenya; *Farm-Book* by CRS in Uganda; *CKW mobile platform* by Grameen foundation in Uganda; and *KHETI* in India funded by the EPSRC, digital platforms developed to support the extension of agricultural advisory services. As a result, the use, functionality and access to these platforms are shaped by programme goals and requirements of funding agencies. Three studies adopted experimental designs to evaluate digital platforms used for extension service delivery. These studies were part of the monitoring and evaluation of development initiatives implemented through: the *Plantwise programme*; *SMART skills* and *Farmbook* ICT tool; and the *CKW mobile platform*. The experimental research approach adopted by Wright et al. (2016) to test the suitability of transitioning from paper-based plant clinic service delivery to digital-based (*e-clinic*) service delivery, entailed a step-wise incremental implementation design which was iterative and allowed for the adaptation of the research design as the experiment progressed. The research was carried out in two stages (March 2014-May 2014 and May 2014 to March 2015) to give room to identify behaviour change over time. By triangulating survey data, with physical observation of extension agents during training; and platform usage analytics obtained through the Plantwise Online Management System⁴ (POMS), the research found significant behaviour change among the 60 extension agents who took part in the experimental trial and farmers who visited plant clinics. These behaviour changes included: better quality of recommendations provided to farmers; timeliness and confidence in diagnosis; and increased trust between farmers and extension workers.

Nakura et al. (2017) adopted an experimental research approach to investigate the suitability of using WhatsApp as a platform for extension advisory service delivery. An experimental WhatsApp group was created with 90 farmers; and information on crop management practices were provided to the group in written and video formats. The research results indicate behavioural changes in farmer's practices relating to selection of agrochemicals (81.1%) and adoption of seed treatment practices (51.1%). However, no control group was included in the experimental design and the experiment duration was not specified. The study relied on only farmer's perception and no panel data to support claims of user engagement over time. Thakur and Chander (2016) also conducted an experimental study on *WhatsApp* usage, for farmer-

³ ICTA holds a coffee auction every Thursday in Bangalore (Banker et al., 2011)

⁴ POMS is an online database which contains records of farmers visits to plant clinics (name, date, village, plant problem etc.) and records of the diagnosis and recommendations provided by plant doctors (Wright et al., 2016).

to-farmer information sharing. Within 6-months, they observed 137 posts on animal husbandry (including photos) and found that the use of *WhatsApp* in animal husbandry was gaining popularity especially because it supports photo sharing, a functionality not supported by the conventional SMS platform.

Nakato et al. (2016) carried out an experiment to assess the usefulness of the digital survey data collection platform, over paper-based survey, for the management and surveillance of banana disease in Uganda through the *CKW mobile platform*. In the first month of the experiment, the number of digital versus paper surveys collected was 812 and 856 respectively and in the second month 942 and 846. In comparing the digital and paper-based survey, it was found that most of the paper-based surveys were torn, incomplete and failed to capture exact locations of disease incident. The digital platform on the other hand used GPS to collect site-specific information which helped programme staff provide farmers with tailored information on disease prevalence and spread in two districts in Uganda which would have been relatively difficult to map using paper based surveys. Similarly, Tata and McNamara (2018) adopted randomised survey data collected between 2013 and 2015 in three phases to assess the impact of the SMART skills and *Farmbook ICT tool* in extension service delivery (Tata and McNamara, 2018). Results from the 60 extension agents used for the research were compared with a control group and revealed that extension agents using the digital platforms were able to work with higher numbers of farmers than the control group.

6. Conclusion and Future Research Questions

Digital technologies are creating *disruptive crossovers* in almost all economic sectors through digital platforms (de Reuver et al., 2017). Therefore, it is important that information systems research should broaden its scope to understand the developmental impacts and implications of digital platforms especially in the developing countries (Donner, 2018, Koskinen et al., 2018). From the review, we see that there is potential for digital platforms to disrupt agricultural value chains especially through re-structuring individual production networks, national level agricultural development initiatives and policy-level initiatives.

The review also finds that technical issues posed by some platforms (e.g., AgriMaps and IFFCO Kisan app) have resulted in the emergence of a passive model of platform engagement where less ‘tech-savvy’ actors engage with digital platforms through intermediaries. This model of platform usage is increasingly pioneered by new-entrant agri-tech digital platforms commonly termed ‘start-ups’ (Ajadi et al., 2018) such as *TiwgaFoods*, *AgroCentral*, *FarmCrowdy*, *Mlouma*, *D’Market Movers* and *RuSokoni* (Rahman and Fong, 2016; Ajadi et al., 2018). Through these platforms, agents acting as intermediaries perform technically complex activities on behalf of less ‘tech savvy’ actors (such as farmers) which include registration, profile creation, commodity advertising and facilitating financial transactions. Some of these digital platform models still adopt the SMS and voice platform to support their platform service delivery such as: sending e-receipts (e.g., *TiwgaFoods*) to farmers and vendors; sending notifications of order confirmation services (e.g., *AgroCentral*) and to deliver e-vouchers to users who do not have smartphones.

The review also maps the methodological landscape of research studies on digital platforms on agricultural value chains. The papers reviewed reveal a dearth of evidence on the impact of these platforms on agricultural value chains which buttresses ongoing debates on methodological challenges associated with assessing the impact of ICTs in agricultural and rural development. In charting the data for this review we observe that most digital platforms used in agricultural value chains beyond SMS, USSD and voice are discussed in practitioner reports such as the GSMA and CTA. These reports tend to adopt anecdotal methodology which is based on success stories which do not provide concrete empirical data to support reported statistics of usage and impact. Particularly, we observe this in publications on agri-tech start-ups by Ajadi et al. (2018) and Rahman and Fong (2017). From these anecdotal studies, the limited data provided is mostly aggregated and does not capture demographic, socio-economic and the gender profile of users, as with the case of Ajadi et al. (2018) who report that *Tiwga Foods* has 3500 registered farmers from whom they source 245 tonnes of bananas each week and deliver to 3500 vendors. These figures do not provide any evidence to support claims reported that through the platform farmers are able to obtain higher prices for their produce.

The review finds that methodological approaches adopted by most academic research on digital platforms does not provide evidence of the actual impact of the platform relative to specific (isolated) usage patterns - which could provide more insight as to disruptiveness for the platform. This is also observed by Baumüller (2018) who identifies that shortcomings in research on m-services (both in agriculture and

other disciplines) stems from a lack of rigor in methodological designs which tend to rely more on farmer's perception of an m-service, rather than panel data collected over time. For instance research carried out by Demenongu et al. (2017) and Godson-Ibeji on the e-Wallet system in Nigeria; and Ali and Kumar (2011) on e-Choupal would have benefitted from triangulating results with panel data on platform usage and transaction patterns to identify other bottlenecks to service delivery as opposed to relying on only farmer's perception through surveys as done by Banker et al (2011).

Due to the sparse empirical evidence on the (disruptive) impact of digital platforms on agricultural value chains, the review posits that future research on ICT4D relating to digital platforms on agricultural value chains should address the following questions:

- What measures should be used to understand the disruptiveness of digital platforms on agricultural value chains?
- How has the mainstreaming of digital platforms on agricultural value chains influenced how and where value is captured on the chain?
- How can the magnitude of benefits that accrue to users from the use of digital platforms on agricultural value chains be measured empirically?
- Who or what groups govern the distribution of benefits from the use of digital platforms?
- What typologies of agricultural commodities are best supported and transacted using digital platforms, and why?
- What is the role of the private sector in digital platform ownership, control and governance?

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