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**Harnessing digital transformation to build social-ecological-systems
resilience into institutional arrangements of agricultural transformation**

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ABSTRACT

This study had the transformative purpose of exploring how to harness digital transformation to integrate small-scale farmers into commercial value chains and markets to effect agricultural transformation like how platform business models integrate small-scale players into commercial value chains and markets whilst fundamentally restructuring industries. Agricultural transformation is constrained by current institutional arrangements for agriculture as a complex social-ecological-system (SES). The critical social sciences study qualitatively explored how to build SES resilience into institutional arrangements for Gauteng's high value horticulture to stimulate the emergence of new trajectories to create new SES regimes that result in agricultural transformation. The study's multi-case participatory action research design with small-scale farmers utilised digital transformation as a conceptual framework.

The study finds and submits that agricultural transformation, an aspirational concept steeped in historical analyses, ignores current realities most important of which is that the smallness of small-scale farmers is a major inhibitor to agricultural transformation. This thesis proposes reconceptualising agricultural transformation as digitally enabled agricultural transformation to address agricultural transformation's scale and currency challenges. The study utilised platform business models to develop an architecture for a hybrid agricultural industry multi-sided marketplace super-app platform that can be built through the study's proposed digital agriculture disruption framework.

Keywords: agricultural innovation systems, agricultural transformation, digital transformation, exponential organisation, institutional arrangements, platform business models, social-ecological-systems resilience.

CHAPTER 1. INTRODUCTION

1.1 Transformative purpose of study

This study had the transformative purpose of exploring how to harness digital transformation¹ to integrate small-scale farmers into commercial markets and value chains in order to effect agricultural transformation². Agricultural transformation and the integration of small-scale farmers into commercial markets and value chains in South Africa is being constrained (Department of Agriculture Forestry and Fisheries, 2014) by the current institutional arrangements³ (Boatema, Drimie, & Pereira, 2018) which include the role of the private sector in agricultural transformation (Qobo & Wood, 2016; Sihlobo & Nel, 2016; Skinner & Haysom, 2016), as well as the country's public policy processes and approaches (Black, Conradie, & Gerwel, 2014; Department of Agriculture Forestry and Fisheries, 2014; Drimie, 2016).

Given that, firstly, the choices of institutional arrangements for agricultural transformation “are constrained by the social context in which they are embedded” (Hollingsworth, 2000, p. 607), and secondly, that agriculture is a complex social-ecological-system⁴ (Lescourret et al., 2015; Ollivier, Magda, Mazé, Plumecocq, & Lamine, 2018; Rivera-Ferre, Ortega-Cerdà, & Baumgärtner, 2013), this study adopted a first proposition that the institutional arrangements

¹ Digital transformation refers to the development and implementation of strategies to transform an enterprise through (a) reimagining the enterprise's strategic direction and leadership on its purpose, vision, mission, values and creating business models to deliver on the enterprise's massive transformational purpose, (b) as well as restructuring the internal core of the enterprise in order to improve internal processes and productivity, (c) whilst simultaneously building capacity for the future through strengthening external linkages (Constantinides, Henfridsson, & Parker, 2018; Gawer & Cusumano, 2014; Gupta, 2018; Hinings, Gegenhuber, & Greenwood, 2018; Ismail, 2014; Kane, Palmer, Phillips, Kiron, & Buckley, 2015).

² Agricultural transformation, as envisaged in the Comprehensive Africa Agricultural Development Programme (CAADP), is the process of converting and reorienting subsistence small-scale farming towards commercial agriculture through two dimensions that improve a farm's productivity and internal processes on one hand and strengthen the external linkages that the farm has on the other hand (ACET, 2017; African Union, 2014; African Union et al., 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; World Bank, 2007).

³ Institutional arrangements are such mechanisms as policies, systems and processes that are used to effectively coordinate stakeholders and entities with other players so that they can execute their functions such as determine what and how to produce, setting prices, quality and other factors, and coordinating amongst players. Institutional arrangements can take the form of associations, communities, hierarchies, markets, networks, or the state (Campbell, 1997; Hollingsworth, 2000; Lindberg et al., 1991).

⁴ Social-ecological-systems are complex, non-linear and adaptive “ecological systems intricately linked with and affected by one or more social systems” (Anderies, Janssen, & Ostrom, 2004, p. 5).

for agriculture could be transformed by building in social-ecological-systems resilience⁵. The study also adopted a second proposition that the application of digitalisation⁶ to agriculture could cause digital disruptions⁷ that would act as system disturbances⁸ to the agricultural social-ecological-system to build social-ecological-systems resilience into the institutional arrangements. However, building social-ecological-systems resilience into the agricultural institutional arrangements could have led to either adaptability⁹ (which would have maintained the existing social-ecological-systems regime¹⁰) or transformability¹¹ (which would have resulted in the emergence of new trajectories that would have created a new social-ecological-systems regimes).

The study's transformative efforts towards building social-ecological resilience sought to lead to transformability that would result in the emergence of new trajectories that would create new social-ecological-systems regimes. The study's third proposition submitted that harnessing digital transformation to build in social-ecological-system resilience would result in social-ecological-systems transformability. This third proposition led to a fourth proposition that

⁵ Social-ecological-system resilience is the capacity of a social-ecological-system to maintain its core functions in response to systems disturbances (Folke, 2006; Folke et al., 2010a; Holling, 1973; Pisano, 2012; Walker, Holling, Carpenter, & Kinzig, 2004).

⁶ Digitalisation is the socio-technical process of radically transforming society, business and everyday life through the application of innovation in digital technologies which include artificial intelligence, augmented reality, big data, block-chain, internet of things (IoT), sensors, system integration, connectivity amongst others (Alm et al., 2016; Klerkx et al., 2019; Smith, 2020; Tilson et al., 2010; Yoo, 2010)

⁷ Digital disruption refers to innovation that utilises digitalisation to transform, create or restructure markets, society and industries through an interplay of digital technology, business model restructuring and societal transformations (Forrester, n.d.; Skog et al., 2018; World Bank, 2016).

⁸ A system disturbance is anything spontaneous, naturally occurring or man-made that "causes a disruption to a system" and include natural events such as fire or droughts and man-made interventions such as revolution, innovations or technological change (Gunderson, Kinzig, & Quinlan, 2007, p. 7).

⁹ Social-ecological-system adaptability is an ability to maintain system functions without a change in a social-ecological-system's regime (Folke, 2006; Folke et al., 2010b; Walker et al., 2004).

¹⁰ Social-ecological-systems regime is a particular configuration and combination of factors and "range of conditions across which a system may fluctuate while retaining a similar structure and function" (Biggs, Peterson, & Rocha, 2018, p. 9). These conditions include the social-ecological-system's sets of functions and feedback structures, which constrains the way it operates and is structured (Bennett, Cumming, & Peterson, 2005; Biggs et al., 2012; Pereira, Drimie, Maciejewski, Tonissen, & Biggs, 2020).

¹¹ Social-ecological-system transformability refers to the social-ecological-system's ability to maintain its core functions despite having shifted from a previous regime to a new one, in response to a system disturbance (Folke, 2006; Folke et al., 2010b; Walker et al., 2004).

transformability would shift the existing regimes for the institutional arrangements of agriculture towards the desired agricultural transformation.

This study's transformative focus and purpose required using a critical social sciences approach and its associated qualitative research methodology (Harvey, 1990; Kemmis, McTaggart, & Nixon, 2013; Leonardo, 2004; Neuman, 2014). The study adopted a participatory action research design because one of its major goals, to "generate knowledge that will be fed back into the setting" (Herr & Anderson, 2014, p. xiii), facilitated for understanding the feedbacks within social-ecological-system resilience's adaptive cycle¹² (Folke, 2006). The study also used a field research approach with multiple cases.

The study identified small-scale farming enterprise in each of the three metropolitan and two district municipalities within Gauteng to be case study participants in the participatory action research. For each of the case studies, the study originally sought to have three iterations of the participatory action research representing the three components of digital transformation which make up the study's conceptual framework. However, the interconnectedness of the three components of digital transformation meant that the process was more iterative as opposed to being composed of the three distinct and separate iterations.

1.2 Context of the Study

South Africa, just like the rest of Africa, is committed to effecting agricultural transformation as a strategy for economic development and growth, empowerment, and redistribution (Black et al., 2014; Drimie, 2016; Drimie, Hamann, Manderson, & Mlondobozi, 2018; Parker, Van Alstyne, & Choudary, 2016; Qobo & Wood, 2016; Sihlobo & Nel, 2016). However, despite sustained economic investments directed towards South Africa's small-scale farming sector, the sector has continued to struggle to integrate into commercial agricultural markets and value chains (Black et al., 2014; Department of Agriculture Forestry and Fisheries, 2014; du Toit, 2016).

¹² The adaptive cycle is an endogenous heuristic model that analyses, describes and portrays the dynamics that a social-ecological-system goes through over time in four developmental phases of growth (r), accumulation (K), collapse (Ω), and renewal (α) which are "driven by discontinuous events and processes" (Folke, 2006, p. 258).

Consequently, the South African government announced a programme to establish agri-parks AIS programme in all the 44 district municipalities in the country with an initial budget of R2 billion during the 2015/16 financial year (Department of Rural Development and Land Reform, 2017; Gauteng Department of Agriculture and Rural Development, 2016). The Department of Rural Development and Land Reform (2017, p. 2) defines an agri-parks as “a networked innovation system of agro-production, processing, logistics, marketing, training and extension services, located in a District Municipality”. The agri-parks AIS programme is a public policy intervention that seeks to systemically re-orient, transform, commercialise, and integrate small-scale farmers, particularly the beneficiaries of land reform farms and communal areas land, into commercial markets and value chains (Department of Rural Development and Land Reform, 2017; Gauteng Department of Agriculture and Rural Development, 2016; Makaepe, 2017).

Whilst the agri-parks AIS programme is the South African government’s most current intervention to address slow agricultural transformation, it appears to be facing challenges with the original target of establishing 44 agri-parks AIS being revised down to now nine (Erasmus, 2019; National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019). This study therefore sought to develop an alternative way of addressing the problem of agricultural transformation in South Africa since the public policy interventions were faltering.

The National Council of Provinces Committee on Land Reform (2019) and the Parliamentary Committee on ALR&RD (2019), whilst lamenting the inadequacies in the implementation of the agri-parks AIS programme within the country’s provinces, has commended the manner in which the agri-parks AIS programme has been implemented in Gauteng Province. Gauteng Province’s agri-parks AIS programmes are geared towards horticulture with a special focus on “high value vegetables¹³” whose growth potential is high and have high labour multiplier ratios (Gauteng Department of Agriculture and Rural Development, 2016; Makaepe, 2017).

¹³ High value vegetable crops are part of horticulture which would normally fall under the StatSA Standard Industry Classification (SIC) 0113. Horticulture is a branch of plant agriculture that focusses on vegetables, fruits and ornamental flowers. This study focussed on high value vegetables sector of horticulture because “Gauteng Agriparks have prioritised Horticulture Value Chain with specific bias towards high value vegetables” (Gauteng

This study specifically focused on Gauteng because of its relative success in agricultural transformation since it was the one province that the National Council of Provinces Committee on Land Reform (2019, p. 1) had commended for having agri-parks AIS that were “actively functional and beneficial to communities”. Consequently, the study also focussed on high value vegetables horticulture within Gauteng.

1.3 Research Problem

This study sought to explore how small-scale farmers could be integrated into commercial agricultural markets and value chains by harnessing digitalisation in the same manner that it has been used on digital platforms that integrate small scale players into their respective commercial markets (Edward, 2020; Jones, 2017; Kwok & Xie, 2019; Schneider, 2018; Zervas, Proserpio, & Byers, 2017b). Specifically, the study explored how to harness digital transformation in order to build social-ecological-systems resilience into the institutional arrangements for agriculture in order to effect agricultural transformation.

Small-scale farmers struggle to be integrated into agricultural commercial markets and value chains because the institutional arrangements for agriculture (du Toit, 2016; Neves & Hakizimana, 2015) exist in social-ecological-systems regimes that perpetuate the status quo (Department of Agriculture Forestry and Fisheries, 2014; Mhone, 2000; National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019; Pereira & Drimie, 2016), and maintain the existing social-ecological-system regimes (Crépin, Biggs, Polasky, Troell, & De Zeeuw, 2012; Herrero-Jáuregui et al., 2018; Rivera-Ferre et al., 2013).

This study sought to harness digitalisation as a system disturbance to build SES resilience into the institutional arrangements for agricultural transformation. Harnessing digitalisation would build in SES resilience which would result in the emergence of new trajectories that could lead

Department of Agriculture and Rural Development, 2016, p. 8). The Gauteng Department of Agriculture and Rural Development provides “examples of high value vegetables crops to be produced on-site as well as in the premises of the surrounding farmers include tomatoes, cucumber, baby spinach, peppers, baby marrows and many others” (Gauteng Department of Agriculture and Rural Development, 2016, p. 15).

to the adaptability or the transformability of the social-ecological-system (Folke et al., 2010b; Walker et al., 2004).

To ensure the transformability of the agricultural institutional arrangements, this study harnessed a digital transformation approach to using digitalisation as a system disturbance to the agricultural social-ecological-system. Digital transformation has reformed and restructured the institutional arrangements for several industries through platform business models (Edward, 2020; Jones, 2017; Schneider, 2018; Skog, Wimelius, & Sandberg, 2018; Zervas, Proserpio, & Byers, 2017a). This offered opportunities to integrate small scale operators into the respective value chains in the same way that big established operators are integrated (Edward, 2020; Jones, 2017; Schneider, 2018; Skog et al., 2018; Zervas et al., 2017a). Consequently, the study's conceptual framework was based on harnessing digital transformation as a strategic initiative to create digital disruptions that would lead to the social-ecological-systems transformability necessary to facilitate agricultural transformation.

1.4 Research Objectives

The study's main aim was to explore how to harness digital transformation to build SES resilience into the institutional arrangements for agriculture to effect agricultural transformation. This was achieved through the following objectives:

1. Explored how the institutional arrangements for the high value vegetables horticulture social-ecological-system in Gauteng maintained the existing social-ecological-systems regimes and perpetuated the status quo in ways that did not achieve agricultural transformation. The study's first proposition was that the institutional arrangements for agriculture could be transformed by building in social-ecological-systems resilience¹⁴.
2. Explored how to harness digital transformation to build social-ecological-system resilience into the institutional arrangements for high value vegetables horticulture in Gauteng; The second proposition of this study was that the application of

¹⁴ Social-ecological-system resilience is the capacity of a social-ecological-system to maintain its core functions in response to systems disturbances (Folke, 2006; Folke et al., 2010a; Holling, 1973; Pisano, 2012; Walker et al., 2004).

digitalisation¹⁵ to agriculture could cause digital disruptions¹⁶ that would act as system disturbances¹⁷ to the agricultural social-ecological-system to build social-ecological-systems resilience into the institutional arrangements.

3. Explored whether, through harnessing digital transformation, the institutional arrangements for high value vegetables horticulture in Gauteng responded to digitalisation's system disturbance of its agricultural social-ecological-system by finding new trajectories towards regime shifts that achieved agricultural transformation or they reinforced the current regimes. This study's third proposition submitted that harnessing digital transformation to build in social-ecological-system resilience would result in social-ecological-systems transformability.
4. Explore whether building social-ecological-system resilience that results in transformability would result in agricultural/structural transformation. The study's fourth proposition that transformability would shift the existing regimes for the institutional arrangements of agriculture towards the desired agricultural transformation.

Research objective number one was to be determined by a qualitative field study that was supposed to be conducted by the researcher. This research objective sought to determine the various communication and feedbacks of the institutional arrangements for high value vegetables. However, challenges in accessing some of the study's prospective institutional respondents hindered the full realisation of this objective. The study however relied on publicly accessible data on which document analysis was conducted. The results of that document analysis were deemed to be sufficient to facilitate continuing the study by addressing the other three research objectives. Research objective numbers two, three, and four were to be conducted

¹⁵ Digitalisation is the socio-technical process of radically transforming society, business and everyday life through the application of innovation in digital technologies which include artificial intelligence, augmented reality, big data, block-chain, internet of things (IoT), sensors, system integration, connectivity amongst others (Alm et al., 2016; Klerkx et al., 2019; Smith, 2020; Tilson et al., 2010; Yoo, 2010)

¹⁶ Digital disruption refers to innovation that utilises digitalisation to transform, create or restructure markets, society and industries through an interplay of digital technology, business model restructuring and societal transformations (Forrester, n.d.; Skog et al., 2018; World Bank, 2016).

¹⁷ A system disturbance is anything spontaneous, naturally occurring or man-made that "causes a disruption to a system" and include natural events such as fire or droughts and man-made interventions such as revolution, innovations or technological change (Gunderson et al., 2007, p. 7).

as participatory action research by the researcher and study participants jointly on the basis of the results of research objective number one obtained from document analysis.

The researcher and the study's participants developed and implemented a participatory action research intervention framework for making digital transformation interventions that influence the leadership and strategic direction of high value vegetables horticulture in Gauteng based on the digital transformation concepts of network effects¹⁸, exponential organisations¹⁹ and platform business models²⁰ (Constantinides et al., 2018; Gawer & Cusumano, 2014; Goerzig & Bauernhansl, 2018; Han et al., 2018; Ismail et al., 2014; Parker et al., 2016). The participatory action research intervention framework was also aimed at strengthening the core of the operations and management for high value vegetables horticulture for the research participants in Gauteng in order to improve their internal processes and productivity (Gupta, 2018; Ismail et al., 2014), as well as building capacity for the future through strengthening external linkages (Gupta, 2018; Ismail et al., 2014).

1.5 Delimitations of the Study

The theoretical delimitations of this study related to the theories and concepts around the institutional arrangements for agricultural transformation, social-ecological-systems resilience, and digital transformation.

The study took an institutional arrangements perspective to agricultural transformation and did not include other components such as productivity enhancement nor institutions for agricultural transformation (Hollingsworth, 2000). Whilst the notion of structural transformation derived from initial conceptualisations of agricultural transformation (Johnston & Mellor, 1961; Lewis,

¹⁸ Network effects is an economic phenomenon in which the utility or value derived by participants in a network depends on the number of participants as the network provides positive feedback for participants who then derive more utility or value with the addition of more participants on the network (Parker et al., 2016; Shapiro, Carl, & Varian, 1998; Täuscher & Laudien, 2018; Uenlue, 2017b). Network effects arise from the “need for users to connect with one another” thus causing each user to “choose the same technology as everyone else to avoid being stranded” (Grant, 2016, p. 192).

¹⁹ Exponential organisations are defined by Ismail (2014) as having disproportionately large impacts and outputs to theirs peers as a result of a result of using new business models and techniques that leverage on the accelerating technological revolution; exponential organisations have impacts and outputs that are at least ten times their peers.

²⁰ Platform business models facilitate interactions between different groups of network participants by connecting them to each other in ways that facilitate network effects (Gawer & Cusumano, 2014; Täuscher & Laudien, 2018; Uenlue, 2017b; Van Alstyne, Parker, & Choudary, 2016).

1954; Ranis & Fei, 1961; Rostow, 1952; Timmer, 1988) has inclusive economic empowerment, development and growth amongst its objectives, this study did not address economic empowerment, development and growth beyond those aspects that are being partially determined by the AU and CAADP's conceptualisation of agricultural transformation as also defined in this document (ACET, 2017; African Union, 2014; African Union et al., 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; World Bank, 2007).

The research was delimited to the SES resilience of agricultural institutional arrangements only. It did not include other aspects of social-ecological-systems such as adaptive management and governance (Anderies et al., 2004; Folke et al., 2010; Herrero-Jáuregui et al., 2018; Hollingsworth, 2000). The study was also delimited to the analysis of institutional arrangements for innovation as outlined by Hollingsworth (2000) and did not go into more substantive issues around institutional theories.

Furthermore, the study's delimitations on digitalisation focused on the social sciences components of digital agriculture, and not the technological components (Klerkx et al., 2019). Within those social sciences components, the study took on a digital transformation approach (Constantinides et al., 2018; Gawer & Cusumano, 2014; Goerzig & Bauernhansl, 2018; Gupta, 2018; Hinings et al., 2018; Ismail et al., 2014). Whilst there are various conceptualisations and definitions of digital transformation (Gupta, 2018; Henriette, Feki, & Boughzala, 2015; Hinings et al., 2018; Ismail, 2014; Kane et al., 2015; Matt, Hess, & Benlian, 2015; Morakanyane, Grace, & O'Reilly, 2017; Nambisan, Wright, & Feldman, 2019; Vial, 2019), this study uses the conceptualisation outlined in the definitions section of this Chapter 1 and more fully laid out in the section describing the study's conceptual framework in Chapter 2. Although the concept of digital maturity (Hinings et al., 2018; Kane et al., 2015; Matt et al., 2015) is integral to digital transformation, this study did not focus on it.

The study's locational delimitation was Gauteng Province, South Africa notwithstanding that agricultural transformation is an area of interest in South Africa and the African continent. The study participants for the action research stages of the research were only limited to small-scale farmers and farming enterprises. Whilst the study was about agricultural transformation, it is delimited to high value fresh vegetables horticulture and did not include other horticultural crops like fruit and ornamental flowers, livestock, or other cropping products such grains and

pulses. This research was delimited around small-scale farmers who are engaged in high value fresh vegetable horticulture within Gauteng Province, South Africa.

1.6 Significance of the Study

The manner in which agricultural transformation can improve economic development and growth in Africa has been eluding policy makers for over two decades; the Comprehensive Africa Agriculture Development Programme (CAADP) was adopted at the Maputo Declaration in 2003, and reaffirmed in the Malabo Declaration of 2015 (ACET, 2017; African Union, 2014; African Union et al., 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; Sütterlin et al., 2018; United Nations, 2014; World Bank, 2007). The research will therefore assist evidence-based policy formulation and implementation for agricultural transformation in South Africa which faces post-apartheid complexities of a faltering agricultural and food system, a burgeoning population, climate variability, policy uncertainties, a profound lack of agricultural policy coherence, and different perspectives on how the country's dualistic agricultural sector can be transformed (Drimie, 2016; Hofmeyr et al., 2016; Neves, 2016; Sihlobo & Nel, 2016).

Theoretically studying agricultural transformation as a complex social-ecological-system has enabled the consideration of the multiple perspectives and subjective nature of knowledge for different stakeholders (Lescourret et al., 2015; Rivera-Ferre et al., 2013). This has enabled an understanding of the power relations, paradigms, and principles that contribute towards policy making and strategic planning in order to improve management procedures (Rivera-Ferre et al., 2013).

The analysis of social-ecological-system resilience has assisted the study in explaining how to use digitalisation as a system disturbance that catalyses the development of institutional arrangements with the capacity of integrating and accommodating considerations for social dynamics as well as ecological sciences as they emerge, whilst also addressing common elements, such as adaptive governance, adaptive management, sustainability, and ecosystem

services²¹, (Herrero-Jáuregui et al., 2018; Hinings et al., 2018; Kane, 2015; Pereira & Drimie, 2016; Rivera-Ferre et al., 2013)

From an empirical vantage, visualising agriculture's SES resilience through different framings and the power relations, the study recognised that there are no simplistic solutions to transforming South Africa's agriculture (Herrero-Jáuregui et al., 2018; Pereira & Drimie, 2016; Rivera-Ferre et al., 2013). The study also addressed the sustainability of agricultural ecosystems and other diverse agriculture related challenges as well (Lescourret et al., 2015; Rivera-Ferre et al., 2013).

By harnessing the digitalisation perspective, this study strengthens social science based research on digital agriculture which is not as prevalent as technologically inclined digital agriculture research (Klerkx et al., 2019). This study falls within a potentially new thematic social sciences cluster of digitally enabled agricultural transition pathways which is one of four such new potential thematic clusters in addition five that have already been identified (Klerkx et al., 2019). This study addressed the lack of “an appropriate theoretical framework for guiding ICT innovations” in the agricultural sector in Africa (Ayim, Kassahun, Tekinerdogan, & Addison, 2020, p. 1). Furthermore, the digital transformation approach taken in the study combines elements of platform business models, exponential organisations and network effects (Constantinides et al., 2018; Gawer & Cusumano, 2014; Goerzig & Bauernhansl, 2018; Han et al., 2018; Ismail et al., 2014; Parker et al., 2016).

The study applied the transformative potential of digitalisation in agriculture to propose a manner in which to address a long trend of agricultural under-performance that has been in existence since the 1970s (Black et al., 2014; DAFF, 2014; Rose & Chilvers, 2018; Shepherd et al., 2018) and hopefully resolve it. The institutional arrangements perspective that the study took on agricultural transformation is in line with growing interest in the social science aspect of digital agriculture which include examining social, institutional and economic aspects as well as their impacts on ecosystems, wildlife and humankind (Klerkx et al., 2019).

²¹ Ecosystem services can be regarded as the “contribution of nature to human well-being” (Jax et al., 2018, p. 416)

This study contributes towards strengthening the implementation of policies for agricultural transformation with specific focus on their institutional arrangements perspectives (ACET, 2017; African Union et al., 2003; AGRA, 2017; Hollingsworth, 2000). Digital agriculture, which also forms part of the study's theoretical framework with regards to how digitalisation disrupts the institutional arrangements for agricultural transformation, will provide a different agricultural perspective towards both the theory and practical application of agricultural transformation (Keogh & Henry, 2016; Klerkx et al., 2019; Shepherd et al., 2018).

From a practical perspective, the study will assist stakeholders in South Africa to collaborate towards developing social and institutional frameworks that can make agriculture the engine for growth (Hofmeyr et al., 2016). The study will also contribute towards addressing the inequalities and socio-economic challenges threatening social cohesion and political stability in spite of the progress within democratic spaces brought about through the Convention for a Democratic South Africa (CODESA) collaborations and negotiations (Hofmeyr et al., 2016).

1.7 Definition of Terms

Adaptive cycle

The adaptive cycle is an endogenous heuristic model that analyses, describes and portrays the dynamics that social-ecological-system goes through over time in four developmental phases of growth (r), conservation (K), release (Ω), and reorganisation (α) which are “driven by discontinuous events and processes” (Folke, 2006, p. 258). These four phases include one of rapid growth and exploitation with freely available resources and high resilience (r) (Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair, Rawluk, Kumar, & Curtis, 2017). This phase merges into the capital and

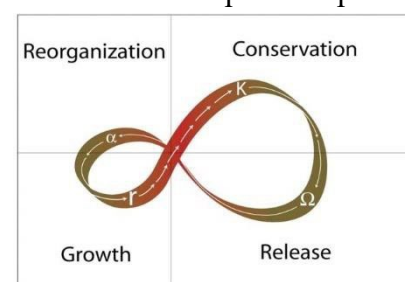


Figure 1. 1 - The adaptive cycle.
Source – Folke, 2006

resource accumulation and conservation phase with resources largely locked up, little flexibility and low resilience (k) (Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017). This is inevitable and eventually followed by sudden chaotic collapse and release of resources which undoes changes in structures and relationships (Ω) (Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017). There will then be renewal and reorganization

with novelty, innovation and new opportunities being prevalent (α) (Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017).

Agricultural Transformation

This study adopts a definition of agricultural transformation to be, as envisaged by the AU in the CAADP, the process of converting and reorienting subsistence small-scale farming towards commercial agriculture through two dimensions that improve a farm's productivity and internal processes on one hand and strengthen the external linkages that the farm has on the other hand (ACET, 2017; African Union, 2014; African Union et al., 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; World Bank, 2007). This notion of agricultural transformation was conceived with the expectation that it would spur development and growth within Africa (ACET, 2017; African Union, 2014; African Union et al., 2003, 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; Sütterlin et al., 2018; World Bank, 2007). Sediri, Trommether, Frascaria-Lacoste, and Fernández-Manjarrés (2020, p. 5) regard transformation as “creating new “stability landscapes” by introducing new components and ways to make a living”

Structural Transformation

Barrett, Christian, and Shiferaw (2017, p. 5) define structural transformation as “the process by which low-income societies, in which agriculture absorbs most labour and generates most economic output, become high-income societies characterized by a relatively smaller but more productive agricultural sector.” This concept of structural transformation builds on Arthur Lewis (1954) model of economic development up to Paul Timmer (1988) definition of agricultural transformation.

Digital agriculture

Digital agriculture is the use of humans, animals, plants, soil, water, machines, sensors, satellites, drones and any other natural object or machine to collect, secure and analyse data through monitoring or big data science analytics, on agricultural related activities and processes to interpret the past, predict the future and make evidence based decision accurately and timely (Keogh & Henry, 2016; Klerkx et al., 2019; Shepherd et al., 2018).

Digital disruption

Digital disruption refers to innovation that utilises digitalisation to transform, create or restructure markets, society and industries through an interplay of digital technology, business model restructuring and societal transformations (Armstrong & Lee, 2020; Forrester, 2018; Skog et al., 2018; World Bank, 2016).

Digital transformation

This study adopts a definition of digital transformation that refers to the development and implementation of strategies that utilise digitalisation to transform an enterprise through (a) reimagining the enterprise's strategic direction and leadership on its purpose, vision, mission, values and creating business models to deliver on the enterprise's massive transformational purpose, (b) as well as restructuring the internal core of the enterprise in order to improve internal processes and productivity, (c) whilst simultaneously building capacity for the future through strengthening external linkages (Constantinides et al., 2018; Gawer & Cusumano, 2014; Gupta, 2018; Hinings et al., 2018; Ismail, 2014; Kane et al., 2015). The components of digital transformation are more fully outlined in the section that describes the study's conceptual framework in Chapter 2 on Literature review

Digitalisation

Digitalisation is the socio-technical process of radically transforming society, business and everyday life through the application of innovation in digital technologies which include artificial intelligence, augmented reality, dig data, block-chain, internet of things (IoT), sensors, system integration, connectivity amongst others (Alm et al., 2016; Klerkx et al., 2019; Smith, 2020; Tilson et al., 2010; Yoo, 2010).

Digitally enabled agricultural transformation²²

This study has crafted a definition of digitally enabled agricultural transformation as the process of harnessing current digitalisation and technological developments and innovations

²² This definition was crafted as part of this study

towards transforming the institutions and institutional arrangements of agriculture to enable the effective, efficient, sustainable and profitable participation of small-scale farmers in the agricultural social-ecological-systems and their constituent sub-ecosystems in order to structurally transform economies in ways that foster sustainable socio-economic growth and development taking into account the inescapable reality of the smallness of small-scale farmers which has previously hindered their access to the advantages of scale which can now be overcome through emerging technology driven business models.

Digitally enabled agricultural transformation builds on both the theoretical tradition of the Lewis model of agricultural transformation and its transitions to structural transformation, as well as the practically applicable conceptualisations of agricultural transformation which jointly incorporate envisioning a future that is not only informed by history but also harnesses current real-world realities.

Institutions

Institutions are the rules and constraints that govern human behaviour, shape human interactions, and regulate that manner that society functions (North, 1984). Examples of common place institutions include family and marriage (North, 1984).

Institutional Arrangements

Institutional arrangements are such mechanisms as policies, systems and processes that are used to effectively coordinate stakeholders and entities with other players so that they can execute their functions such as determine what and how to produce, setting prices, quality and other factors, and coordinating amongst players. Institutional arrangements can take the form of associations, communities, hierarchies, markets, networks, or the state (Campbell, 1997; Hollingsworth, 2000; Lindberg et al., 1991). Examples of institutional arrangements include associations, communities, organisational hierarchies, markets, networks, or states (Campbell, 1997; Hollingsworth, 2000; Lindberg et al., 1991).

Hollingsworth (2000) submits that the imbedded context of institutions and institutional arrangements constrains how needs are defined, the choices and preferences that actors make, and the choice of institutional arrangements.

Social-ecological-system

Social-ecological-systems are complex, non-linear and adaptive “ecological systems intricately linked with and affected by one or more social systems” (Anderies et al., 2004, p. 5). They are delimited units that include biological, geographic, natural and physical components within functional and spatial boundaries encompassing particular contexts and ecosystems (Allen et al., 2014; Anderies et al., 2004; de Vos et al., 2019; Herrero-Jáuregui et al., 2018; Lescourret et al., 2015). Social-ecological-systems are non-linear, have different scales and display an ability to emerge and self-organise (Allen et al., 2014; Anderies et al., 2004; de Vos et al., 2019; Herrero-Jáuregui et al., 2018; Lescourret et al., 2015). Walker et al. (2004, p. 5) states that “three related attributes of social-ecological-systems determine their future trajectories: resilience, adaptability, and transformability”.

Social-ecological-systems resilience

Social-ecological-systems resilience is the capacity of a social-ecological-system to continue to exist and perform its functions by transforming or adapting in response to changes, normally referred to as systems disturbances (Folke, 2006; Folke et al., 2010a; Folke et al., 2010b; Holling, 1973; Walker et al., 2004).

Walker et al. (2004) states that “resilience (the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks) has four components—latitude, resistance, precariousness, and panarchy—most readily portrayed using the metaphor of a stability landscape. Adaptability is the capacity of actors in the system to influence resilience in such a manner as to maintain the systems functions in the same state (in a social-ecological-system, essentially to manage it). There are four general ways in which this can be done, corresponding to the four aspects of resilience. Transformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable.”

Folke (2006, p. 259) states that “social-ecological-systems resilience is about the opportunities that disturbances open up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories”. He further submits that “the concept of resilience in relation to social–ecological-systems incorporates the idea of adaptation,

learning and self-organization in addition to the general ability to persist disturbance” (Folke, 2006, p. 260).

Social-ecological-systems adaptability

Social-ecological-system adaptability is an ability to maintain system functions without a change in a social-ecological-system’s regime (Folke, 2006; Folke et al., 2010b; Walker et al., 2004).

Social-ecological-systems transformability

Social-ecological-system transformability refers to the social-ecological-system’s ability to maintain its core functions despite having shifted from a previous regime to a new one, in response to a system disturbance (Folke, 2006; Folke et al., 2010b; Walker et al., 2004). “Transformability relates to the social-ecological capacities that enable shifts from one regime to new pathways and even to the creation of new systems” (Sediri et al., 2020, p. 4).

Social-ecological-systems regime

Social-ecological-systems regime is a particular configuration and combination of factors, including the social-ecological-system’s sets of functions and feedback structures, which constrains the way it operates and is structured (Bennett et al., 2005; Biggs et al., 2012; Pereira et al., 2020).

Social-ecological-systems regime shifts

Social-ecological-systems regime shifts occur when the structure of a social-ecological-system and its associated functions and feedbacks are substantially reorganised resulting in changes to ecosystems services and the associated human wellbeing (Crépin et al., 2012).

System disturbance

A system disturbance is anything spontaneous, naturally occurring or man-made that “causes a disruption to a system” and include natural events such as fire or droughts and man-made interventions such as revolution, innovations or technological change (Gunderson et al., 2007,

p. 7). System disturbances that exert gradual or cumulative pressure are called “press disturbances” whilst those that occur as discrete events are called “pulse disturbances” (Gunderson et al., 2007, p. 7).

1.8 Assumptions

The assumptions that the study made related to the ability to access the field site and secure cooperation from study participants. Another assumption was that the study would be able to secure participants that have the capacity and are willing to be both practitioners and co-researchers with the study’s researcher. These participants were expected to also have digital access and literacy.

Given that the study followed a participatory action research design, another assumption was that study participants will not opt out of the study partway through the study. As co-researchers who contribute towards the development of the intervention frameworks for the participatory action research, the study assumed that the participants will be willing to abide by the ethics that bind the researcher.

Lastly, the study also assumed that the research participants will be willing to have the results of the research published within the bounds of confidentiality and ethics. The study also assumed that participants will be willing to share their strategic objectives which they consider as their intellectual property and capital.

1.9 Outline of thesis and chapter structure

This thesis is presented in eight chapters with Chapter One presenting this introduction. The introduction outlines the purpose and context of the study. The research problem and research objectives of the study are also discussed in this introductory chapter. The study’s delimitations, significance and assumptions are also described in the introduction together with some definition of the terms used in the study. The introduction concludes with this outline of the thesis’ structure.

The second chapter of this study presents the literature review in three parts. Part A of chapter two provides a background and context of agricultural transformation in South Africa. The

study's theoretical framework is presented in Part B. Chapter Two concludes by presenting the conceptual framework in Part C. Chapter Three of this thesis discusses the participatory action research methods that were used to collect and analyse data.

Chapters Four presents the data in accordance with the components of the research instrument. Additional data is also presented within Chapters Five, Six, and Seven which also discuss the study's key finding by combining that additional data presentation and interpretation within the ambit of those findings.

Chapter Five submits the thesis that agricultural transformation should be re-defined as digitally enabled agricultural transformation. Building on that redefinition, Chapter Six presents a platform architecture of a hybrid platform consisting of an agricultural industry platform, a multi-sided marketplace platform (MSMP), and a super-app to implement the digital enablement of agricultural transformation. Chapter Seven discusses how that platform architecture can be implement through a digital agriculture disruption framework.

This study's main thesis that agricultural transformation should be re-conceptualised with a heightened focus on scale is submitted in Chapter Five. Small-scale farmers face challenges because of being small. The chapter's thesis is that agricultural transformation has been considered from historical perspectives to come up with futuristic aspirations. The thesis advocates for considering agricultural transformation within current timeframes. This can be achieved by harnessing digitalisation as an enabler. The chapter presents a reconceptualization of the definition of agricultural transformation as digitally enabled agricultural transformation.

The sixth chapter builds on the reconceptualised definition of agricultural transformation as digitally enabled agricultural transformation to present how digital platform business models can address the scale challenges that small-scale farmers face. The chapter is in four parts with Part A discussing multi-sided marketplace platforms (MSMP), and Part B discussing agricultural industry platforms. Part C discuss the hybrid agricultural industry MSMP super-app platform that is proposed in the study. The chapter concludes by describing the platform architecture of the hybrid agricultural industry MSMP super-app platform.

Chapter Seven presents a digital agriculture disruption framework as the basis for implementing the platform architecture presented in Chapter Five The two-part framework is

comprised of, firstly, a hybrid disruptive innovation and big bang disruption model. The second part of the framework is a digital agriculture user development model that is based on Blank and Dorf (2005) customer development model.

Chapter Eight concludes this thesis in two parts. Part A presents concluding syntheses on the summary findings outlined in Chapters Five, Six, and Seven. Those concluding syntheses are discussed in four sections that unpack the four components of this study' title. Part B makes recommendations for both policy and practice, as well as recommendations for further research and recommendations on methodology.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

This chapter on literature review is composed of three major parts with several sections in each part. Part A of the literature review discusses the context of SMMEs in South Africa and a more detailed background of SMMEs in agriculture from the perspective of agricultural transformation in South Africa. Part B outlines the study's theoretical framework which consists of four theoretical areas which include theories on (a) agricultural transformation, (b) social-ecological-systems, (c) institutional arrangements for social innovation, and (d) digital agriculture. Part C of this literature review describes the study's conceptual framework which is built around three areas which include (a) agricultural innovation and disruption, (b) digital transformation, and (c) platform business models.

Part A of this chapter starts off in the next section by describing the problem situation at a macro level as how SMME have not been able to resolve South Africa's triple challenges of poverty, unemployment and inequality (de Jongh, Ferreira, Dickason-Koekemoer, & Sunde, 2020; Rambe & Mosweunyane, 2017) whose origins stem from apartheid (Aliber & Cousins, 2013; de Jongh et al., 2020; Sikwela, Tshuma, & Tshabalala, 2018). That SMME context serves as a prelude to discussing agricultural transformation in the following section as the background narrows the context further into how SMMEs in agriculture are still not able to resolve South Africa's triple challenges of poverty, unemployment, and inequality.

This Part A also provides a background discussion on South Africa's agricultural transformation. Whilst the theoretical component of the literature review considered the broader context of available knowledge on agricultural transformation, the empirical component however narrowed down onto South Africa with a focus on Gauteng Province given that the South African Parliament has acknowledged that the most commendable progress on the agri-parks AIS programme (South Africa's current efforts on agricultural transformation) was in Gauteng (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019).

This Part A of the literature review then took a deeper dive into literature on how agricultural transformation has sought to integrate small-scale farmers into markets and commercial value chains in South Africa (Black et al., 2014; Boatemaa et al., 2018; Department of Agriculture Forestry and Fisheries, 2014; Drimie, 2016; Erasmus, 2019; Sihlobo & Nel, 2016). This deep dive into literature also reviewed agricultural transformation in Africa as set out in CAADP as adopted by the African Union (AU) at the Maputo Declaration in 2003 (African Union, 2003; African Union, NEPAD, & CAADP, 2003; Masters, Rosenblum, & Alemu, 2018; Senbet & Simbanegavi, 2017; Suetterlin, Reinig, & Klingholz, 2018), and re-emphasised at the Malabo Declaration in 2014 (African Union, 2014; Masters et al., 2018; Senbet & Simbanegavi, 2017; Suetterlin et al., 2018).

Part B of the literature review outlines the study's theoretical framework. The theoretical framework specifically interrogated how theories on agricultural transformation can be considered from the perspectives of the theories around social-ecological-systems, institutional arrangements for social innovation, and digital agriculture. Literature on social-ecological systems theories was reviewed with a focus on agriculture as a complex social-ecological system. Social-ecological-systems theories were a golden thread that ran through this study. The literature review took an institutional arrangements perspective on agriculture as a complex social-ecological-system to discuss agricultural transformation within the African and South African context. Literature on digital agriculture was also considered taking a special focus on digitally disrupting agricultural institutional arrangements. The literature on the institutional arrangements of agricultural transformation was integrated with the literature on digitally disrupting agricultural institutional arrangements to come up with the theoretical framework on how to build social-ecological-system resilience, and its associated pathways of adaptability and transformability (Folke, 2006; Folke et al., 2010b; Holling, 1973), into the institutional arrangements for agricultural transformation.

The study's conceptual framework, outlined in Part C, was based on digital transformation's three aspects of (a) re-imagining leadership and strategic direction, (b) improving internal processes and productivity, and (c) strengthening external linkages. The execution of that conceptual framework was informed not only by theories on disruptions (Christensen, McDonald, Altman, & Palmer, 2018; Downes & Nunes, 2013) and platform business models (Gawer & Cusumano, 2015; Parker et al., 2016; Van Alstyne et al., 2016), but was also

underpinned by a development partnership premised on digitalisation's crucial triad (Armstrong & Lee, 2021).

PART A: BACKGROUND AND CONTEXT OF AGRICULTURAL TRANSFORMATION IN SOUTH AFRICA

South Africa has been battling with the triple challenges of unemployment, poverty and inequality (de Jongh et al., 2020). Unemployment in South Africa hit a new record in the third quarter of 2021 (Dludla, 2021; Smit, 2021). This Part A has two sections the first of which is on South Africa's SMME context. That section outlines how SMMEs in South Africa have been unable to address the economic challenges that South Africa faces. The context of South Africa's SMMEs serves as a prelude to the discussion on this study's background on South Africa's efforts on agricultural transformation in the following section. This study focused on the SMME component of agriculture through the notion of agricultural transformation.

2.2 South Africa's SMME context as prelude to agricultural transformation

The backbone of the growth of most African economies is considered to be the SMME sector (Tsatsenko, 2020) given that 22% of the working population in Africa are starting businesses. Entrepreneurship is perceived as a driver of economic growth that accounts for "95 percent of enterprises of all sizes" (Tsatsenko, 2020, p. 2). However, SMMEs in South Africa have a high failure rate with many of them not surviving beyond their first few years (Leboea, 2017). The high expectation of SMME contributing more to economic growth are further dampened (Tsatsenko, 2020, p. 9) by the constrained access of the sector to the formal economy as evidenced by the fact that 65% of SMMEs in South Africa operate in the informal sectors. The vulnerability of the SMME sector is further compounded by the relatively small sizes of the enterprises 36% of which are micro, 60% small and 4% medium sized (Tsatsenko, 2020). SMMEs are therefore failing to "address the chronic social ills of poverty, inequality and social deprivation ravaging" South Africa (Rambe & Mosweunyane, 2017, p. 1).

The South African government has put in place several policy objectives and support programmes for SMME development because of their "potential to make a contribution to structural transformation" (Tsatsenko, 2020, p. 10). Beyond availing financial support to

SMMEs, South Africa's Development Finance Institutions (DFI) have also been providing technical support (de Jongh et al., 2020). de Jongh et al. (2020) recommended that DFIs enhance linkages between private and public sectors as well as strategically taking a more local and regional focus that prioritises "assistance towards SMMEs specifically located in geographically disbursed areas" (p. 1). Their approach on local and regional focus is conceptually similar with the focus of the agri-parks AIS programme. Furthermore, some rural municipalities have been developing frameworks for stimulating rural SMMEs which however still need to be more effectively implemented (Bomani & Derera, 2018). Whilst these efforts at developing the SMME sector are expected to encourage sustainable economic growth due to their potential poverty reduction impact and how entrepreneurship can stimulates innovation, South Africa's level of economic development and the institutional contexts affect the dynamics of entrepreneurship. (Tsatsenko, 2020, p. 1)

SMMEs in South Africa are failing to "address the chronic social ills of poverty, inequality and social deprivation ravaging" the country (Rambe & Mosweunyane, 2017, p. 1), due to high early failure rates (Leboea, 2017), lack of access to the formal economy (Tsatsenko, 2020), failure to adopt ICT (Bvuma & Marnewick, 2020; Mabulele, 2020), and the weak linkages to between the public and private sectors (de Jongh et al., 2020). The institutional contexts of South Africa's level of economic development affect the entrepreneurial dynamics (Tsatsenko, 2020). This is so despite the interventions being made by the South African Government for SMMEs "to make a contribution to structural transformation" (Tsatsenko, 2020, p. 10), as well as the focus on local and regional initiatives in the non-financial technical assistance provide by DFIs (de Jongh et al., 2020), and frameworks for stimulating rural SMMEs being developed by local authorities (Bomani & Derera, 2018). This study therefore considered these institutional contexts that affect the dynamics of entrepreneurship in SMMEs within the agricultural sector by taking an institutional arrangements perspective on agricultural transformation.

Over and above the institutional challenges that SMMEs face in South Africa, Mabulele (2020, p. 3) submits that SMMEs in South Africa need to adopt ICT. Despite technology being recognised as enabling competitive advantage for SMME, South Africa's SMME lag behind other countries in using the internet (Mabulele, 2020). Mabulele (2020) recommends ways of addressing the six challenges that he identifies as being faced by SMME in harnessing digitalisation for their businesses. Bvuma and Marnewick (2020) also propose an ICT adoption

framework for SMME within South Africa's townships. However, these initiatives do not specifically focus and recognise the agricultural sector with its own specific peculiarities. This study therefore sought to harness digitalisation within the agricultural sector; to be more specific, the study considered the potential of harnessing digital agriculture for agricultural transformation.

Sustained good performance for SMME involved in agriculture could be attributed to entrepreneurial effectiveness contrary to small scale agricultural businesses' (SSAB) perception that diversification is a strategy for better business performance and managing dynamic risks, (Orlu, Van Zyl, & Umesiobi, 2017). This study therefore adopted digital transformation as a strategic approach (Constantinides et al., 2018; Gawer & Cusumano, 2014; Gupta, 2018; Hinings et al., 2018; Ismail, 2014; Kane et al., 2015) that would enhance entrepreneurial activity whilst also harnessing digitalisation's potential to be disruptive (Armstrong & Lee, 2021).

SSAB with stronger international linkages through foreign alliances (Rambe & Agbotame, 2018) also performed better than their counterparts without such alliances. This is supported by findings that agriculture in South Africa tends to be "locally disembedded, (and) linked to distant markets" (du Toit, 2016, p. 2). Rambe (2018, p. 1) further advocates for the SSABs to consider the "economic benefits of recruiting foreign labour even if that may increase their overhead costs". The study therefore adopted a conceptual framework based on digital transformation since digitalisation can facilitate virtual international linkages through, for example, the externalisation of labour, with concepts such as exponential organisation (Ismail, 2014) and platform business models (Parker et al., 2016).

The institutional dynamics of South Africa's SMME context suggested that the study should take an institutional arrangements perspective to agricultural transformation. The recognition that although technology can provide competitive advantage for SMMEs, coupled with the realisation that ICT frameworks for SMMEs do not specifically address SMMEs in agriculture, prompted the study to harness digital agriculture for agricultural transformation. The role of entrepreneurial effectiveness for SMMEs in agriculture motivated for the study to consider digital transformation as a strategic approach for agricultural transformation to enhance entrepreneurial effectiveness as well as stimulate digital disruption. The need to foster linkages also advocated for the study to consider platform business models.

2.3 Background discussion on South Africa's agricultural transformation

Having foregrounded the study on South Africa's SMME context in the previous section, this section takes a deeper dive into the role that SMME within the agricultural sector can contribute towards economic transformation. Greenberg (2015) argues that agrarian reform has the potential to contribute to progressive economic transformation and a just society. This is particularly so given the rising levels of unemployment in South Africa and the declining contribution of commercial agriculture to employment (Black et al., 2014). Agrarian reform is premised on land reform.

However, land reform in South Africa has not produced the expected results (Black et al., 2014). Furthermore, land reform suffers from perceived implementation shortcomings and criticisms by a variety of stakeholders calling for its abandonment (Twala & Selesho, 2013). Land reform still remains a social concern for black South Africans (Twala & Selesho, 2013). This background section on South Africa's agricultural transformation narrowed the context of this study further from SMMEs in general to SMMEs in the agricultural sector whilst also raising several issues highlighted below.

This section discusses the state of agricultural employment in South Africa and how the policies that have been put in place by the South African government towards agricultural transformation have targeted a small number of small-scale farmers. These policies include the National Development Programme (NDP) and the agri-parks AIS programme.

There have been reductions in agricultural employment (despite South Africa experiencing growth in agricultural production) as large scale commercial agriculture becomes more capital intensive (Black & Gerwel, 2014; Daniels, Partridge, Kekana, & Musundwa, 2013; de Satgé & Phuhlisani, 2020; Ferguson & Li, 2018; Hall & Aliber, 2010). Greenberg (2015) suggests that South Africa should look to small scale agriculture to boost agricultural employment and address poverty and inequality. This is important because of the role that SMMEs in agriculture can contribute to structural transformation (Barrett et al., 2017).

South Africa is estimated to have 200,000 small-scale commercial farmers and 2.5 million householders that supplement their livelihoods on subsistence agriculture (Hall & Aliber, 2010). However, estimates of employment in agriculture vary (Black et al., 2014; Daniels et

al., 2013; Department of Agriculture Forestry and Fisheries, 2014; Liebenberg, 2013). This study submits that integrating the 200,000 small-scale commercial farmers and 2.5 million householders who supplement their food security from agriculture into commercial markets and value chains can help to transform their agricultural activities in ways that enhance economic development and growth whilst also stimulating employment.

Black and Gerwel (2014) argue that South Africa needs policies that stimulate greater employment to counter the declining levels of support to agriculture and an over-emphasis on supporting capital intensive manufacturing. The National Development Programme (NDP) is targeting to create 643,000 primary jobs and 325,500 secondary jobs in “agriculture, agro-processing and related sectors” by 2030 (South Africa National Planning Commission, 2012, p. 64). The NDP was developed in the backdrop of South Africa having been increasing the amounts budgeted to support small-scale farmers, whose impact, Aliber and Hall (2012) argue, has been small because the support has targeted few farmers at the expense of bulk of small-scale farmers. The NDP backdrop of small number of farmers targeted is corroborated by Department of Agriculture Forestry and Fisheries (2014, p. 10) claims that government support for small-scale farmers has improved citing, as an example, that the number of “small-scale who were visited by extension officer” increased from 8% in 2010 to “between 13% and 14% for 2012/13”. This study submits that such low rates of growth in support to small-scale farmers are not sufficient to stimulate agricultural transformation.

Building on from the NDP, South Africa’s Department of Rural Development and Land Reform (2017) has established agri-parks AIS as a system of innovation to support an agricultural transformation programme in the hope of strengthening economic empowerment, development and growth (Black et al., 2014; Department of Agriculture Forestry and Fisheries, 2014; Department of Rural Development and Land Reform, 2017). The agri-parks AIS can be regarded as an institutional arrangement for social innovation. This study therefore adopted theories on institutional arrangements for social innovation (Hollingsworth, 2000) within its theoretical framework.

When the agri-parks AIS programme was launched in 2016, it intended, over a period of ten years, to bring full production to under-utilized land and expand irrigated agriculture in order to improve household food and nutrition security in rural areas (Department of Rural Development and Land Reform, 2017). Klerkx, Jakku, and Labarthe (2019, p. 390) submits

that an “AIS approach is not just about new technologies but also about institutional change”. The agri-parks AIS programme is a public policy intervention that seeks to alter the institutional structure of agriculture which is, in itself, a market-based industry. However, the manner in which the programme is faltering (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019) prompted the study focus on the small-scale farmers to conceptualise that institutional change. That focus bolstered the study’s adoption of theories on institutional arrangements for social innovation (Hollingsworth, 2000) within its theoretical framework.

South Africa’s agri-parks AIS programme is in line with how the African Union’s (AU) CAADP has also conceptualised agricultural transformation (African Union, 2003, 2014; African Union et al., 2003; Lopes, 2015; Otsuka, 2016; Senbet & Simbanegavi, 2017). Similar to CAADP, the agri-parks AIS programme expects agricultural transformation to stimulate economic development and growth in South Africa (ACET, 2017; African Union, 2014; African Union et al., 2003, 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; Sütterlin et al., 2018; World Bank, 2007). Consequently, this study adopts the theories of agricultural transformation within its theoretical framework.

The agri-parks AIS programme, beyond the confines of agricultural transformation, also has an economic empowerment orientation, development and growth redistribution agenda whereby, in the end, small-scale farmers will own 70% equity in the infrastructure for these multi-billion Rand agri-parks, whilst the remaining 30% minority shares will be held by public entities and other private sector participants (Department of Rural Development and Land Reform, 2017). This fundamental paradigm of small-scale farmers participating, as private sector business and commercial actors, in the agri-parks AIS infrastructure is expected to resolve the slow rate of transformation and address lack of inclusivity in South African agriculture and food systems (Department of Agriculture Forestry and Fisheries, 2014; Department of Rural Development and Land Reform, 2017; Drimie, 2016; Skinner & Haysom, 2016; South Africa National Planning Commission, 2012). The agri-parks AIS programme is a state-led public policy intervention into market based institutional arrangements which, paradoxically, hopes to create additional market based institutional arrangements. This study submits that such a public-sector led initiative has not been able to achieve its private sector aspirations. Consequently, this study brought in small-scale farmers as private sector

participants who created market-based institutional arrangements in Demeter and AgriHub Africa.

Whilst the agri-parks AIS programme is the South African government's most current intervention to address slow agricultural transformation, it appears to be facing challenges that manifest as slow progress (Erasmus, 2019; National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019). For example, the original target of establishing at least one agri-park AIS programme in the 44 district municipalities of South Africa has been revised down to 9 agri-parks AIS programmes for the whole country. Given that agriculture is context and ecology dependant, this study submits that it may not be practical for South Africa's agricultural innovation system to be supported by this reduced number of agri-parks AIS programmes. Consequently, this study has established AgriHub Africa as a framework around which local based institutional arrangements like Demeter can also emerge.

The Parliamentary Committee on ALR&RD (2019) and the National Council of Provinces Committee on Land Reform (2019) believe that the Department of Agriculture, Land Reform and Rural Development (DALRRD) does not have proper planning expertise to adequately implement the agri-parks AIS programme. This suggests that the ideal purpose of a business-oriented economic development and growth agenda of having small-scale farmers eventually own 70% of the agri-parks may not be achieved. Given that the agri-parks AIS programme does not appear to be on track (van der Walt, 2019), it is not possible that the programme may be able to achieve its ideal purpose of business oriented economic empowerment, development and growth on the back of agricultural transformation. Consequently, this study developed AgriHub Africa as an institutional arrangement within business oriented economic empowerment, development and growth can be achieved on the back of agricultural transformation.

Some of the issues raised in this section are indicative of what Neves and Hakizimana (2016) refer to as the "the dynamics of this, a 'stalled agrarian transition', (which) are starkly evident in South Africa and driven by the legacy of land dispossession and widespread structural unemployment". This study considers the approaches to transformation that can be taken to transform agriculture to address the situation.

Ollivier et al. (2018, p. 2) submits that there are two approaches to the transformation of agriculture; namely socio-technical transitions (Markard, Raven, & Truffer, 2012) and social-ecological system frameworks (Binder, Hinkel, Bots, & Pahl-Wostl, 2013). Both approaches “emphasize the need to consider interactions among technical innovations, the structure and type of social-economic-system, and eco-system functions and services²³ at multiple levels” (Ollivier et al., 2018, p. 2). Some of the best-known socio-technical transition approaches include transition management (TM) and multilevel perspective (MLP) (Markard et al., 2012). The social-ecological-systems approaches to transformation include, amongst others, institutional analysis and development (IAD) (Ostrom, 2009), and social-ecological-systems resilience theories and thinking (Folke et al., 2010b; Holling, 1978). This study adopts an approach to agricultural transformation that is premised on social-ecological-systems resilience theories and thinking and also uses aspects of institutional analysis.

In conclusion, Part A of this literature review discussed the background and context of agricultural transformation within two sections on the South Africa’s SMME context, and on the background to South Africa’s agricultural transformation. Those two sections identified theories on (a) agriculture as a social-ecological-systems, (b) an institutional-arrangements-for-social-innovation perspective on agricultural transformation, and (c) digitally disrupting agricultural institutional arrangements.

PART B: THEORETICAL FRAMEWORK

This Part B of the literature review interrogates the theories around these three concepts to integrate them into a four-dimensional theoretical framework that builds onto theories of agricultural transformation to talk towards harnessing digital transformation to build social-

²³ Eco-system functions and services can be broadly defined as the “benefits nature provides to people” (Barnaud et al., 2018, p. 14; Lescourret et al., 2015; Millennium Ecosystem Assessment, 2005; Teixeira, Vermue, Cardoso, Claros, & Bianchi, 2018). These are in the form of four categories of supporting services (which is the basis of the other three services), provisioning services, regulating services, and cultural services (Millennium Ecosystem Assessment, 2005). “ES have been recently defined by Harrington et al. (2010:2781) as the “benefits that humans recognize as obtained from ecosystems that support, directly or indirectly, their survival and quality of life.” This definition that stresses the subjectivity of ES fits well with the constructivist perspective that we adopt in this paper, i.e., ES do not exist per se, but as subjective perceptions, socially situated and constructed (Latour 2004)” (Barnaud et al., 2018)

ecological-systems resilience into the institutional arrangements for agricultural transformation.

The first section of this Part B submits a proposition to reform and restructure institutional arrangements for agriculture in pursuit of agricultural transformation by taking a perspective on social-ecological-system regime shifts (Gupta, 2018; Hanson & Heeks, 2020; Hinings et al., 2018; Klerkx et al., 2019; Skog et al., 2018; World Bank, 2016). This proposition was supported by three further propositions that are discussed in the subsequent sections of this Part B on the study's theoretical framework of this literature review chapter. The second proposition was that harnessing digitalisation would create a system disturbance to the agricultural institutional arrangements. The system disturbance to the institutional arrangements for agricultural transformation would build social-ecological-system resilience that would lead to either adaptability or transformability. the emergence of new trajectories and pathways for agricultural transformation. The study's third proposition is that harnessing digital transformation as a strategic approach would result in social-ecological-systems resilience that fosters the transformability. The study's fourth and last proposition was that transformability would shift the existing regimes for the institutional arrangements of agriculture towards the desired agricultural transformation.

2.4 Social-ecological-systems: agriculture as a complex social-ecological-system

This section considered theoretical literature on why agriculture is considered as a complex social-ecological-system. The characteristics of a complex social-ecological-system were outlined whilst also discussing literature on how considering agriculture as a complex social-ecological-system has implications on agricultural transformation. This section also reviewed the opportunities that exist for agricultural transformation from recognising agriculture as a complex social-ecological-system. Although social ecological systems can be considered as complex adaptive systems (Crépin, Biggs, Polasky, Troell, & De Zeeuw, 2012; Herrero-Jáuregui et al., 2018; Rivera-Ferre et al., 2013), this study considers agriculture only from the narrow lens of social-ecological-systems.

Several authors have described agriculture as a complex social-ecological-system (Lescourret et al., 2015; Musvoto et al., 2009; Ollivier et al., 2018; Pereira et al., 2020; Rivera-Ferre et al., 2013; Rivera-Ferre, 2020; Sinclair et al., 2017; Teixeira et al., 2018), with some “scientists driving a paradigm shift to address the key features of food as a complex socioecological system (Erickssen, 2008; Ingram, 2011; Rivera-Ferre, Ortega-Cerdà, & Baumgärtner, 2013; Rockström et al., 2017)” (Rivera-Ferre, 2020, p. 2731). Musvoto et al. (2009, p. 2) advocate that considering agriculture as a complex social-ecological-system enables for a “to better understand(ing of) the various influencing factors and to identify potential points of intervention”. This study has therefore taken this approach in an endeavour to identify where and how to intervene during the PAR stages of the research.

Campbell (2012, p. 2) submits that transforming agriculture requires “bringing agricultural research into a world where governance, institutions, human wellbeing, ecosystem services and natural capital all matter”. However, farmers manage agricultural system as complex social-ecological-system in order “to achieve desired outcomes, including food production and other ecosystem services (ES)” (Teixeira et al., 2018, p. 44). This means that by considering agriculture as a complex social-ecological system, this study recognises farmers as agents for transformation who can make appropriate interventions based on understanding various factors. Over and above using social-ecological-systems thinking to explore how and where to make such interventions, this study enlisted small-scale farmers as the drivers of the interventions that were carried out during the PAR stages of the research.

Anderies et al. (2004, p. 5) define social-ecological-systems as complex, non-linear and adaptive “ecological systems intricately linked with and affected by one or more social systems”. Social-ecological-systems are delimited units that include biological, geographic, natural, and physical components within functional and spatial boundaries encompassing particular contexts and ecosystems (Allen et al., 2014; Anderies et al., 2004; de Vos et al., 2019; Herrero-Jáuregui et al., 2018; Lescourret et al., 2015). They are dynamic, non-linear, have different scales and display an ability to emerge and self-organise (Allen et al., 2014; Anderies et al., 2004; de Vos et al., 2019; Herrero-Jáuregui et al., 2018; Lescourret et al., 2015).

The adaptive cycle

The dynamics of social-ecological-systems can be explored, described and analysed using the four phases of the adaptive cycle that most natural systems pass through over time (Gunderson et al., 2007; Gunderson & Holling, 2002; Walker et al., 2004).

The adaptive cycle is an endogenous heuristic model that is generated from observations and studies of eco-system dynamics and changes (Holling 1986), as well as “Schumpeter’s work on technical innovation and economic cycles (Gunderson and Holling 2002, Allison and Hobbs 2004)” (Folke, 2006; Ollivier et al., 2018, p. 4). The adaptive cycle analyses, describes and portrays the dynamics that a social-ecological-system goes through over time in four developmental phases of growth (r), accumulation (K), collapse (Ω), and renewal (α) which are “driven by discontinuous events and processes” (Folke, 2006, p. 258).

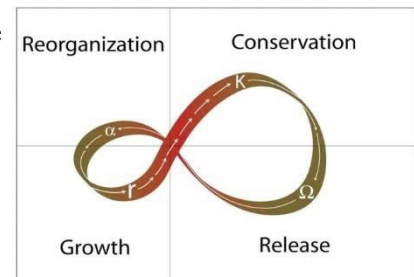


Figure 2. 1 - The adaptive cycle.
Source – Folke, 2006

The adaptive cycle has a relatively slow and more-or-less predictable “front” or “fore loop” that reflects the r-K dynamic, and a “a chaotic, fast “back loop” that strongly influences the nature of the next fore loop” (Folke et al., 2010b, p. 20).

The four phases of the adaptive cycle follow a common trajectory which includes one of rapid and exponential growth and exploitation (r) with freely available resources and high resilience (Folke et al., 2010b; Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017). This phase merges into the capital and resource accumulation and conservation phase (k) with resources largely locked in “a gradually rigidifying phase” of stasis and rigidity that exhibits little flexibility, low resilience, minimal innovations, and are more responsive to external shocks (Folke et al., 2010b; Gunderson et al., 2007; Ollivier et al., 2018; Sinclair et al., 2017).

This is inevitably and eventually followed by sudden chaotic collapse and release of resources phase (Ω) of readjustment and collapse which undoes structures and relationships (Folke et al., 2010b; Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017). There will then be a renewal and reorganization phase (α) during which novelty, innovation and new opportunities are possible and prevalent (Folke et al., 2010b; Gunderson et al., 2007, p. 7; Ollivier et al., 2018; Sinclair et al., 2017).

This study used the adaptive cycle to explain how the “interlinked phases of change in SES structures and functions” can be regarded as akin to regime shifts (Walker et al. 2004). Similarly, the study regarded how social-ecological-systems are subjected to “critical transitions and are responsive to external shocks” in similar ways to how systems disturbances are “external or higher-scale influences (that) can cause a move from any phase to any other phase” Folke et al. (2010b, p. 20). This study was guided by how Sinclair et al. (2017, p. 20) regard that the adaptive cycle can be “used as a heuristic for resilience assessments (Allison and Hobbs 2004, Lyon and Parkins 2013), for exploring change in resilience in SES over time (Walker et al 2009, Lockwood et al. 2014), for conceptualizing changing power dynamics (Pelling and Manuel-Navarrete 2011), and for identifying social traps (Fath et al. 2015)” to incorporate the concepts of regime shifts and system disturbances.

This study reviewed power dynamics in the institutional arrangements for high value vegetables horticulture as a basis for identifying that “social traps” that inhibited agricultural transformation. The review of those power dynamics informed the emergence of Demeter and AgriHub Africa as institutional arrangements that served as systems disturbances to effect regime shifts.

Regime shifts

Crépin et al. (2012, p. 15) consider regime shifts as “substantial reorganizations in system structure, functions and feedbacks, which can lead to changes in the provision of ecosystem services with significant impacts on human well-being”. Biggs et al. (2018, p. 8) submit that, theoretically, regime shifts are “systemic reorganization of systems (that) correspond to critical transitions between alternative stable states, separated by critical thresholds or tipping points” caused by systems disturbances. They submit that social-ecological-systems “shift from being organized around one set of dominant, reinforcing processes and structures to another (Scheffer 2009, Levin et al. 2013)” (Biggs, Westley, & Carpenter, 2010); in other words, they shift from one regime to another regime.

Biggs et al. (2018, p. 9) define a regime as a “range of conditions across which the system may fluctuate while retaining a similar structure and function”. The dynamics of social-ecological-systems can be understood and analysed by identifying the feedbacks that regulate them (Biggs et al., 2018; Meadows, 2008). In this ways, social-ecological-systems can be viewed as

“networks of elements linked by feedback loops, which can be either balancing (counteracting change) or reinforcing (enhancing change)” in such a manner that in social-ecological-systems the “same set of feedbacks always dominates so that the system always has a similar structure (e.g., dominated by grasses) and functions in broadly the same way” (Biggs et al., 2018, p. 8). Most complex social-ecological-systems have “more than one configuration of dominant feedbacks (in terms of structuring the flow of matter and energy in the system)” (Biggs et al., 2018, p. 8).

A particular regime is formed when “a specific set of feedback loops will tend to become dominant over time so that the system becomes structured and functions in a particular way” (Biggs et al., 2012). The particular regime that is dominant “at a particular point in time depends on the starting conditions of the system and its history of disturbances and pressures (Scheffer 2009)” (Biggs et al., 2018, p. 8). Some regimes become dominant “because at least some of the dominant feedbacks are usually reinforcing, creating conditions that enhance the persistence of the particular regime, making it “sticky” (Biggs et al., 2018, p. 8).

A switch in the dominant feedbacks of a social-ecological-system is called a regime shift that is “often associated with rapid nonlinear change as the system reorganizes into a different structure and starts functioning in a different way” (Biggs et al., 2018, p. 9). A regime shift can be caused by a gradual change that “slowly erodes the strength of the dominant feedbacks until a critical threshold or tipping point is reached at which a different set or direction of feedbacks becomes dominant, and the system reorganizes into a new regime” (Biggs et al., 2018, p. 9). Alternatively, a regime shift can be caused by large shocks, such as a fire, which can “overwhelms the dominant system feedbacks or changes the direction of a reinforcing feedback” (Biggs et al., 2018, p. 9). These system disturbances, both gradual changes and shocks, that drive regime shifts “are usually external variables that directly or indirectly influence the feedback dynamics of the system” (Biggs et al., 2018, p. 9).

System disturbance

A system disturbance is anything spontaneous, naturally occurring or man-made that “causes a disruption to a system” and include natural events such as fire or droughts and man-made interventions such as revolution, innovations or technological change (Gunderson et al., 2007, p. 7). System disturbances that exert gradual change or cumulative pressure are called “press

disturbances” whilst those that occur as discrete events or shocks are called “pulse disturbances” (Gunderson et al., 2007, p. 7). Walker et al. (2004, p. 5) state that “three related attributes of social-ecological-systems determine their future trajectories: resilience, adaptability, and transformability” as they respond to system disturbances.

Resilience, adaptability, and transformability

The manner in which a social-ecological-system responds to a system disturbance depends on its social-ecological-system resilience (Folke, 2006; Folke et al., 2010a; Folke et al., 2010b; Holling, 1973; Walker et al., 2004). Social-ecological-systems resilience is the capacity of a social-ecological-system to transform or adapt in response to unexpected changes, normally referred to as systems disturbances, in such a manner as to continue to exist and perform the functions of the social-ecological-system (Folke, 2006; Folke et al., 2010a; Folke et al., 2010b; Holling, 1973; Walker et al., 2004).

Walker et al. (2004) states that “resilience (the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks) has four components—latitude, resistance, precariousness, and panarchy—most readily portrayed using the metaphor of a stability landscape. Adaptability is the capacity of actors in the system to influence resilience (in a social-ecological-system, essentially to manage it). There are four general ways in which this can be done, corresponding to the four aspects of resilience. Transformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable.”

Folke (2006, p. 259) states that “social-ecological-systems resilience is about the opportunities that disturbances open up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories”. He further submits that “the concept of resilience in relation to social–ecological-systems incorporates the idea of adaptation, learning and self-organization in addition to the general ability to persist disturbance” (Folke, 2006, p. 260).

Agriculture as a complex social-ecological-system

This study, took the perspective of agriculture as a complex social-ecological-system with different scales. This therefore meant that this study considered the individual farm, upon

which the small-scale farmer operates, as the basic unit of operation and analysis. Conceptually, each small-scale farmers was considered as being part of a micro social-ecological-system with all the components of a social-ecological system.

Each of the small-scale farmers that were participants in this study's PAR stages have an adaptive cycle within which they are at one of its four stages at any point in time. They have certain régimes that they are in and they are subject to regime shifts in response to systems disturbances. They also experienced natural system disturbances such as adverse weather (e.g. frost, hail, or black spot fungal infestation), as well as man-made ones such as technical advice from colleague farmers. These system disturbances can be press disturbances or pulse disturbances. In response to system disturbances, the small-scale farmers exhibited social-ecological-system resilience that manifested as either adaptability or transformability.

Recognising that agricultures is a complex social-ecological-system informed this study to take a perspective that focusses agricultural transformation on social-ecological-systems régimes. The social-ecological-systems régimes within which the agricultural social-ecological-systems exist are manifestations of the mechanisms that economic players use to resolve several economic questions. In essence these social-ecological-systems régimes represent the stage of the adaptive cycle for the institutional arrangements for agriculture. In order to effect agricultural transformation, this study thus took an institutional arrangements perspective towards shifting those social-ecological-systems régimes.

2.5 Agricultural transformation: an institutional arrangements perspective

This section reviews theoretical literature on the role of agricultural transformation in economic development from the works of Lewis (1954) to this contemporary period during which agricultural transformation is now being referred to as structural transformation²⁴ (Alobo Loison, 2015; Barrett, Carter, & Timmer, 2010; Barrett et al., 2017; Dercon & Gollin, 2014; Jayne, Chamberlin, & Benfica, 2018; Johnston & Mellor, 1961; Lewis, 1954; Mhone, 2000;

²⁴ Barrett et al. (2017, p. 5) define structural transformation as “the process by which low-income societies, in which agriculture absorbs most labour and generates most economic output, become high-income societies characterized by a relatively smaller but more productive agricultural sector.”

Ranis & Fei, 1961; Rostow, 1956; Timmer, 1988). The literature review also considered empirical evidence on agricultural transformation in Africa as well as South Africa's record of implementing its own current variant of agricultural transformation (Black et al., 2014; Boatemaa et al., 2018; Department of Agriculture Forestry and Fisheries, 2014; Drimie, 2016; du Toit, 2016; Qobo & Wood, 2016; Sihlobo & Nel, 2016) in its agri-parks AIS programme (Department of Rural Development and Land Reform, 2017; Erasmus, 2019; Makaepe, 2017; Makhura, 2020; National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019; van der Walt, 2019). This literature review section concludes by submitting a proposition that the institutional arrangements for agriculture tend to inhibit agricultural transformation in South Africa by maintaining the existing social-ecological-system regimes (Biggs et al., 2018; Crépin et al., 2012; Hollingsworth, 2000; Mhone, 2000; O'Connell et al., 2019; Van Der Merwe, Biggs, & Preiser, 2018; Zhuwao, 2013).

Theoretical perspectives on agricultural transformation

Agricultural transformation has been considered as the growth in the agricultural sector that precedes or occurs concurrently with economic growth in a defined territory (Barrett et al., 2017; Jayne et al., 2018; Johnston & Mellor, 1961; Lewis, 1954; Senbet & Simbanegavi, 2017; Timmer, 1988; World Bank, 1982). According to Lewis (1954, p. 433) "industrial and agrarian revolutions always go together, and ... economies in which agriculture is stagnant do not show industrial development" for a two sector closed economy. Whilst the assumptions adopted by Lewis (1954) do not reflect reality, his model provides a useful heuristic tool to consider the process of economic development.

Johnston and Mellor (1961), building on the works of Lewis (1954) for a two sector closed economy, submitted that increases in agricultural productivity would result in surplus rural incomes. These surplus rural incomes would form the basis of domestic savings that would be reinvested in the industrial sector. The industrial sector would produce non-farm products that would be sold to the agricultural sector which would have been earning surplus income from the increased agricultural productivity. Concomitantly, the increases in agricultural productivity would result in lower food prices for feeding the growing industrial sector. Johnston and Mellor (1961) provided a framework that explained production and consumption linkages between the agricultural and industrial sectors in virtuous cycles of growth. However,

the Johnston and Mellor (1961) framework is still predicated on assumptions of a closed two sector economy.

Ranis and Fei (1961) also built on the Lewis (1954) model to provide a more rigorous analysis and explanation of the “critical minimum effort” (Ranis & Fei, 1961, p. 534) required for the take-off stage in the Rostow (1956) processes and stages of economic growth models (Rostow, 1952; Rostow, 1990). They reformulated the assumptions stated by Lewis, incorporated and integrated real-world dynamism, population growth and balanced growth. Their formulation of a precise mathematical model explained in a more rigorous manner how an economy moves into self-sustaining growth from stagnation. Ranis and Fei (1961) provide a quantitative complement to the qualitative proposition by Johnston and Mellor (1961) that agriculture is a necessary pre-condition for industrial development (Lewis, 1954).

Timmer (1988) referred to the Johnston and Mellor (1961) virtuous cycle of growth as agricultural development and claimed that the engine of economic growth for all successful countries was a phase of fast paced agricultural growth. However, it must be noted that the analyses conducted by Timmer (1988) were based on economies that were not as open and well linked and connected as present day economies. Today’s current realities are such that most, if not all, economies are very far removed from being closed and isolated.

Dercon and Gollin (2014) believe that there are sound theoretical bases for considering improvements in agricultural productivity as catalysts for industrialisation given the assumptions of a closed economy domestically satisfying its own food requirements. However, the South African reality is that the local economies are not closed but are “influenced by the terms of integration to the larger regional and national economy” (Neves & Hakizimana, 2015, p. 130).

Furthermore, some economic historians have been challenging the notion that agricultural growth is a necessary pre-condition for industrial development with some arguing that the empirical causal relationships for industrialisation are complex and could also be attributed to technology and commerce apart from agriculture alone (Allen, 2009; Clark, 2003; Tsakok & Gardner, 2007). Consequently, the Barrett et al. (2010) review of a century of literature on agricultural transformation describes how some researchers, including Peter Timmer (2009), have moved towards describing agricultural transformation as structural transformation.

Consequently, this study regards digital agriculture as a potential mechanism for considering the effects of technology and commerce on industrialisation.

However, the AU and CAADP conceptualised agricultural transformation at the 2003 Maputo Declaration (African Union, 2003) before the notion of agricultural transformation shifted to structural transformation. They have nonetheless continued to re-affirm that conceptualisation of agricultural transformation at the 2015 Malabo Declaration (African Union, 2014) despite the shift in terminology to structural transformation. The World Bank (2007, p. 35), in its 2008 World Development Report, advocated for structural transformation based on history showing that “higher agricultural productivity generating an agricultural surplus, taxed to finance industrial development, and enabling lower food prices underpinned early development in Western Europe, the United States, and Japan, and later in Taiwan, China, and the Republic of Korea”.

Agricultural Transformation in Africa and South Africa

This study was informed by the theoretical conceptualisation of agricultural transformation from its early days of the Lewis (1954) two sector model of development, through its framing by Johnston and Mellor (1961) and Ranis and Fei (1961), and to its articulation by Timmer (1988). The study however took on the practically applicable definition adopted by the AU and CAADP, development organisations such as Alliance for a Green Revolution in Africa (2017) and African Center for Economic Transformation (2017), and multi-lateral institutions which include FAO (2017) and International Fund for Agricultural Development (2016).

The AU and CAADP have reconceptualised agricultural transformation into a practically applicable concept (African Union, 2003, 2014; African Union et al., 2003). The then Chairman of the NEPAD Implementation Committee, President Obasanjo of Nigeria, set the tone for what has been almost two decades of aspirations when he said, “Agriculture will provide the engine for growth in Africa” (African Union et al., 2003, p. iii) with the notion that “improving agricultural performance is at the heart of improved economic development and growth” (African Union et al., 2003, p. iii).

This notion of agricultural transformation for Africa which has spurred on hope for economic development is premised on the Lewis and Ranis-Fei models (Lewis, 1954; Mhone, 2000; Ranis & Fei, 1961) with its assumptions which include a closed two sector economy. Empirical

evidence on real world open economies suggests that this notion of agricultural transformation is not yielding the expected wide spread and inclusive economic empowerment and development, despite some successes on economic growth (Alobo Loison, 2015; Barrett et al., 2017; Dercon & Gollin, 2014; Jayne et al., 2018; Masters et al., 2018; Mhone, 2000). A review of empirical literature on agricultural development conducted by Barrett et al. (2010) identifies three themes on the more contemporary notion of structural transformation driven by the macro, meso, and micro roles of agricultural development.

The macro role of agricultural development relates to agriculture's linkages to the broader economy (Barrett et al., 2010; Hayami & Ruttan, 1971; Johnston & Mellor, 1961; Lewis, 1954; Ranis & Fei, 1961; Rostow, 1956; Staatz & Eicher, 1998; Timmer, 1988, 2009; World Bank, 2007). Stylised macro models of economic growth in Africa, based on computable general equilibrium (CGE) models for development policy (Dervis, 1982; Lofgren, Harris, & Robinson, 2002), suggest that there are significant improvements in economic growth for Africa that arise out of policy interventions which favour investing more into agricultural productivity (Barrett et al., 2017; Dercon & Gollin, 2014; Diao, Hazell, & Thurlow, 2010; Dorosh & Mellor, 2013). Dercon and Gollin (2014) report that there is a widespread perspective that policies on agricultural development should focus on Africa's small-scale farmers because they constitute the bulk of the poor in Africa. Consequently, South Africa's agri-parks AIS programme focuses on small-scale farmers.

Another macro perspective that considers the role of agricultural development in poverty reduction in Africa is due to the large number of poor people who survive on agriculture (Dercon & Gollin, 2014). Growth in agriculture is more important than growth in other sectors for reducing poverty for poorer African household than for richer ones, and vice versa (Ligon & Sadoulet, 2007). On the whole, agricultural growth has an impact on poverty in Sub-Saharan Africa which is two to three times higher than growth in other sectors (Christiaensen, Demery, & Kuhl, 2011), and its impact is four times higher for China (Chen & Ravallion, 2007).

The meso-level theme considers the roles of markets, institutions and technology in enhancing agricultural productivity especially on smaller farms (Antle & Crissman, 1990; Bandiera & Rasul, 2006; Barrett et al., 2010; Besley & Case, 1993; Conley & Udry, 2010; Fackler & Goodwin, 2001; Fafchamps, 2004; Feder, Just, & Zilberman, 1985; Foster & Rosenzweig, 1995; Hayami & Ruttan, 1971; Lin & Nugent, 1995; Moser & Barrett, 2006; Schultz, 1964;

Schultz, 1975; Solow, 1957). Market failures and institutional failures at the meso level (Dercon & Gollin, 2014) provide opportunities for South Africans to develop the institutional and social framework required to make agriculture an engine for growth (Lescourret et al., 2015; Qobo & Wood, 2016). This study therefore focused how to develop the institutional and social frameworks that can address market and institutional failures that affect small-scale farmers.

Barrett et al. (2010) review the theme of micro perspectives on how individuals and households decide to participate in agricultural development (Barrett et al., 2010; Chayanov, 1966; Feder, 1985; Sen, 1966; Singh, Squire, & Strauss, 1986). Experiential learning and action can address and mitigate inefficient individual decision making. Another reason for targeting small-scale farmers in Africa is the inverse productivity claim that small-scale agriculture has better yields than bigger sized operations (Eastwood, Lipton, & Newell, 2010; Larson, Otsuka, Matsumoto, & Kilic, 2012). South Africa's agri-parks AIS programme targets small-scale farmers (Department of Rural Development and Land Reform, 2017; Gauteng Department of Agriculture and Rural Development, 2016; Makaepe, 2017). At the micro-level, this study also considered how to assist individuals and households to make efficient decisions that are based on experiential learning.

For post-apartheid South Africa, agricultural transformation faces complexities, including significant mismatches between policy pronouncements and implementation (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019). These complexities are highlighted by a profound lack of agricultural policy coherence (Drimie, 2016; Erasmus, 2019). Given these levels of policy incoherence, this study focussed on enabling small-scale farmers to take a more active role in determining their destiny in line with the notion of "seeds of a good Anthropocene" which point to how local level actors can develop solutions to their challenges (Bennett et al., 2016, p. 441).

Social-ecological-system regime shifts in institutional arrangements for Agricultural Transformation

Given that agriculture is a complex SES (Lescourret et al., 2015; Pereira et al., 2020; Rivera-Ferre et al., 2013; Sinclair et al., 2017), transformative changes in the institutional arrangements for agricultural and food systems can be effected by integrating social-

ecological-system approaches to regime shifts (Biggs et al., 2018; Crépin et al., 2012; Pereira et al., 2020; Scoones et al., 2020). A key research issue is the design of mechanisms for coordinating various players as institutional arrangements (Herrero-Jáuregui et al., 2018). These require innovation in rules, institutions and stakeholder organisations in order to build synergies between ecological system functions and social dynamics for collective multiservice management (Herrero-Jáuregui et al., 2018). The study sought to innovatively harness digital technologies and design institutional arrangements which could foster synergies between the social spheres and the ecological arena from the perspective of social-ecological-system regime shifts.

Consequently, this study had a proposition that taking a perspective on social-ecological-system regime shifts can reform and restructure the institutional arrangements for agriculture in order to achieve agricultural transformation (Gupta, 2018; Hanson & Heeks, 2020; Hinings et al., 2018; Klerkx et al., 2019; Skog et al., 2018; World Bank, 2016). The following section discusses the study's second proposition that harnessing digitalisation created system disturbance to the institutional arrangements for agriculture in order to effect agricultural transformation.

2.6 Digital Agriculture: digitally disrupting agricultural institutional arrangements.

In this section of the literature review, digitalisation and digital agriculture are examined prior to discussing the concept of digital disruption. This section interrogates literature on the potential to digitally disrupt agricultural institutional arrangements and demonstrate that agricultural transformation can be driven by using digitalisation as system disturbances to the social-ecological-system for high value vegetables horticulture in Gauteng. Harnessing digital transformation as a strategic approach on agriculture can build social-ecological-system resilience into agricultural institutional arrangements (Herrero-Jáuregui et al., 2018; Hollingsworth, 2000; Mhone, 2000; Parker et al., 2016; Pereira & Drimie, 2016a; Rivera-Ferre et al., 2013).

Digitalisation has been described variously (Armstrong & Lee, 2021; Ismail, 2014; Klerkx et al., 2019; Stolterman & Fors, 2004). Digitalisation places operational and management focus

on data secured through digital technologies to analyse previous trends and predict future scenarios (Eastwood, Klerkx, Ayre, & Rue, 2019; Janssen et al., 2017; Klerkx et al., 2019; Wolfert, Ge, Verdouw, & Bogaardt, 2017). Some of the technologies and concepts that are used in digitalisation include artificial intelligence, augmented and virtual realities, block-chain, digital connectivity, drones, internet of things, precision farming, remote sensing, and a host of others (Alm et al., 2016; Hanson & Heeks, 2020; Klerkx et al., 2019; Tilson, Lyytinen, & Sørensen, 2010).

This study adopts (Armstrong & Lee, 2021) crucial triad view of digitalisation as the application of digital innovation that occurs at the interface of digital technology development, evolving social dynamics and changing business models. This study took a pragmatic approach to digitalisation's crucial triad (Armstrong & Lee, 2021) which sought to place the small-scale farmer at the front and centre within the context of engaged scholarship (Van de Ven, 2007). The study's transformative approach was also influenced by (Bennett et al., 2016) page 441 "seeds of a good Anthropocene" which seeks to identify potentially beneficial examples from which to learn and drive transformation.

Although there are several decades of digitalisation in agriculture in areas such as precision farming and decision support systems (Leeuwis, 1993; McCown, 2002; Wolf & Buttel, 1996), digital agriculture is still expected to provide additional benefits to agriculture (Ajani, 2014; Eastwood et al., 2019; Hanson & Heeks, 2020; Janssen et al., 2017; Klerkx et al., 2019; Wolfert et al., 2017). Rose and Chilvers (2018), as well as Shepherd, Turner, Small, and Wheeler (2018) are confident in the potential that digital agriculture has to transform agriculture. The systematic review of literature by Klerkx et al. (2019) on digital agriculture suggests that whilst there is significant research on its technical aspects, the research on its social sciences dimensions is still at a nascent and scattered stage. Whilst having identified five clusters of existing social science research on digital agriculture, Klerkx et al. (2019, p. 11) call for research on "digitally enabled agricultural transition" as one of four proposed new clusters of social science research on digital agriculture. This study therefore seeks to contribute knowledge around "digitally enabled agricultural transitions" for that cluster of social science research on digital agriculture.

Whilst Westley et al. (2011) acknowledge the potential of digitalisation and other technological advancement for transformability, they nonetheless submit the need for institutional

entrepreneurship to address the dominance of existing institutional arrangements. Furthermore, Ajani (2014) submits that digitalisation and technological advancement need to be complimented by developing institutional arrangements and social structures that incorporate agency and power dynamics. This study has demonstrated that institutional entrepreneurship with the establishment of both Demeter and AgriHub Africa.

Hanson and Heeks (2020, p. 3) also concur that digitalisation in agriculture needs to be “looking beyond the technology to make parallel, complementary changes in resource provision and development of rural institutions and social structures”; in effect transcend from merely applying digital technology to operations and management but to digitalisation which incorporates digital technologies with new business models and new ways of socially engaging (Alm et al., 2016; Klerkx et al., 2019; Tilson et al., 2010; Yoo, 2010). This study demonstrated that adopting digitalisation’s crucial triad went beyond the digital technology revolution towards the institutional entrepreneurship that saw the creation of Demeter and AgriHub Africa.

Literature on digital agriculture suggested a proposition to harness digital transformation as an approach that makes digital disruption a system disturbance to the institutional arrangements for agricultural transformation. This study therefore adopted a proposition to utilise digitalisation for developing disruptive solutions and innovations to convert South Africa’s constraints and challenges into opportunities.

As a result, this study has birthed innovations that saw the emergence of Demeter and developed a minimum viable product (MVP) for AgriHub Africa as an agricultural industry MSMP super-app platform to catalyse agricultural transformation. These disruptive innovations and solutions can advance agriculture towards economic development and growth similar to the agricultural and green revolutions of the East Asian Tigers in the late 1960s revolution, and in 18th century United Kingdom (World Bank & China Development Bank, 2017).

Whilst there has been extensive work on the natural and technical aspects of digitalisation in agriculture, the research on the social sciences perspectives on digital agriculture is scattered (Klerkx et al., 2019). Consequently, Klerkx et al. (2019) have identified five existing thematic clusters of social sciences research on digital agriculture and proposed four prospective themes

for future research. Research on platform business models for digital agriculture has included the 2 x 2 topology proposed by Phillips, Relf-Eckstein, Jobe, and Wixted (2019). Phillips et al. (2019) analysis of digital agriculture network and platform topologies cannot determine which model has the “potential to dominate a market due to winner-take-all dynamics” of network effects (Hagiu & Wright, 2015).

This study contends that a solution that is driven by a partnership based on digitalisation’s crucial triad, as well as one that deploys hybrid disruption model of both the big bang and disruptive innovation has the potential to dominate a market. The architecture of AgriHub Africa was designed with the perspective of creating a hybrid agricultural industry platform and MSMP as a super-app.

This study considered the application of some of the five existing themes identified by Klerkx et al. (2019) in their review of social science research on digital agriculture. These themes are on (1) “adoption, uses and adaptation of digital technologies on farm” as part of enhancing the on-farm productivity envisaged with agricultural transformation, (2) “digitalization and agricultural knowledge and innovation systems (AKIS)” as implemented on AgriHub Africa, and (3) the “economics and management of digitalized agricultural production systems and value chain” within the South African context of a dualized agricultural sector (Klerkx et al., 2019, p. 1). Klerkx et al. (2019) also proposes four more potential themes for future research within which this study contributed towards themes on (1) “digitally enabled agricultural transition pathways” to achieve agricultural transformation, (2) “digital agriculture socio-cyber-physical-ecological systems conceptualizations” through exploring SES resilience, and “digital agriculture policy processes” which will hopefully inform policy as the 20th anniversary of CAADP beckons in 2023, and the agri-parks AIS programmes draws to a close in 2025 (Klerkx et al., 2019, p. 1).

Because digital agriculture has impacts on “farmer identity, farmer skills, and farm work” as well as on “power, ownership, privacy and ethics” (Klerkx et al., 2019, p. 1), this study adopted a participatory action research design to incorporate farmers as a way of fostering the “anticipation, inclusion, reflexivity, and responsiveness” dimensions of “responsible innovation in an era of smart farming” (Rose & Chilvers, 2018, p. 1). This study was motivated by the need to both generate evidence on and demonstrate the potential and “power to digitalise African agriculture” (Tsan, Totapally, Hailu, & Addom, 2019, p. 2) in order to also “promote

an environment for public-private interplays (PPIs) as well as a landscape for large scale commercial farmers to support small-holder farmers” within South Africa in particular (Aguera et al., 2020, pp. 2-4). The architecture of AgriHub Africa was designed with these considerations in mind.

Whilst Lohento and Sotannde (2019, p. ix) study “focuses on youth-led companies offering digital services to the agri-food sector in West Africa” and Krishnan, Banga, and Feyertag (2020, p. iv) also focussed on youth. However, Phillips et al. (2019) observed that in one of their cases under study, the digital agriculture platform “found all of his clients were aged 50 or older”. This suggested that this study should not unduly place too much emphasis on age. Consequently, this study deliberately sought to access respondents across wide demographics within South Africa. The evidence in this study is that most, if not all of the PAR participants are above the official age of youth.

Despite the increasing importance of digital information exchange between growers and other actors in horticulture supply chains, Robbemonde, Verdouw, and Benninga (2017, p. 1) “identify the drivers and barriers for exchanging information digitally” behind some of the reasons why large groups of growers do not participate digitally. Given that several authors concur that supply chain digitalisation has not yet reached its full potential (Buyukozkan Feyzioglu & Gocer, 2018; Hartley & Sawaya, 2019; Salvini, Hofstede, Verdouw, Rijswijk, & Klerkx, 2020), Salvini et al. (2020) submit that digital transformation can address the organisational and behavioural barriers that affect business operations. Chisoro-Dube, das Nair, and Landani (2019, p. 1) submit that the key driving investments on innovation, technological adoption, and horticultural value chain participation are determined by the “institutional power of industry associations, market power of lead firms, constitutive power of growing consumer demands and civil society organisations”. This submission was amply demonstrated through the creation of Demeter as an organisation for farmers.

The emergence of Demeter as an outcome of this study, together with the mushrooming of several WhatsApp groups and communities demonstrates this study’s second proposition on how digitalisation is causing systems disturbances to the institutional arrangements for agriculture. However, those systems disturbances may not necessarily build the social-ecological-systems resilience that would result in transformability. As a matter of fact, some of the key champions and drivers of Demeter seem to be driven by normative needs for

adaptability that enables their own profitable participation in the agricultural social-ecological-system without necessarily transforming agriculture for the bulk of small-scale farmers.

With that observation in mind, AgriHub Africa was built with specific normative intentions of not only building social-ecological-systems resilience into agricultural institutional arrangements, but to also steer that resilience into transformability. This normative intention as premised on the study's third proposition that a system disturbance to the institutional arrangements for agricultural transformation would build social-ecological-system resilience that would lead to the emergence of new trajectories and pathways for agricultural transformation. That third proposition influenced that the study's conceptual framework be developed around agricultural transformation as a strategic approach. The study's theoretical framework which is described in the following section provides the foundation for that conceptual framework.

2.7 Building Social-ecological-systems Resilience: the theoretical framework

This study is informed by the fact that agriculture is a complex social-ecological-system (Allen, Prosperi, Cogill, & Flichman, 2014; Bennett et al., 2014; Herrero-Jáuregui et al., 2018; Lescourret et al., 2015; Pereira & Drimie, 2016; Rivera-Ferre et al., 2013). This assists for a better understanding of the studies on the social dimensions of agricultural systems, and systematic reviews of food systems literature in South Africa which indicate that the country's agriculture and food system have negative food security outcomes (Herrero-Jáuregui et al., 2018; Pereira & Drimie, 2016; Rivera-Ferre et al., 2013).

Social-ecological-system resilience, the capacity of a social-ecological-system to maintain its core functions in response to systems disturbances (Folke, 2006; Folke et al., 2010a; Holling, 1973; Walker et al., 2004), can trigger the emergence of new trajectories that can lead to the adaptability or the transformability of the social-ecological-system (Folke et al., 2010b; Walker et al., 2004). Adaptability refers to the ability of the social-ecological-system to maintain its system functions without a change in its regime (Folke et al., 2010b; Walker et al., 2004). Transformability refers to the social-ecological-system's ability to maintain its core functions despite having shifted from a previous regime to a new one in response to system disturbances (Folke et al., 2010b; Walker et al., 2004).

Applying the concept of social-ecological-system transformability results in regime shifts that may reform and restructure agricultural institutional arrangements in order to effect agricultural transformation (Bennett et al., 2016; Folke et al., 2010b; Hamann et al., 2020a; Pereira et al., 2020; Scoones et al., 2020; Westley et al., 2011). Westley et al. (2011) and Scoones et al. (2020) advocate for nurturing social and technological innovations and combining institutional and enabling approaches to transformability in order to normatively shift social-ecological-system regimes towards desired outcomes. Bennett et al. (2016), Hamann et al. (2020a) and Pereira et al. (2020) also submit that bottom-up approaches enhance transformability towards normatively positive future regimes. Consequently, this study sought to make interventions at the level of the small-scale farm as a micro social-ecological-system nested by panarchy within the broader social-ecological-system of high value horticulture in Gauteng.

The study's third proposition is that harnessing digital transformation as a strategic approach would result in social-ecological-systems resilience that fosters the transformability. The study's fourth and last proposition was that transformability would shift the existing regimes for the institutional arrangements of agriculture towards the desired agricultural transformation.

PART C: CONCEPTUAL FRAMEWORK

This Part C of the literature review discusses the study's conceptual framework. The improvements in agricultural productivity required for agricultural transformation need agricultural innovations. However, this study submits that agricultural transformation requires going beyond innovation to move into the realms of disruption. That disruption was caused by digital transformation as a strategic approach. Consequently, the study's conceptual framework was premised on harnessing a digital transformation approach.

The digital transformation approach applied the transformative features and elements of network platform business models and the exponential organisations concept (Ismail, 2014; Parker et al., 2016). Such an approach enabled the study to conceptualise future pathways that were generated from bottom-up scenarios (Pereira et al., 2020; Scoones et al., 2020; Westley

et al., 2011). Such bottom-up scenarios were encapsulated in the small-scale farms as complex social-ecological-system. Furthermore, the farms are also essentially internal product platforms as discussed in the following section.

2.8 Agricultural innovation, digital disruption, abundance and the 6 Ds of digital disruption

This section describes how agricultural innovation and digital disruption provide catalysts for agricultural transformation. The section summarises the nature of agricultural innovation in its double dimensions of embodied exogenous innovations (EEI) and as packages of disembodied agronomic and managerial innovations (PDAMI) (Toborn & Harvesting, 2011). This section also introduces innovation's three dimensions of supply, demand, and the link between supply and demand to outline the three modes of digital disruptions (Armstrong & Lee, 2021). The section also outlines the concept of abundance (Diamandis & Kotler, 2012) and 6 D's of digital disruption (Ramirez, 2017).

Agricultural innovations can be classified in two ways as embodied exogenous innovations (EEI) and as packages of disembodied agronomic and managerial innovations (PDAMI) (Toborn & Harvesting, 2011). PDAMI can be created, delivered, and captured by connecting producers and consumers of such agronomic and managerial innovations (who would not have been previously matched) through platforms (Täuscher & Laudien, 2018). Using platforms, supply side participants who can also be demand side participants (and vice versa) can create, deliver, and capture value (Parker et al., 2016). The digital tools that were created as an outcome of this study provide such functionality; they include the Demeter WhatsApp group, the Demeter.Africa website and app, and AgriHub Africa.

Agricultural innovation must result in better profitability. However, Armstrong and Lee (2021) submit that innovation can be viewed from three perspectives of being demand driven, supply driven, and motivated by the link between supply and demand. They go further to define disruption in term of how it impacts on profits (Armstrong & Lee, 2021). The Armstrong and Lee (2021) framework on the modes and root causes of digital breaks down the profit equation in ways that connect root causes of disruption to demand, supply, and market engagement.

This study therefore adopted the framework proposed by Armstrong and Lee (2021) on the modes and root causes of digital disruption towards directing agricultural innovation to profitability. Consequently, AgriHub Africa was built as a profitability facilitation and enhancement platform. The key functions of AgriHub Africa are encapsulated in its Master Farmer Programme as a profitability based mentoring, training, and advisory service.

The AgriHub Africa Master Farmer Programme essentially encapsulates PDAMI. These PDAMI work concurrently with EEI such as weed covers, shadenets etc. Consequently, the AgriHub Africa Master Farmer Demonstration unit was established to also demonstrate the PDAMIs as well as EEIs. Because all of these innovations are focussed on increasing profitability, this study adopted the profitability-based conceptualisation of digital disruption (Armstrong & Lee, 2021). However, digitalisation is resulting in a concept referred to as abundance (Diamandis & Kotler, 2015, 2020).

Peter Diamandis has popularised the theme of abundance in which he optimistically asserts that almost every facet of human life is becoming easier and more available in abundant measures (Diamandis & Kotler, 2015, 2020). Diamandis' reason for being optimistic about today and the future is the perspective that technological progress has been and will continue to make things that were previously scarce to be available (Diamandis & Kotler, 2015, 2020). He suggest that not only is technology and the free flow of information accelerating innovation, but that innovation itself is also accelerating innovation (Diamandis & Kotler, 2015, 2020).

Diamandis lists ten key determinants which he asserts are becoming abundant whereas they used to be scarce (Diamandis & Kotler, 2015, 2020). The technological leaning key quality of life and economic opportunity determinants include computational abundance, technological convergence, and intelligence (Diamandis & Kotler, 2015, 2020). From a human perspective, he lists intelligence (which this study categorises as both technological and human albeit counting it as one), health span abundance, and time abundance (Diamandis & Kotler, 2015, 2020). Diamandis also lists such economic enablers as transportation abundance, energy abundance, capital abundance, and demonetisation (Diamandis & Kotler, 2015, 2020)

The abundance school of thought submits that many of the world's challenge have been, can be, and will, indeed in the future, be fixed by technological progress (Armstrong & Lee, 2021). The abundance school of thought contends that the 6 D's of digital disruption will be prevalent in every facet of human life (Armstrong & Lee, 2021; Ramirez, 2017). This means that

digitisation within agriculture will open the space up to exponential change (Afun-Ogidan, 2021; Aguera et al., 2020; Ayim et al., 2020; Hanson & Heeks, 2020; Jellason, Robinson, & Ogbaga, 2021; Klerkx et al., 2019). Deception and disruption will automatically follow digitisation (Armstrong & Lee, 2021; Ramirez, 2017).

Digital disruption in agriculture will lead to demonetisation that will make digital agriculture more commercially viable and feasible (Armstrong & Lee, 2021; Ramirez, 2017). Easy deployment and infinite scaling of digital agriculture will be possible due to dematerialisation (Armstrong & Lee, 2021; Ramirez, 2017). Ultimately, digital agriculture will be democratised through universal and ubiquitous access and availability (Armstrong & Lee, 2021; Ramirez, 2017).

2.9 The farm as an internal product platform

This study submits that a farm exhibits the typical characteristics of an internal product platform. This section reviews the literature of platforms as well as outlining the essential characteristic of an internal product platform. The section then submits that a farm is an internal product platform.

The academic history of platforms has been built on the internal product platform (Armstrong & Lee, 2021). Armstrong and Lee (2021) cite the academic literature on platforms from the works of Wheelwright and Clark (1992), through works by McGrath (1995), Meyer and Lehnerd (1997), Cusumano, Nobeoka, and Kentaro (1998), and Krishnan and Gupta (2001), up to works by Muffatto and Roveda (2002).

Armstrong and Lee (2021, p. 424) consequently propose a definition of platforms as “a set of subsystems and interfaces that form a common structure, from which a company can efficiently develop and produce a family of automobile products or consumer electronic devices”. However, that definition is specific to “automobile products and consumer electronic devices” and that definition has “emerged out of complex manufacturing environments” (Armstrong & Lee, 2021, p. 424). This study submits that agriculture is a complex social-ecological-system whose complexity is akin to the complex manufacturing environments mentioned above.

Considering a farm as an internal product platform is consistent with the widened definition of Robertson and Ulrich (1998) which Armstrong and Lee (2021, pp. 424-425) state as “viewing

platforms as the collection of assets (which they define as components, processes, knowledge, people, and relationships) that a set of products share”. Applying this definition to a farm, it can be seen that sets of farm products as diverse as livestock (e.g. chickens) and horticulture (e.g. spinach) share a collection of assets that are used in their production. Such assets include the ones cited in the above definition as well as other farm specific assets like the water harvesting and water deliver and reticulation systems, farm mechanization such as tractors, and farm infrastructure such as storage and handling facilities among a host of other resources.

Gawer and Cusumano (2014) submit that platforms are a structure for managing innovations, technology, and market disruption. Recognising that a farm is an internal product platform opens up new possibilities of how a small-scale farmer can re-imagine their enterprise within the ambit of the characteristics of platforms.

Platforms can open up economic structures by externalising economies of scale, radically altering supply and demand concentrations (Parker et al., 2016) , and optimising the use of factors of productions including “unlocking the commercial value of underused personal assets” (Kenney & Zysman, 2016, p. 62). The digitalisation that is forcing the deep reorganisation and change in economic structures and mobilising people to create, deliver and capture value is redefining the nature of work (Kenney & Zysman, 2016).

Platform business models can “change the nature of work and structure of the economy” depending on the choices that we make economically, socially and politically as the economy recalibrates and power dynamics shift (Kenney & Zysman, 2016, p. 61). Kenney and Zysman (2016, p. 62) submit that the value of human work will be more flexible and dispersed with a remote likelihood of a “workerless society” and attendant implications on research around “farmer identity, farmer skills, and farm work” (Klerkx et al., 2019, p. 1).

Kenney and Zysman (2016) submit that the reorganised economy will concentrate power in few platform owners. Ismail (2014) argues for benevolent dictatorship within the platform leadership (Gawer & Cusumano, 2014) whilst Eastwood, Klerkx, and Nettle (2017) envisage a role for public sector entities to coordinate, and possibly regulate the development of the platform economy. Rose and Chilvers (2018) call for responsible innovation amongst platform ecosystem participants, with de Vasconcelos Gomes, Salerno, Phaal, and Probert (2018) submitting a framework along which collective uncertainty in the innovation ecosystem can be

managed. This study's adoption of digitalisation's crucial triad as the founding principle not only allows for such responsible innovation but also enables engaged scholarship (Van de Ven, 2007).

This study uses Williamson's (1989) transaction cost approach to the theory of the firm because one of the essential characteristics of platform business models is the capacity to reduce transaction costs (Han, Martinez, & Neely, 2016). Han et al. (2016) submit that platforms have two essential characteristics. Platforms can reduce transaction cost because they have a common "core" or "architecture" with certain essential functions providing the basis of development of new products or services (Han et al., 2016). Platforms also create network effects because of their capability for reinforcing feedback loops among platform participants. (Han et al., 2016). Platform business models have become dominant because their architecture externalises assets and is based on a software platform (Parker et al., 2016) thus providing limitless capacity to scale relatively quickly and inexpensively. Because the dominance of platform business models is due to the externalisation of assets, the study does not adopt the resource based view of the firm (Parker et al., 2016).

This section has submitted that a farm can be considered as an internal product platform. Recognising that agriculture can be regarded as a complex social-ecological-system with various levels of nested ecosystems, this study also submits that a farm is not only a system (Dixon, Gibbon, & Gulliver, 2001; Janker, Mann, & Rist, 2019; Keating & McCown, 2001; Klerkx, Mierlo, & Leeuwis, 2012; Norman, 2002) but is a micro sub-ecosystem of the agricultural social-ecological-system. This means that the agricultural social-ecological-system is made up of the internal product platforms that constitute the farms within it. This perspective thus also informs the notion of addressing the scale challenges that small-scale farmers face by using platform business models.

2.10 Digital Transformation: conceptual framework for participatory action research for platform business models

This section of the literature review outlines that study's conceptual framework. Having outlined that the study's theoretical framework is premised on social-ecological-system resilience, this study also considered the small-scale farm as a micro social-ecological-system

in a nested panarchy of the broader agricultural social-ecological-system. The study acknowledged that high value vegetable horticulture in Gauteng is a complex social-ecological-system (Allen et al., 2014; Lescourret et al., 2015; Ollivier et al., 2018; Pereira et al., 2020; Rivera-Ferre et al., 2013; Sinclair et al., 2017). The regime states of the high value vegetables horticulture social-ecological-system maintain institutional arrangements that constrain the choices that actors and participants have in such a manner as to perpetuate the status quo and hinder the achievement of agricultural transformation (Biggs et al., 2018; Crépin et al., 2012; Hollingsworth, 2000; Pereira et al., 2020; Rivera-Ferre et al., 2013; Zhuwao, 2013).

The researcher and some study participants conducted participatory action research (Whyte, 1991) on interventions designed to build social-ecological-system resilience into the institutional arrangements for the small-scale farm as a high value vegetable horticulture social-ecological-system. This involved working with study participants to reimagine the leadership and strategic direction for high value vegetables horticulture towards a “massive transformational purpose” (Ismail, 2014, p. 10; Parker et al., 2016), improving internal processes and productivity by strengthening the core of existing operations, and enhancing their linkages through building capacity for the future.

The researcher and the study’s participants developed a framework for making digitalisation interventions that influence the study participants’ leadership and strategic direction based on the digitalisation concepts of network effects, exponential organisations and platform business models (Constantinides et al., 2018; Gawer & Cusumano, 2014; Gupta, 2018; Han et al., 2016; Ismail, 2014; Parker et al., 2016; Täuscher & Laudien, 2018; Uenlue, 2017b; Van Alstyne et al., 2016). The digital interventions on leadership and strategic direction addressed matters that include:

- interrogating the study participants’ purpose, vision, mission, and values;
- conceptualising a massive transformational purpose for the study participants;
- developing the study participants’ agricultural business models;
- planning how to manage the transition to digital agriculture; and
- designing learning and innovative agricultural enterprises (Gupta, 2018; Ismail, 2014).

Working jointly, the researcher and the study participants developed an intervention framework that aims to strengthen the core of the participants’ operations and management in order to:

- improve internal processes and productivity;
- managing the transition to digital agriculture through agricultural innovation and knowledge creation and sharing in order to enhance agricultural productivity and operational efficiency;
- the establishment of interfaces with external assets and resources;
- creating dashboards to monitor operations and engagements;
- experimentation to facilitate for innovation;
- improving autonomy to bypass hindrances to coal face innovation; and
- deploying social technologies to ensure maximum social engagements (Gupta, 2018; Ismail, 2014).

The study's participants and researcher jointly developed a framework for digitalisation interventions that are aimed at building capacity for the future through strengthening external linkages (Gupta, 2018; Ismail, 2014). The external linkages included:

- accessing markets and value chains;
- accessing skills that are on demand but external to the participants;
- developing communities and crowds through a platform for the participants and other stakeholders;
- coming up with algorithms that enable the participants to collect, secure, utilize and monetize data on past trends and predict future trends;
- leveraging external assets and resources; and
- engagements with stakeholders (Gupta, 2018; Ismail, 2014).

These processes were aimed at developing agricultural ecosystems and platforms that optimise agricultural value chains and multiple channel strategies in order to acquire, engage, maintain, measure and optimise agricultural produce markets, initiatives and consumers (Gupta, 2018).

2.11 Conclusion of Literature Review

This literature review has made four propositions. The first proposition is that the social-ecological-system regimes of institutional arrangements can be shifted so that there is reform and restructuring that can result in agricultural transformation. The second proposition is to

harness digitalisation to make digital disruption a system disturbance to the institutional arrangements for agricultural transformation. The system disturbances to the institutional arrangements for agricultural transformation will build social-ecological-system resilience that results in either adaptability or transformability. The third proposition sought to ensure that the social-ecological-system resilience that would be built in response to the system disturbances foster transformability. Consequently, the third proposition was premised on harnessing digital transformation as a strategic approach that would result in social-ecological-systems resilience. The study's fourth and last proposition was that transformability shift the existing regimes for the institutional arrangements of agriculture leading to the emergence of new trajectories and pathways towards normatively desired agricultural transformation.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Introduction

This methodology chapter describes why the study's transformative purpose led it to taking the critical social sciences approach and its associated qualitative methodology. The assumptions of the theories upon which the study methodology rest are also spelt out in this chapter. The methodology chapter describes such contingent factors as the study's transformative purpose. That transformative purpose influenced the adoption of the participatory action research design that was used around the study's multiple case studies within the context of a field study. These approaches provide the reasons why the study worked with qualitative data. This chapter on methodology also explains how the study was able to generalize from the analyses of the qualitative data since qualitative research deals with very small bodies of data.

This chapter on methodology has nine sections, with this introduction being the first section. The critical social sciences research approach and the associated qualitative methodology adopted during the study are described in section two whilst the multi-case participatory action research design and research techniques which were used during the study are explained in the third section. Section four describes the study site, the study population, and the study sample whilst the methods and instruments that were used to collect the data for the study are described in section five. The six section of this chapter details the way in which that data was analysed and interpreted. Section seven of this chapter highlights the limitations of this study, whilst the eight section addresses issues of quality and trustworthiness prior to the concluding section on ethical considerations. Whilst some researchers prefer to address ethical issues during data collection and also address quality and trustworthy issues during data analysis, this study is inclined towards having separate sections on ethical issues, as well as on quality and trustworthy issues.

3.2 Critical social sciences research approach and qualitative methodology

From a philosophical perspective, the transformative purpose of this study sought to empower small-scale farmers to harness digitalisation and SES resilience to launch new trajectories for agricultural transformation. The research approach for this study was informed by the

Hollingsworth (2000) premise that institutional arrangements for agricultural transformation are constrained by the environment in which they exist and they in turn limit the choices that actors have. This approach is consistent with the critical social science approach which sees people and human nature as shaped by society and human agency operating within bounded autonomy (Neuman, 2014). The critical social sciences approach taken by this study considers that people can be misled and have unrealised potential manifesting in reification²⁵ (Neuman, 2014). What is normally viewed as common sense is regarded as false consciousness requiring research to dig deeper to observe periods of conflict (Neuman, 2014) as submitted in the thesis on economic dualism and enclavity in Southern African economies by Mhone (2000). This study considered institutional arrangements for agricultural transformation as operating within the adaptive cycle of social-ecological-systems resilience (Folke, 2006; Holling, 1973) in the same way that critical social sciences views social reality as dialectical and historical (Neuman, 2014).

The study took the perspective that history enabled it to interpret facts whilst the theory that was needed to interpret objective reality is built on values (Mhone, 2000; Neuman, 2014). Consequently, the critical social sciences approaches taken in this study adopted a set of normative moral-political values (Johnston & Mellor, 1961; Lewis, 1954; Mhone, 2000; Ranis & Fei, 1961; Scoones et al., 2020) requiring the study to look at underlying structures (Hollingsworth, 2000; Mhone, 2000). The critical social sciences approach's requirement for deeper understanding was achieved through a qualitative research methodology using "abduction²⁶ to create explanatory critiques²⁷" (Neuman, 2014, p. 114). This study's abduction approach applied and evaluated interventions across multiple cases (Neuman, 2014) based on a conceptual framework premised on digital transformation's three dimensions of re-imagining leadership and strategic direction, improving internal processes and efficiency, and strengthening external linkages and value chains. Neuman (2014, p. 114) submits that an explanatory critique "often enlightens and helps to emancipate people" so that "people may

²⁵ "Reification is an idea used in critical social science referring to when people become detached from and lose sight of their connection to their creations and treat them as being alien, external forces" (Neuman, 2014, p. 113)

²⁶ "Abduction is an approach to theorising in which several alternative frameworks are applied to data and theory, which are redescribed in each and evaluated" (Neuman, 2014, p. 114).

²⁷ "Explanatory critique is a type of explanation used in critical social sciences in which the explanation simultaneously explains conditions (or tells why) events occur and critiques conditions (or points out discrepancies, reveals myths, or identifies contradictions" (Neuman, 2014, p. 114).

awaken to the underlying structures of society” and they can “learn how to influence mechanism to change larger social structures”.

This study’s critical social sciences approach accepted that objective reality is subjectively interpreted in nomothetic²⁸ and ideographic²⁹ approaches that adopt components of both positivist social sciences and interpretive social sciences approaches (Neuman, 2014). The critical social sciences approach of this study took a reflexive dialectic³⁰ orientation to blend subjective and objective insights that integrated cycles of observation, reflection, negotiation, and taking action (Neuman, 2014) in a participatory action research design (Whyte, 1991). Consistent with the critical social science approach, this study’s participatory action research design took a reflexive dialectic orientation with a transformative purpose and an activist orientation approach (Neuman, 2014). The purpose of this study was to empower and transform through knowledge which must be about praxis³¹ (Neuman, 2014).

From an ontological perspective, the study took a “methodological interactionism” approach (Sörvik, 2010, p. 68) that recognised that actors are also influenced by institutional arrangements within their context (Hollingsworth, 2000) even though these same actors have agency (Hodgson, 2007). This ontological perspective allowed for explanations of how the interactions and reconstitutions required for transformations in institutional arrangements of agricultural transformations were caused by individuals, and how the institutional arrangements also influenced individual actions (Sörvik, 2010). This ontological approach conforms to the Hollingsworth (2000, pp. 606-607) two-dimensional taxonomy of institutional arrangements which has “on the vertical dimension, the economist’s view of a self-interested agent (is) contrasted with a more sociological perspective, according to which social rules, obligation and compliance shape human actions”.

²⁸ Nomothetic reflects a tendency to generalize and is an approach that is typically used in natural sciences (Diener & Fujita, 1995).

²⁹ Ideographic reflects a tendency to be specific and is an approach that is typically used in the humanities (Diener & Fujita, 1995).

³⁰ “Reflexive dialectic is an orientation towards social knowledge used in science in which subjective and objective sides are blended together to provide insights in combinations unavailable from either side alone; the value of knowledge as a process that integrates making observations, reflecting on them, and taking action” (Neuman, 2014, p. 116).

³¹ “Praxis is a way to evaluate explanations in social sciences by putting theoretical explanations into the real life practice and the subsequent outcomes is used to refine explanation” (Neuman, 2014, p. 115)

3.3 Longitudinal multi-case participatory action research design

The study used participatory action research because one of its major goals, to “generate knowledge that is fed back into the setting” (Herr & Anderson, 2014, p. xiii), facilitates for understanding the feedback within social-ecological-system resilience’s adaptive cycle (Folke, 2006). The study conducted field research (Neuman, 2014) on multiple selected cases using a participatory action research design (Whyte, 1991) taking a longitudinal case study approach over 10 months.

The study used the field research approach to access the lived and real experiences of the people, organizations and institutions involved in fresh vegetable horticulture value chains (Neuman, 2014). Neuman (2014, p. 51) defines field research as “qualitative research in which the researcher directly observes, and records notes on people in a natural setting for an extended period of time”.

The study’s field research intended to focus on about five cases with selected study participants involved in fresh vegetable horticulture from each of the three metropolitan municipalities and the two district municipalities in Gauteng province. However, the study identified thirteen researcher participants to allow for any potential opt-out. By taking a case study approach, the study was able to obtain “in-depth, detailed knowledge” (Ragin & Amoroso, 2011, p. 92) that was also “varied and extensive” (Neuman, 2014, p. 42). The case study approach enabled the study to link the micro-level details of study participants to the institutional arrangements for fresh vegetable horticulture at the meso-levels and to the macro-level dynamics of agricultural transformation (Neuman, 2014; Vaughan, 1992; Walton, 1992). Walton (1992, p. 129) says that “case studies are likely to produce the best theory” because in-depth detailed case familiarity helps to shape and build theory to new situations, makes relationships and social processes more visible, and “provides evidence that more effectively depicts complex, multiple factor events/situations and processes that occur over time and space” (Neuman, 2014, p. 42).

The cases were studied using participatory action research (PAR) undertaken by a team comprised of the researcher and these PAR participants who wished to change their situation by jointly defining the problems that needed to be examined and then co-create knowledge about the problems by discussing the problem and potential solution, taking action, observing the results of the action and interpreting the results of what they would have learnt (Greenwood

& Levin, 2006; Herr & Anderson, 2014; Whyte, 1991). This was done in several iterations and cycles. Action research is a “research practice with a social change agenda” that democratizes knowledge creation (Greenwood & Levin, 2006, p. 4) whilst generating “knowledge that is fed back into the setting” (Herr & Anderson, 2014). Using participatory action research in this study was supported by research findings that small scale farmers’ performance is enhanced by them jointly participating in studies with a researcher (Amanor, 1989; Whyte, 1991) because participatory action research better addresses the “complex, diverse and risk-prone (CDR) farming systems of most small-scales” (Chambers, 2011, p. 1).

The study intended to conduct three longitudinal iterations of participatory action research which were built around the three major components of this study’s conceptual framework: namely re-imagining leadership and strategic direction, improving internal processes and productivity, and strengthening external linkages. The study originally intended to introduce one of the three components of the conceptual framework at each iteration until all three of the study’s conceptual framework dimensions would have been explored. However, because it was practically impossible to delink the three components into distinct and separate iterations, the study was done in one iteration for each case. That single iteration dealt with all three components of the study’s conceptual framework.

The research proposal was to have each of the three longitudinal iterations correspond to a growing season for specific high value vegetables for the study participants. However, the objective reality and practicality of the PAR participants agricultural activities were such that they had diverse high value horticultural crops with various growing cycles and at different stages of growth and production. This also motivated against having three longitudinal iterations to address the three components of the conceptual framework individually.

Consequently, the participatory action research then proceeded in three sequential steps the first of which was to provide the PAR participants with an introduction and appreciation of the fundamentals of digital agriculture strategy. The second step of the PAR process involved the actual development of a digital agriculture strategy for the PAR participants prior to the concluding step of implementing the developed digital agriculture strategy according to a common framework for a digital agriculture architecture.

3.4 Study site, population, and sample

The population and sample for the study are drawn from the study site which Neuman (2014, p. 385) defines as “the context within which events or activities occur, a socially defined territory with shifting boundaries”. This section identifies and describes the site of the study before discussing the study’s population and its sample.

Study site

Some researchers on social-ecological-systems transformations and regime shifts, including in the agricultural and food systems spaces (Pereira et al., 2020; Scoones et al., 2020), submit that focus should be placed on the features of the more successful cases of transformation in order “to find plausible pathways of development that hold the most promise for fostering a better future” (Bennett et al., 2016, p. 441). This perspective seeks to counter “the dominance of dystopian visions of irreversible environmental degradation and societal collapse, along with overly optimistic utopias and business-as-usual scenarios that lack insight and innovation, frustrate progress” (Bennett et al., 2016, p. 441).

Given that the South African Parliament has recognised and acknowledged that Gauteng Province has performed the best out of all of provinces in relation to implementing the agri-parks AIS programme, Gauteng was selected as the geographical and administrative location housing the site for this study (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019).

Population

Since this study was examining how the institutional arrangements (Hollingsworth, 2000) for fresh vegetables horticulture in Gauteng province affect small-scale farmers, the population was derived from the institutional arrangements that coordinate small-scale farmers in Gauteng who are involved in the high value vegetables horticulture. In order to ensure quality in data collection, the study identified and selected participants from each of the five regions of Gauteng, namely the three Metropolitan Municipalities of Ekurhuleni, Johannesburg and Tshwane and the two District Municipalities of Sedibeng and West Rand. Although the study

originally sought to selected one small-scale farmer from each of the five regions, at least two farmers from each region were selected to be research participants.

The population for this study were the institutional arrangements involved in the value chain for high value vegetables horticulture in Gauteng including those involved in what Porter (1985) described as the primary and support activities of small-scale farmers. Institutional arrangements are the mechanisms for coordinating various economic actors in resolving conflicting economic problems (Campbell, Hollingsworth, & Lindberg, 1991; Hollingsworth, 2000; Hollingsworth & Boyer, 1997; Hollingsworth & Lindberg, 1985; Hollingsworth, Schmitter, & Streeck, 1994). Institutional arrangements, consisting of “markets, various types of hierarchies and networks, associations, the state, communities and clans” (Hollingsworth, 2000, p. 604), resolve economic problems which include setting prices, determining production quantities, setting standards for products and processes, determining the quality of products and processes, and establishing how to finance various societal activities and processes (Campbell et al., 1991; Hollingsworth & Boyer, 1997).

Guided by the notion of “emphasizing hopeful elements of existing practice” (Bennett et al., 2016, p. 441), the institutional arrangements that were the population of this study are those within Gauteng because the Parliamentary Committee on ALR&RD (2019) and National Council of Provinces Committee on Land Reform (2019) recognise Gauteng as performing the best at implementing the agri-parks AIS programme. Given that the Gauteng Department of Agriculture and Rural Development (2016) has prioritised high value vegetables horticulture for its agri-parks AIS programme, the study’s population was the specific institutional arrangements for high value horticulture in Gauteng. The agri-parks AIS programme generally places emphasis on small-holder farmers (Department of Rural Development and Land Reform, 2017; Gauteng Department of Agriculture and Rural Development, 2016). Consequently, the study’s participatory action research interventions population was built around small-scale farmers. This was because small-scale farmers can potentially “generate creative, bottom- up scenarios that feature well-articulated pathways toward a more positive future” (Bennett et al., 2016, p. 441). In summary, the population of this study is made up of the institutional arrangements for the small-scale farmers in the three metropolitan municipalities and two district municipalities of Gauteng as well as the upwards linkages and the downward linkages to other ecosystem participants.

Samples and sampling methods

The sample from where data for the study was collected depended on the various stages of data collection that the research went through. The first stage of data collection involved qualitative document analyses and observations of the institutional arrangements for high value vegetables horticulture in Gauteng to provide the baseline for participatory action research interventions. The second stage involving participatory action research utilised observations, semi- structured interviews, and informal conversations. The third stage of data collection involved observations, semi-structured interviews and focus group discussions to better understand the results of the participatory action research interventions and outcomes in relation to the baseline data secured during the first stage.

During the first stage of data collection, document analyses was conducted on annual reports, state of the territories, digital platforms (e.g. websites and social media pages), and any other relevant documents of the following sources of data:

- Parliamentary Portfolio Committee on Agriculture, Land Reform and Rural Development
- National Council of Provinces Committee on Land Reform, Environment, Mineral Resources and Energy
- Department of Agriculture, Land Reform and Rural Development (DALRRD);
- National Agricultural Marketing Council (NAMC);
- African Farmers Association of South Africa (AFASA);
- Agri SA
- Agricultural Business Chamber AgBiz
- Producer Marketers Association (PMA)
- Gauteng Department of Agriculture and Rural Development;
- City of Ekurhuleni Metropolitan Municipality;
- City of Johannesburg Metropolitan Municipality;
- City of Tshwane Metropolitan Municipality;
- Sedibeng District Municipality; and
- West Rand District Municipality.

Data was also collected from a market agent based at the Johannesburg Fresh Produce Market.

Data for the second stage of data collection which was conducted during the participatory action research was secured from thirteen study participants. One participant was selected based on their interest in digitalisation and their specific request to be included in the study. This particular participant was an outlier because, firstly, their farm was outside Gauteng, and secondly, their main crop of garlic exhibits vastly different characteristics to the crops that the other twelve participants were engaged in. However, the institutional arrangements that affected this farmer were effectively the same as those that affected the other participants. This was primarily because this participant lived within Gauteng and would therefore secure their inputs from suppliers within Gauteng and sell their produce to markets within Gauteng.

Twelve of the participants were purposively selected in order to have at least two participants from each of the five municipalities of Gauteng since this province was touted by Parliament as having agri-parks with successful operations (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019), guided by the need to emphasize “hopeful elements of existing practice” (Bennett et al., 2016, p. 441). The second criteria for selecting the study participants involved in high value vegetable horticulture was their common involvement in growing leafy green vegetables. This provided a level of consistency and uniformity. Thirdly, the study participants’ willingness to share their activities through their previous participation in public fora (as evidenced by their presence on and levels of activity within digital platforms) was also used to purposively select study participants to participate in the participatory action research phase of the study because of the requirements for reporting on participatory action research. Lastly, the aptitude, orientation, and disposition of the study participants to participatory action research was also a determinant in selecting them into the study sample in order to facilitate the training that was required to prepare them for engaging in the participatory action research.

Data for the third stage of data collection was conducted through observations of events conducted for farmers at social networking braais and field days held at the farms operated by the research participants. The objective of collecting data from these events was to determine the extent of transformation that would have occurred during the participatory action research phase of the study. More data was also collected from observing how the digital platforms that some of the participants established would have been impacted the research participants.

3.5 Data collection methods and instruments

The study collected the bulk of its data from the participatory actions research interventions which are in concert with the three major components of this study's conceptual framework. Those three major components being around study participants (a) re-imagining leadership and strategic direction, (b) improving internal processes and productivity, and (c) strengthening external linkages. However, prior to conducting the participatory action research on the thirteen study cases, this study conducted preliminary qualitative investigation of the status of the institutional arrangements for the high value vegetables horticulture social-ecological-system in Gauteng.

Document analyses (Neuman, 2014, pp. 371-384) on electronic platforms such as websites and social media was used to collect data from public enterprises, associations and media entities who publish reports on high value horticulture, and agriculture in general, within both Gauteng and South Africa. The data obtained from the document analyses provided insights on how the agri-parks AIS programme has been originally conceptualised, implemented, and perceived. The document analysis provided historical data that represented screenshots of perceptions at particular periods in time and thus established the context of the most current initiatives aimed at agricultural transformation.

Sediri et al. (2020, p. 11) submit that dealing with transformability wickedness³² calls for “street-level observations of governance practices” to analyse how people in their daily practices deal with wickedness. The study was also supposed to use semi-structured interviews with key public officials in fresh produce horticulture value chains to obtain data on what has transpired, what is currently occurring and what is likely to happen around fresh produce horticulture in Gauteng. Additional data on current activities was supposed to be collected from semi-structure interviews with public officials, and through observations of the activities at various fresh produce markets in Gauteng and agri-parks that had been set up or are under construction by public sector entities within the province. Unfortunately, because the

³² Transformability wickedness or “wicked problems arise in transformation initiatives in the presence of high complexity, deep uncertainty, deep conflicts, and divergence among stakeholders, as well as scale mismatches concerning spatial, temporal, and institutional processes” (Sediri et al., 2020).

researcher did not obtain consent from the relevant public entities involved, those interviews and observations were not conducted.

Focus group discussions were supposed to be used to provide and validate data on collected from the observations and semi-structured interviews on what was currently transpiring and possible future scenarios. Focus groups would have been made up of the study's participants who would have formed part of the participatory action research. Since the semi-structured interviews were not done and the observations were not conducted, the focus group discussions were also not done.

The research instruments

The study's research instrument sought to obtain rich and detailed data of the institutional arrangements for high value vegetables horticulture during the different stages of data collection. As indicated earlier, data was collected using content analysis, observation, semi-structured interviews and informal conversations and discussions. The research instrument had five parts which were guided by the various methods that were used to collect data. The first three parts of the research instrument sought data to describe high value vegetables horticulture social-ecological-system whilst the last two parts sought data on how to intervene in its social-ecological-system resilience to cause regime shifts.

The first part of the research instruments sought to identify the various economic actors and players involved in high value vegetables horticulture in Gauteng and what they do and how they do it. These economic players, who include "producers and suppliers of raw materials, knowledge, etc.; processors of raw materials, information; workers; customers of raw materials, finished products, information, etc.; financiers; governmental and other types of regulators" (Hollingsworth, 2000, p. 605). The second part of the research instrument sought to establish the particular institutional arrangements for fresh vegetables horticulture in Gauteng which are described as consisting of "markets, various types of hierarchies and networks, associations, the state, communities and clans" (Hollingsworth, 2000, p. 605). The third part of the research instrument sought to determine how the institutional arrangements for high value vegetable horticulture in Gauteng assist the various economic players to resolve economic problems which include "how are prices to be set? What quantity of various products is to be produced? How are standards of various products, processes, etc. to be set? How is the

quality of products and processes to be determined? How are various societal processes to be financed?” (Hollingsworth, 2000, p. 605). All of these three parts of the research instrument (i.e. identifying the various economic actors and players, establishing the institutional arrangements for high value vegetables horticulture, and determining how the economic players resolve economic problems) were delimited to only the ones that interacted directly with this study’s PAR participants.

The fourth part of the research instrument sought to determine at which of the four stages of the adaptive cycle (Folke, 2006) the various institutional arrangements are currently at as a basis to determine how to intervene with specific system disturbances. The fifth and final part of the research instrument tried to ascertain the panarchy³³ (Folke, 2006) of the various institutional arrangements in order to anticipate how interventions with specific systems disturbance will result in regime shifts (Crépin et al., 2012).

Procedure for data collection

Data for the study was collected in different stages with the emphasis on data collection following a life history approach (Neuman, 2014). During the first stage of data collection for this study, the researcher used the first five of the six steps of field research suggested by Neuman (2014, p. 438) to conduct qualitative research. The researcher followed the six step guide suggested by Neuman (2014) because he has used these steps previously even though other authors, such as Denzin (2017) who suggests eight steps, propose differently. The participatory action research part of the study represented the second stage of data collection during which, the researcher used iterative processes of three steps suggested by James, Slater, and Bucknam (2011) after they had reconfigured the four step traditional action research model (Greenwood & Levin, 2006; Herr & Anderson, 2014; Whyte, 1991). The researcher used the last three steps of the six step guide suggested by Neuman (2014) as he concluded the data collection part of this study.

As earlier stated, this study used the six step field research model suggested by Neuman (2014). The first step in this study’s field research was for the researcher to prepare himself by reading

³³ Panarchy is interacting set of hierarchically structured scales (Gunderson & Holling, 2002). They draw on the notion of hierarchies of influences between embedded scales, that is panarchies, to represent structures that sustain experiments, test its results and allow adaptive evolution.

literature and documentary data and defocussing. During the second step, the research selected and entered Gauteng fresh vegetables horticulture with a specific focus on leafy greens as a field site. The researcher then entered the site and established relations with members in the field during the third step. In the fourth step, the researcher adopted “a social role, learns the ropes and gets along with members” in order to collect quality data through listening and watching in the fifth step (Neuman, 2014, p. 439). During the sixth and final step, although the researcher disengaged and physically left the site to conclude the analyses and report writing (Neuman, 2014), the researcher still maintained contact with the site by attending the networking braais and field days that the research participants had established.

James et al. (2011, pp. 16-18) suggest a cyclical three step process of conducting participatory action research which starts with what they term as “discovery”, followed by what they call “measurable action” and concluding with “reflection”. During this study’s discovery step, the researcher and participants jointly examined the participants’ current realities to understand as well as to decide what to do, and how to address the problem (James et al., 2011). The study also underwent a measurable action step as evolved by James et al. (2011) from the two steps of action and measurement in traditional action research (Greenwood & Levin, 2006; Herr & Anderson, 2014) in order to ensure that the actions embarked upon were designed with measurement in mind. The study’s third step of reflection assisted the researcher and participants to “delve deeply into what is working and not working” (James et al., 2011). This was largely done during final concluding observations, semi-structured interviews, and informal conversations and discussions as the researcher and the individual participants conducted concluding presentation.

3.6 Data analysis and interpretation

This section describes how the data for this study was analysed and interpreted. Data analysis was done through chronological sequencing, path dependency explanations, and comparing events and paths. These processes that were conducted during the analysis of the data are described in this section as well as outlining some of the techniques and tools that were used during data analysis such as analytic memo writing, looking out for markers, and searching for outcroppings. Whilst some researchers incorporate issues of data quality with regards to

reliability and validity in the data analysis section, this study addresses those issues separately in the next section.

Data analysis processes

The processes for data analyses were conducted in three stages. The first stage was to organize the data in a chronological manner in order to outline how agricultural enterprises of the research participants were conceived, how they had progressed up to the stage before participatory action research interventions were initiated, and the processes and events that have occurred as a result of the participatory action research interventions. The second stage of data analysis involved building path dependant explanations that were used to illustrate relationships and causal factors. The third and final stage of data analysis was to conduct comparisons of the events and paths identified from the data secured in all three stages of data collection. This provided comparisons of what was happening with the institutional arrangements for high value vegetables for the various participants, what happened during the participatory action research interventions, and what happened as a result of the interventions made during the participatory action research stage of data collection.

The study data was organized chronologically. This was made easier by the fact that data collection was structured to follow the life history approach. The data was first organized into events, and then the events were placed into chronological order. This process helped the researcher to see the sequence of events in a manner that facilitated for him to see the relationships of the events.

However, the sequence of events could only provide the researcher with visual aids, maps and diagrams that made it easier to see relationships between events. It did not provide the researcher with a complete and holistic picture of the relationships between institutional arrangements. Such sequencing of events could not guide the researcher to understand the processes that were underpinning and leading to the sequence of events.

Furthermore, whilst the sequence of events provided the researcher with a map of relationships between events, it however did not provide the researcher with a deep understanding of what was transpiring. The researcher needed to use another tool to get to better understand what was emerging from the data. The researcher therefore chose to use the path dependency tool.

The researcher had specifically chosen to use the path dependency tool to analyse the data since it “explains a process or chain of events as having a beginning that triggers a structured sequence such that the chain of events follows an identifiable trajectory over time” (Neuman, 2014, p. 479). Because agricultural transformation in South Africa seeks to resolve “problems inherited from the colonial period (that) have been perpetuated and accentuated” (Mhone, 2000, p. 19), the researcher selected to use self-reinforcing path dependency (Neuman, 2014).

In building the path dependent explanation, the researcher started with an outcome of scenarios at particular points in time. Using the sequenced map of events that had been constructed during the sequencing of events, the researcher followed the sequence of events backwards to the initial events and conditions. The study then retraced back from the initial conditions to the outcomes again. This would either confirm or deny that the outcomes followed from the sequence of events.

The third and final stage of data analysis was to conduct comparisons of the events, paths, and states identified from the data secured. This provided comparisons of what was happening with the institutional arrangements for high value vegetables for the various participants, what happened during the participatory action research interventions, and what happened as a result of the interventions made during the participatory action research phase of data collection. The objective of the comparison was to determine how the reality of institutional arrangements for agricultural transformations compare to the envisaged position as espoused by the documents that reflected the aspirations of agricultural transformation.

This study used the AU and CAADP conceptualisation of agricultural transformation as a two dimensional process of improving internal on-farm productivity and enhancing the farm’s external linkages with the broader economy (African Center for Economic Transformation, 2017; Alliance for a Green Revolution in Africa, 2017). The study needed to use this conceptualisation to interpret data in a manner that was alive and sensitive to the background, context and reality of agricultural transformation within South Africa. The study’s intention was to bring out the specifics of the institutional arrangements for the agricultural transformation of high value vegetables horticulture in Gauteng.

Techniques used during data analysis

During the analysis, a number of analytic techniques were used. These techniques were employed during the three stages of data analyses. The techniques included analytic memo writing, looking out for markers, and searching for outcroppings.

Neuman (2006) describes an analytic memo as a note that a researcher writes to himself around a thought or idea that he or she has about the coding process with the intention of conceptual theory building. The analytic memos talked about how data was tied together into categories. The categories of data would then form an instance of a general theme or concept. There were separate memos for each theme or concept. The analytic memos contained links between ideas, hypothesis, proposed conjectures and new developing themes.

As suggested by Neuman (2006), the researcher started to write analytic memos immediately after the first instance of data collection and continued up until the researcher was finalising the thesis. The researcher tracked the progression of the researcher's thoughts by dating each entry that was made on the analytic memos. Whenever there is a new insight, it was recorded on the voice recorder on the researcher's cell phone and then written up when the researcher has the chance to.

The researcher would then go back to read his analytic memos. This allowed the researcher to review memos on similar themes and combine them if necessary. All of the memos were kept even if it is thought that they have no bearing to the study. They proved useful in subsequent times as fresh insights would sometimes eventually emerge from the data. There were, however, false starts.

A marker is defined as "a passing reference made by a respondent to an important event or feeling state" (Weiss, 1994: 77 as cited in Neuman, 2006: 408). The researcher actively looked out for markers. Markers are usually made by several respondents in any almost by-the-way manner indicating largely unconscious biases and perceptions. Most of the markers emerged during informal conversations and discussions when the participants were relaxed. It could have been quite easy for apparently innocuous remarks to be initially disregarded by both the respondents and the researcher. Markers however tend to mask deep underlying issues in relation to the issue being studied.

These markers and outcroppings were very useful in unmasking the underlying causes of the social phenomenon being researched. Neuman (2006: 466) argues that researchers use qualitative data analysis to examine and organize social phenomenon. However, the data that is observed can be equated to a rocky outcrop which has a small portion of that rock visible outside, but the major portion of that rock is hidden below the surface. Qualitative data analysis has to therefore generate social theories that are holistic enough to explain surface level realities as well as, “more importantly, the deeper structures and forces that may lie unseen beneath the surface”.

3.7 Limitations of the study

The study had methodological limitations that were imposed by the research approach and orientation which steered the study towards a qualitative research methodology. Secondly, selecting Gauteng as the site of the study because of its relative success with the agri-parks AIS programme (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019) introduced a possible limitation of sampling bias. The study’s research design meant that the research focussed on a particular sub-sector of agriculture and how that particular subsector operates within the geographic location of a small province in one country on the African continent. Furthermore, the participatory action research nature of the study limits that number of cases that could be used in the study. In order to address this limitation, the study worked with study participants from the five different areas of Gauteng so that a certain amount of heterogeneity could be included.

3.8 High quality data

This section describes what was done to adequately address data quality issues as well as detailing what this study actually did to provide for quality assurance measures as well. This section discusses what the study deemed to be high quality data, and how the study sought to ensure reliability and validity. Neuman (2006) proposes that the validity of field data emanates from the researcher’s analysis and data. The analysis and data must be accurate representation of the social world that is being studied.

Neuman (2006: 402) defines high quality data as data which is reliable and valid. Neuman (2006) says that data is reliable if it exhibits internal consistency and external consistency. High quality data will yield “precise and consistent measures of the same ‘objective’ truth for all researchers”.

For a member, the truth emanates from social interaction and interpretation. In field research, high quality data identifies processes of interaction and interpretation as well as providing an understanding of the member’s perspective. Quality field data is made up of detailed descriptions that the researcher arrives at from his or her authentic experiences and immersions into the social world of members. In order to ensure quality field data for this study, the researcher immersed himself into the social world of small-scale farmers involved in high value vegetables horticulture in Gauteng.

The researcher’s insight, awareness, suspicions, and questions determine the reliability of data. The researcher needs to check members’ credibility whilst taking into account subjectivity and context. Reliability is affected by misinformation, evasions and lies, as well as fronts. Fronts are shared and common lies and deceptions, such as the existence of Santa Claus.

Neuman (2006) says that data is reliable if it exhibits internal consistency and external consistency. Internal consistency refers to whether the data pieces fit together to form a coherent picture, whilst external consistency refers to whether the data fits into the overall context. In terms of reliability, this study sought to build in internal consistency and external consistency. To ensure internal consistency, the researcher conducted data collection from sources in each of Gauteng province’s three metropolitan municipalities and two district municipalities. Furthermore, documentary data was also collected from the provincial and national departments and associations connected to high value horticulture. This meant that for each category of data sources, effort was made to have more than one data collection point. Internal consistency was further strengthened by the interactions that occurred within Demeter, as well as the researcher’s own knowledge of the site which he obtained and continued to refine during observations. External consistency was sought by reviewing recent papers on the state of agricultural transformation in other territories.

Neuman (2006) proposes that the validity of field data emanates from the researcher’s analysis and data. The analysis and data must be accurate representation of the social world that is being

studied. Neuman proposes four tests of the accuracy of the data and analysis, namely ecological validity (Schmuckler, 2001), natural history, member validation, and competent insider performance. Ecological validity refers to how the researcher's description matches the world of members. Natural history provides a detailed description of what was done during the research so that others can evaluate. Member validation is conducted by members when they judge the adequacy of the researcher's description. Competent insider performance refers to the ability of a non-member to pass off as a member on the basis of the researcher's description.

The study sought ecological validity in accordance to how Schmuckler (2001, p. 420) defines it as "relation between real-world phenomena and the investigation of these phenomena in experimental contexts" and its three dimensions of the nature of (a) the study setting and context, (b) the interventions, and (c) activities of the study participants. The study site and context of Gauteng has representations of all types of South Africa's municipal structures being metropolitan municipalities, district municipalities, and local municipalities. Furthermore, the study's participants represented a diverse range of small-scale farmers with different backgrounds. The study's stimuli are based on "an increasingly ubiquitous trend" on digitalisation in agriculture (Klerkx et al., 2019, p. 1) as interventions onto the SES. The interventions were conducted in accordance with the three components of harnessing digital transformation by considering (a) leadership and strategic direction, (b) internal productivity processes, and (c) external linkages. These interventions conform to the normal activities of the study participants in their farming activities.

Member validation was sought by presenting the study's findings to the research participants. The study provided for natural history validation by making detailed descriptions of what was done during the study so that others can evaluate. It can only be left to the future to determine whether the report can be validated by competent insider performance.

3.9 Ethical considerations

In this section the ethical issues relating to data collection are described. Neuman (2006) identifies five ethical issues in field research that a researcher had to deal with. The first issue related to whether a researcher deceived the members and pointed to whether research was conducted covertly or overtly. Secondly, the researcher had a moral obligation to maintain the

confidentiality of data whilst balancing the need of reporting the study. The researcher did not expose deviant behaviour. The researcher had to deal with those in positions of power and authority and manage issues of hierarchy of credibility (Becker, 1970). Finally, the researcher had to deal with maintaining the privacy of informants with the need to publish the research report and the right to know. All of these specific measures by the researcher to address ethical issues were also supported by the researcher obtaining ethical clearance from the university.

In terms of these five ethical issues, the study was conducted overtly. In attempting to maintain confidentiality, the study's findings were presented to research participants. This was done to not only validate the research findings but to enable the research participants to raise issues that they may have felt violated their rights to privacy and confidentiality. The researcher did not observe any deviant behaviour, and therefore the researcher did not seek guidance from the ethics committee. The researcher was able to carefully manage interactions with those in positions of power and authority. This is important for the researcher to manage the issue of hierarchy of credibility especially in light of the fact that the study investigates the work of small-scale farmers who have genuine fears of farm crime.

However, the researcher struggled to obtain research permission from some of the public institutions. As a result, data that was sought from such institutions was obtained from publicly available sites which were mainly digital portals. This lack of access to public institutions did not impede the study. The main thrust of the study was conducted with small-scale farmers during the PAR stages of the research.

The researcher is currently a farmer albeit at a large scale, in a different county to South Africa and operating with different crops. One of the most challenging issues for the researcher in the field was for him to maintain his position as a researcher and balance the benefit of his 20 years of farming experience. He needed to normalize the research by ensuring that members were comfortable with the research process to such an extent that they view the researcher as a person that needs to be given information. It was important for the researcher to refrain from fostering, in an over-bearing manner his own suggestions and solutions to issues that were being discussed. He was acutely aware and consciously accepted that he needed to be informed and that he had to own a certain level of incompetence.

The respondents were informed about the research and were required to give their consent to participating in the study and for their views to be published. The names and identities of study participants were not used, and where it is necessary to refer to study participants, they were assigned labels and pseudo names that mitigate against their being identifiable. All pre-planned interviews were recorded, and the respondents gave their consent to be interviewed. However, some informal conversations yielded valuable data. In such instances, the research participants were specifically requested for permission to use such data.

CHAPTER 4. DATA PRESENTATION

4.1 Introduction

This chapter on data presentation describes the three major categories of data collected for this study as being (a) the various economic actors and players involved in high value vegetables horticulture in Gauteng, (b) the institutional arrangements for fresh vegetables horticulture in Gauteng, and (c) how the institutional arrangements for high value vegetable horticulture in Gauteng assist the various economic players to resolve economic problems. Having presented that data, the ecosystem services cascade model (Haines-Young & Potschin, 2010; Potschin & Haines-Young, 2016; Potschin & Haines-Young, 2011) is used to describe Gauteng's high value vegetables horticultures as a social-ecological-system. Describing Gauteng's high value vegetables horticulture as a social-ecological-system provides an opportunity to understand it from the perspective of panarchy and the adaptive cycle.

The data for this study is presented in six sections of this Chapter Four. Five of those sections talk to the five parts of the research instrument, whilst one integrates them data. The second section of this chapter presents data on various economic actors and players involved in high value vegetables horticulture in Gauteng. Section three of this chapter presents data on the institutional arrangements for fresh vegetables horticulture in Gauteng. Data on the way in which the institutional arrangements for high value vegetable horticulture in Gauteng assist the various economic players to resolve economic problems is presented in section four of this chapter.

Section five of this data presentation chapter provides an integration between the previous three parts of the research instrument and the other two parts. The six and seventh sections of this chapter describes the adaptive cycles and the panarchy³⁴ respectively of high value vegetable

³⁴ Panarchy is interacting set of hierarchically structured scales (Gunderson & Holling, 2002). They draw on the notion of hierarchies of influences between embedded scales, that is panarchies, to represent structures that sustain experiments, test its results and allow adaptive evolution.

horticulture in Gauteng. The data presented in this chapter is delimited to only the institutions and institutional arrangements that interacted directly with this study's PAR participants.

4.2 Economic actors and players in high value vegetable horticulture in Gauteng

The study identified several economic actors and players during interactions with the PAR participants. The researcher is aware of some agricultural actors and players who were not mentioned by the PAR participants. This thesis deals with the agricultural actors and players whom the PAR participants engaged with directly during the interactions that the PAR participants had with the researcher.

Economic actors and players who interacted with all fourteen PAR participants include farmers, farm workers, informal vegetable traders, fresh produce market agents, input suppliers, and other farmers most notably seedling suppliers. Formal retail shops and supermarkets interacted with all but one of the PAR participants. That particular participant was a small-scale farmer as well as being an academic whose special areas of research focussed specifically on informal vegetable traders. Agricultural infrastructural equipment suppliers were interacted with by thirteen of the PAR participants except for the market agent.

The fourth most interacted group of economic players and agents are equipment hire enterprises who were interacted by twelve of the fourteen PAR participants. One of the two PAR participants who did not interact with equipment hire enterprises was a fresh produce market agent, whilst the other one was a small-scale farmer who was adamant that they did not need mechanisation for their highly intensive horticultural production. There were nine PAR participants out of the fourteen who interacted with agronomists. There also nine PAR participants out of the fourteen who had family members as part of their farming enterprise's operation. Nine PAR participants also identified as landowners in their own right, thus leaving the other four small-scale farming participants as tenants who interacted with landlords. The fresh produce market agent did not interact with a landlord, and neither was she a landowner.

Six PAR participants interacted with independent artisans who were required to do different jobs such as electrical work, irrigation, plumbing or construction. Five PAR participants interacted with independent transport contractors who would either transport inputs to the farm

or produce to the various markets. Four participants interacted with digital technology enterprises specifically having them assist their small-scale farming enterprises. Three of those four PAR participants are digital technology professionals whilst the fourth PAR participant has a passion for digital agriculture to the point of envisioning her farm being transformed by digital technology

Only three participants interacted with their local municipality for support services that central government provides to support small-scale farmers through local municipalities. Three participants had interactions with academics for purposes of acquiring knowledge on various aspects of their farming enterprises. Only one PAR participant identified as a non-profit company that interacted with the agripreneurial incubatees it was training. This participant was the only one that interacted with the GDARD. Only one participant also interacted with an insurance broking enterprise mainly because the farm owner also owns the insurance broking enterprise and it is engaged in significant levels of agricultural insurance.

4.3 Institutional arrangements for fresh vegetables horticulture in Gauteng

This study considered institutional arrangements as the mechanisms that economic players use to determine what to produce, how to produce, how to set prices, how to maintain quality, how to maintain order, and how to coordinate activities within the agricultural social-ecological-system. These mechanisms can take various forms. This study categorised the forms of institutional arrangements for the agricultural social-ecological-system as farming enterprises, resources and funding provision, inputs supply, agricultural operations, produce markets, knowledge provision, behaviour management and regulatory compliance, and coordination and aggregation.

Of the fourteen PAR participants, thirteen are farming enterprises whilst one was a market agent. Farming enterprises are engaged in farming activities that secure inputs, utilise those inputs in farming operations, and sell the produce obtained from the farming operations. The categories of farming enterprises identified in this study include four farming enterprises that are operated by an individual farmer each. Three farming enterprises are operated by purely business partnerships of two or three individuals. There are two farming enterprises that are operated by married couples and two more that are operated as family enterprises mainly made up of siblings with a surviving elderly parent in attendance. There is one farming enterprise

operated by a registered company and another farming enterprise operated by a non-profit company (NPC).

The study identified six institutional arrangements for providing resources and funding for agricultural activities. These six institutional arrangements include the farming enterprises themselves, financial services institutions, and the state through the GDARD. Local municipalities are a fourth category of institutional arrangements that are sometimes mandated by the state to avail resources to small-scale farmers. For this study, the most important resource, namely the land, is being availed by farm owners to four tenants amongst the PAR participants, and by nine farming enterprise who own their land.

The nine farming enterprises operate their own on farms, whilst four of the farming enterprises are tenants on farms owned by other entities. It was interesting to note that two of the farming enterprises that are tenants have been given access to those farms at no rental charge. Coincidentally, one of the PAR participants who owns their own farm has also made available a portion of that farm to another farmer at no rental charge. The AgriHub Africa Master Farmer Training and Demonstration Unit was also leased out to the AgriHub Africa founders at no rental charge as well.

Institutional arrangements for inputs supply include categories for farming inputs suppliers, seed and seedlings suppliers, farming infrastructural equipment suppliers. Farming inputs suppliers provide such material physical farming inputs like fertilizers, crop chemicals, stock feed, and animal medicines, and personal protective equipment necessary for handling such material physical inputs. Seeds and seedling suppliers provide living material inputs that farmers further grow into farm produce such as crop seeds and seedlings and seed livestock for additional growing such as day-old poultry chicks and weaner cattle. The third category of inputs supply institutional arrangements includes farming infrastructure equipment suppliers who provide both fixed and movable infrastructure and components to put up such infrastructure. Examples of such movable infrastructure include tractors, implements and inputs applicator devices such as knapsacks. Fixed infrastructure would include boreholes and their fittings, irrigation equipment, fencing, as well as storage warehouses, packing sheds, and staff housing.

The study identified six categories of institutional arrangements for agricultural operations. These categories include human capital-based services that are engaged in routine agricultural

operations as permanent or casually contracted staff, as well as skilled specialised artisans that may be engaged to conduct work that is ad hoc and often rare enough to not warrant long term engagement such as fitting a borehole pump. The other three categories of agricultural operations institutional arrangements include those that provide services through various equipment and machinery such as tractors and vehicles. One of these categories are private contractors that offer agricultural operations services such as tillage. The state, through local municipalities, is also one of those categories that provide tillage services, in the same way that private contractors do. Risk and loss management is a category of institutional arrangements through which farmers ensure their operation through such measures as installing appropriate infrastructure or getting insurance. The final category involves logistics operations that deliver produce from the farm to the various markets and from input suppliers to the farm.

There are five categories of institutional arrangements for produce markets which include fresh produce markets, registered formal retail outlets, informal fresh produce traders, caterers and food processing enterprises, and direct household consumers. Fresh produce markets are physical buildings to which farmers bring their fresh produce to be sold by registered market agents. This study's PAR participants sold their vegetables through the Johannesburg Fresh Produce at City Deep, the Tshwane Fresh Produce Market at Marabastad, and the Vereeniging Fresh Produce Market in Sedibeng District Municipality. Whilst Ekurhuleni Metropolitan municipality has the Springs Fresh Produce Market, none of the PAR participants sold their produce through it.

The registered formal retail outlets to which the PAR participants sold their vegetables were largely comprised of supermarket chains within their immediate localities. The PAR participants also sold their vegetables to informal fresh produce traders with one PAR participants exclusively selling their produce to them to the extent of deliberately acquiring farm close to densely populated formal and informal urban settlements. Caterers and food processing enterprises such as restaurants, supermarket delicatessens, and outdoor food caravans were the fourth category of institutional arrangements for produce markets, whilst direct household consumers were the fifth category.

Institutional arrangements for knowledge provision include digital platforms and tools, farmer networks and membership institutions and organisations, agronomists and consultants, the state through GDARD, mentorship and incubation programmes, training institutes, academia and research institutes, and standards and certification mechanisms such as the Global and South

African Good Agricultural Practices (GAP) frameworks. Digital platforms and tools appear to be the first port of call for the study's PAR participants when they need knowledge for their farming activities. A second category of knowledge provision institutional arrangements relates to the farmers themselves as they interact within their networks and membership institutions and organisations.

The third and fourth categories of institutional arrangements for knowledge provision are based on subject matter expert advice provided by private agronomists and consultants, and state provided agricultural extension support services respectively. Mentorship and incubation programmes as well as training institutions provide two other categories of institutional arrangements. Academia and research institutes make up a category of knowledge provision institutional arrangements that generate and disseminate new knowledge. One of the PAR participants was both a farmer and a distinguished professor whose main areas of research focussed on informal fresh produce traders. Standards and certification mechanisms such as the GAP frameworks were another category of institutional arrangements for knowledge provision.

Institutional arrangements for behaviour management and regulatory compliance have a category for law enforcement. The other category is around compliance to regulations and by-laws imposed managed by the state through GDARD and local municipalities. Examples of such by-laws include the regulations at fresh produce markets. Standards and certification mechanisms such as the GAP frameworks also form another category of institutional arrangements for behaviour management and regulatory compliance.

An important institutional arrangement that was identified in this study and formed a key component of this thesis is one on coordination and aggregation. The state, through various agencies like GDARD and municipalities, provide a category of this institutional arrangement. A second category of this institutional arrangement for coordination and aggregation relates to farmer networks and membership institutions and organisations such as Demeter which emerged as a result of this study. Digital tools and platforms represent another category of institutional arrangement for coordination and aggregation. This study developed and deployed AgriHub Africa as one such institutional arrangement.

4.4 How institutional arrangements for fresh vegetables horticulture in Gauteng assist the various economic players to resolve economic problems

Agriculture is a complex social-ecological-system. The resolution of economic problems around agricultural production is determined by both the social systems components of the agricultural social-ecological-system as well as its ecological systems components. The social systems components of the agricultural social-ecological-system are represented by the institutional arrangements for agriculture as discussed earlier. In describing how institutional arrangements for fresh vegetables horticulture in Gauteng assist the various economic players to resolve economic problems, this study also mentions the ecological systems components that contribute to those resolutions.

This study established how the institutional arrangements for high value vegetable horticulture in Gauteng assist the various economic players to resolve economic problems. Over and above establishing what to produce, Hollingsworth (2000) states that some of the economic problems that require resolution by institutional arrangements include “how are prices to be set? What quantity of various products is to be produced? How are standards of various products, processes, etc. to be set? How is the quality of products and processes to be determined? How are various societal processes to be financed?” (Hollingsworth, 2000, p. 605).

What to products to produce

The problem of what to produce is largely resolved by farming enterprises as institutional arrangements for agriculture. In determining what to produce, this study established that farming enterprises are guided by what other farming enterprise are producing. Farming enterprises also consider contributions from other institutional arrangements which include those for inputs supply, agricultural operations, produce markets, knowledge provision, resources and funding provision, and coordination and aggregation. Farming enterprises also consider ecological systems components in determining what to produce. These ecological systems components, which include the weather, climate, soils, and water, influence ecosystem services that Jax et al. (2018, p. 416) regard as the “contribution of nature to human well-being”.

When farming enterprises began their farming operation, they mostly consulted other farming enterprises in determining what crops to produce. The decisions on which crops to produce included not only the specific crop to produce but the specific varieties as well. The study established farming enterprises relied more on the advice and guidance of other farming enterprises. In particular, farming enterprises discussed with other farming enterprises on “crops that are currently paying well”. The theme of peer influence was a strong determinant on deciding what to produce. This theme manifested itself in the institutional arrangements of coordination and aggregation that emerged as part of this study. These institutional arrangements are Demeter and AgriHub Africa.

Whilst there is a lead time to when a crop is planted up to the stage that the crop gets harvested, most farming enterprises that were part of this study’s PAR participants made their decisions on crops to produce based on current observations and reality. Farming enterprises would sometimes be advised that there were lead times to get the crop into the ground and finally get it harvested and ready for market. Advice and guidance would be offered to farming enterprises that there was a possibility that by the time a crop is harvested, the prices would not be same. More often than not, the prices would have dropped by that time even though a particular crop was paying well at particular present moments. Even with such advice and guidance on lead times from subject area specialist such as agronomists, farming enterprises would still make decisions based on “crops that are currently paying well”. This theme of the present was a strong motivation on the decisions that farming enterprises made on what to produce.

Decisions on which crops to subsequently produce after the first crop were influenced by the farming enterprises own experiences as well as the other institutional arrangements described above. Experiential learning was an important determinant for which subsequent crops would be produced. Negative experiences with a particular crop would sometimes lead farming enterprises to trying out different crops. The decision on trying out different crops was also influenced by other farmers. Once again, the theme of peer influence remained a strong determinant on deciding what to produce.

Positive experiences of good harvests and reasonable returns motivated farming enterprises to maintain the same crops that they had started with. Another determinant for maintain the same crops emanated from the institutional arrangements for produce market. Acquiring markets was quite stressful for farming enterprises that were starting out. As a result, farming enterprises selected to maintain the same crop types. This was done even at the cost of building

up disease pressure due to not adhering to crop rotation principles. The theme of experiential learning was a determinant on what to produce. That theme of experiential learning transcended the production and operations arena but also covered other aspects such as getting to know and understand the institutional arrangements for produce markets, inputs supply, knowledge provision and other determinants of what to produce.

Once the decision was made on what crops to produce, farming enterprises then engaged with other institutional arrangements for fresh produce horticulture from the perspective of the crops that were decided on. Farming enterprises then engaged with the institutional arrangements for inputs supply, agricultural operations, produce markets, knowledge provision, resources and funding provision, and coordination and aggregation with that crop in mind. For example, when a farming enterprise had decided on producing spinach, the farming enterprise sought institutional arrangements for the supply of spinach inputs such as providers of spinach seedlings. Similarly, farming enterprises would engage workers with knowledge and experience of growing spinach in the same way that they would consult online resources on spinach production. The theme of speciality on what to crop produce influences the speciality of the other institutional arrangements.

Quantity of various products to be produced

The quantity of crops to be used is determined by farming enterprises in the same way that they determine what crop to use. Farming enterprise are largely influenced the institutional arrangements for resources and funding provision. Key aspects of the resources and funding that determine the quantity of crop that a farming enterprise decides on producing relate to the ecological systems components of the land that is being farmed upon. Such ecological components of weather, climate, water, and soil amongst others effectively place constraints and boundaries on not only what crop to produce, but also what quantities of that crop can be produced. Factors such as adverse weather conditions can affect the quantity of crops to produce. The theme of context was a determining factor on deciding what quantities of crops to produce.

Beyond the boundaries imposed by ecological systems components, the resources and funding institutional arrangements also place boundaries on what quantities a farming enterprise can produce. The total amount that a farming enterprise can access to produce a crop also places an upper limit on the other institutional arrangements that also determine the quantity of a crop

that a farming enterprise can produce. These other institutional arrangements include those for input supply, agricultural operations, and knowledge provision.

Produce markets are another form of institutional arrangements that helps farming enterprises to determine what quantities of a crop to produce. Produce markets provide indications that enable farming enterprises to determine whether to increase or reduce the quantities of the crops that they produce. However, the indications from produce markets are influenced by the quantities of crops that other farming enterprises would have decided to produce or otherwise. The theme of peer influence was a strong determinant on both deciding what crop to produce and on influencing the quantities of crops to produce.

How prices are set

The institutional arrangements for produce markets appear to be the main determinants of how prices are set. Farming enterprises that were part of this study did not have a major direct input or influence in the setting of prices. However, farming enterprises could determine the prices that their crops were being sold at to a certain extent within limits. When farming enterprises wanted to charge prices that were considered too high for the institutional arrangements for produce markets they would not be able to sell their products.

Nonetheless, farming enterprises could state the prices that they wanted for their crops. In determining those prices, the farming enterprises engaged with their colleague farming enterprises to find out what prevailing prices were. Farming enterprises also relied on the prices that they sold their crops at previously. Although farmers would have liked to determine their own prices, the reality was that they had to consider prevailing prices, advice from other farmers and their own experiences. In essence, the three themes of (a) the present, (b) experiential learning, and (c) peer influence emerged as determinants of the prices that farming enterprises stated as wanting for their crops.

Other determinants of prices included the quantity of crops that were being produced. This quantity was influenced by aggregated quantities that all the farming enterprises were producing. Furthermore, the factors that determined the quantities of crops that were being produced had an indirect influence on prices for crops produced. The theme of feedback was thus a determinant of how prices were set.

The theme of feedback provided an opportunity of not only influencing the institutional arrangements for coordination and aggregation, but of building social-ecological-systems resilience into those institutional arrangements. This influenced the emergence of institutional arrangements that emerged and were created as a result of this study. These institutional arrangement for coordination and aggregation that emerged and were created as part of this study are Demeter and AgriHub Africa respectively.

How are various societal processes are financed

This study determined that the financing of agriculture was largely orchestrated by the farming enterprises that were PAR participants. These farming enterprises provided the initial financing and resources that were needed to kick-start farming activities. In some instances, the farming enterprises approached funding entities for resources. Some of these funding entities included private sector organisations such as financial institutions. It was observed that none of the PAR participants actually secured funding from private financial institutions that was specifically designated as agricultural funding. Farming enterprises that secured loans from financial institutions did so on the back of personal loans and provision.

Once farming enterprises had established their operations and produced crops in sufficient quantities and quality, the financing of further expansion then came through from re-invested profits. Given that the initial financing was provided by farming enterprises and that financing for expansion was also provided from re-invested profits, the theme of boot-strapping emerged as a mechanisms for financing agricultural production.

Although the state has financing available for small scale farmers, only two of the farming enterprises accessed this financing on only one occasion each during the period of this study. One of the farming enterprises secured agricultural inputs from the GDARD, whilst the other one was able to secure state supported and resourced tillage services through their local municipality. Most of the farming enterprises that formed the PAR participants of this study opined that securing financing from state was too difficult and problematic. A theme on the inaccessibility of state resourcing and financing emerged in this study.

How are standards and quality of various products and processes are set

The standards and quality of the various products and processes are largely determined by the farming enterprises as strategic choices on how they want to operate. Standards and quality

certification mechanisms such as the GAP frameworks are part of the institutional arrangements for behaviour management and regulatory compliance. One of this study's PAR participants invested in the physical infrastructure that would be necessary for GAP certification. However, the other farming enterprises did not institute mechanisms for GAP certification since it is voluntary.

Farming enterprises have implemented standards and quality initiatives for the crops they produce and the processes that they use based on their engagement with colleague farming enterprises. Institutional arrangements for knowledge provision as well as those for coordination and aggregation play an important role in getting farming enterprises to utilise these standard and quality initiatives.

4.5 Using the ecosystem services cascade model to describe Gauteng's high value vegetables horticulture as a complex social-ecological-system

This study used the ecosystem service cascade model (Haines-Young & Potschin, 2010; Potschin & Haines-Young, 2016; Potschin & Haines-Young, 2011) to describe Gauteng's high value vegetables horticultures as a social-ecological-system. This study's use of the cascade model is consistent with how it has been used to "to reflect on how ecosystem services can be used to better understand the way socio-ecological systems operate" (Potschin-Young et al., 2018, p. 430).

The cascade model explains the relationship between society and ecology using the "notion of ecosystem services" (Potschin-Young et al., 2018). Potschin-Young et al. (2018, p. 429) take ecosystem services as the "contributions that ecosystems make to human well-being". They go on to argue that human well-being is a state "that is also intrinsically and not just instrumentally valuable (or good) for a person or a societal group" (Potschin-Young et al., 2018, p. 429) as shown on this picture of the researcher evaluating soil structures with some research participants.



The cascade model was used in this study because it “sets out what are recognised to be the key elements of the ecosystem service paradigm by distinguishing the functional characteristics of ecosystems from services, and services from benefits” (Potschin-Young et al., 2018, p. 428). The cascade model’s five elements include the ecosystems biophysical structures elements which support the functional characteristics elements of ecosystems (Potschin-Young et al., 2018). Those functional characteristics elements form the foundation upon which services elements are provided by the ecosystems (Potschin-Young et al., 2018). The services elements in turn provide benefits elements to humans which then deliver value elements (Potschin-Young et al., 2018). A diagram of the ecosystems services cascade model is shown in figure 4.1 below.

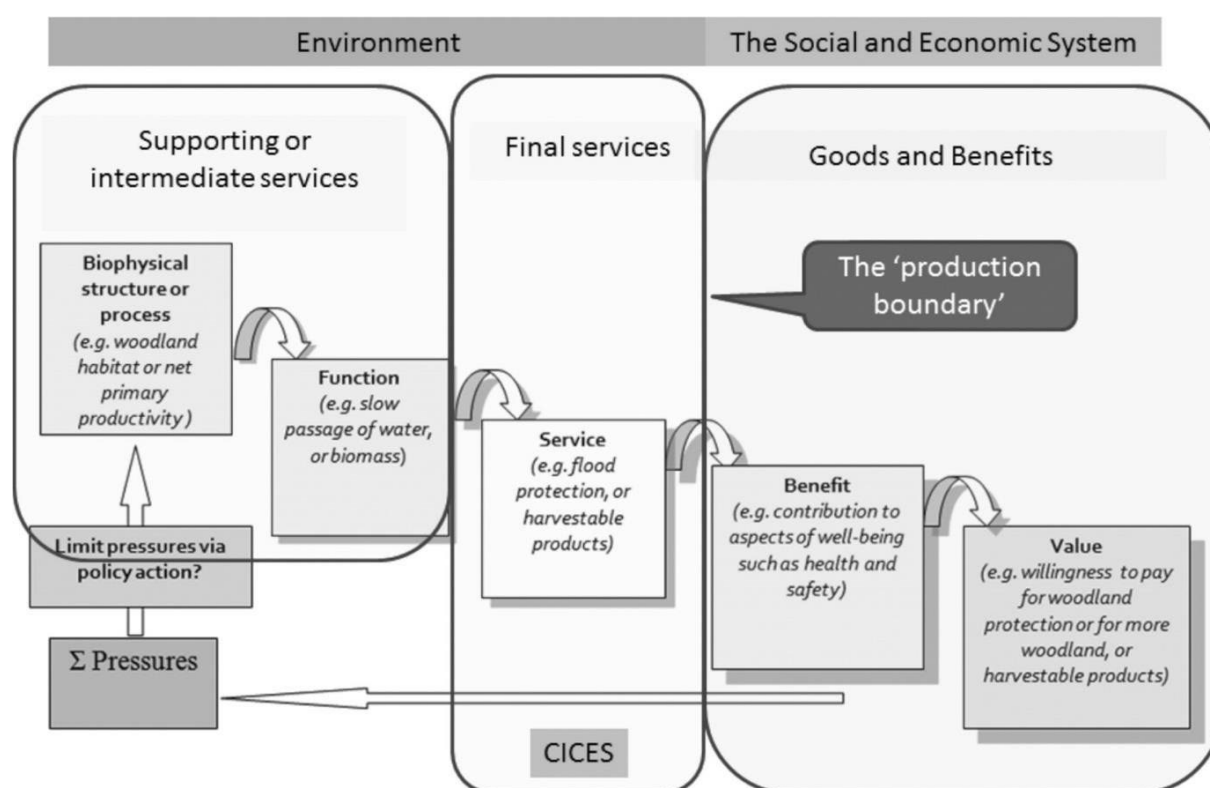


Figure 4. 1 - The ecosystem services cascade model. Source - (Potschin-Young et al., 2018)

The biophysical structure and/or process of the social-ecological-systems that this study’s PAR participants were part of is largely made up of small-scale farms. Of this study, thirteen PAR participants that operated farms, there were three farms that were less than one hectare each, three that were slightly above one hectare each, five that were around two hectares each, and two that were above seven hectares each. The major components of the biophysical structure and/or process that these properties had were arable land and access to underground water for irrigation.

The land on these properties differed significantly in terms of soil types, chemical composition of the soil, soil acidity, effective depth of the soil, and other characteristics such as drainage capacity and available carbon. The availability of irrigation water also differed quite significantly on these properties due to different underground borehole yield and replenishment capacities, water quality, and installed water abstraction and harvesting infrastructure. Similarly, weather and climate were largely different on the PAR participants' farms. The heterogeneity of the biophysical structure and/or process on the properties resulted in differing agricultural land practices.

The ecosystem functions on the farms operated by the study's PAR participants were relatively similar despite the varied biophysical structure and/or process as well as the attendant agricultural land practices. This was largely because the sampling approach taken for this study focussed on high value vegetables production. That focus on high value vegetables production influenced the ecosystem functions that the PAR participants chose to harness.

Differences in ecosystem functions nonetheless existed especially where there was installed



infrastructure. The erection of crop protection infrastructure such as greenhouse tunnels and shade-net tunnels provided for enhanced functionality especially when they mitigated and compensated for weather and climate. Some of the PAR participants were able to continue growing certain vegetable horticulture crops in winter because greenhouse tunnels mitigated against inclement weather like frost as seen on this picture.

The final ecosystem services that were observed on all the farms operated by the study's PAR participants included the establishment of productive agricultural systems. Whilst these systems differed, they all provided provisioning of harvestable crops for both food and cash. An interesting ecosystem service that emerged were ultra-micro levels of agricultural innovation systems based on the specificity and peculiarities of the different farms. The emergence of Demeter as a farmers' organisation also provided for training and agro-tourism as additional ecosystem services.

It was interesting to note that most of the study's PAR participants used organic mature to not only provide additional crop nutrients to the soil, but also to condition the soil and enable healthier micro-biology onto the biophysical structures and processes. This ecosystem service of enhanced soil micro-biology. Concomitantly, the agricultural production also enhanced biodiversity by providing for such wildlife as bird, rabbits, and monkeys that partook of the farming produces being grown, and in most instances to the annoyance of the farmers.

The goods and benefits that Gauteng's high value vegetables horticultures social-ecological-system provided were most visible in the actual agricultural produce that the farmers managed to harvest. This agricultural produce contributed to food security, human health and safety directly. The other goods and services included the employment that was provided by the agricultural activity.



Some of this study's PAR participants earned their livelihood from the agricultural activities that they were conducting on their farms. Other PAR participants considered the farming enterprises as livelihood security especially given the loss of jobs that occurred during the Covid pandemic which subsisted during the currency of this study.

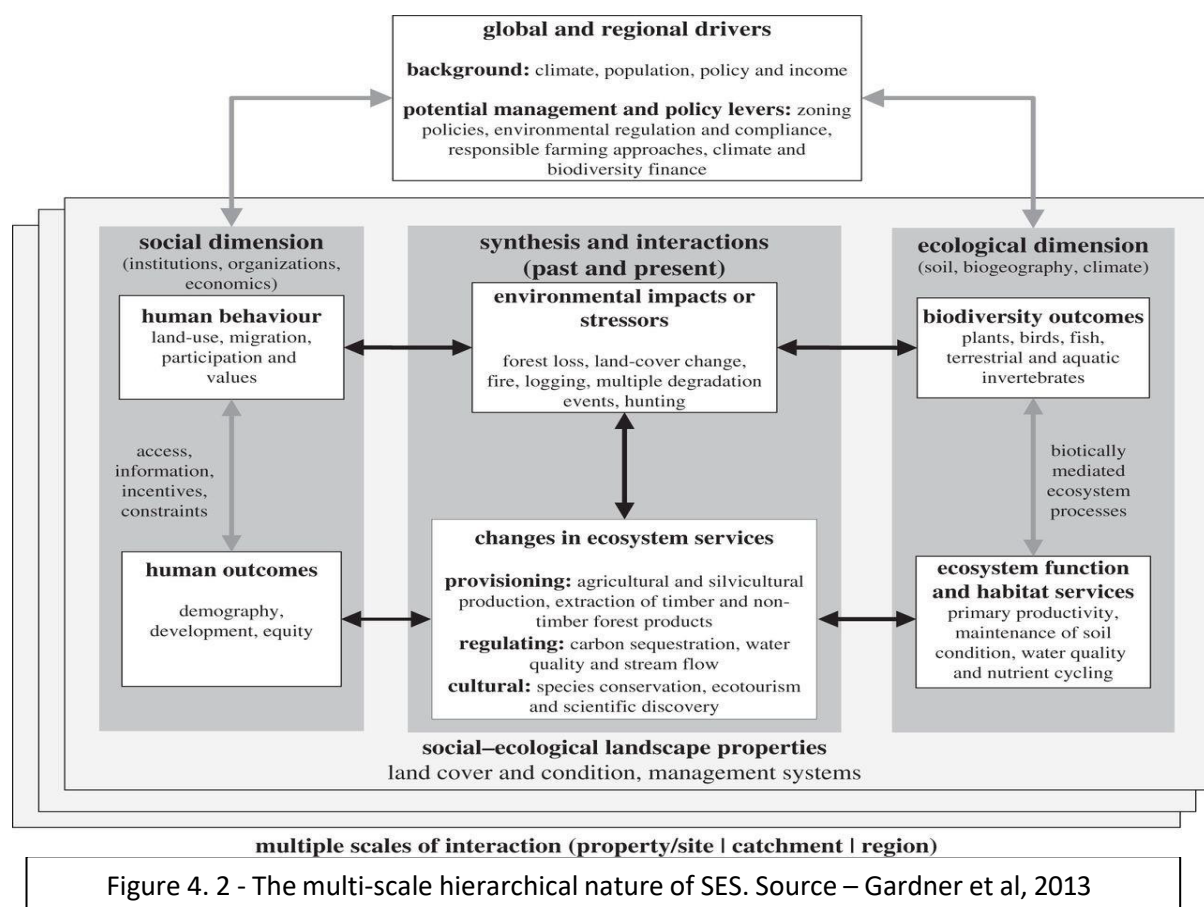
Gauteng's high value vegetables horticultures social-ecological-system provide monetary and commercial value. This value manifested in the revenue that accrued to the farmer for produce harvested as seen on this picture. Some of that monetary and commercial value was in the form of salaries and wages paid to those who worked on the various farms. Inputs suppliers and other service providers also received that monetary and commercial value.

The general health and well being of the community that consumed the produce from Gauteng's high value vegetables horticultures social-ecological-system was another form of value. Family cohesion was another form of value that was observed especially for the farming enterprises that were operated by families and couples. Self-actualisation was also an interesting value as well as additional resilience that came out of having a functional farming enterprise as an additional source of livelihood.

Indirect value was available from Gauteng's high value vegetables horticultures social-ecological-system in the form of innovation that farmers came up with. The emergence of new institutional arrangements in the form of Demeter and the creation of AgriHub Africa enabled the value of those innovations to be disseminated. Furthermore, those institutional arrangements formed the basis of social capital formation as another manifestation of value.

Berkes, Kislalioglu, Folke, and Gadgil (1998) describe social-ecological-systems as systems that link humans with nature in such ways that people are intrinsically part of nature. Social-ecological-systems have two dimensions comprised of biophysical structures and processes, as well as social and economic factors that are in regular, constant, and sustained interaction (De Groot, Alkemade, Braat, Hein, & Willemen, 2010; Redman, Grove, & Kuby, 2004). Social-ecological-systems have sets of critical natural, socio-economic, and cultural resources that are continuously adapting as a perpetually dynamic complex system (Redman et al., 2004).

Social-ecological-systems interact at hierarchically linked multiple spatial, temporal, and



organisational scales (Gardner et al., 2013; Perez-Soba & Dwyer, 2016; Redman et al., 2004).

This study considered social-ecological-systems at the property site level of the farm as well as at the municipal and provincial government defined level. The primary focus was at the farm level following on how local level actors initiate solutions for the challenges they face as advocated by Bennett et al. (2016, p. 441) through their the notion of “seeds of a good Anthropocene”.

The ecological system component is made up of two of the five elements of the cascade model for ecosystem services (Potschin & Haines-Young, 2011). The biophysical structures and/or process provides for net primary productivity of biodiversity outcomes through such ecological elements like soil and water (Gardner et al., 2013; Potschin & Haines-Young, 2011). As discussed earlier the biophysical structures of the farms operated by this study’s PAR participants varied across dimensions such as soil, water, climate and weather as shown on this picture.



The second element of the cascade model’s ecological system component talks to functions of the ecological systems component that arise out of “biotically mediated ecosystem processes” (Gardner et al., 2013, p. 4) to provide such functions as producing biomass. Examples of such biotically mediated ecosystem processes include the pollination that was done by bees for fruit based horticultural produce like tomatoes and peppers. Despite the heterogeneity of the biophysical structures and/or process, and the attendant differing agricultural land practices, this study’s PAR participants harnessed ecosystem functions of producing biomass in the form of high value vegetables horticultural produce such as that shown on this picture.

The cascade model's third element of final ecosystem services provide such services as biomass in the form of harvestable produce (Haines-Young & Potschin, 2010). Although the final services element is part of the ecological component of the cascade model, it mediates between the social-ecological-system's two dimensions comprised of biophysical structures and processes, and of social and economic



factors (Potschin & Haines-Young, 2011; Redman et al., 2004). The final ecosystem services elements provides harvestable products that contribute to the social and economic component of the cascade model. The high value vegetable horticultural produce in Gauteng is part of the provisioning of the final ecosystems services element such as that shown on this picture.



The cascade model's social and economic component has the two elements of ecosystems of goods and benefits for well-being, as well as the social and economic value that can be derived from such goods and benefits for human well-being (Potschin & Haines-Young, 2011; Redman et al., 2004). This study's PAR participants operated farms that constituted the ecological systems component to

produce harvestable biomass in the form of high value vegetables horticultural produce. The PAR participants constituted the socio-economic entities that actually converted the harvestable biomass into high value vegetables horticultural produce. This is done through the processes of harvesting the harvestable biomass such as that shown on this picture.

The fifth element of the cascade model relates to the socio economic value that is derived from the goods and benefits element of the agricultural social-ecological system. It is not sufficient to only derive good and benefits for human well-being from the final ecosystem services. The social and economic component of the agricultural social-ecological-system converts those goods and benefits for human well-being into commercial and social value. All of this study's PAR participants converted the harvested produce into commercial monetary value. This requires institutional arrangements for produce markets to effect that conversion into value such as that shown on this picture.



Whilst the ecological systems components of the social-ecological-systems provides ecosystem services, the social and economic components of the cascade model need to convert those ecosystem services into goods and benefits for human well-being. Those good and benefits for human well-being must ultimately be translated into social and economic value. This study recognises that the mechanisms for converting ecosystem services into good and benefits for human well-being as well as for translating those goods and benefits into social and economic value are in essence institutional arrangements.

This study submits that the institutional arrangements for high value vegetables horticulture inhibit agricultural transformation because they are stuck in specific social-ecological-systems regimes. To shift the institutional arrangement into social-ecological-systems regimes that will enable agricultural transformation, the study had a proposition to harness digital transformation to cause systems disturbances into the institutional arrangements for agricultural transformation. However, it was important to establish at which stages of the adaptive cycle the institutional arrangements would be at to determine the type and nature of system disturbance that would be utilised.

4.6 Adaptive cycle of Gauteng's high value vegetables horticulture social-ecological-system

This study recognised that Gauteng's high value vegetables horticulture is a complex social-ecological-system with different scales. The PAR participants' farming enterprises effectively represented agricultural social-ecological-systems. Consequently, they were taken as a basic unit of operation and analysis for this study. This study also determined that the PAR participants' farming enterprises were also institutional arrangements. This study analysed the adaptive cycle of these farming enterprises to establish how system disturbances could be introduced into them.

The study considered all the thirteen PAR participants who were farming enterprises to be operating on farms that all went through a system disturbance when they were acquired by the PAR participants. This therefore meant that all thirteen PAR participants were going through the adaptive cycle and had all gone through the adaptive cycle's stage of renewal. The rates at which the farming enterprises were going through the adaptive cycle differed. That rate of growth depended on several factor one of which included the resources available for the farming enterprise to grow.

Two of the thirteen farming enterprises have stopped farming. These farming enterprises can be regarded as agricultural social-ecological-systems that have undergone the collapse stage of the adaptive cycle. One of the farming enterprises experienced a naturally occurring pulse system disturbance in the form of a severe hailstorm which wiped out their crop. The other farming enterprise experienced a man-made press disturbance that manifested as diminished interest in the farming enterprise's operations by its owners. This farming enterprise does not consider agriculture as its core activity but only undertakes it a support to its core business. Both farming enterprises that have gone through the collapse stage of the adaptive cycle have not yet transitioned to the renewal stage.

There are three other farming enterprises that are teetering on the brink of collapse but have not yet collapsed. One of the farming enterprises was run by an individual who unfortunately passed away. It is not clear whether the individual's successors would want to continue operating. The other farming enterprise on the brink of collapse is operating on a rented farm that was acquired by the government for resettlement. The farming enterprise was advised by

government to continue operating up until the farm has been allocated to a new beneficiary. Both two farming enterprises experienced pulse system disturbances with the latter being a natural system disturbance (death of the owner) and the other being a man-made system disturbance (government policy).

The third farm that is on the brink of collapse is run by an individual who, despite being offered agronomic advice, continues to exercise non-viable agricultural practices. As a result, the farming enterprise continues to be affected by natural systems disturbances in the form of pests and diseases. The rain seasons have not been particularly kind to this farming enterprise because it gets affected by fungal diseases like powdery mildew and black spot. However, as the humidity levels drop, these fungal diseases dissipate and normal production resumes. There are several measures that can be taken by the farming enterprise to address these press system disturbances. However, the farming enterprise is not initiating any of those measures.

Two other farming enterprises are at the accumulation stage of the adaptive cycle. One of these farming enterprises has been operating for over ten years. The farming enterprise has well established and regular markets with several retail chains. The farming enterprise has also fully developed the farm on which it is operating by erecting appropriate infrastructure. It appears that this farming enterprise is in a comfort zone.

The second on the two farming enterprises that are at accumulation stage operates farming ventures as support to its core business. Consequently, this farming enterprise does not have much interest in agricultural production, but it nonetheless maintains farming operations as a necessary support to its core activities. This farming enterprise had already established a digital community membership platform. The researcher engaged with this farming enterprise according to this study's conceptual framework for digital transformation. The farming enterprise has proceeded to continue developing and growing its digital community membership platform using a different architecture to that used for developing AgriHub Africa.

Six farming enterprises are in the growth stage of the adaptive cycle. These farming enterprises have established markets that they regularly and consistently supply. They have developed sufficiently credible operational competencies for the crops that they grow. All six farming enterprises have invested in infrastructure for crop protection from inclement weather both during winter and during summer. Crop protection during winter is being provided by plastic

covered greenhouse tunnels to mitigate against frost. Shade-net covered tunnels provide crop protection during summer against hail and flying pests. Three of the six farming enterprises that are in the growth stages of the adaptive cycle are close to fully installing crop protection infrastructure on their entire farms. To a large extent, these three farming enterprises are close to being fully capitalised.

Two of these three ultra-advanced farming enterprises together with another farming enterprise that is also in the growth stages are also the founders of AgriHub Africa. These three farming enterprises recognise that they are close to the reaching the accumulation stage and are therefore willing to consider other horizons of growth. Consequently, these AgriHub Africa founders were willing to take on the roles for the leadership and strategic direction of Gauteng's high value horticulture towards agricultural transformation.

This study's PAR phases introduced the digital transformation conceptual framework to all thirteen PAR participants who are farming enterprises. Four of the thirteen PAR participants had interests and willingness to develop digital solutions to agricultural transformation. The study initially intended to separately work with each farming enterprise to develop separate digital solutions to agricultural transformation. One PAR participant chose to work on a digital agriculture solution that was based on an architecture of a digital community membership platform distinct from an architecture that was geared towards agricultural transformation.

Three of the PAR participants decided to work jointly to develop a digital agriculture solution based on this study's conceptual framework of digital transformation. Consequently, they resolved to establish AgriHub Africa as an institutional arrangement that developed and deployed a digital agriculture solution whose main focus was to facilitate agricultural transformation.

By adopting AgriHub Africa as a digital agriculture solution for agricultural transformation, the AgriHub Africa Founders were able to conceptualise it as an institutional arrangement that went beyond their individual farming enterprise to embrace the whole agricultural eco-system. This required that the AgriHub Africa digital solution architecture needed to cater for the how social-ecological-systems interact at hierarchically linked multiple spatial, temporal, and organisational scales (Gardner et al., 2013; Perez-Soba & Dwyer, 2016; Redman et al., 2004).

This study therefore considered panarchy of Gauteng's high value vegetables horticulture social-ecological-system.

4.7 Panarchy in Gauteng's high value vegetables horticulture social-ecological-system

Panarchy is both a component and a conceptual framework of social-ecological-systems resilience (Garmestani et al., 2020). Panarchy describes the nested nature of relationships within the concept of social-ecological-systems resilience (Berkes & Ross, 2016). Berkes and Ross (2016) argues that panarchy's strength comes from how it provides a framework and structure that enables analyses of nested and multi-level relationships in social-ecological-systems. Berkes and Ross (2016) submits that panarchy "provides an integrative approach for understanding the linkages and dynamics within and across levels of social-ecological systems".

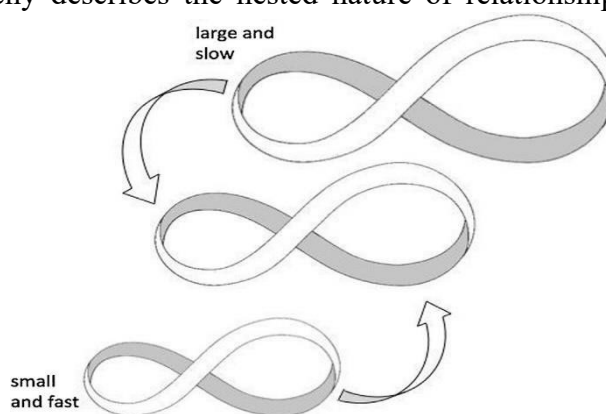


Figure 4. 3 – Panarchy showing both “small and fast” and “larger and slow” adaptive cycles.
Source - (Potschin-Young et al., 2018)

Garmestani et al. (2020) states the panarchy is built on three basic propositions that were introduced by Allen, Angeler, Garmestani, Gunderson, and Holling (2014). Firstly, complex systems such as the agricultural social-ecological-system, are organised into discrete groups that are discontinuously structured (Garmestani et al., 2020). Secondly, agricultural social-ecological-systems, like all other complex systems, have adaptive cycles of renewal, growth, accumulation and destruction (Garmestani et al., 2020). Lastly, the agricultural complex social-ecological-system requires critical cross-scale linkages for the system to function. Consequently, Allen et al. (2014, p. 578) describe panarchy as a “framework that characterizes complex systems of people and nature as dynamically organised and structured within and across scales of space and time”

This means that the social-ecological-systems resilience that was being built into farming enterprises, as done in this study, can have impact at different levels. The resilience of the PAR participants' farming enterprises was and is influenced by internal process (Berkes & Ross,

2016) within the farming enterprise as both social-ecological-system and an institutional arrangement. Similarly, that resilience is “also impacted by actions at lower levels of organization (individuals, households), and by drivers of change originating at higher levels (national level policies, globalized market forces)” (Berkes & Ross, 2016, p. 185).

This study focussed on the resilience of the farming enterprise as both an institutional arrangement and a social-ecological-system. The study’s focus on the resilience of the farming enterprise borrowed from how Berkes and Ross (2016, p. 188) consider the manner in which an “individual becomes resilient, through a combination of personal strengths and interactions with their (usually social) environment”. The interactions of individual farming enterprises with other farming enterprises in this study illustrated this point.

This study observed that some of the PAR participants who were part of farming enterprises that took on leadership roles to mobilise other farming enterprises in pursuit of improving collective resilience. As a result, two institutional arrangements in the form of Demeter and AgriHub Africa emerged. This was consistent with how Berkes and Ross (2016) submit that agency and leadership at an individual level can “mobilises networks of managers and resource users at various levels in the panarchy in order to increase the resilience of the social-ecological system as a whole”.

4.8 Conclusion

This chapter has presented the primary data collected in three major categories which are (a) the identified economic actors and players involved in high value vegetables horticulture in Gauteng, (b) the institutional arrangements for fresh vegetables horticulture in Gauteng, and (c) how those institutional arrangements for high value vegetable horticulture in Gauteng assist the various economic players to resolve economic problems. That data formed the basis for describing Gauteng’s high value vegetables horticultures as a social-ecological-system by applying the ecosystem services cascade model (Haines-Young & Potschin, 2010; Potschin & Haines-Young, 2016; Potschin & Haines-Young, 2011). Describing Gauteng’s high value vegetables horticulture as a social-ecological-system provided an opportunity to understand this study’s data the perspective two other major categories being (d) the panarchy perspective of Gauteng’s high value vegetables horticultures as a social-ecological-system, and (e) the adaptive cycle perspective of Gauteng’s high value vegetables horticultures as a social-

ecological-system. These two perspectives lay a solid grounding for the following three chapters.

The following Chapter Five reconceptualises the concept of agricultural transformation using the lenses of panarchy and the adaptive cycle as well as addressing the scale and currency challenges of agricultural transformation. That Chapter Five lays the foundation for Chapter Six which discusses how digital platform business models can address the scale challenges that have been bedevilling the theoretical construct of agricultural transformation, and the practically applicable CAADP version of agricultural transformation. Chapter Seven then discusses how digital platforms can be harnessed to drive the more contemporary construct of structural transformation and its notion of agricultural development which this study proposes to reframe as digitally enabled agricultural transformation.

CHAPTER 5. RE-CONCEPTUALISING AGRICULTURAL TRANSFORMATION WITH HEIGHTENED FOCUS ON SCALE: DIGITALLY ENABLED AGRICULTURAL TRANSFORMATION

5.1 Introduction

This chapter revisits the concept of agricultural transformation. Agricultural transformation is by re-conceptualised with a heightened focus on scale. The chapter interrogates the concept of agricultural transformation as a theoretical construct. That interrogation is followed by a discussion of agricultural transformation as a practically applicable construct in the manner in which it was defined within CAADP (African Union et al., 2003) in 2003, and subsequently adopted by agricultural development partners operating within Africa (African Center for Economic Transformation, 2017; Alliance for a Green Revolution in Africa, 2017; FAO, 2017; International Fund for Agricultural Development, 2016; World Bank, 2007).

This chapter also discusses how the concept of agricultural transformation has transitioned into being referred to as structural transformation (Barrett et al., 2017; Dercon & Gollin, 2014; Timmer, 2009). Concomitant with that transition, the notion of agricultural development is also discussed as a component of structural transformation.

The dynamics of scale that emerged as part of the results of this study are unpacked. These scale dynamics serve to provide the grounding upon which this study argues for reconceptualising agricultural transformation with a heightened focus on scale dynamics. The chapter concludes by setting the scene on how the revisited notion of agricultural transformation, with its heightened focus on scale, lends itself to the digital disruption and industry restructuring that can be achieved through digital platform business models. This re-conceptualisation calls for reframing of the notion of agricultural development as envisaged within structural transformation. This study calls for the above-mentioned notion of agricultural development to be recast as “digitally enabled agricultural transformation” within the concept of structural transformation.

5.2 Agricultural transformation as a theoretical construct

This thesis submits that agricultural transformation is a theoretical concept that is steeped in historical analyses. That emphasis on historical analyses detracts from conducting more rigorous analyses and assessments of current conditions as the basis for interventions. This thesis has therefore been motivated, influenced, and informed by such contemporary analyses and assessments.

This section's interrogation of agricultural transformation serves to bring to the fore the foundations and premises of the theoretical concept as a prelude to discussing it as a practically applicable concept in the next section. The driving force and motivation for paying attention to agricultural transformation is the perspective that economic growth and development is preceded by a period of fast and rapid agricultural transformation.

Agricultural transformation has been used as a theoretical construct to explain the processes that several countries have undergone through to achieve economic growth and development. As a theoretical construct, from its articulation by Lewis (1954) and its more elaborate renditions by Johnston and Mellor (1961) and by Ranis and Fei (1961), agricultural transformation has been built on the assumptions of a two sector closed economy. Agricultural transformation is a usefully intuitive and conceptually elegant heuristic tool to explain economic growth and development from a historical perspective.

That historical perspective has gained significant currency with such prestigious institutions like The World Bank (2007, p. 35), in its *2008 World Development Report*, emphasising that history has shown that “higher agricultural productivity generating an agricultural surplus, taxed to finance industrial development, and enabling lower food prices underpinned early development in Western Europe, the United States, and Japan, and later in Taiwan, China, and the Republic of Korea”. Other economic historians have argued that the empirical causal relationships for economic growth and development go beyond agricultural transformation to also include other factors such as technology and commerce (Allen, 2009; Clark, 2003; Tsakok & Gardner, 2007). Nonetheless, the emphasis and perspective has been to provide historical explanations of how the process of economic development has progressed.

Those historical lenses have then been used to project how the future of economic growth and development could look like. Consequently, the African Union and its affiliate institutions

(2003), as well as the World Bank (2007), have adopted agricultural transformation as the guiding principle in CAADP. In essence, agricultural transformation, as a theoretical construct, envisions the future by looking at the past.

5.3 CAADP's reconceptualization of agricultural transformation as a practically applicable construct

When the CAADP was adopted in 2003, it sought to project a future for Africa in which “agriculture will provide the engine for growth in Africa” (African Union et al., 2003, p. iii). This entailed reconceptualising agricultural transformation into being a practically applicable construct driven by the notion that “improving agricultural performance is at the heart of improved economic development and growth” (African Union et al., 2003, p. iii).

The practically applicable construct of agricultural transformation as reconceptualised within CAADP (African Union et al., 2003) seeks to convert and re-orient subsistence small-scale farming into commercial agriculture. The first of its two dimensions seeks to improve the internal processes and productivity of small-scale farming, whilst the second dimension seeks to strengthen small-scale farm's external linkages.

The practically applicable conceptualisation of agricultural transformation appears to be a futuristic aspirational prescription that is informed by a historical diagnosis. This prescription is heavily steeped in theoretical assumptions that do not reflect real-world realities. Nonetheless, this practically applicable construct of agricultural transformation has been adopted by several multi-lateral and multi-national development organisations within Africa's agricultural sphere (ACET, 2017; African Union, 2014; African Union et al., 2003; AGRA, 2017; FAO, 2017; IFAD, 2016; World Bank, 2007).

5.4 Transition of agricultural transformation to structural transformation: The role of agricultural development in structural transformation

There have been criticisms that the theoretical construct of agricultural transformation (Johnston & Mellor, 1961; Lewis, 1954; Ranis & Fei, 1961; Timmer, 1988) cannot be the only causal factor that accounts for economic growth and development with some economic

historians attributing other factors such as commerce and technology (Allen, 2009; Clark, 2003; Tsakok & Gardner, 2007). Consequently, the theoretical construct of agricultural transformation has transitioned into being referred to as structural transformation (Barrett et al., 2017; Timmer, 2009; World Bank, 2007).

Whilst structural transformation acknowledges and accounts for other causal factors that account for economic growth and development, agricultural development is still considered an important causal factor. Three themes around the macro-level, meso-level and micro-level effects of agricultural development on structural transformation have been identified in a review of empirical literature conducted by Barrett et al. (2010).

The macro-level role of agricultural development to structural transformation relates to agriculture's linkages to the broader economy (Barrett et al., 2010; Hayami & Ruttan, 1971; Johnston & Mellor, 1961; Lewis, 1954; Ranis & Fei, 1961; Rostow, 1956; Staatz & Eicher, 1998; Timmer, 1988, 2009; World Bank, 2007). Policy interventions that focus on small-scale farmers and favour more investment in agricultural productivity point to significant economic growth improvements (Barrett et al., 2017; Dercon & Gollin, 2014; Diao et al., 2010; Dorosh & Mellor, 2013). Policy interventions supporting agricultural development's macro role in improving economic growth and development specifically focus on small-scale farmers, who are the majority of Africa's poor (Dercon & Gollin, 2014). Such policy interventions also assist in reducing poverty amongst most poor people who subsist on agriculture (Dercon & Gollin, 2014).

How technology, institutions and markets affect smaller farms relates to the meso-level role of enhancing agricultural development within structural transformation. (Antle & Crissman, 1990; Bandiera & Rasul, 2006; Barrett et al., 2010; Besley & Case, 1993; Conley & Udry, 2010; Fackler & Goodwin, 2001; Fafchamps, 2004; Feder et al., 1985; Foster & Rosenzweig, 1995; Hayami & Ruttan, 1971; Lin & Nugent, 1995; Moser & Barrett, 2006; Schultz, 1964; Schultz, 1975; Solow, 1957). One of the outcomes of this study was the creation of the Demeter as an institutional and social framework that seeks to address some of the market failures and institutional failures at the meso level (Dercon & Gollin, 2014). This was consistent with the perspective that there are opportunities for South Africa to develop the institutional and social framework required to make agriculture an engine for growth (Lescourret et al., 2015; Qobo &

Wood, 2016). This study followed through on that opportunity by developing such institutional and social frameworks through emergence of Demeter and the creation of AgriHub Africa.

The manner in which individual and households decide to participate in agricultural development talks to its micro-level role in structural transformation (Barrett et al., 2010; Chayanov, 1966; Feder, 1985; Sen, 1966; Singh et al., 1986). Demeter also provided an opportunity for this study's participants, together with other small-scale farmers, to improve the efficiency and effectiveness of their decision making through sharing knowledge, experience, and resources as they underwent experiential learning during their regularly scheduled monthly meetings. Furthermore, the AgriHub Africa Master Farmer Programme provided such another opportunity for shared experiential learning.

The focus on small-scale farmers is a golden thread that runs through both the theoretical and practically applicable constructs of agricultural transformation. The theoretical notions of agricultural transformation as originally conceptualised (Johnston & Mellor, 1961; Lewis, 1954; Ranis & Fei, 1961; Timmer, 1988), and of structural transformation (Barrett et al., 2017; Dercon & Gollin, 2014; Timmer, 2009) emphasise small-scale agriculture. Empirically, small-scale farmers are also the centre of attention in the three themes of how agricultural transformation impacts structural transformation at the macro-level, meso-level, and micro-level. The next section discusses those dynamic of that golden thread on small scale agriculture.

5.5 The dynamics of scale in agricultural development

Most of the discussions around agricultural transformation in its various formulations have been from a historical perspective. Agricultural transformation, whether as the theoretical construct or as agricultural development within structural transformation, has sought to shed light on historical processes. The discussions around agricultural transformation as a practically applicable concept have focussed on the future; they have been about what to do.

The practically applicable definition of agricultural transformation has focussed on a future desired state of commercially oriented small-scale farmers. Even the two dimensions of the practically applicable construct of agricultural transformation are future focussed. Improving internal processed and productivity looks to future aspirations. Similarly, strengthening external linkages also looks to the future.

This study has deliberately sought to consider agricultural transformation from the present perspective. This study considers agricultural transformation as an activity of the here and now. This study submits that agricultural transformation is a practical current activity which is driven by real-world current realities as opposed to being a historically informed future aspiration. The data obtained from the study all point to the existential reality that the challenges that confront all small-scale farmers are a result of the inescapable reality that they are SMALL.

The smallness of small-scale farmers has been hiding in plain sight. From the lexicon and nomenclature that describes them as small-scale farmers, to the agricultural development themes at the macro, meso and micro level, the smallness of agricultural development remains a golden thread. This study has therefore focussed on addressing the nature of that smallness.

5.6 Reconceptualising agricultural transformation with a heightened focus on scale

This study recognised that the inescapable reality of small-scale farmers is that they are small. However, small-scale farmers must operate in an environment where they compete with bigger farming enterprises that can take advantage of their bigger scale. Such advantages of bigger scale provide the bigger farming enterprises with costs advantages (Grant, 2016) that include economies of scale, economies of learning, capacity utilization, lower input costs, better bargaining power and a host of other scale benefits (Armstrong & Lee, 2021). CAADP's practically applicable construct of agricultural transformation seeks to improve internal productivity and strengthen external linkages but does NOT address the disadvantage of smallness that small-scale farmers have.

Consequently, this study has focussed on working with that inescapable reality of the smallness of small-scale farmers. This study borrows on how platform business models having been reshaping industries through various mechanisms one of which is the externalisation scale advantages (Parker et al., 2016; Van Alstyne et al., 2016). This study submits that the sources of the cost advantages that bigger farming enterprises have could be externalised through harnessing platform business models.

5.7 Reframing the narrative from agricultural development to “***digitally enabled agricultural transformation***” within the agenda for structural transformation

This study has submitted that the theoretical perspectives of agricultural transformation need to be revisited to also incorporate real-world dynamics. These real-world dynamics include the inescapable reality that small-scale farmers have not been able to access the advantages of scale because of their smallness. However, another real-world dynamic is that digital technologies and platform business models are re-making industry structures and boundaries. This means that small-scale farmers can harness digitalisation to remake the institutional arrangements for agriculture in such ways that smallness becomes less of a factor.

Given the inescapable reality of smallness, this study puts forward the proposal to introduce that reality into the guiding principles that drove and inspired the CAADP when it was adopted in 2003 (African Union et al., 2003). This may entail getting the various multi-lateral and multinational development partners to conceptualise massive transformative purposes that will drive the agricultural sphere in Africa. Such massive transformative purposes may be informed by CAADP aspirations such as encapsulated in notions that “agriculture will provide the engine for growth in Africa” (African Union et al., 2003, p. iii), and that “improving agricultural performance is at the heart of improved economic development and growth” (African Union et al., 2003, p. iii).

However, the concept of agricultural transformation has been in a state of flux especially from the theoretical perspective. The theoretical construct of agricultural transformation has transitioned into being referred to as structural transformation, whilst the notion of agricultural development has assumed more prominence within structural transformation. On the other hand, the practically applicable notion of agricultural transformation has maintained relative terminological stability around its objective of re-orienting small-scale farmers by improving their internal productivity and strengthening their external linkages.

It must be borne in mind that this study’s conceptual framework has borrowed from the concepts of exponential organisations (Ismail, 2014) and platform business models (Parker et al., 2016; Van Alstyne et al., 2016). A significant dimension of exponential organisations is the notion of a massive transformative purpose (MTP) (Ismail, 2014). A massive

transformative purpose becomes a rallying call that can muster resources across various ecosystems (Ismail, 2014) in pursuit of a common agenda especially when used within platform business models which heavily rely on externalised resources (Parker et al., 2016; Van Alstyne et al., 2016).

The massive transformative purpose, that organisations can craft, will need to be informed by a revisited conceptualisation of agricultural transformation. Consequently, this study proposes to redefine agricultural transformation revisit as follows:

Digitally enabled agricultural transformation is defined as the process of harnessing current digitalisation and technological developments and innovations towards transforming the institutions and institutional arrangements of agriculture to enable the effective, efficient, sustainable and profitable participation of small-scale farmers in the agricultural social-ecological-systems and their constituent sub-ecosystems in order to structurally transform economies in ways that foster sustainable socio-economic growth and development taking into account the inescapable reality of the smallness of small-scale farmers which has previously hindered their access to the advantages of scale which can now be overcome through emerging technology driven business models. Digitally enabled agricultural transformation builds on both the theoretical tradition of the Lewis model of agricultural transformation and its transitions to structural transformation, as well as the practically applicable conceptualisations of agricultural transformation which jointly incorporate envisioning a future that is not only informed by history but also current harnesses real-world realities.

This study proposed two options of a massive transformative purpose for AgriHub Africa as:

<i>African Agriculture for Sustainable Socio-Economic Transformation; AfricanASSET or Agriculture for Africa's Sustainable Socio-Economic Transformation AgricultureASSET</i>

5.8 Conclusion

This chapter has submitted that the theoretical construct of agricultural transformation is heavily steeped in historical analysis whilst the practically applicable definition is aspirational and futuristic. The chapter has also highlighted how the theoretical construct of agricultural transformation has transitioned into being referred to as the notion of structural transformation which is influenced by agricultural development. The empirical studies have identified three themes of agricultural development's macro-level, meso-level and micro-level effects on structural transformation. A golden thread that runs through these themes is that they are all focussed on small-scale farmers.

This chapter submits that the theoretical constructs of agricultural transformation and the re-conceptualised notion of agricultural development's role in structural transformation have a historical perspective. The practically applicable definition of agricultural transformation looks into the future. Consequently, this chapter argues that an examination of current realities highlights how small-scale farmers have to live with the inescapable reality of their smallness.

The chapter also borrows from how platform business models are currently reshaping industries. This study combines those current realities of the smallness of small-scale farmers, and how platform business models are reshaping industries to argue for revisiting the notion of agricultural development with a heightened focus on scale. This chapter also recognises how platform business models leverage externalised resources and can grow exponentially on the back of massive transformative purposes.

Consequently, this chapter advocates for re-drafting the definitions of agricultural transformation in ways that enable players to draft massive transformative purposes around which they can create communities and cultural movements to further agricultural transformation. This chapter has therefore presented a reframed definition of agricultural transformation in the preceding section, as well as two possible options of a massive transformative purpose for AgriHub Africa.

CHAPTER 6. ADDRESSING SCALE CHALLENGE OF AGRICULTURAL TRANSFORMATION USING PLATFORM BUSINESS MODELS

6.1 Introduction

It was established, in the previous chapter, that small-scale farmers face challenges of scale which can be addressed by this study's construct of "Digitally enabled agricultural transformation" as defined in that chapter. This chapter outlines how that concept of "digitalisation enabled agricultural transformation" can be effected by harnessing platform business models. Armstrong and Lee (2021, p. 436) state that "platforms are a set of subsystems and interfaces that form a common structure, from which a stream of derivative products can be efficiently developed and produced, by partners along the supply chain". Although the above definition has initially been applied within industries that have complex manufacturing processes (Armstrong & Lee, 2021, p. 436), this thesis submits that the definition is also applicable within the agricultural space.

Consequently, the AgriHub Africa platform was developed in accordance with that definition as outlined within this chapter. The chapter is made up of four parts, with Part A discussing multi-sided marketplace platforms (MSMP), and Part B focussing on industry platforms. Part C outlines how the principles of super-apps were incorporated and combined with aspects of MSMPs and industry platforms to create AgriHub Africa as a hybrid agricultural industry MSMP super-app platform. Part D discusses how the AgriHub Africa platform architecture was designed to facilitate social-ecological-system based digitally enabled agricultural transformation.

However, prior to elaborating on the four parts of this chapter, reference must be made to a section³⁵ in the literature review chapter which discussed how a farm is essentially an internal product platform. That discussion provides a foregrounding and emphasises the nested nature and panarchy of agriculture as a complex social-ecological-system. The discussion of internal product platforms also provides a brief history of platforms and a description of platform types to provide for completeness

³⁵ Section 2.10 – The farm as an internal product platform

Part A of this chapter outlines how MSMPs can address the challenges of scale within the small-scale farming environment in Africa. This Part A explores how MSMPs can facilitate effective, efficient, profitable, and sustainable participation of small-scale farmers through easing transactions by reducing transaction costs as well as fostering network effects. The opportunities that MSMPs have for leveraging external assets are also explored together with how the software core allows for scalability and better management through data analytics and algorithms. Part A concludes with a review the state of digital tools and multi-sided marketplace platforms in Africa as a prelude to discussing, within Part B, the need for inter-operability amongst platforms in the agricultural space within Africa.

Part B of this chapter opens by outlining how the need for inter-operability can be addressed through an agricultural industry platform in response to that need for interoperability that closed off Part A. The other sections in Part B discuss how an agricultural industry platform can transform institutions and institutional arrangements in order to solve both business systems and technology systems challenges. These business systems challenges manifest as scale challenges which reduce the viability and profitability of small-scale farmers. The technology systems challenges revolve around the difficulties encountered in accessing information especially within the major technological tool of WhatsApp that emerged as the main digital tool for small-scale farmers.

Part B's section on structurally transforming the agricultural social-ecological-system and its sub-systems focuses on discussing how these business system and technology system challenges are addressed through interfaces and standards. The penultimate section of Part B describes how sustainable economic growth and development is driven by promoting innovation through complementors and interoperability. Part B concludes with a section that addresses how the AgriHub Africa platform's key features help it to increase platform switching costs.

Part C of this chapter focusses on how AgriHub Africa was conceptualised as a hybrid platform combining aspects of an agricultural industry platform, an MSMP, and an agricultural lifestyle super-app. The largely agricultural nature of the African social environment is discussed in motivation for how it is amenable to being serviced by an agricultural lifestyle super-app which also serves as an agricultural industry platform. The characteristics of super-apps are ventilated prior to discussing the conceptualisation of AgriHub Africa as a hybrid agricultural industry MSMP super-app platform

The concluding Part D of this chapter discusses how social-ecological-systems based digitally enabled agricultural transformation was implemented through the AgriHub Africa platform architecture. A foregrounding section provides conceptual clarity on how the AgriHub Africa architecture combines aspects of an agricultural industry platform, a MSMP, and a super-app. That foregrounding section briefly introduces the layers of the AgriHub Africa platform architecture as well as highlighting how the digital infrastructures layer is taken as given. Separate sections describe how the AgriHub Africa platform architecture's core layer, ecosystems layer, and services layer were designed and developed.

PART A: MULTI-SIDED MARKETPLACE PLATFORMS

6.2 Scale challenges that small-scale farmers face – This section is data presentation

This study identified that small-scale farmers face a myriad of challenges ranging from (i) acquiring resources necessary to farm, (ii) accessing agricultural knowledge, training, innovation, and other services, (iii) securing inputs and accessing farming equipment and/or farm equipment services, (iv) conducting production and farming operations, and (v) marketing and selling their agricultural produce. Furthermore, small scale farmers struggle to access the opportunities that can be obtained from integrating into agricultural processing and food production value chains.

Almost all of the challenges that the small-scale farmers face can be attributed to scale. In order to discuss how to mitigate against the challenges that this study's participatory action research (PAR) participants face, it was observed that they engage with their other colleague small-scale farmers.

The PAR participants' engagement with their colleagues was initially confined to each individual PAR participant's network and circle of contacts. The PAR participants then also widened their individual circles to also engage the other PAR participants to this study. As a way of further widening their network and circle of contacts, three of the PAR participants and two other actors within the agricultural space, formed the Demeter.

Demeter formalised the manner in which small-scale farmers discuss by establishing a monthly field day and braai to be held at different farmer's premises. The Demeter founders requested the researcher to assist them in firming up their conceptualisation of the organisation. The researcher, due to his own network of actors in the agricultural space, also assisted them to identify and invite other farmers into Demeter.

Demeter thus increases the number of small-scale farmers that any individual small-scale farmer can engage with had they not been part of Demeter. Over and above that, the Demeter field days and braai also scale up the need to identify, visit and learn experientially from exemplary farms. In essence the creation of Demeter sought to address the scale challenges that individual small-scale farmers have in identifying, engaging with, and learning from other small-scale farmers. Demeter makes the circle bigger; it scales the individual small-scale farmer's circle of influence.

6.3 Harnessing technology to address the scale challenges face – This section is data presentation

This section describes how the study harnessed digital technology to address the scale challenges that small-scale farmers face, with the first subsection introducing the direct participatory action research interventions that were facilitated by the researcher. The second and last subsection in this chapter outlines how organic processes for harnessing digital technology emerged around Demeter without the direct intervention of the researcher. The subsection outlines the establishment of the Demeter WhatsApp group as well as the creation of a Demeter.Africa website. Demeter also established social media accounts. Apart from the Demeter digital tools mentioned above, three other PAR participants were part of creating AgriHub Africa with the active collaboration of the researcher. This section also describes how farmers have also been joining other WhatsApp groups.

Direct research interventions to harness digital technology for agricultural transformation

The PAR participants attended workshops with the researcher on the development of digital agriculture strategies. Four of the thirteen PAR participants expressed serious interest in developing digital agriculture solutions. One of the participants selected to develop a digital

platform which did not involve the other PAR participants, but the platform seems to have floundered.

The other three PAR participants decided to collaborate in creating a platform that would focus on aggregating the activities of small-scale farmers as they sought to overcome their scale challenges. The researcher helped to midwife the creation of AgriHub Africa as a platform whose mission is “aggregating African agriculture online”. The following sections of this chapter focus on discussing AgriHub Africa.

The three PAR participants who agreed to collaborate on developing AgriHub Africa as a platform also chose to adopt the crucial triad approach to digitalisation (Armstrong & Lee, 2021). The crucial triad approach to digitalisation considers digitalisation as occurring at the interface of (i) a digital technology revolution, (ii) a transforming society, and (iii) evolving business models. The three PAR participants considered themselves as representing the transforming society as emerging farmers. They also engaged Digitalyca (Pty) Ltd as the digital technology partner, and Afrovation Institute (Pty) Ltd as the business model architecture partner. These are collectively referred to as the AgriHub Africa Founders. The motivation driving the establishment of AgriHub Africa is more fully explained in the following section.

Organic emergence of digital technology tools for agricultural transformation

Demeter established a WhatsApp group which provides small-scale farmers with a platform to engage a wider community of other small-scale farmers. The WhatsApp group served to communicate Demeter activities such as notice of the monthly field days and braais. Individual small-scale farmers also used the Demeter WhatsApp group as a platform within which individuals could post issues that they need assistance with from other small-scale farmers. Such issues ranged from seeking advice on pest management, how and where to secure markets, and advertising various agricultural products amongst a host of other things. At the time of writing this report, the Demeter WhatsApp group has over 700 participants.

At one of the field days and braais, an agronomist and sales representative from a seed company was invited to join the Demeter WhatsApp group. Upon joining the Demeter WhatsApp group, the seed company agronomist and sales representative also invited Demeter WhatsApp group members to also join a WhatsApp group set up by his company to share vegetable production guidelines, enable farmers to advertise and sell their produce, assist farmer to access fertilizers in their areas, and assist farmers to get in contact with agricultural funding organisations. Upon

joining that company's WhatsApp group, farmers have been invited to join several other WhatsApp groups.

Recognising the short comings of WhatsApp, Demeter established a website as well as an app linked to the website. The Demeter.Africa website and app allows small-scale farmers to register for the monthly field day and pay for the accompanying networking braai. Demeter has also opened social media accounts through which it posts content relating to its events. The same content is also posted on the Demeter WhatsApp group.

6.4 Enabling efficient, effective, sustainable and profitable participation: Platform power of multi-sided marketplace platforms

The AgriHub Africa Founders recognised that enabling the efficient, effective, sustainable, and profitable participation of small-scale farmers in the agricultural social-ecological-system required solutions that connected them to other agricultural SES participants. Multi-sided marketplace platforms have solutions that provide such connections among system participants. Multi-sided marketplace platforms are powerful because they (i) reduce transaction costs, (ii) foster network effects, (iii) leverage external assets, and (iv) are built on a software core that allows instant scalability and efficient analytics (Armstrong & Lee, 2021).

The AgriHub Africa Founders also recognised that the agricultural social-ecological system is quite complex and thus chose to work on the six sub-systems identified in this study. Depending on which of the sub-ecosystems small-scale farmers are participating in, they can participate in agricultural social-ecological-systems as either buyers or sellers. This means that a solution that the AgriHub Founders would develop would need to accommodate more than one multi-sided marketplace platform, and thus benefit from the platform power of multi-sided marketplace platforms.

Whilst this study focussed on small scale farmers as the primary object of agricultural transformation, AgriHub Africa is conceptualised as the mechanism through which that agricultural transformation can occur. AgriHub Africa essentially acts as the digital enabler for digitally enabled agricultural transformation. Consequently, the components of platform power that are described in this thesis relate to AgriHub Africa as the platform.

Reducing Transaction Costs

One of the biggest benefits that small scale farmers can obtain from multi-sided marketplace platforms is that they can reduce transaction costs by having a common core architecture (Armstrong & Lee, 2021; Gawer & Cusumano, 2015). That common core architecture enables the reduction of costs at the three levels of (i) pre-transaction search costs, (ii) costs incurred during the actual transacting process, and (iii) post transaction costs (Armstrong & Lee, 2021; Williamson, 1989; Uenlue, 2017a; North, 1992).

Armstrong and Lee (2021) submit that platforms reduce transaction costs at all three levels because they (i) incorporate some trust, (ii) have some embedded logic and algorithms, and (iii) enable a once-only sign up. However, their submission is based on the platform being “large, well reputed businesses” (Armstrong & Lee, 2021, p. 428). The AgriHub Africa Founders acknowledge the reality that their platform is not only at a nascent stage but is an inadequately resourced minimum viable product (MVP) seeking to create a proof of concept.

Consequently, the AgriHub Africa Founders have focussed their platform on enabling a single sign-up as a key component to the reduction of transaction costs. The capacity to build in embedded logic and algorithms can be set-up once resources have been secured as the platform moves from being an MVP toward full commercialised launch. In terms of building trust, the AgriHub Africa Founders are creating a quality assurance programme for small-scale farmers; the AgriHub Africa Master Farmer Programme (Fisher, Holden, Thierfelder, & Katengeza, 2018; Ragasa, 2019).

Fostering Network Effects

A second advantage of multi-sided marketplace platforms is that they foster network effects which are defined as “positive reinforcing cycles, where supply stimulates demand, which in turn stimulates supply, and so on” (Armstrong & Lee, 2021, p. 430). This study sought to build network effects by recognising that small-scale farmers can participate in the agricultural social-ecological-system through its sub-systems which enable the small-scale farmer to be a buyer in one sub-system, and/or a seller in another sub-system.

Consequently, the AgriHub Africa Founders sought to grow the platform exponentially by building in a capacity to foster network effects, through conceptualising a platform that enables a small-scale farmer to simultaneously be a buyer and a seller depending on the sub-ecosystem

that they are participating in. Again, as the platform moves from being an MVP toward full scale commercialisation, the progressive deployment and progressive uptake (Armstrong & Lee, 2021) can further lead to exponential growth.

The AgriHub Africa is conceptualised to foster both one-sided and multi-sided network effects. By providing the functionality for small-scale farmers to create groups of common interests with other small-scale farmers, AgriHub Africa fosters one-sided network effects. Because AgriHub Africa has a facility for different profile types based on the agricultural social-ecological system's sub-ecosystems, it is possible to foster multi-sided network effects. A critical component of furthering these network effects is the rate of growth of the number of users.

Other sources of network effects include the ability to provide complementary services and functionality. Basing the architecture of AgriHub Africa on the agricultural social-ecological-system and its sub-ecosystems builds-in the capability of enabling innovation for complementary services. The AgriHub Africa MVP, AgriHub.Online, is built on WordPress with a BuddyBoss Platform Plugin. WordPress also allows other plugins. Two of the plugins planned for the current MVP, which are an e-commerce plugin and a learning management system, are good examples of complimentary services that can foster network effects.

Furthermore, by designing AgriHub Africa as a super-app, it was expected and hoped that the cost of switching can increase. As a super-app, AgriHub Africa can host more functionality than a single-use digital tool such as WhatsApp. Coupled with ensuring the availability of complimentary services, which obviate the need to exit the platform, it was planned and hoped that AgriHub Africa becomes an industry standard. This can, in turn, strengthen the ability to foster network effects.

Leveraging External Assets

AgriHub Africa can enable small-scale farmers to aggregate their requirements for big ticket equipment such as farm mechanisation. That ability to leverage external assets enables small-scale farmers to access resources that they do not own. This provides for easier expansion and scaling of their operations. Leveraging external assets reduces not only operational risk, also reduces financial risk since the small-scale farmers may be able to outlay less of their own capital.

However, small-scale farmers may not be able to fully leverage external assets otherwise they would essentially cease to be farmers. Assets such as land and water rights are integral to any farming operations. Control of such assets is important because any potential denial of access to them renders the farming enterprise untenable. It is worth noting that a farm is essentially an internal product platform as will be explained in Part C of this chapter.

However, more importantly, AgriHub Africa is the entity that can leverage external assets as a platform. For example, AgriHub Africa can leverage the various small-scale farms towards the production of specific products according to predetermined quantities and qualities. The AgriHub Africa Master Farmer Programme was designed to enable the leverage of such external assets. Taking into cognisance that a farm is essentially an internal product platform, and that agriculture is a complex SES, the AgriHub Africa platform performs the role of smoothening and facilitating the panarchy that builds SES resilience into the institutional arrangements for agricultural transformation.

Digital Software Reach and Scalability

Armstrong and Lee (2021) suggest that it may be possible to fully externalise assets to an extent that only the software core remains as the enterprise's major asset. However, as indicated above, farming enterprises cannot fully externalise assets. Small-scale farmers can however harness the limitless reach of digital tools to access agricultural knowledge and innovation resources.

This study submits that the dynamics of multi-sided marketplace platforms can be turned inside out for small-scale farms. In normal multi-sided marketplace platforms, the digital software core of an organisation's platform is "extremely quick, easy, and relatively cheap to scale" (Armstrong & Lee, 2021, p. 435). Small-scale farmers who are part of a platform can be aggregated to scale up *extremely quickly, easily, and relatively cheaply*. Further research can be conducted to determine whether this could be because farms are themselves platform enterprises.

AgriHub Africa's major assets include the software core that makes the platform as well as the intellectual property around which the AgriHub Africa Master Farmer Programme is built. Similar to how iOS and Android constitute platforms around which innovation occurs, and they also own apps that provide key functionalities, AgriHub Africa remains the key coordinating

platform with the AgriHub Africa Master Farmer programmes being akin to an app providing key functionality.

6.5 State of digital agriculture tools and multi-sided marketplace platforms in Africa: Need for interoperability

This Part A of this chapter has so far discussed the scale challenges that small-scale farmers face, and how harnessing digital technology can help address those scale challenges. The previous section discussed how the power of MSMPs can potentially enable small-scale farmers to participate more efficiently, effectively, sustainably, and profitably within the agricultural social-ecological-system. This section takes a step back to review the state of digital agricultural tools and MSMPs in Africa.

Digital technologies have the potential of transforming agriculture in Africa (Goedde, McCullough, Ooko-Ombaka, & Pais, 2021; Jellason et al., 2021; Kudama, Dangia, Wana, & Tadese, 2021; Tsan et al., 2019). From having around 41 digital solutions for African agriculture in 2012 (Tsan et al., 2019), digital agriculture has grown with various numbers of digital solutions being quoted such as 390 in 2019 (Tsan et al., 2019), over 400 in 2021 (Goedde et al., 2021), and the current number of 541 registered solution on the Digital Agrihub Dashboard (D4Ag, 2022).

The Digitalisation of African Agriculture reports that the number of small-scale farmers subscribing to digital agriculture services is growing at the rate of 40% to 45% annually (Tsan et al., 2019). The same report estimates that 33 million small-scale farmers have subscribed to digital agriculture services (Tsan et al., 2019). This number represents 13% of the roughly 250 million small-scale farmers in Sub-Saharan Africa (Tsan et al., 2019).

However, these digital agriculture solutions in Africa are struggling to scale and have less than 30% active users . (Goedde et al., 2021). With only twenty applications having more than a million users, and accounting for 80% of the registered farmers, these digital agriculture solutions do not seem to be materially improving the livelihoods of small-scale farmers . (Goedde et al., 2021). Tsan et al. (2019) submit that most digital agriculture solutions only provide services that are core to their own business models and do not provide complementor services to other platforms. The next section in Part B discusses the need for interoperability

which motivated for the conceptualisation of AgriHub Africa to also be an agricultural industry platform as well as being an MSMP as discussed in earlier sections of this Part A.

PART B: AGRICULTURAL INDUSTRY PLATFORM

In presenting a taxonomy of platforms, Armstrong and Lee (2021, p. 437) define an industry or technology platform as one in which “products or services or technologies, developed by one or more firms, which serve as a foundation upon which a large number of other firms can build other complementary innovations, other products and other related services or component technologies”. Africa’s digital agricultural services need for interoperability required an architectural framework to serve as a foundation around which they could be built.

The AgriHub Africa platform thus provided the architectural framework to address the need for inter-operability amongst Africa’s digital agricultural services and tools as an agricultural industry platform whose value focus is external and mainly downstream (Armstrong & Lee, 2021). This study therefore adopted this definition to guide the development of the AgriHub Africa platform as an agricultural industry platform as well.

6.6 Agricultural industry platform addresses need for interoperability in Africa’s digital agriculture

The “walled garden” approach and disparate operations of most digital agriculture solutions discussed in the previous section presents an opportunity for the creation of a platform that provides inter-operability amongst those platforms (Tsan et al., 2019). The creation of such a platform could have unlocked the potential of digital agriculture solutions which were worth R38.4 billion in 2018 compared to the 2018 turnover of R1.2 billion (Tsan et al., 2019). Tsan et al. (2019) submits that coordinating Africa’s digital agriculture solutions has the potential to increase small-scale farmers’ yields by 168% and profits by 57%.

AgriHub Africa is a platform that can be the digital catalyst to drive agricultural transformation. As an agricultural industry platform, AgriHub Africa can be able to address the digitalisation requirements of all types of participants within the agricultural industry. This means that AgriHub Africa can be in a position to accommodate any and all digital solutions for Africa.

This therefore meant that AgriHub Africa was conceptualised as an agricultural industry platform. Furthermore, AgriHub Africa was conceptualised as a super-app in such a way that the small-scale farmers do not need any other app on their mobile devices.

To make it attractive to developers of digital agriculture solutions in Africa, the AgriHub Africa platform offers opportunities for realising value to the platform eco-system participants as complementors (Armstrong & Lee, 2021). For those opportunities to be realised, it must be easy for complementors to connect to the platform architecture thus requiring the AgriHub Africa platform to have architectural openness (Armstrong & Lee, 2021).

The AgriHub Africa platform benefits from network effects by availing value opportunities which are harnessed because of its architectural openness (Armstrong & Lee, 2021). Furthermore, having complementors on the the AgriHub Africa platform helps to externalise innovation and further bolster network effects (Armstrong & Lee, 2021). However, to maintain architectural integrity, the AgriHub Africa platform needs to enforce architectural integrity (Armstrong & Lee, 2021). The following four sections describe how the AgriHub Africa platform was designed as an agricultural industry platform to build its intrinsic network power as part of addressing the requirements for this study

6.7 Transforming institutions and institutional arrangements: Solving agricultural industry problems through the industry platform's core intellectual property

The AgriHub Africa platform was developed to transform the institutions and institutional arrangements for agriculture in order to solve the business systems and technology systems challenges afflicting small-scale agriculture. The transformation of these institutional arrangements unlocks the customer value propositions, represents the business models, and enables the platform to address the agricultural industry challenges. This in turn attracts complementors. All of these represent the intellectual property of the AgriHub Africa platform. That intellectual property forms the basis for creating value for the AgriHub Africa platform owners.

The AgriHub Africa platform addresses the business systems challenges that small-scale farmers encounter. This study has determined that these business systems challenges are attributable to scale. Section 5.2 of this chapter has described these scale challenges that small-

scale farmers face. This chapter, in Section 5.3, also proposed that harnessing technology can help to address these scale challenges.

However, technology challenges have also emerged as the small-scale farmers attempted to harness technology to address those scale challenges. In particular, the major tool that the small-scale farmers have been using, WhatsApp, has limited functionality. Further to that, this study has also evaluated, in Section 5.5 of this chapter, the state of digital agriculture tools and multi-sided marketplace platforms in Africa to determine whether there is capacity to overcome the limited functionality inherent in the digital tools that small-scale farmers have resorted to. That evaluation resulted in identifying the need for interoperable platforms as discussed in Section 5.6 of this chapter. That section recommended the conceptualisation of the AgriHub Africa platform as an agriculture industry platform and as a super-app.

6.8 Structurally transform agricultural social-ecological-system & subsystems: Interfaces and standards

It was described, in the previous section, how the AgriHub Africa platform was designed in such a way as to enable complementors to join it easily. This means that the AgriHub Africa platform has interfaces and standards that are well defined and open so that complementors can join the AgriHub Africa platform ecosystem. As part of that ecosystem, complementors can develop complementary products and services. Complementors can thus add value to the AgriHub Africa platform through their innovations.

Although most of these interfaces and standards are technical, the AgriHub Africa platform also has interfaces and standards that related to business and commercial aspects. Key to those business and commercial interfaces and standards is the recognition that agriculture is a complex social-ecological-system. It was therefore important that the AgriHub Africa platform's architecture be congruent with the six different sub-ecosystems identified in this study. The common interface for all the sub-ecosystems is the small-scale farmer. It is the same small-scale farmer that engages in the six different sub-ecosystems.

Furthermore, the AgriHub Africa interfaces and standards also include governance, rules, standards, and operational interfaces. By having such open interfaces and standards, the

AgriHub Africa platform will grow its network effects and secure platform lock-in, whilst simultaneously creating barriers to competition.

6.9 Driving sustainable economic growth and development: Foster innovation through complementors and interoperability:

Although standards and interfaces provide the mechanisms with which complementors can connect to the AgriHub Africa platform, it is important that those connections can foster innovation. Constantinides et al. (2018, p. 381) argue that “digital platforms enable the building of a powerful innovation ecosystem”. Fostering innovation within any one of the sub-ecosystems of the agricultural social-ecological-system has spill over effects of promoting innovation to the other sub-ecosystems. That is consistent with the abundance notion that innovation that fuels further innovation Diamandis and Kotler (2012). The innovations, coupled with those spill over effects, have the potential to stimulate agricultural development and thus drive sustainable economic growth and development.

Having complementors on the AgriHub Africa platform externalises and scales innovation. This externalisation of innovation creates momentum which in turn creates user utility as the basis of delivering value to the customer and user. The incorporation of the agricultural social-ecological-systems sub-ecosystems onto the platform architecture allows those sub-ecosystems to feed innovation into and from each other.

6.10 Increasing switching costs: the AgriHub Africa platform’s key features

This section discusses why and how the AgriHub Africa platform has been developed with some key features. These key features were designed to help the AgriHub Africa platform to strive to be a market leader in the Africa digital agriculture space. Not only does the AgriHub Africa platform seek to be a market leader, but it also seeks to increase platform ecosystem switching costs. The AgriHub Africa platform actively seeks to create network effects that lock in both users and complementors through these key features.

The first of these key features is that, to enable the AgriHub Africa platform to address the challenge of interoperability amongst Africa’s digital agriculture offerings, the AgriHub Africa

platform is open to complementors. This is achieved through having open interfaces and standards.

Not only is the AgriHub Africa platform open to complementors, but the platform also seeks to create value and incentives for other digital agriculture developers to adopt the platform and join it. That way, the AgriHub Africa platform becomes ubiquitous and moves the rate of digital agriculture services usage in Africa from its paltry 13% (Tsan et al., 2019). This occurs because the AgriHub Africa platform offers higher value to users and consumers due to the presence of complementary products.

Furthermore, the AgriHub platform externalises innovation. This means that complementors can conceptualise, develop, and deploy complementary functionality. This obviates the need for the AgriHub Africa platform to search for the resources that would be needed to develop all of these complementary products and services.

PART C: HYBRID AGRICULTURAL INDUSTRY MSMP SUPER-APP: AGRIHUB AFRICA

This study established, in Part A of this chapter, that digital solutions that seek to service small-scale farmers in Africa should be interoperable. This then led to a discussion, within Part B of this chapter, on how that interoperability can be achieved through an agricultural industry platform. However, to conceptualise an agricultural industry platform for small-scale farmers in Africa, the next section in this Part C discusses the context of Africa's small-scale farming environment and the opportunities that exist for a super app. This study submits that Africa's main socio-economic identity revolves around small-scale farming. This therefore means that Africa's small-scale agriculture can form the basis of a super-app that is not only fit for purpose for farmers but one that addresses the lifestyle requirements of Africa's people. Consequently, the following sections of this Part C discusses the conceptualisation of a hybrid MSMP and agricultural industry platform as a super-app.

6.11 Africa's agricultural environment : Socio economic identity of most Africans as small-scale farmers presents opportunities for an African super-app agriculture

This section submits that the socio-economic footprint of Africa's agriculture is so huge that the socio-economic identity of most of Africa's population is based on agriculture. Over 50% of Africa's population is employed in agriculture (Bruzzone, 2021; Goedde, Ooko-Ombaka, & Pais, 2019; OECD, 2016) which accounts for 23% of the continent's GDP (Bruzzone, 2021). With over 60% of the world's uncultivated land being in Africa (Bruzzone, 2021), and consumer spending food and beverages produced within Africa expected to grow by about US\$167 billion between 2015 and 2025 (Goedde et al., 2019) there is great potential for Africa's agriculture. Goedde et al. (2019, p. 6) identified several opportunities for interventions that can be facilitated by digitalisation.

The socio-economic footprint of agriculture in Africa is huge (Goedde et al., 2019). More than half of Africa's labour force is employed in agriculture (OECD, 2016). The percentages of people employed in agriculture differ with the World Bank putting it at 52% (Bruzzone, 2021), and with other researchers such as Kudama et al. (2021) putting it at 54%, and Goedde et al. (2019) putting it at 60%.

The value of agricultural production in Africa increased by 11% during the period 2011 to 2016 (Bruzzone, 2021, p. 5). The FAO and OECD project that Sub-Saharan Africa's agricultural production will rise by 21% between 2020 and 2029 (Bruzzone, 2021, p. 5). Goedde et al. (2019, p. 2) estimate that agriculture accounts for 23% of the GDP in Sub-Saharan Africa. However, at the national levels, the diverse range of economic structures means that the contribution of agriculture to GDP is as low as 3% for natural resource rich countries like South Africa and Botswana, and as high as 50% for other countries like Chad (OECD, 2016, p. 60). The OECD (2016, p. 60) submits that on average, agriculture accounts for 15% of the national GDP of countries in Sub-Saharan Africa.

Beyond employing over 175 million people directly, Africa's agriculture provides for livelihoods within people's rural settings (Kudama et al., 2021; OECD, 2016). Rapid and rising urbanisation (Goedde et al., 2019; OECD, 2016) is not only causing growth in Africa's urban middle class (Goedde et al., 2019) but is also causing shifts in food demand (OECD, 2016).

Consumer spending in Africa is expected to grow by about US\$645 billion between 2015 and 2025 with US\$167 billion of that in food and beverages produced within Africa (Goedde et al., 2019). That growth is largely attributed to not only rising urbanisation but also to higher consumption of food and agricultural products by urban consumers relative to their rural counterparts (Goedde et al., 2019).

Furthermore, there is a rise in emergent farmers who reside in urban areas but are acquiring “land later in life” (Goedde et al., 2019, p. 2). This class of rising emergent farmers are not only relatively well educated, but are well connected to value chains which include inputs and markets, as well as policy elites that influence policy (Goedde et al., 2019). This class of rising emergent farmers has “growing access to new information and communication technologies” (OECD, 2016, p. 60). However, Goedde et al. (2019, p. 5) contend that “these farmers often fall into ‘a missing middle’ and can have trouble obtaining access to loans or more sophisticated services to meet their needs”.

According to the FAO, 60% of the world’s uncultivated land is in Africa (Bruzzone, 2021). This, coupled with the rise in agricultural commodity prices during the past decade to two, has resulted in rising global interest in agricultural land in Africa (OECD, 2016). Despite this interest, the potential of Africa’s agriculture is still to be realised (Goedde et al., 2019). Analyses conducted by Goedde et al. (2019) suggest that African agriculture could double or treble its cereal and grain production to add up to 20% more to the world’s current production of 2.6 billion tonnes. Goedde et al. (2019) submit that livestock and horticulture production could also increase by similar levels. According to Goedde et al. (2019), opportunities for growing Africa’s agricultural potential can be realised by (a) expanding the amount of agricultural land under use, (b) improving farmers cost competitiveness, and (c) enhancing farmer productivity.

Even in the face of such opportunities and potential, food security still remains a challenge with 30% of the population in Sub-Saharan Africa being food insecure (Bjornlund, Bjornlund, & Van Rooyen, 2020, p. 20). African agriculture plays an important role in addressing food security (OECD, 2016, p. 60), and has thus been prioritised within the developmental agenda for Africa (OECD, 2016, p. 60). The New Partnership for Africa’s Development (NEPAD) has therefore made the Comprehensive African Agricultural Development Programme (CAADP) an integral component for improving food security and eradicating hunger (OECD, 2016, p. 60).

Several African governments have placed policy focus on moving beyond subsistence farming in order to strengthen food security (Bjornlund et al., 2020, p. 20). Some of the measures that are essential to effect transformation to commercial farming from subsistence farming include (a) developing skills required for commercial farming, (b) developing functional value chains, and (c) strengthening rural financial institutions and associated infrastructure (Bjornlund et al., 2020, p. 20). Unfortunately, these efforts have been sporadic and lacked persistence and sustainability (Bjornlund et al., 2020, p. 20).

Some African countries consider the biggest driver of growth to be small-scale productivity (Goedde et al., 2019). Although there have been increases in farm sizes, these countries have taken initiatives aimed at consolidating the activities of small-scale farmers in order to (a) to “increase productivity”, (b) “provide market access”, and (c) “reduce risk” (Goedde et al., 2019, p. 6). Some of those initiatives included “farmer aggregation through cooperatives, out-grower schemes, and nucleus farms” (Goedde et al., 2019, p. 6). This is particularly relevant since small-scale farms make up 80% of Sub-Saharan Africa’s farms (OECD, 2016, p. 60).

Goedde et al. (2019, p. 6) have identified seven intervention opportunities: three on the demand side and four on the supply side. Demand side interventions require investing in farmers engagement with their demand side (Goedde et al., 2019). Farmers need to understand their consumers’ preferences, buying behaviours, product needs, and preferences (Goedde et al., 2019). Farmers will also need to get close to their consumers to play the “ground game,” including using innovative and non-traditional mechanisms such as the disruptive nature of digital technologies (Goedde et al., 2019, p. 6). Lastly, farmers could harness data and analytics to develop innovative business models that get them closer to their demand side (Goedde et al., 2019).

On the supply side, Goedde et al. (2019, p. 6) propose interventions that “innovate in routes to market” for the farmers. Such interventions include harnessing digital innovations to “disrupt highly fragmented supply chains and reduce cost to reach “agro-dealers” (including through digital innovation) (Goedde et al., 2019). The other interventions include initiatives to “ease agro-dealer payments”, providing “value-added services to high performing agro-dealers so they can better serve farmers”, and segmenting “farmers to target demand-creation efforts” (Goedde et al., 2019, p. 6).

The above-described calls advocating for various innovations to grow agriculture in Africa suggest that digital innovations could be harnessed. However, the proposed innovations are themselves as disjointed and as disparate as the Africa's digital agriculture services. Furthermore, these calls for innovations only focus on the agricultural activities. Similarly, the digital agriculture services in Africa also only focus on agricultural activities.

Both the innovations to strengthen agriculture in Africa and the digital agriculture services in Africa focus only on agricultural activities. They both do not acknowledge that the farmers, to whom these innovations and digital agriculture services are targeted, also have lifestyles even though agriculture plays an important part in those lifestyles. The important role that agriculture plays in the lifestyles of the majority of Africa's population motivated for developing AgriHub Africa as not only a hybrid agricultural industry platform and MSMP, but also as a super-app.

PART D: AGRIHUB AFRICA PLATFORM ARCHITECTURE FOR SOCIAL-ECOLOGICAL-SYSTEM BASED DIGITALLY ENABLED AGRICULTURAL TRANSFORMATION

Prior parts of this chapter described how platform business models and the super-app concept were harnessed to implement the construct of “digitally enabled agricultural transformation” which is defined within this study. Part D of this chapter describes the social-ecological-system based digitally enabled agricultural transformation super-app architecture that was used to implement those platform business models. Chapter Five of this thesis set the foundation of that architecture by reconceptualising agricultural transformation with a heightened focus on scale. As a result, this thesis proposes a definition of digitally enabled agricultural transformation that unifies digital transformation with agricultural transformation.

Part D of this chapter is informed by recognising that agriculture is a complex social-ecological-system. Consequently, this Part D describes how to build on the definition of digitally enabled agricultural transformation through a hybrid agricultural industry MSMP super-app architecture. That architecture renders the social-ecological-system representation of the high value vegetables horticulture onto the reconceptualised digitally enabled agricultural transformation definition. The AgriHub Africa architecture is based on social-ecological-systems. AgriHub Africa has a social-ecological-systems based agricultural industry MSPM super-app architecture.

6.12 Architecture for AgriHub Africa as a hybrid agricultural industry MSMP super-app

This section describes the architecture AgriHub Africa as a hybrid agricultural industry MSMP super-app platform. AgriHub Africa is a combination of three types of platforms being (a) a multi-sided marketplace platform, (b) an agricultural industry platform, and (c) a super-app. As a multi-sided marketplace platform, AgriHub Africa addresses the scale challenges of small-scale farmers by enabling their efficient, effective, sustainable, and profitable participation in agriculture as described in an earlier section³⁶. AgriHub Africa is also an agricultural industry platform that is addressing the interoperability challenges of Africa's digital agriculture tools as outlined in another previous section³⁷. Lastly, AgriHub Africa is designed as a super-app in order to offer value to most Africans whose socio-economic identity is that of small-scale farmers as described in the preceding section³⁸.

This section describes how AgriHub Africa, as platform, is essentially what Kretschmer, Leiponen, Schilling, and Vasudeva (2022, p. 405) refer to as a “meta-organisations or organisations of organisations”. Prior to discussing key aspects of the AgriHub Africa platform architecture, this section discusses a definition of platform architecture as well as such aspects such as the platform sponsor and founder, and nature of the platform's complements. The section also outlines the layers of that architecture that were used to develop the AgriHub Africa platform architecture.

AgriHub Africa Platform is a metaorganisation

AgriHub Africa is an institutional arrangement for organising farmers and their farms through a platform. Given that a farm is also essentially a platform as discussed in an earlier section³⁹, then AgriHub Africa is not only a platform of platforms but can be classified as a meta-organisation (Kretschmer et al., 2022). Kretschmer et al. (2022, p. 405) describe meta-

³⁶ Section 5.4 - Enabling efficient, effective, sustainable and profitable participation: Platform power of multi-sided marketplace platforms

³⁷ Section 5.6 - Agricultural industry platform addresses need for interoperability in Africa's digital agriculture

³⁸ Section 5.11 - Africa's agricultural environment: Socio economic identity of the most Africans as small-scale farmers presents opportunities for an African super-app

³⁹ Section 2.10 – The farm as an internal product platform

organisations as being “less formal and less hierarchical structures than firms, and yet more closely coupled than traditional markets”. Kretschmer et al. (2022) definition of a meta-organisation is consistent with definitions of institutional arrangements as mechanisms for resolving economic questions (Campbell, 1997; Hollingsworth, 2000; Lindberg et al., 1991).

Blaschke, Haki, Aier, and Winter (2019) define platform ecosystems as “complex network of platform-mediated actor-to-actor interactions, turning increasingly accessible to end users through third parties’ platform derivatives”. Platform ecosystems such as AgriHub Africa have not only reshaped industry boundaries and restructured markets (Parker et al., 2016), but they have also brought about innovations that improved economic efficiency through new products and services (Kretschmer et al., 2022).

However, for AgriHub Africa to successfully harness the power of such platform ecosystems, AgriHub Africa’s platform architecture needed to provide coordination amongst different and diverse platform ecosystem participants with common and aligned visions and interests . (Kretschmer et al., 2022). The vision that guided AgriHub Africa was to aggregate African agriculture using online tools. The AgriHub Africa architecture caters for the diverse and different interests of the platform ecosystem participants by being a “modular and interdependent system of core and complementary components bound together by design rules and an overarching value proposition” (Kretschmer et al., 2022, p. 405).

Bearing in mind that agriculture is a complex, social-ecological-system, the AgriHub Africa platform architecture depicts that complex system in a modularised manner (Facin, de Vasconcelos Gomes, de Mesquita Spinola, & Salerno, 2016). In modularising the agricultural social-ecological-system, the AgriHub Africa architecture is guided by Baldwin and Woodard (2009) view that the system should be “partitioned into a set of ‘core’ components with low variety and a complementary set of ‘peripheral’ components with high variety”. Consequently, the core layer of the AgriHub Africa platform architecture was designed to be stable (Facin et al., 2016), whilst the services layer allows for a wide variety of services to be provided.

Defining platform architectures

Tiwana et al. (2010, p. 677) define platform architecture as the “conceptual blueprint that describes how the ecosystem is partitioned into a relatively stable platform and a complementary set of modules that are encouraged to vary, and the design rules binding both” (Constantinides et al., 2018; Tiwana, Konsynski, & Bush, 2010). Beyond facilitating

transactions and connecting platform ecosystems participants together, the AgriHub Africa platform architecture enables them to collect and store data in ways that allow for the aggregation and commercialising of that data (Alaimo, Kallinikos, & Valderrama, 2020; Constantinides et al., 2018; Jovanovic, Sjödin, & Parida, 2021; Tiwana et al., 2010).

The AgriHub Africa platform was conceptualised, developed, and deployed by the AgriHub Africa founders described in an earlier section⁴⁰. The AgriHub Africa founders established a company, Digitalyca (Pty) Ltd, which then became the hub around which the platform ecosystems were organised. Such a firm is usually referred to as the platform sponsor (Jovanovic et al., 2021; Rietveld & Schilling, 2021). Digitalyca, as the platform sponsor, designed the AgriHub Africa platform architecture. The AgriHub Africa platform architecture was designed to enable complements that are product agnostic (Constantinides et al., 2018).

Constantinides et al. (2018) submit that digitisation is a key aspect to having product agnostic complements. They submit that the increased digitisation of physical products and openness create the basis for platforms to emerge (Constantinides et al., 2018). Embedding digital components onto physical products enables the layering of the modular structure of platform architectures (Constantinides et al., 2018). Ecosystems premised on architectures that are both modular and layered can emerge if such boundary resources as API are available (Constantinides et al., 2018). Consequently, the agricultural social-ecological-system needs to be digitised in order to unlock opportunities for developing complements.

AgriHub Africa Platform Architecture Layers

The AgriHub Africa platform architecture is both modular and layered. Although there are several different approaches to platform architecture layers. The AgriHub Africa platform architecture considered Blaschke et al. (2019) four layered approach and the Zutshi and Grilo (2019) seven layered format. Blaschke et al. (2019) identify four layers of the platform architecture being (a) the digital infrastructures layer, (b) the core layer, (c) the ecosystem layer, and (d) the services layer.

⁴⁰ Section 7.3 - Harnessing technology to address the scale challenges

For purposes of developing the AgriHub.Online MVP, the Blaschke et al. (2019) four layered approach was adopted as more fully explained below. However, as the project moves from the AgriHub.Online MVP towards full commercial development and launch, AgriHub Africa will adopt the seven layered format put forward by Zutshi and Grilo (2019) since it enables higher levels of granularity at the lower level layers of digital technology layer, data layer, integration layer, and development layer.

The AgriHub Africa platform architecture considers and assumes the digital infrastructures layer to be already provided and available. As a result, this study did not place much emphasis and attention to the digital infrastructures layer. However, this study designed and developed the AgriHub Africa platform architecture's core layer, ecosystem layer, and services layer. The following paragraph of this section briefly explains what the digital infrastructures layer is. The core layer, ecosystems layer, and services layer of the AgriHub Africa platform architecture are described separately in the following three sections.

The digital infrastructures layer is composed of digital technology resources upon which platform ecosystem participants interact (Blaschke et al., 2019). These resources range from the consumer devices such as smartphones and computers, through standards such as USB and IEEE 802.11, the internet, and even the connectivity infrastructure such as mobile telephony networks (Blaschke et al., 2019). Digital infrastructures are used to collect, store and avail data (Blaschke et al., 2019). Consequently, digital platforms are developed and deployed on top of digital infrastructures (Blaschke et al., 2019).

As mentioned earlier, the digitisation of the physical components of the agricultural social-ecological-system helps to develop product agnostic complements. Constantinides et al. (2018) submits digitisation of the physical components of the agricultural social-ecological-system enables their layering onto the modular structure of platform architectures (Constantinides et al., 2018). Once the physical components of the agricultural social-ecological-system are digitised, they become part of the digital infrastructures layer. The digitisation of the physical components of the agricultural social-ecological-system is an area for further research.

6.13 AgriHub Africa's Core Layer

Blaschke et al. (2019) place the platform's core layer directly on top of the digital infrastructures layer. The platform's core layer is a "set of stable technical core artefacts of software and hardware" that "acts as technological foundation for a family of value-added platform derivatives" (Blaschke et al., 2019, p. 579). The AgriHub Africa platform architecture's core layer is built on two major open-source core software artefacts. The AgriHub.Online MVP was built on a WordPress platform using the BuddyBoss Platform plugin.

WordPress is an open-source website builder and content management system which features a template system and a plugin architecture. WordPress's plugin architecture promotes "third-party, platform-augmenting derivatives" (Blaschke et al., 2019, p. 579). To transform the WordPress website builder into a social network platform builder, the AgriHub Africa platform architecture used the BuddyBoss Platform plugin. Other additional functionality, such as e-commerce and learning management systems, can be added onto the AgriHub.Online MVP through the WordPress plugin architecture.

The core layer of the AgriHub Africa platform architectures seeks to provide institutional arrangements for digitally enabled agricultural transformation. AgriHub Africa, as a platform, is a meta-organisation (Kretschmer et al., 2022). Kretschmer et al. (2022, p. 405) description of meta-organisations, and by extension platforms, as being "less formal and less hierarchical structures than firms, and yet more closely coupled than traditional markets" essentially redefines platforms as institutional arrangements.

Platforms co-evolve with ecosystems (Hou & Shi, 2021; Jovanovic et al., 2021; Tiwana et al., 2010). This means that platforms become manifestations of evolving institutional arrangements. The core layer of the AgriHub Africa platform architecture provided a stable mechanism within which institutional arrangements for digitally enabled agricultural transformation can evolve.

However, whilst AgriHub Africa is evolving, that evolution should be focussed on agricultural transformation. This means that AgriHub Africa's platform architectures should have social-ecological-systems resilience incorporated in such a manner as to promote transformability as opposed to adaptability. Beyond providing institutional arrangements for digitally enabled

agricultural transformation through the AgriHub Africa platform architecture's core layer, AgriHub Africa's platform architecture should build in social-ecological-systems resilience. Building social-ecological-systems resilience into AgriHub Africa, as an institutional arrangement for agricultural transformation, was implemented through the ecosystems layer.

6.14 AgriHub Africa's Ecosystem Layer

The platform's ecosystem layer can be considered as the flesh which is built around the platform's core layer as a skeleton. To illustrate, consider a situation where the platform core, as a skeleton, only has a torso without arms and legs. The functionality that can be provided by the arms and legs cannot be accessed. Concomitantly, the sub-ecosystems around such functionality cannot develop. This analogy was more amplified by the case of the AgriHub.Online MVP whose core layer did not include the functionalities for e-commerce and learning management systems. Consequently, the compliments and sub-ecosystems around e-commerce and learning management systems could not develop.

Armstrong and Lee (2021, p. 436) list five different types of platform ecosystem participants being (a) the platform owner, (b) complementors, (c) users, consumer or buyers of the platform offering, (d) producers, providers or sellers of the platform offering, and (e) "the vehicle over which or within which the platform is delivered or made available to customers". However, the last of the platform ecosystem participant that Armstrong and Lee (2021) mention as being the vehicle can be more aptly referred to as the digital infrastructure layer.

The platform ecosystem, through the platform ecosystem participants, provide the functionality that is required on the platform (Blaschke et al., 2019). The AgriHub Africa platform architecture was designed to mediate the interactions of small-scale farmers amongst themselves and other agricultural players, as platform ecosystem participants, towards aggregating their activities.

The architecture of AgriHub Africa is built around the individual agricultural social-ecological-systems participant. That participant is a principal user and a central component of the AgriHub Africa platform. Users on can register their profiles on AgriHub Africa, and within that profile, they can declare their profile types. The profile type feature on the AgriHub.Online MVP

allows for users to declare which of the agricultural social-ecological-system sub-ecosystems⁴¹ they participate in. Profile types enable users to have an idea of the main activities of other users. This provides for ease of connections and interactions amongst users.

Users can create groups or join already created groups on AgriHub Africa. Groups can also have sub-groups within them to cater for more specific interests. For example, one of the groups on the AgriHub.Online MVP focuses on livestock production. Within that group, there are sub-groups to cater for the various specialised interests such as cattle farming or poultry. Groups and sub-groups can also be used to organise enterprises according to their various organisational structures and divisions.

For example, a farming enterprise that grows spinach and rears rabbits has sub-groups according to those activities. Another enterprise that engages in agricultural marketing has sub-groups according to the services they provide such as branding or digital marketing. The AgriHub Africa platform architecture was also designed to facilitate access to additional complements through the services layer.

6.15 AgriHub Africa's Service Layer

The digital services layer facilitates the services that platform ecosystem participants provide and receive from each other “through a platform-mediated digital transaction” (Blaschke et al., 2019, p. 579). These platform mediated services, offered through the platform services layer, address the requirements of platform ecosystem participants by integrating various resources available on or through the platform (Blaschke et al., 2019). Although such services might be provided once, it is more often the case that the services are provided on a continuous basis and to multiple other platform ecosystem participants (Blaschke et al., 2019).

The services layer configures how services can be provided by the platform owner, or any other platform ecosystem participant, to a user (Blaschke et al., 2019). The AgriHub.Online MVP's service layer provided for the creation of groups and sub-groups as platform owner provided services. Other platform ecosystem participants have created groups within which they are able to interact and transact as part of the platform mediation that the services layer provides.

⁴¹ Section 4.4 - The sub-ecosystems Gauteng's high value horticulture's social-ecological-system

The AgriHub Africa platform architecture's services layer also takes advantage of the functionalities provided by the core layer to facilitate for services. Examples of the functionalities within the cores layer include (a) the ability to create forums and discussions, (b) the provision to post content on documents, images and audio, and (c) the facility for plugins that add extra functionality. The AgriHub Africa platform architecture's services layer provides for an innovation promotion framework through the forums and discussions functionality. Knowledge management on the AgriHub Africa platform architecture's services layer can be done through the content functionality. The facility for plugins enables the AgriHub Africa platform architecture's services layer to allow third parties to provide other services through plugins such as e-commerce or leaning management systems.

6.16 Conclusion

This chapter has described how MSMPs have the potential to addresses the challenges of scale that small-scale farmers face. AgriHub Africa could have been developed as a MSMP to address the scale challenges faced by small-scale farmers. However, it appears that the potential of digital agriculture to help transform agriculture in Africa is being hampered by how digital agriculture and MSMPs in Africa are disparate and uncoordinated. Consequently, the need for interoperability within the digital agriculture space became a key consideration for AgriHub Africa.

That need for interoperability could be addressed though an industry platform. The AgriHub Africa conceptualisation then evolved to not only operate as a MSMP, but to also be an agricultural industry platform. As an agricultural industry platform, AgriHub Africa addresses the business systems challenges of scale that reduce small-scale farmers viability and profitability. AgriHub Africa also addresses the technology systems challenge of accessing information particularly from the WhatsApp platform which appears to be the technology of choice for Africa's small-scale farmers.

AgriHub Africa was being conceptualised as a hybrid agricultural industry platform and an MSMP. However, the socio-economic identity of most Africans as small-scale farmers presented an opportunity for strengthening the network effects of AgriHub Africa. Consequently, AgriHub Africa was re-conceptualised as a three-way hybrid platform of an agricultural industry platform, an MSMP, and a super-app.

The platform architecture of AgriHub Africa, as an agricultural industry MSMP super-app, was designed to facilitate this study's thesis of digitally enabled agricultural transformation. Agriculture is a complex social-ecological-system. Consequently, the AgriHub Africa platform architecture was designed to implement social-ecological-systems based digitally enable agricultural transformation. To that effect, this chapter described AgriHub Africa platform architecture's core layer, ecosystem layer, and services layer.

This chapter submits that the AgriHub Africa platform architecture described herein has the capacity to remake the industry structure, boundaries, and institutional arrangements for the agricultural social-ecological-system. That architecture is designed to not only build social-ecological-systems resilience into the institutional arrangements for agricultural transformation, but to direct that resilience into transformability that will achieve the objectives of agricultural transformation as envisaged by the African Union and NEPAD.

CHAPTER 7. DIGITAL AGRICULTURE DISRUPTION FRAMEWORK: HYBRID DISRUPTIVE INNOVATION AND BIG BANG DISRUPTION COMBINED WITH DIGITAL AGRICULTURE USER DEVELOPMENT

7.1 Introduction

The architecture for building social-ecological-system transformability into the institutional arrangements for agricultural transformation was discussed in the previous chapter. This chapter discusses a framework for digitally disrupting agriculture. The two-part framework harnesses digital agriculture as a system disturbance to the agricultural social-ecological-system to cause regime shifts that result in agricultural transformation. Part A of the framework discusses a hybrid disruptive innovation and big bang disruption model. A digital agriculture user development model is described in Part B

Part A of this chapter discusses the way digital disruption was planned into the creation of this study's minimum viable product (MVP). Central to the building of this study's MVP, was the adoption and use of the disruptive innovation approach pioneered by Christensen (1997). Part A of this chapter also describes the abundant proliferation of several technologies (Diamandis & Kotler, 2012) with which the study's super-app platform architectures was translated into a working MVP. This highlighted the application of the big bang disruption model (Downes & Nunes, 2013). Although some scholars, like McGrath (2013), argue that the Christensen (1997) disruptive innovation theory and the Downes and Nunes (2013) big bang innovation theory are diametrically opposed (Armstrong & Lee, 2021), this study submits that abundance (Diamandis & Kotler, 2012) has created the ground for this study's hybrid disruption model for digital agriculture.

Part B of this chapter proposes a model for digital agriculture user development. By integrating the use of the MVP concept together with the proposed digital agriculture hybrid disruption model, this study builds on Blank and Dorf (2005) customer development model to contextualise the theory (Hamann et al., 2020b) through the AgriHub Africa Master Farmer Programme. Digital agriculture user development is particularly useful for the African digital agriculture space which only has 13% of Africa's small-scale farmers subscribing to digital agriculture services (Tsan et al., 2019).

PART A: HYBRID DISRUPTIVE INNOVATION AND BIG BANG DISRUPTION MODEL

7.2 Building AgriHub.Online as a minimum viable product

This section discusses the development and deployment of AgriHub.Online as a minimum viable product (MVP), as well as why and how that was done. The section also discussed the benefits and drawbacks of adopting the MVP approach for developing and deploying the AgriHub.Online MVP. Some of the concepts associated to the MVP that have emerged as a part of this strategy are also discussed. The section concludes by briefly referring to the concept of customer development (Blank, 2010a) that also subsequently emerged from the AgriHub.Online MVP process.

Features of AgriHub.Online that made it an MVP

AgriHub.Online was developed with just enough core features to be effectively deployed as an MVP (Lenarduzzi & Taibi, 2016; Moogk, 2012). As an MVP, the AgriHub.Online MVP, had a few features that would enable it to be usable by early users so that feedback could be obtained for its future development (Ries, 2009; Tripathi, Oivo, Liukkunen, & Markkula, 2019). Frank Robinson coined and defined the term minimum viable product in 2001 (Lenarduzzi & Taibi, 2016; Scott Ambler, 2017). Eric Ries and Steve Blank subsequently popularised the term and defined it as a version of a new product that developers spend the least amount of time, effort and resources on in order to collect the maximum amount of validated feedback about it from customers (Ries, 2009).

The AgriHub Africa founders adopted the MVP concept as a strategy to screen their product ideas, test the market, and assess the impact (Moogk, 2012) of their proposed platform. The AgriHub.Online MVP process did not invest a lot of time, energy, effort, and resources in developing a product first, and was thus different from conventional market testing strategies (Blank, 2020). The AgriHub.Online MVP process also differed from open-source software development methodologies of fully releasing products early and releasing them often in order to obtain user feedback as a basis for defining the features of the future product (Ries, 2009).

The AgriHub.Online MVP was guided by the product vision (Ries, 2009) of aggregating African agriculture online. This vision was and will continue be maintained through-out the development and product life cycle (Ries, 2009) of AgriHub Africa. However, the vision was

and will continue to be adapted in response to both explicit and implicit user feedback (Ries, 2009). Guided by that vision, the AgriHub.Online MVP's software development was done through rapid application development tools (Tripathi et al., 2019) being WordPress and BuddyBoss Platform.

The AgriHub Africa founders used the MVP to test the assumption underpinning their business idea to establish whether it would be viable and profitable (Lenarduzzi & Taibi, 2016). Deploying the AgriHub.Online MVP sought to test the potential business model of AgriHub Africa to determine how users in the agricultural industry would react (Blank & Dorf, 2020).

Key to the conceptualisation of the AgriHub.Online MVP, were the concepts of expending least efforts in order to secure maximum feedback (Santos, Pereira, Ferreira, & Machado, 2018). The AgriHub.Online MVP was not just a mere software product but was part of a strategic process that was aimed at making and selling a product (Blank & Dorf, 2005; Blank & Dorf, 2020) that would catalyse agricultural transformation for small-scale farmers.

Why the AgriHub.Online MVP was developed and deployed as an MVP

Developing and deploying an MVP was very useful for AgriHub Africa as a new enterprise because it enabled the founders to identify and validate potential business opportunities beyond merely executing the predetermined and isolated business model (Tripathi et al., 2019) developed around aggregating small-scale agriculture. This approach was similar to conducting scientific experiments albeit for validating some business hypotheses (Tripathi et al., 2019) within the small-scale agricultural social-ecological- system.

Developing and deploying the AgriHub.Online MVP helped to validate (or invalidate rather) whether there was a need for developing the AgriHub Africa online agricultural aggregation product, and whether it was necessary or possible to incrementally develop already existing products (Dennehy et al., 2019). The process of data collection and analysis that was conducted during the PAR interventions was akin to the market analysis that is conducted as part of the process of developing and deploying a MVP (Blank & Dorf, 2020).

By focusing on developing and deploying the AgriHub.Online MVP, the AgriHub Africa founders were able to avoid lengthy and unnecessary work (Blank, 2020) such as providing e-commerce functionality. The AgriHub Africa founders iterated on the AgriHub.Online working version by responding to feedback (Acharya & Colomo-Palacios, 2019). Some of the

feedback was the absence of organic user base growth which was challenging and validating, or rather invalidating, some of the assumptions around the product's requirements (Acharya & Colomo-Palacios, 2019) of aggregating African agriculture online.

The AgriHub.Online MVP strategic approach, especially by utilising standard WordPress and BuddyBoss Platform functionality, reduced software engineering and development time, resources and effort (Lenarduzzi & Taibi, 2016) whilst simultaneously getting the product to customers and users as early as possible (Blank, 2010a). Consequently, the AgriHub Africa founders were able to test the hypotheses underpinning their business model with minimal resources and thus also accelerate their learning (Moogk, 2012).

Simultaneously, the AgriHub Africa founders established their capacity, or rather deficiencies thereof, to build the required product resulting in their drafting in additional resources from the digitalisation crucial triad (Armstrong & Lee, 2021) ecosystems comprising of the agricultural domain, the digital technology sphere, and the business model architecture terrain (Tripathi et al., 2019). Beyond assisting the AgriHub Africa founders in identifying the base for developing other products (Bocken & Snihur, 2020) and pivoting (Blank, 2010d) to the Master Farmer initiative, the AgriHub.Online MVP provided a fertile base for quickly building the AgriHub Africa brand (Blank & Dorf, 2020).

How the development and deployment of AgriHub.Online as an MVP was done

According to Steve Blank (2010c), when you develop and deploy a MVP, "You're selling the vision and delivering the minimum feature set to visionaries, not everyone." The AgriHub.Online MVP, through early prototyping, sought to sell the vision (Blank, 2020; Blank & Dorf, 2005) of aggregating African agriculture online to a select group of small-scale farmers who were close to the AgriHub Africa founders. These farmers are a subset of possible users and early adopters, who in essence were hoped to be more tolerant of the AgriHub.Online MVP's short comings, and would be more likely to provide feedback (Blank, 2020; Blank & Dorf, 2005).

The MVP strategy differs with traditional business planning approaches which are detailed, go over long time horizons, and adopt stealth modes of product development (Alvarez, 2017; Blank, 2013). The AgriHub.Online MVP was a strategy that deliberately sought to avoid building a product that users did not want whilst simultaneously obtaining user information with the least amount of effort, resources and time spent. The MVP was a strategy that sought to test

the business hypotheses for AgriHub Africa and validate the associated learnings (Alvarez, 2017; Dennehy et al., 2019). Incidentally, the MVP's testing objective is one of the principles of the lean start-up methodology (Alvarez, 2017; Dennehy et al., 2019).

Ries and Blank's definition of MVP, utilising the concepts of least effort to obtain maximum feedback, implies that the concept is not rigid and formulaic (Ries, 2009). Ries (2009) submits that developing and deploying an MVP requires judgment on what features should be included given the context within which the MVP subsists. Consequently, agile methodologies' components of product owner and product backlog work well to effect the MVP strategy (Blank, 2010d).

Blank and Dorf (2020) submit that the MVP strategy is an iterative process involving the generation of ideas, prototyping the ideas, presenting them as features in an MVP, collecting and analysing data on users' reaction to them, and learning from those processes. They recommend that the least amount of time should be spent on any iteration (Blank & Dorf, 2020). The iteration process is conducted until the developers succeed in obtaining a fit of the product to the market, or until they determine that the product or feature is not viable (Blank & Dorf, 2020). If a product or feature is not viable, then the developers have to pivot (Blank, 2010d; Financial Times, 2016; Gallegos, 2012).

The benefits of developing and deploying AgriHub.Online as an MVP

Taking the MVP approach made it cheaper to validate the business idea (Lenarduzzi & Taibi, 2016) of aggregating African agriculture online which was the bed rock of the AgriHub.Online MVP. This was primarily due to how this approach limited risk, and helped with savings costs (Lenarduzzi & Taibi, 2016). It was quite evident that some of the functionality and features originally envisaged, such as the e-commerce functionality, would initially be commercial unviable and were thus suspended (Lenarduzzi & Taibi, 2016) before they had even been implemented.

Beyond the few users that the AgriHub Africa founders recruited onto the AgriHub.Online MVP, the platform did not generate its own organic user base in good numbers. This suggested that the AgriHub.Online MVP was not needed by many people (Blank, 2013; Dennehy et al., 2019). Consequently, the AgriHub.Online MVP would not have been able to generate sufficient revenue to cover its costs and recover the investment made to develop it (Blank, 2013; Dennehy et al., 2019). This apparent lack of a market need is regarded as one of the main

causes of start-up failure (Blank, 2013; Dennehy et al., 2019). True to what authors like Blank (2013) and Dennehy et al. (2019) have said, the AgriHub Africa founders, like other entrepreneurs, have used an MVP to check and validate the demand for their platform on the market.

The drawbacks of developing and deploying AgriHub.Online as an MVP

Utilising the MVP approach has a few drawbacks. One of those drawbacks may relate to the reputational damage that both the developers' enterprise and the actual product may suffer due to negative sentiment and/or feedback (Contigiani, 2018b). Such negative sentiment and/or feedback may be the result of actual quality deficiencies within the MVP or inability of the MVP to meet user requirements (Contigiani, 2018a). The AgriHub.Online MVP experienced one such challenge of users struggling to register their accounts using mobile phones to a point where some potential users gave up registering on the platform.

Other drawbacks of the MVP approach relate to the risk of imitation (Contigiani, 2018b) especially in environments where the intellectual property cannot be safeguarded and the MVP can then be copied (Contigiani, 2018a). Aligned to this drawback was the possibility that potential users of the AgriHub.Online MVP could switch to similar and competing platforms (Beneyto, 2018). The AgriHub Africa founders, however, took a strategic decision that the emergence of platforms that allow small-scale farmers to improve their businesses was in the public good and thus were not too concerned by the possibility of being imitated.

Some authors have suggested that, given these drawbacks, the concept of the MVP could be replaced by similar but slightly modified concepts such the Minimum Awesome Product (MAP) (Beneyto, 2018), the minimum business increment (MBI) coined by Al Shalloway (Scott Ambler, 2017), the Minimum Viable Experiment (MVE) (Contigiani & Levinthal, 2019), the minimum marketable feature (MMF) first proposed by Denne and Cleland-Huang (Scott Ambler, 2017), the minimum marketable release (MMR) (Scott Ambler, 2017), or the Simple, Lovable, Complete (Cohen, 2017). The AgriHub Africa founders considered some of these concepts but took a decision to stick with the traditional MVP approach although some of these other emerging aligned concepts were used.

Associated Emerging concepts to MVP used in the development and deployment of AgriHub.Online

The drawbacks of the MVP spawned several other emerging terms (Beneyto, 2018; Cohen, 2017; Contigiani & Levinthal, 2019; Scott Ambler, 2017). The notion of the MVP has been used to describe a range of approaches as described above (Scott Ambler, 2017). However, the MVP concept has also been adopted to several other aspects of start-ups. The AgriHub Africa founders used some of these aspects, namely the minimum viable brand (MVB) (John, 2014; Roshanzamir, 2018), the minimum viable co-founder (Shah, 2011), and the minimum viable team (Kromer, 2011; O'Donnell, 2012; Shah, 2011).

The study also utilised the minimum viable brand (MVB) notion. The AgriHub Africa founders sought to ensure that all aspects of the development of the AgriHub.Online MVP would be guided by market insights that are grounded in their strategic intent (John, 2014; Roshanzamir, 2018) of aggregating African agriculture online. Some of the feedback that emerged was that even though the AgriHub.Online MVP was initially deployed with the domain extension “.Online”, the term Africa should be prominent with the domain name and brand. Consequently, the AgriHub Africa founders resolved that the MVP would continue as AgriHub.Online whilst the full commercial product would be set up as AgriHub.Africa. Beyond just the identity and brand, the AgriHub Africa notion and the AgriHub.Online MVP would always be accompanied by the payoff line “aggregating African agriculture online” to constantly signal its strategic intent in the same manner that an MTP (Ismail, 2014) does.

With regards to the minimum viable co-founders, this study had identified thirteen small-scale farmers who were PAR participants. One of those small-scale farmers exhibited tremendous zeal and commitment to developing a digital product. As a result, she actively sought to identify other small-scale farmers with whom to co-found AgriHub Africa. She experienced challenges of finding co-founders with attributes that Darmesh Shah (2011) listed as being essential in a co-founder. Some of these attributes include trust, exceptional at building or selling, company commitment, personally likable, productivity, reasonable, rational, realistic (Shah, 2011). She eventually found three other co-founders.

Another challenge that the AgriHub Africa founders experienced was in putting together a founding team at minimal cost. The AgriHub Africa founders adopted the concept of the minimum viable team (Kromer, 2011; O'Donnell, 2012; Shah, 2011) to develop and deploy the

AgriHub.Online MVP. The team was established after the AgriHub Africa founders worked together to develop a product backlog, and had resolved on using the WordPress and BuddyBoss platforms. This then enabled them to list the basic features (Kromer, 2011; O'Donnell, 2012; Shah, 2011) of the AgriHub.Online MVP, to outline the tasks that needed to be done, as well as determine the skill sets that were needed (Kromer, 2011; O'Donnell, 2012; Shah, 2011).

Customer development

Blank and Dorf (2005) submit that the MVP can be used as part of their customer development methodology. The customer development methodology uses customer feedback to continuously refine products during iterations (Blank, 2013, 2020; Blank & Dorf, 2005; Blank & Dorf, 2020). Furthermore, the customer development methodology also enables the development of previously non-existent products and features (Blank, 2013, 2020; Blank & Dorf, 2005; Blank & Dorf, 2020). This study extensively used the customer development model to create a digital agriculture used development model as more fully explained in Part B of this chapter.

7.3 Disruptive innovation

The AgriHub Africa development was guided by Christensen (1997) disruptive innovation theory. Consistent with the disruptive innovation theory (Christensen, 1997; Christensen, 2013; Christensen et al., 2018), the AgriHub.Online MVP sought to provide features that were at the periphery of the agricultural social-ecological-system. By introducing these features in a staggered manner, AgriHub Africa therefore followed the MVP approach (Blank, 2013, 2020; Lenarduzzi & Taibi, 2016; Ries, 2009) described in an earlier section of this chapter. This section focusses on discussing disruptive innovation by firstly outlining what constitutes sustaining innovation prior to interrogating how disruption occurs. The section then discusses what disruptive innovation is, as well as some characteristics and causes of disruptive innovation.

Sustaining innovation

Christensen (1997) makes a distinction between sustaining innovation and disruptive innovation. Christensen (1997) defines sustaining innovation as innovations that improve already existing products. Armstrong and Lee (2021) submit that sustaining innovation is

conceptually like incremental innovation. Sustaining innovations enable businesses to keep pace with market expectations by constantly improving existing products (Christensen, 1997; Christensen et al., 2018; Christensen, Raynor, & McDonald, 2015).

Improvements in technology are largely the basis upon which sustaining innovations are possible (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Sustaining innovations therefore result in improvements in the performance of existing product (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). The extent of the sustaining innovations determines the rate at which product performance also rises (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). However, sustaining innovations do not result in the emergence of new markets nor in the creation of new product (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

How disruption occurs

Although this study has adopted Armstrong and Lee (2021, p. 345) profitability denominated perspective of disruption as occurring when “profits are materially impacted” , this section discusses how Christensen et al. (2015) view disruption. Christensen et al. (2015, p. 3) describe disruption as “a process whereby a company with fewer resources is able to successfully challenge established incumbent businesses”. The next few paragraphs describe how Christensen (1997) considers disruption to occur as a prelude to discussing what disruption is.

Christensen (1997) submits that well established incumbent businesses focus on addressing the requirements of their key anchor customers and clients at the exclusion of the requirements of marginal and peripheral possible customers and clients. New entrants then opt to service those marginal and peripheral possible customers and clients by providing the features and functionalities they require at a lower price (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). These entrants succeed at accessing those overlooked segments (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

On the other hand, the more well-established incumbent businesses do not usually respond, preferring to continue servicing their key anchor customers and clients (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Eventually, the new entrants make inroads into the key anchor customers and clients whilst simultaneously maintaining and preserving the key functionalities and features that provided them with a foothold into the market (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Christensen (1997)

submits that disruption will occur when large numbers of the key anchor customers and clients opt for the offerings from the new entrants (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

Disruptive innovation

Christensen (1997) regards disruptive innovations as innovations that create completely new products and product categories as well as innovations that create hitherto non-existent demand and hence new markets (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Whilst Armstrong and Lee (2021) draw parallels between sustaining innovation and incremental innovation, they however, submit that sustaining innovation are significantly different from prior definitions of radical innovation.

Disruptive innovations initially emerge as relative cheaper and simpler alternatives to existing products (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). They normally present in a different manner offering new hitherto unexpressed functionality (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Because customers are not yet aware that the new functionality satisfies a need, or rather that they actually have that need, disruptive innovations are not paid too much attention by the bulk of the customer base (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

Disruptive innovations are usually at the beginning of the product lifecycle (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). As such disruptive innovations undergo several iterations of fast refinements and experimentation (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015), akin to the minimum viable product concept (Blank, 2013, 2020; Lenarduzzi & Taibi, 2016; Ries, 2009). Consequently, disruptive innovations, especially those that follow the minimum viable product strategy, experience fast improvements in their functionality and features (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

Eventually such improvements in functionality build up to points where the disruptive innovation is able to surpass the performance of incumbent products and demand then surges (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

Incumbent product's performance gets lower than that of the disruptive innovation to levels where incumbent producers are not in a position to respond and are hence disrupted

(Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). It is however important to note that right from the outset of his disruptive innovation theory, Christensen (1997) has argued strongly that disruption is a process and not an event (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

Characteristics and causes of disruptive innovation that influenced AgriHub Africa

There are numerous examples of disruptive innovation, particularly within Africa, some of which include how cellular phones disrupted fixed line telephony (Armstrong & Lee, 2021), and how mobile financial service disrupted traditional banking (Friederici, Wahome, & Graham, 2020; Mbiti & Weil, 2015). In almost all cases where disruptive innovation has occurred, the disruptive innovation's performance was below that of incumbent product and its demand was low (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

As a result, incumbent players have not been attracted to the new product category and hence have not responded by entering that category (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). However, if incumbent players had entered those new product categories, they were very likely to have prevailed in them because of their better resources and capabilities (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015).

It is also worth noting that customers did not initially buy into the disruptive innovation (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). However, the disruptive innovation's performance kept improving rapidly because of MVP iterations until it outperformed the incumbent products (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Whilst the AgriHub.Online MVP was not able to generate sufficient organic user growth at its inception, the AgriHub Africa founders resolved to maintain the vision of aggregation African agriculture online,

Armstrong and Lee (2021) note that the irony of Christensen's model is that "incumbent firms get disrupted by doing precisely what they have been taught is right: listen to customer's needs and allocate resources to improving product performance to meet those evolving needs". This has been attributed to perspectives that customers may not know that there have a particular need up until a solution for that particular need is proffered (Armstrong & Lee, 2021). In this study, small-scale farmers do not quite see that they have a need for aggregation to address their scale challenges.

Armstrong and Lee (2021) summarise some theories on the causes of disruptive innovation. The focus of incumbent firm on already served market segments that give high volumes and high returns results in resources being insidiously allocated in a biased manner to those markets that are already served (Christensen, 1997; Christensen et al., 2018; Christensen et al., 2015). Armstrong and Lee (2021) further suggest that, through the resources dependency theory, long established relationships and linkages with incumbent customers results in the prioritisation of those customers and a focus on sustaining innovations. These causes of disruptive innovation suggest that since services are provided to well-established farmers at the expense of small-scale farmers, fertile ground exists for disruptive innovation envisaged by the AgriHub Africa founders.

7.4 Abundance and Big Bang Innovation: WordPress and BuddyBoss Platform technologies

The AgriHub.Online MVP was developed due to the proliferation of relatively abundant and cheap tools such as WordPress and BuddyBoss Platform. The concept of abundance (Armstrong & Lee, 2021; Diamandis & Kotler, 2012) as well as its related notion of the 6D's of digital disruption (Armstrong & Lee, 2021; Ramirez, 2017) were discussed in a previous section⁴². However, beyond just facilitating for the development and deployment of the AgriHub.Online MVP, the concept of abundance bodes well for future development of digital agriculture tools. The proliferation of digital tools paves way for big bang disruption.

Downes and Nunes (2013) use the analogy of the cosmic big bang to dramatically describe types of innovation that are rapidly adopted and have significantly disrupted incumbents. Although they cite several examples, three examples of Twitter, Google Maps, and Kindle stand out (Downes & Nunes, 2013). Downes and Nunes (2013, p. 47) describe big bang innovations as coming “out of left field, combining existing technologies that don't even seem related to your offerings to achieve a dramatically better value proposition”

Twitter significantly disrupted the media industry to a point where almost all media house use it such that it is a de facto media house (Downes & Nunes, 2013; Kwak, Lee, Park, & Moon, 2010). Google Maps completely obliterated traditional “navigation product makers like

⁴² Section 2.8 - Agricultural innovation, digital disruption, abundance and the 6 Ds of digital disruption

TomTom, Garmin, and Magellan” (Downes & Nunes, 2013, p. 47). Amazon was able to disrupt the publishing industry with Kindle despite not having previously been considered a publisher (Downes & Nunes, 2013).

Downes and Nunes (2013) submit that big bang innovation introduces products that are both cheaper and better performing than incumbent products, contrary to Christensen (1997) disruptive innovation which submits that disruptive products come in at lower performance albeit also cheaper. Downes and Nunes (2013, p. 47) also argue that big bang innovation disrupts incumbents with products that are “perfected with a few trial users and then are embraced quickly by the vast majority of the market”. This is the philosophy that guided the AgriHub Africa founders. Not only is the adoption of big bang disruptive products rapid, but it is wholesale taking in all segments of the market as was the case with Apple’s iPad (Downes & Nunes, 2013). AgriHub Africa was therefore conceptualised to go beyond the small-scale farmers that inspired its creation to encompass all participants in the agricultural social-ecological-system and its sub-ecosystems.

Big bang innovations are also more integrated into the eco-systems of other products and service as exemplified by how Google Maps integrates into smart-phones and the Android and iOS eco-systems (Downes & Nunes, 2013). Because of both this integration and the ubiquitous nature of digital technologies which provide for “near-perfect market information”, the adoption of big-bang innovation is extremely rapid (Downes & Nunes, 2013, p. 46). Big bang innovation has the three defining characteristics of “unencumbered development, unconstrained growth, and undisciplined strategy” rapid (Downes & Nunes, 2013, p. 48).

Downes and Nunes (2013) argue that big bang innovation has the advantage that product development is not encumbered for a few reasons. Technological development and the concept of abundance has availed “readily available components that cost little or are free” with which big bang disruption can be developed and deployed rapidly (Downes & Nunes, 2013, p. 48). Some of these technological developments also “allow consumers to pick and choose the content and features they want” (Downes & Nunes, 2013, p. 48). The AgriHub.Online MVP was developed and deployed on WordPress and BuddyBoss Platforms in these ways because these tools are readily available, and users can select the functionality they require.

Furthermore, Downes and Nunes (2013, p. 48) argue that the unencumbered development that big bang innovation go through has been the result of “rapid-fire, low-cost experiments on fast-

maturing, ubiquitous technology platforms”. Such experiments are conducted directly with users taking advantage of technological developments around “open platforms built on the internet, cloud computing, and fast-cycling mobile devices” (Downes & Nunes, 2013, p. 48).

The second defining characteristic of big bang innovations is that they can expand at unconstrained growth rates (Downes & Nunes, 2013). Downes and Nunes (2013) submit that big bang innovations collapse the Rogers (1962) diffusion of innovation product life cycle from five stages (innovators, early adopters, early majority, late majority, and laggards) to just two stages of trial users and everyone else. Downes and Nunes (2013) also claim that the big bang innovation product lifecycle has the three basic stages of development, deployment and replacement. However, looking at a few of the examples they cite such as the iPad, Twitter, Kindle and Google Maps, it appears that what they considered to be replacement can be more aptly described as upgrades since all these products appear to still be going strong.

Another reason for unconstrained growth that Downes and Nunes (2013) put forward is that big bang innovation “obviates the need for the carefully timed shifts in marketing strategy that Geoffrey Moore described in *Crossing the Chasm* (1991)”. This does away with the need that the Christensen (1997) disruptive innovations have to cross Moore (1991) marketing chasm from early adopters to early majority since big bang innovation targets all market segments right at the beginning (Downes & Nunes, 2013).

Big bang innovation’s third defining characteristic refers to how the notion does not subscribe to the concepts of disciplined strategy advocated by Wiersema and Treacy (1995) in their “*The Discipline of Market Leaders*” (Downes & Nunes, 2013). Wiersema and Treacy (1995) advocate for pursuing “only one of three value disciplines: low cost (operational excellence), constant innovation (product leadership), or customized offerings (customer intimacy)” (Downes & Nunes, 2013). Porter (1985) also implies the need for discipline to not follow more than one of his three generic strategies, and indeed he does warn against it (Downes & Nunes, 2013).

Contrary to the tenets of disciplined strategy advocated by Wiersema and Treacy (1995) and Porter (1985), big bang disruptions enter the markets at both low cost and high customisation (Downes & Nunes, 2013). Google Maps is a very good example of having achieved all three of Wiersema and Treacy (1995) value disciplines of being (a) a low cost product, (b) a leading innovator with multiple updates, and (c) offering unparalleled customer intimacy because of

seamless integration. This is possible because technological development has been lowering, and continue to lower the costs of the three major cost drivers of any product or service being (a) research and development costs, (b) intellectual property and embedded technology cost, and (c) manufacturing and components costs (Downes & Nunes, 2013).

7.5 Digital agriculture hybrid disruption model

This study proposes a digital agriculture hybrid disruption model that is built on the foundations of Christensen (1997) disruptive innovation theory. Small-scale farmers within Africa represent the peripheries of the digital agriculture space. As such, Africa's small-scale farmers present an opportunity for disruptive innovation to occur within the digital agriculture arena. Based on the Diamandis and Kotler (2012) concept of abundance, there is a plethora of technologies that are readily available to address the digital agriculture requirements of small-scale farmers.

This study's proposal for a digital agriculture disruption model proposes to combine this multitude of technologies to address the peripheral needs of small-scale farmers. The resulting innovation could be massive enough to be a big bang disruption on digital agriculture in such a way that the future could be "faster than we think" (Diamandis & Kotler, 2020). With only 13% of Africa's small-scale farmers subscribing to digital agriculture services (Tsan et al., 2019), the opportunities for growth are tremendous.

This study proposes implementing a digital agriculture user development model that adopts an MVP strategy to address the peripheral requirements of small-scale within the ambit of Blank and Dorf (2005) customer development model. The following Part B of this chapter discusses how to contextualise the Blank and Dorf (2005) customer development approach according to both the digital and agricultural environments as well as the African context.

PART B: DIGITAL AGRICULTURE USER DEVELOPMENT MODEL

The inability of the AgriHub.Online MVP to organically grow its user base fast enough prompted the AgriHub Africa founders to pivot to the AgriHub Africa Master Farmer initiative. This pivoting was done within the customer development model created by Blank and Dorf (2005).

7.6 Customer development as a segue to digital agriculture user development

Steve Blank created customer development (Blank & Dorf, 2020; Roush, 2012) as a formal methodology for establishing new business ventures and building business start-ups (Alvarez, 2017). Whilst writing his memoirs as a Silicon Valley based entrepreneur, Steve Blank noticed some common patterns within the start-up business that he engaged with (Wise, 2011). Blank observed that start-ups were not just smaller versions of established business that were more developed and larger (Blank & Dorf, 2020; Roush, 2012).

Start-ups operated in a manner that differed significantly from how large established companies operated (Blank & Dorf, 2020; Roush, 2012). Whilst larger and more established companies had built up some institutional capacity and memory to develop and implement tried and tested business strategies, start-ups needed to develop and deploy new and untested business models (Blank & Dorf, 2020; Roush, 2012).

Steve Blank (2013) submits that many new start-up companies spend an inordinate amount of time developing and fine-tuning their products internally compared to the very little time that they go out into the field to obtain customer insights. This meant that entrepreneurs needed a systematic approach that would guide them to come up with business models that were both scalable and repeatable. (Wise, 2011). Consequently, customer development helps to guide start-ups in developing and deploying their business models so that they are scalable and repeatable (Cooper, 2009). However, it is useful to quickly discuss what constitutes a business model and the associated business model canvas

Business model design (Osterwalder & Pigneur, 2010) and customer development hypotheses have been integrated into the business model canvas (Blank, 2010d; Roush, 2012). The various nine blocks of the business model canvas each represents a customer development hypothesis or more (Blank, 2010a, 2010d; Roush, 2012). Should a hypothesis be found to be invalid, the customer development model is used to turn that failed hypothesis into what is referred to as a pivot (Blank, 2010d; Roush, 2012). A pivot is an invalidated hypothesis that can be converted into a learning strategy and is then used to redraft the business model (Blank, 2010a, 2010d; Roush, 2012).

The customer development perspective regards a business model as the manner in which a business captures value after creating and delivering that value (Osterwalder, Pigneur, & Tucci,

2005). The business model perspective of customer development is designed as an iterative process that responds quickly to customer realities (Blank, 2010a, 2012b; Osterwalder, 2012). Blank (2012b) submits that the business model for established businesses is normally executed through a written operational document referred to a business plan.

Blank (2012b) however submits that a start-up, such as AgriHub Africa, does not have sufficient knowledge and information about the market to develop a viable business plan. Business plans, normally produced as static documents, are bound to change as the business interacts with the market and its environment (Blank, 2012b). Consequently, Blank (2012b, p. 17) submits that “No business plan survives first contact with customers.”

AgriHub Africa, just like any other start-up, had to engage in searching and discovering an appropriate business model (Blank, 2012a) to fulfil its mandate. The AgriHub.Online MVP tested AgriHub Africa’s business model in the real world to secure feedback and inputs from users and make necessary and appropriate changes (Blank, 2012b). Should the AgriHub.Online MVP validate that the business model is viable, then AgriHub Africa will need to develop AgriHub.Africa as a fully-fledged commercial agricultural industry platform which operates as an agricultural industry MSMP super-app, thus entering business plan and product execution phase of customer development (Blank, 2012b).

The customer development model is strongly based on the Osterwalder (2004) business model canvas. The business model canvas was designed by Osterwalder and Pigneur (2010) based on Osterwalder (2004) PhD thesis which Pigneur supervised. They designed the business model canvas to help start-ups to focus on customers whilst simultaneously encouraging testing through rapid changes that highlight alternatives (Osterwalder, 2012)

The business model canvas has nine blocks and components which AgriHub Africa, as a start-up, used to plan and structure its business model (Blank, 2010a). Selected blocks and components of the business model canvas were used to design (Kromer, 2014) the AgriHub.Online MVP. These business model blocks and components formed the bases for crafting AgriHub Africa’s customer development hypotheses as well as monitoring and reviewing iterations (Blank, 2010d; Osterwalder, 2012).

Customer development, as an approach, is significantly different to the traditional product centric approach of building a product and then hoping, and in some cases pushing for customers to take up the product (Alvarez, 2017). Such a product-centric approach is fraught

with many risks which may result in the business failing (Alvarez, 2017; Cooper, 2009; Ries, 2008a).

Consequently, the customer development model requires that real potential customers are identified in the field, and the business strives to learn from these real potential customers how their needs can be met (Alvarez, 2017; Cooper, 2009; Ries, 2008a). Customer development places significant emphasis on empirical research (Blank & Dorf, 2020; Roush, 2012).

7.7 Rationale for adopting the customer development strategy

An underlying assumption about customer development is that start-ups operate with untested hypotheses about their business models; they do not know the reality about the nine components of the Osterwalder (2004) business model canvas (Blank & Dorf, 2020; Roush, 2012). From the demand perspective, the AgriHub Africa founders could only hypothesise about (i) the customer segments they were targeting, (ii) the value proposition that was being offered, (iii) the channels through which the customer base could be accessed, (iv) how the customer relationship could be managed, and (v) revenue models that would be deployed (Blank & Dorf, 2020; Roush, 2012). Similarly on the supply side, AgriHub Africa founders also hypothesised about (vi) the key resources that were available, (vii) the key activities that would need to be undertaken, (viii) extent of partnerships that could be harnessed, and ultimately (ix) the structure of the costs needed to deliver (Blank & Dorf, 2020; Roush, 2012)

Internally, AgriHub Africa, just like other start-ups, did not have tested and tried knowledge about the nine key components of the business model canvas (Blank & Dorf, 2020; Roush, 2012). Although AgriHub Africa had hypotheses about these components of the business model, AgriHub Africa still needed to go out and test these hypotheses (Blank & Dorf, 2020; Roush, 2012). The testing of these hypotheses followed a four step process which started with the formulation of the actual hypothesis, followed by designing an experiment before going out to test the experiment (Blank & Dorf, 2020; Roush, 2012). The fourth step involved taking the data from the experiment and analysing it to determine whether the hypothesis had been validated, invalidated, or even whether the hypothesis needed to be changed (Blank & Dorf, 2020; Roush, 2012)

7.8 Implementing the customer development manifesto

Blank and Dorf (2005) propose a manifesto for customer development. The manifesto is informed by the supposition that metrics for start-ups are vastly different to those of large established companies (Blank & Dorf, 2020; Roush, 2012). Blank and Dorf (2005) therefore submit that no business plan can survive in its original form the first contact it makes with its customers.

This therefore necessitates the use of the business model canvas (Blank & Dorf, 2020; Roush, 2012). However, because there was no data inside AgriHub Africa as a start-up, it was necessary to get out to collect the data from customers in the market (Blank & Dorf, 2020; Roush, 2012). This however could only be done effectively if there is consensus and agreement on what constitutes the market since this is the data source from which the hypotheses are tested (Blank & Dorf, 2020; Roush, 2012). For that market, this study identified the agricultural social-ecological-system, and its six sub-ecosystems, for high value vegetables horticulture in Gauteng.

The customer development manifesto was paired with Agile development (Blank & Dorf, 2020; Roush, 2012). Experiments were designed to test and validate AgriHub Africa's hypotheses on the business model canvas (Blank & Dorf, 2020; Roush, 2012). The invalidation or failure of the business hypothesis forms an integral component of the search for a scalable and repeatable business model (Blank & Dorf, 2020; Roush, 2012). This therefore meant that the AgriHub Africa customer development process involved continuous iterations and three consequent pivots (Blank & Dorf, 2020; Roush, 2012). AgriHub Africa conducted pivots three times. Customer development for AgriHub Africa required fast cycle time and quick decision making with speed and tempo that talked to failing fast and failing often (Blank & Dorf, 2020; Roush, 2012).

A key motivational aspect of customer development is passion (Blank & Dorf, 2020; Roush, 2012). This passion needs to be supported by communication and shared leaning (Blank & Dorf, 2020; Roush, 2012). Ultimately, the success of customer development is predicated on commitment and buy-in (Blank & Dorf, 2020; Roush, 2012). This means that the skills requirements for start-ups are quite different from those in large established business (Blank & Dorf, 2020; Roush, 2012). As the customer development process is being undertaken, it is

important to be frugal, save resources and money, and then only spend when it becomes necessary once the hypotheses have been validated.

7.9 AgriHub Africa's customer development journey

The AgriHub Africa customer development followed the standard model with its four steps which involve (a) customer discovery, (b) customer validation, (c) customer creation, and (d) company building (Blank & Dorf, 2005; Blank & Dorf, 2020). The first two steps of customer discovery and customer validation support and confirmed the AgriHub Africa's business model (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). The last two steps of customer creation and company building went beyond confirming the AgriHub Africa business model into executing and actualising that business model (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b).

Customer development's first step of customer discovery required that the Agrihub Africa vision of aggregating African Agriculture online be translated into various hypotheses within the nine components of the business model canvas. (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). In a quest to turn these hypotheses into facts, AgriHub Africa then tested these hypotheses in the real world to determine customers' reactions to them (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b).

The facts generated during those tests outlined the nature of the problem in the market, the extent of interest in the solution proposed for the problem, and ultimately the business viability of implementing that solution to the problem (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). The nature of the problem was that small-scale farmers struggle to compete because of scale challenges. The solution was to aggregate the activities of small-scale farmers in such a way as to obviate those scale challenges. However, the viability of the solution could not be validated because the AgriHub.Online MVP could not muster sufficient organic growth to enable the aggregation.

Customer development's second step of customer validation seeks to determine the business viability of the start-up through actual customer purchases of the solution being offered (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). Actual customers validate the solution and that process also creates a clear and repeatable process and trajectory of purchases

Customer validation confirms and validates that the business model can be scaled because actual customers would have validated the solution through a sales channel (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). However, if there are not enough and sufficient purchases, then the start-up founders will need to revisit the customer discovery step (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). The AgriHub.Online MVP could not go past the customer validation step thus directing the AgriHub Africa founders to pivot to the AgriHub Africa Master Farmer Programme.

Customer creation step represents the commencement of business execution towards scaling (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). Customer creation starts the execution phase by taking the sales channel created during customer validation to build the customer demand that is necessary to scale up the business (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). Customer creation scales up the business by acquiring customers, creating and stimulating demand for the start-up's solution, and directing that demand towards the start-up's sales channel (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b).

Customer development's final step of company creation focusses on converting the start-up into a fully-fledged enterprise that is structured to execute a business model that has been validated (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b). This step involves setting up the operating procedures and structures of the company (Blank, 2010b; Blank & Dorf, 2020; Cooper, 2009; Ries, 2008b).

7.10 Pivoting to the AgriHub Africa Master Farmer initiatives

The customer development process is designed with an assumption that the initial hypotheses that make up a start-up's business model will be wrong (Blank, 2010d; Gallegos, 2012). Because of this assumption, customer development has two mechanism for dealing with the invalidation of a hypothesis being iteration and pivoting (Andersen, 2012; Financial Times, 2016; Gallegos, 2012). Iteration refers to small changes that may need to be made to a business model's hypothesis (Andersen, 2012; Financial Times, 2016; Gallegos, 2012). Pivoting, on the other hand, refers to major and substantial changes that need to be done (Andersen, 2012; Financial Times, 2016; Gallegos, 2012).

Pivoting occurs when a business model is not achieving its intended purpose (Blank, 2010d; Gallegos, 2012). Pivoting involves making a decision on which changes should be made to a business plan and acting upon those decisions (Blank, 2010d; Gallegos, 2012). Ries (2011, p. 32) has described pivoting as “a structural course correction to test a new fundamental hypothesis about a product, strategy [or] engine of growth.” In essence pivoting changes components of the business model so that they accurately reflect prevailing realities (Blank, 2010d; Gallegos, 2012).

Instagram is an example of a company that successfully pivoted from being a micro-blogging site into being an image creation and sharing platform (Andersen, 2012; Financial Times, 2016; Gallegos, 2012). Whilst the essence of their business model remained anchored on a vision of content creation and sharing, the nature of the content changed from micro-blogs to images.

Pivoting process can be undertaken in four processes of observing, orienting, deciding and action (Blank, 2010b). Observing simply refers to consciously acknowledging that a business model is not working (Blank, 2010b). Orienting refers to internalising the new facts around which the business model is not working (Blank, 2010b). This is then followed by making decisions on what needs to be changed within the business model (Blank, 2010b). The final step of pivoting involves acting decisively on the changes that would have been decided upon (Blank, 2010b).

Because the AgriHub.Online MVP could not go past the customer validation step, AgriHub Africa founders pivoted to the AgriHub Africa Master Farmer Programme. This was the first of three pivots. AgriHub Africa Master Farmer Programme was established as a profitability-based mentorship, training and advisory programme. The intention was to create a cohort of small-scale farmers who would aggregate their activities based on agreed operating mechanisms in order to scale the combined and aggregated production at consistent quality.

The second pivot was necessitated once again by a low uptake of the AgriHub Africa Master Farmer Programme. Whilst small-scale farmers were attracted to the conceptual notion of a profitability-based mentorship, training and advisory programme, they nonetheless were sceptical about its viability and veracity. Consequently, the second pivot was on establishing a demonstration farm. The AgriHub Africa founders searched for a farm on which to establish the AgriHub Africa Master Farmer Demonstration and Training Farm. They eventual found a property in Donkerhoek, Pretoria East.

The third pivot came about as the AgriHub Africa founders were establishing the AgriHub Africa Master Farmer Demonstration and Training Farm. The AgriHub Africa founders conducted borehole water yields tests and soil quality analysis tests. The results of those tests meant that the originally planned business model could not be achieved. Consequently, the third pivot was made to further narrow down the AgriHub Africa Master Farmer Programme and focus on organic production training. Consequently, the AgriHub Africa Master Farmer Organics non-profit company was then established to be an organic agriculture profitability-based mentorship, training and advisory programme at the AgriHub Africa Master Farmer Demonstration and Training Farm.

The original objectives of the previous pivots would still be maintained. The AgriHub Africa Master Farmer Demonstration and Training would be a physical point of presence at which scepticism on the profitability component AgriHub Africa Master Farmer Programme would be addressed. Furthermore, the aggregation objective of the AgriHub Africa Master Farmer Programme would be the guiding principles in such a more refined manner that the AgriHub Africa founder resolved to create the Master Farmer Organics brand. Master Farmer Organics brand would encompass the whole organic production value chains and ecosystems including inputs, production and marketing as well as the other sub-ecosystems of the agricultural social-ecological-systems identified in this study.

7.11 Conclusion

This chapter has described a framework for digital agriculture disruption. The framework has two dimensions which are represented by, firstly, a hybrid disruptive innovation and big bang disruption model, and secondly, a digital agriculture user development model. The framework recognises users of a digital platform as not only platform ecosystem participants but also as co-creators of the platform.

CHAPTER 8. CONCLUSION AND SYNTHESIS: CONTRIBUTIONS TO THEORY, ACADEMIC CITIZENSHIP, AND PRACTICE

8.1 Introduction

The concluding chapter to this thesis is in two parts. Part A provides concluding syntheses of the study's summary findings. These concluding syntheses are structured to be discussed in four sections that unpack the study title's four components. Part B focuses on recommendations that come out of this study. Recommendations are made for practices, policy, further research, and for methodological issues.

PART A: CONCLUDING SYNTHESIS OF SUMMARY FINDINGS

Part A of this chapter provides concluding syntheses of the findings in Chapters Five, Six and Seven. This study's thesis that agricultural transformation should be reconceptualised as digitally enabled agricultural transformation is synthesised with the study's designs for the platform architecture of a hybrid agricultural industry MSMP platform. The thesis of digitally enabled agricultural transformation is also synthesised with this study's proposed digital agriculture disruption framework. The digital agriculture disruption framework is an implementation methodology for the development and deployment of the hybrid agricultural industry MSMP platform.

The first section in Part A provides a concluding synthesis on "harnessing digital transformation". The following section discusses how that harnessed digital transformation is applied "to build social-ecological-systems resilience". The target into which social-ecological-systems resilience is built is then described in the section after that which is headed "into institutional arrangements". The concluding section of Part A of this chapter outlines that the purpose of harnessing digital transformation to build social-ecological-system resilience into institutional arrangements is to effect "agricultural transformation".

The concluding syntheses on this study's summary findings are informed by the reconceptualization of agricultural transformation into a re-definition as digitally enabled agricultural transformation. That definition provides a basis upon which various enterprises

can craft their massive transformative purposes. The AgriHub Africa hybrid agricultural industry MSMP super-app has crafted two possible MTP as shown underneath this definition of digitally enabled agricultural transformation below.

Digitally enabled agricultural transformation is defined as the process of harnessing current digitalisation and technological developments and innovations towards transforming the institutions and institutional arrangements of agriculture to enable the effective, efficient, sustainable and profitable participation of small-scale farmers in the agricultural social-ecological-systems and their constituent sub-ecosystems in order to structurally transform economies in ways that foster sustainable socio-economic growth and development taking into account the inescapable reality of the smallness of small-scale farmers which has previously hindered their access to the advantages of scale which can now be overcome through emerging technology driven business models. Digitally enabled agricultural transformation builds on both the theoretical tradition of the Lewis model of economic development and its transitions to structural transformation, as well as the practically applicable conceptualisations of agricultural transformation which jointly incorporate envisioning a future that is not only informed by history but also harnesses current real-world realities.

This study proposed two options of a massive transformative purpose for AgriHub Africa as:

<i>African Agriculture for Sustainable Socio-Economic Transformation; AfricanASSET or Agriculture for Africa's Sustainable Socio-Economic Transformation AgricultureASSET</i>

8.2 Harnessing digital transformation ...

This section synthesises the study's findings on harnessing digital transformation. The reconceptualization of agricultural transformation into digitally enabled agricultural transformation provided the conceptual mainstay on harnessing digital transformation. That conceptualisation on harnessing digital transformation was then translated into the AgriHub Africa platform architecture as a hybrid agricultural industry MSMP platform. The digital

agriculture disruption framework developed a mechanism through which the AgriHub Africa platform architecture was developed, deployed and translated into physical existence.

This study proposed redefining agricultural transformation as digitally enable agricultural transformation. That definition recognised that the two dimensions of agricultural transformation are congruent with two of the three dimensions of digital transformation, namely improving internal productivity and strengthening external linkage. However, the definition of agricultural transformation does not have digital transformation's third dimension of strategic direction and leadership. Consequently, the proposed redefinition of digitally enabled agricultural transformation encapsulates the purposes of transforming agriculture in ways that articulate leadership and strategic direction for agricultural transformation so that practitioners of digitally enabled agricultural transformation can conceptualise and develop massive transformative purposes. The two options for a massive transformative purpose for AgriHub Africa are either:

***African Agriculture for Sustainable Socio-Economic Transformation;
AfricanASSET
or
Agriculture for Africa's Sustainable Socio-Economic Transformation
AgricultureASSET***

Secondly, the redefinition of agricultural transformation as digitally enabled agricultural transformation specifically talks to harnessing digital and technological developments and innovations. Furthermore, the definition is specific on how emerging technology driven business models can help small-scale farmers overcome the scale disadvantages they have because of them being small.

This study has specifically considered platform business models as a specific manifestation of technology driven business models. In particular, the study developed and deployed the AgriHub Africa platform as a hybrid architecture of an agricultural industry platform, an MSMP, and a super-app. The proliferation of computation abundance allowed for translating the AgriHub Africa platform's core layer using standard open source software packages that included the WordPress website builder and content manager, as well as the BuddyBoss Platform's social network platform builder.

8.3 ... to build social-ecological-systems resilience ...

This study sought to build social-ecological-systems resilience. The building of that social-ecological-systems resilience was captured in the reconceptualised definition of digitally enabled agricultural transformation. That definition considers the inescapable reality of the smallness of small-scale farmers which has previously hindered their access to the advantages of scale. The definition seeks to enable the effective, efficient, sustainable, and profitable participation of small-scale farmers in the agricultural social-ecological-systems and their constituent sub-ecosystems. Therefore, to build social-ecological-system resilience, the definition requires that digitally enable agricultural transformation is not only informed by history but also harnesses current real-world realities.

That definition considers the inescapable reality of the smallness of small-scale farmers which has previously hindered their access to the advantages of scale. This study established that small-scale farmers are faced with the inescapable existential reality of being small. Because they are small, small-scale farmers cannot effectively compete with larger farming enterprises which are able to take advantages of their bigger scale to access economies of scale. Platform business models are restructuring industries by externalising the sources of scale advantages that bigger enterprises enjoy. Consequently, platform business models are making those sources of scale advantage available to small-scale farmers.

The definition also talks to how small-scale farmers can be enabled to participate effectively, efficiently, sustainably, and profitably in the agricultural social-ecological-systems and their constituent sub-ecosystems. This study addresses this requirement through the AgriHub Africa hybrid agricultural MSMP super-app which, amongst others, reduces transaction costs. The AgriHub Africa platform architecture's ecosystems layer has its design being congruent to the agricultural social-ecological-system and its sub-ecosystems. As a result, the AgriHub.Online MVP allows users to register their profiles to include profile types that mirror and match the sub-ecosystems of the agricultural social-ecological-system.

Beyond those immediate and current benefits of AgriHub Africa, the potential to harness digital disruption is inbuilt into the platform architecture to allow for complements to be developed and deployed on AgriHub Africa. However, there is need to develop a framework for crafting digitally disruptive solutions that talk to the modes and root causes of digital disruption (Armstrong & Lee, 2021). This is another area for further research.

The definition advocates that digitally enable agricultural transformation is not only informed by history but also harnesses current real-world realities in order to build social-ecological-system resilience. Current real-world realities are particularly important because they determine the social-ecological-systems regimes that influence how the agricultural social-ecological-systems operate. Without taking those current real-world realities into consideration, it will be difficult to build social-ecological-systems resilience into any institutional arrangement, more so if that resilience is normatively desired to tilt towards transformability. However, social-ecological-systems resilience need to be built into institutional arrangements.

8.4 ... into institutional arrangements ...

This study's title of harnessing digital transformation to build social-ecological-systems resilience into institutional arrangements for agricultural transformation was captured in the reconceptualised definition of digitally enabled agricultural transformation. This section discusses that target for building resilience into, namely the institutional arrangements.

The small-scale farmers that were PAR participants of this study recognised and accepted that they had no capacity nor capability to influence any of the pre-existing institutions and institutional arrangements around agriculture. A poignant discussion on agricultural insurance was held amongst some of the PAR participants with one of their fellow PAR participants who was owned by an insurance company. That discussion brought to the fore how painfully obvious it was that even the small-scale farming participant who was owned by an insurance company could not do anything to help small-scale farmers access agricultural insurance.

As a result of the small-scale farmers inability to influence the pre-existing institutions and institutional arrangements, the small-scale farmers resolved to create their own institution around which they would develop their required institutional arrangements. That is how Demeter was created. Institutional arrangements then also emerged around Demeter which included the networking field braais and Demeter digital tools. One of these digital tools was the Demeter WhatsApp group which became a platform for informal and ad-hoc institutional arrangements for coordinating various aspects of the agricultural value chains and ecosystems.

It also emerged that other small-scale farmers were creating WhatsApp groups ⁴³ that also evolved to be platforms for informal and ad-hoc institutional arrangements.

However, these WhatsApp groups and associated platforms for informal and ad-hoc institutional arrangements had business systems and technology systems challenges. Consequently, the concept of AgriHub Africa was born. AgriHub Africa, as a platform and meta-organisation (Kretschmer et al., 2022), is also an institutional arrangement as described in an earlier section⁴⁴. As an institutional arrangement, the AgriHub Africa platform architectures has been designed in such a way as to facilitate the building of social-ecological-systems resilience into it.

A key component of building social-ecological-systems resilience into AgriHub Africa as an institutional arrangement is the digital agriculture disruption framework described in Chapter Seven. The hybrid disruptive innovation and big bang disruption model provides for creating systems disturbances to the agricultural social-ecological-systems that will result in social-ecological-systems resilience. However, systems disturbances can trigger either adaptability or transformability. In order to ensure that the systems disturbances created by the hybrid disruptive innovation and big bang disruption model result in transformability, this study developed the digital agriculture user development model based on Blank and Dorf (2005) customer development model.

8.5 ... for agricultural transformation.

The last phrase of this study's title, for agricultural transformation, provides the ultimate objective for all the initiatives that were conducted as part of this study. The reconceptualised definition of digitally enabled agricultural transformation builds on both the theoretical tradition of the Lewis model of economic development and its transitions to structural transformation, as well as the practically applicable conceptualisations of agricultural transformation. Both the theoretical definition and practically applicable conceptualisations of digital agriculture envision a future of economic growth and development. This future is

⁴³ Section 5.3 - Harnessing technology to address the scale challenges

⁴⁴ Section 5.12 - Architecture for AgriHub Africa as a hybrid agricultural industry MSMP super-app

achievable by structurally transforming economies in ways that foster sustainable socio-economic growth and development.

This study submits that sustainable socio-economic transformation can be achieved if Africa's small-scale farmers are successful. This study's definition of digitally enabled agricultural transformation provides the roots of that success. That success is implemented through this study's proposed digital agriculture disruption framework. A key dimension of that digital agriculture disruption framework is the digital agriculture user development model. Given that the AgriHub Africa platform should develop into a super-app, the digital agriculture user development model effectively seeks to integrate the bulk of Africa's population in a virtuous cycle of economic growth and development.

This section therefore discusses the study's proposition that existing agricultural institutional arrangements are predisposed to inhibiting agricultural transformation. This proposition is born out of the theoretical literature on agricultural transformation as well as empirical evidence from Africa which are also summarised in this section. The three macro, meso and micro level themes on agricultural transformation are discussed prior to outlining how interventions by small-scale farmers through harnessing digital transformation can build social-ecological-systems resilience into the institutional arrangements for agricultural transformation. The section's concluding message re-emphasises the reconfigured definition of digitally enable agricultural transformation.

Theoretical perspectives of agricultural transformation

This study was premised on a proposition that the institutional arrangements for agriculture in South Africa tend to inhibit agricultural transformation (Biggs et al., 2018; Crépin et al., 2012; Hollingsworth, 2000; Mhone, 2000; O'Connell et al., 2019; Van Der Merwe et al., 2018; Zhuwao, 2013). This proposition was partly based on reviews of agricultural transformation's theoretical literature on economic development following on the tradition of Arthur Lewis (1954) to the more contemporary renditions of agricultural transformation as structural transformation (Alobo Loison, 2015; Barrett et al., 2010; Barrett et al., 2017; Dercon & Gollin, 2014; Jayne et al., 2018; Johnston & Mellor, 1961; Lewis, 1954; Mhone, 2000; Ranis & Fei, 1961; Rostow, 1956; Timmer, 1988).

Agricultural transformation has been seen as the agricultural sector's growth that occurs prior to or during a country, region, or continent's period of economic growth (Barrett et al., 2017; Jayne et al., 2018; Johnston & Mellor, 1961; Lewis, 1954; Senbet & Simbanegavi, 2017; Timmer, 1988; World Bank, 1982). Johnston and Mellor (1961) built on the Lewis (1954) model of agricultural transformation with the qualitative proposition that agriculture is a necessary pre-condition for industrial development.

Ranis and Fei (1961) also complemented the Lewis (1954) model quantitatively to outline how an economy moves from stagnation into self-sustaining growth. They argued that there was need for the "critical minimum effort" (Ranis & Fei, 1961, p. 534) required for the take-off stage in the Rostow (1956) processes and stages of economic growth models (Rostow, 1952; Rostow, 1990). Timmer (1988) claimed that agricultural transformation consisted of phases of rapid agricultural growth which provided the impetus for economic growth through the Johnston and Mellor (1961) virtuous cycle of growth model.

Empirical evidence from Africa on agricultural transformation

Empirical evidence from Africa on agricultural transformation (Black et al., 2014; Boatemaa et al., 2018; Department of Agriculture Forestry and Fisheries, 2014; Drimie, 2016; du Toit, 2016; Qobo & Wood, 2016; Sihlobo & Nel, 2016) also contributed to the proposition as did South Africa's own experiences of trying to implement agricultural transformation through its agri-parks AIS programme (Department of Rural Development and Land Reform, 2017; Erasmus, 2019; Makaepe, 2017; Makhura, 2020; National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019; van der Walt, 2019).

The empirical evidence highlights the deficiencies that exist in the assumptions to the theoretical conceptualisation of agricultural transformation. The two key assumptions in the Arthur Lewis (1954) model of agricultural transformation are of a closed economy with only two sectors. From a practical and empirical perspective, South Africa's local economies cannot be described as closed two sector economies since they are "influenced by the terms of integration to the larger regional and national economy" (Neves & Hakizimana, 2015, p. 130).

Beyond the unrealistic nature of those assumptions, some historians question the idea that agricultural growth is the only pre-requisite for industrial development and economic growth

(Allen, 2009; Clark, 2003; Tsakok & Gardner, 2007). These authors submit that empirical causes for industrial growth are complex and cannot be attributed to agriculture alone because commerce and technology also have roles to play (Allen, 2009; Clark, 2003; Tsakok & Gardner, 2007). Consequently, this study's perspective to harness digital agriculture is an institutional arrangement for incorporating the effects of commerce and technology on the broader notion of agricultural transformation that underpins industrialisation.

The empirical evidence conducted in Barrett et al. (2010) review of a century of literature on agricultural transformation adds, to agricultural development, the effects of commerce and technology to economic development. This has resulted in some researchers, including Peter Timmer (2009), describing agricultural transformation as structural transformation. The World Bank (2007) 2008 World Development Report shifted its lexicon to structural transformation.

However, the AU and CAADP still continue to use the term agricultural transformation as evidenced by the 2015 Malabo Declaration (African Union, 2014). This study took on that practically applicable definition of agricultural transformation as adopted by the AU and CAADP because it is also used by other developmental organisations such as Alliance for a Green Revolution in Africa (2017) and African Center for Economic Transformation (2017), and multi-lateral institutions which include FAO (2017) and International Fund for Agricultural Development (2016). That conceptualisation of agricultural transformation is aspirational as illustrated by statements that “Agriculture will provide the engine for growth in Africa” (African Union et al., 2003, p. iii), and that “improving agricultural performance is at the heart of improved economic development and growth” (African Union et al., 2003, p. iii).

Macro, meso and micro level roles of agricultural development

At an empirical level, the economic growth and development expected from agricultural transformation are not being realised (Alobo Loison, 2015; Barrett et al., 2017; Dercon & Gollin, 2014; Jayne et al., 2018; Masters et al., 2018; Mhone, 2000). Barrett et al. (2010) review of empirical literature on agricultural development identifies three themes on the more contemporary notion of structural transformation. They submit that these themes are driven by the macro, meso, and micro roles of agricultural development (Barrett et al., 2010).

Agricultural development has macro roles that relate to how agriculture links to the broader economy (Barrett et al., 2010; Hayami & Ruttan, 1971; Johnston & Mellor, 1961; Lewis, 1954; Ranis & Fei, 1961; Rostow, 1956; Staatz & Eicher, 1998; Timmer, 1988, 2009; World Bank, 2007). Consequently, policy interventions to invest more into agricultural productivity can achieve higher improvements in Africa's economic growth (Barrett et al., 2017; Dercon & Gollin, 2014; Diao et al., 2010; Dorosh & Mellor, 2013). These perspectives are based on computable general equilibrium (CGE) models for development policy (Dervis, 1982; Lofgren et al., 2002).

These macro perspectives are also supported by Dercon and Gollin (2014) who advocate for focussing on Africa's small-scale farmers since the majority of Africa's poor are small-scale farmers. They also argue that agricultural development is important for poverty reduction in Africa because of the multitudes whose livelihoods are in agriculture (Dercon & Gollin, 2014). The impact of agricultural growth on poverty is two to three times higher than growth in other sectors (Christiaensen et al., 2011).

The roles of institutions, technology, and markets in improving small-scale agricultural productivity are some of the meso roles of agricultural development. (Antle & Crissman, 1990; Bandiera & Rasul, 2006; Barrett et al., 2010; Besley & Case, 1993; Conley & Udry, 2010; Fackler & Goodwin, 2001; Fafchamps, 2004; Feder et al., 1985; Foster & Rosenzweig, 1995; Hayami & Ruttan, 1971; Lin & Nugent, 1995; Moser & Barrett, 2006; Schultz, 1964; Schultz, 1975; Solow, 1957). These meso level failures of institutions and markets (Dercon & Gollin, 2014) present opportunities to develop the institutional and social framework required to make agriculture an engine for South Africa's economic growth (Lescourret et al., 2015; Qobo & Wood, 2016). Consequently, this study therefore developed AgriHub Africa as an institutional and social framework that is addressing the market and institutional failures affecting small-scale farmers. Similarly, Demeter also emerged as another such institutional and social framework.

Micro perspectives on agricultural development include the way individuals and households make decisions on their participation in agricultural development (Barrett et al., 2010; Chayanov, 1966; Feder, 1985; Sen, 1966; Singh et al., 1986). Demeter and AgriHub Africa provide mechanisms for experiential learning and action. These institutional arrangements have been assisting small-scale farmers to use those experiential learnings to improve their

productivity by making more efficient decisions. The inverse productivity claim that small-scale agriculture has better yields than bigger sized operations (Eastwood et al., 2010; Larson et al., 2012) is also another reason for targeting small-scale farmers and thus improving economic growth.

Digitally enabled agricultural transformation: Small-scale farmer intervention in the light of policy failures

There are significant mismatches between policy pronouncements and implementation that complicate post-apartheid South Africa's agricultural transformation (National Council of Provinces Committee on Land Reform, 2019; Parliamentary Committee on ALR&RD, 2019). These complications manifest as a profound lack of agricultural policy coherence (Drimie, 2016; Erasmus, 2019). With such levels of policy incoherence and inconsistency, this study placed the onus on small-scale farmers to take the mantle of determining their destiny borrowing from the concept of "seeds of a good Anthropocene" which point to how local level actors can develop solutions to their challenges (Bennett et al., 2016, p. 441). This manifested in this study as the emergence of Demeter and AgriHub Africa.

In particular, the AgriHub Africa platform architecture was designed around recognising that agriculture is a complex SES (Lescourret et al., 2015; Pereira et al., 2020; Rivera-Ferre et al., 2013; Sinclair et al., 2017). Consequently, AgriHub Africa represents transformative changes in the institutional arrangements for agricultural and food systems that have been effected by integrating social-ecological-system approaches to regime shifts (Biggs et al., 2018; Crépin et al., 2012; Pereira et al., 2020; Scoones et al., 2020).

This study has managed to innovatively harness digital technologies and design AgriHub Africa as a meta-organisation. AgriHub Africa houses institutional arrangements which harness digital transformation to create systems disturbances that are fostering synergies between the social spheres and the ecological arena from the perspective of social-ecological-system regime shifts. As a result, this study has responded to calls for designing mechanisms that coordinate various players as institutional arrangements (Herrero-Jáuregui et al., 2018). This was achieved by the innovations of Demeter and AgriHub Africa as institutions and stakeholder organisations in order to build synergies between ecological system functions and social dynamics (Herrero-Jáuregui et al., 2018).

PART B: RECOMMENDATIONS

In Part B of this concluding chapter, this study makes recommendations for the practice of digital agriculture in pursuit of agricultural transformation. Whilst farmers and other participants within the agricultural social-ecological-system can engage in digital agriculture practices for agricultural transformation, those practices would be better effected within an appropriate policy environment. Consequently, this study makes recommendations for policy at various levels from local municipality level through national level up to regional, continental level and multi-national organisational levels.

This study also makes recommendations for further research. The recommendations for further research relate to the main theses submitted in Chapters Five, Six, and Seven. Further research is required to interrogate the re-conceptualised definition of digitally enabled agricultural transformation. There is also need for further research on platform architectures for such hybrid platforms as AgriHub Africa which combine elements of industry platforms, MSMPs, and super-apps.

Beyond recommending areas for further research, the study makes recommendations on methodological issues. A key issue is the practical dynamics of conducting participatory action research. Such practical dynamics include issues such as how to robustly capture data that emerges out of informal conversations. This study resulted in the emergence of several institutions and institutional arrangements that were not foreseen as the research proposal was being developed. This brings to the fore aspects of how engaged scholarship not only generates new knowledge but prompts social transformation.

8.6 Recommendations for practice

The recommendations for practice that this study makes are largely encapsulated in the platform architectures of AgriHub Africa as an agricultural industry MSMP super-app platform. The AgriHub Africa platform architecture is built around addressing the scale challenges that small-scale farmers face. From a practical point of view, those scale challenges can be overcome by aggregating African agriculture online as the AgriHub Africa pay-line says. However, the recommendations for practice that are inbuilt into the AgriHub Africa

architecture talk to participants in the agricultural social-ecological-system and its sub-ecosystems.

An important stakeholder grouping around agricultural transformation consists of the implementing agencies that exist in the national and provincial departments of agriculture as well as those in municipal departments charged with various aspects of agricultural transformation. These stakeholder groupings need to be made aware of the platform architecture of AgriHub Africa so that they can incorporate their activities onto the platform. By so doing, the agri-parks AIS programmes can then become a true agricultural innovation system.

8.7 Recommendations for policy

This study has recommendations for policy at the African Union and multi-lateral organisation levels around the reconceptualised definition of agricultural transformation. At the national level, the study also makes the same recommendations around the reconceptualised definition of agricultural transformation. The agri-parks AIS programme may also need to have its component of being an agricultural innovation system re-emphasised. The national level recommendations for policy would be implemented at both provincial and municipality levels. Consequently, the local level recommendations for policy are more inclined towards how implementation of national government policy should be implemented.

This study recommends that the conceptualisation of agricultural transformation be redefined for the African Union, for development organisations such as AGRA and ACET, and for multi-lateral organisations such as FAO and IFAD. Already, the concept of agricultural transformation has shifted terminology towards structural transformation. Concomitant with that shift in terminology, the potential visibility of agricultural transformation has been relegated to agricultural development as one of other causal factor for economic growth and development such as technology and commerce.

This study puts forward a reconceptualization of agricultural transformation to be redefined as digitally enable agricultural transformation. The definition of digitally enabled agricultural transformation can accommodate for the other causal factors for economic growth and development mentioned as technology and commerce. Such a redefinition can put back some

wind onto the sails of floundering programmes such as CAADP which have significant potential impact on Africa's population, the bulk of whom are poor.

At the national level for South Africa, the redefined concept of digitally enabled agricultural transformation will also provide the same benefits as obtained at the international and multi-lateral levels. Incorporating the digital agriculture component onto the South African government's policies on agriculture, will also secure support from stakeholders in the digitalisation space towards agricultural transformation. The incorporation of that redefined concept of digitally enabled agricultural transformation will therefore add impetus to the agricultural transformation agenda.

A deeper dive into the redefined concept of digitally enabled agricultural transformation reveals its heavy emphasis on innovation. This will provide opportunities to re-emphasise the fact that the agri-parks AIS programme is predicated on the notion of agricultural innovation systems. A clearer articulation of the agri-parks AIS programme as an agricultural innovation system opens the programme up to a wider community since it will be open to any farmer who is seeking to innovate. Furthermore, innovations of an agronomic and managerial nature such as PDAMI can be widely disseminated through digital technologies. This will in essence move the agri-parks AIS programmes from being a programme focussed on managing accesses to scarce public resources.

8.8 Recommendations for further research

Recommendations for further research are largely around areas where the study was not able to obtain access, and around issues that were delimited from the study. There are also recommendations for further research on areas that emerged from the study itself. Whilst the study discusses the platform architecture for AgriHub Africa as a hybrid agricultural industry MSMP super-app, there are no specific guidelines on how complements to the platform can be developed. It is therefore recommended that research be conducted to develop frameworks for building platforms based on social-ecological-system theories.

Although social-ecological-systems theories were the golden thread that ran throughout the study, more research needs to be conducted on agriculture as a social-ecological-system. Such research should investigate the nature of panarchy within agriculture since an individual farm

can quite conceivable constitute a micro social-ecological-system. Parallel with the concept of panarchy is the observation that since an individual farm can be viewed as an internal product platform, an agricultural industry platform is a platform of platform. Research should be conducted on how nested nature of platforms is akin to panarchy.

Furthermore, more research is needed to understand the social-ecological-systems regimes of the agricultural social-ecological-system. Such research should also be supported by additional research on the adaptive cycle of the agricultural social-ecological-system. Such research will make it easier to develop systems disturbances that move the agricultural social-ecological-systems through the various phases of the adaptive cycle in order to better effect agricultural transformation.

Further research should also be conducted on how digital agriculture platform business models can enhance the linkages between public policy processes and private sector participation. Given that the nature of digital platform is that they co-evolve around their ecosystems, that co-evolution should also factor in public policy processes. An inability to factor in public policy processes will result in the promulgation of public policies that will always be behind the curve of digital agriculture platform evolution.

8.9 Recommendations on methodology

This study's research proposal originally envisaged an initial phase of qualitative data collection around the state of the South African government's agri-parks AIS programmes. However, that initially phase was only conducted through collecting data that was in the public domain. Although verbal communications of support were made to the researcher, the documented letters of approval were not forthcoming from public entities. Consequently, this study recommends that research that requires data from public officers should have a backup of accessing that data from publicly available sources.

The participatory action research component of this study was originally slated to have only five participants representing each of the two district municipalities and three metropolitan municipalities in Gauteng. However, the researcher decided to have at least two participants from each of those five municipalities. That decision proved to be prudent since one of the participants opted out of the study midway through it and another one unfortunately passed

away. Exclusion of the data from those two PAR participants did not adversely affect the study. This study therefore recommends that participatory action research project should always have provision for participants not being able to go through the whole duration of a study.

Although the study had research instruments such as interview guides and participatory action research intervention guides, the eclectic nature of agriculture was such that it was impossible to adhere to some of those instruments religiously. Even the requirement to be recording observations became practically untenable as the researcher participated in some of the PAR participants activities. As a result, some of the most important pieces of data were obtained during informal conversations. It was not uncommon that valuable data insights would be uttered by PAR participants as the researcher was packing up recording equipment or getting into his car to leave. Consequently, this study recommends that guidelines for recording informal conversations be developed.

8.10 Conclusion

The concluding chapter to this study has provided concluding syntheses on this study's summary findings in terms of the four components of this study's title. The concluding syntheses have incorporated summary findings on how this study re-conceptualised agricultural transformation with a heightened focus on scale to define digitally enabled agricultural transformation. How this study has addressed the scale challenges of agricultural transformation is the study's second summary finding that was incorporated into the concluding syntheses. The third and final summary finding that was incorporated into the study's concluding syntheses was this study's proposed two-part digital agriculture disruption framework made up of a hybrid disruptive innovation and big bang innovation model and a digital agriculture user development model.

The second part of this study's concluding chapter has made recommendation for practice and for policy, as well as recommendations for further research and recommendations around methodological issues. That Part B on recommendations compliments this chapter's Part A which synthesises the study's summary finding to submit a thesis on how to harness digital transformation to build social-ecological-system resilience into institutional arrangements for agricultural transformation.

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