Urban-rural interactions for diffusion of sustainability business model for food, energy and water: Case study of Tshwane Food and Energy Centre (TFEC, Gauteng) and kwaSwayimane (KZN)

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand in partial fulfilment of the requirements for the degree of Masters of Architecture in Sustainable and Energy Efficient Cities.

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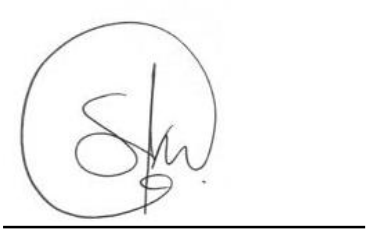
DECLARATION

I, **Sphelele Khanyile** declare that this research report is my own unaided work except where otherwise acknowledged. It is submitted for the degree of Master of Architecture at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.



Signature of Candidate

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ABSTRACT

The study is rooted in the food-security and job-creation drive for urban areas as urbanisation and unemployment intensifies thus driving urban-agriculture innovations that focus on small-scale crop and animal production. In contrast, several rural areas with high potential agricultural land are stagnating mainly due to a lack of farming knowledge and skills especially as the younger generation migrate to cities. As a result, an opportunity emerges for the diffusion of innovations in sustainable agricultural practices from innovative urban-agriculture farmers to the slow-to-innovate rural farmers. This study therefore substantiates on this scenario based on diffusion opportunity from urban-to-rural case study communities in South Africa

Based on a qualitative study approach and case-study method as well as interviews with purposely selected respondents, the study appraised and compared status-quo practices in the Tshwane Food and Energy Centre (TFEC) and kwaSwayimane communities. Primary data were also collected through direct observation based on field visits to the two case studies. Secondary data on purposely-selected reported cases on diffusion of innovation models/processes in various sectors were also captured and analysed. Data analyses were guided mainly by a comparative approach where status-quo practices across both case studies were compared, variations in practices were applied as the guide to diffusion opportunities, and secondary data on models guided the conceptualisation of the diffusion model.

Following on the comparative data analysis, the study finds that even though the initially planned innovation practices for TFEC were not sustained beyond a period of about two months, the case study still serves the diffusion opportunity by demonstrating the integration/synthesis of interventions and optimisation of the economies-of-scale-benefits. Equally, the diffusion shortfalls in the project highlight areas for caution especially with regard to the critical significance of provision for initial piloting at small-scale before scale-up, security system, beneficiary-selection criteria/process and sustaining/expanding on initial networks. Coupled with additional insights from secondary data analysis of reported diffusion models/processes, the study conceptualised a two-phase model (partnering and piloting) for innovation diffusion to host community in kwaSwayimane. As part of the findings, guidelines towards implementation of the model were also conceptualised and substantiated. Besides the innovation diffusion model to be shared with the actors in the diffusion opportunity, the other key recommendation of the study is that innovations such as the integrated sustainability interventions and cooperative business model diffused into the TFEC are adaptable through reinvention towards the uplifting of rural communities such as kwaSwayimane.

Key words: Diffusion of innovation, sustainability practices/interventions, sustainable agriculture, cooperative business model, innovation, communication channels.

DEDICATION

To my late parents and the rest of the family

"Treasure the love you receive above all. It will survive long after your good health has vanished" Og Mandino

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ABBREVIATIONS AND ACRONYMS

CO_2	Carbon Dioxide
DARD	Department of Agriculture and Rural Development
DLED	Department of Local Economic Development
F1-7	System-functions
GDP	Gross Domestic Products
Ha	Hectare
IDP	Integrated Development Plan
KZN	Kwa-Zulu Natal
kV	Kilovolt
NGO	Non-Governmental Organisation
OCA	Organic Conservation Agriculture
PV	Photovoltaic
SDSN	Sustainable Development Solutions Network
SHS	Solar home lighting systems
SMME	Small, medium and micro-enterprises
SWOT	Strengths, Weaknesses, Opportunities and Threats
TFEC	Tshwane Food and Energy Centre
TIS	Technology Innovation System
UKZN	University of Kwa-Zulu Natal

CHAPTER 1: INTRODUCTION

1.1 Introduction

The intersection between housing, energy, food security, water and sanitation for economic development constitutes for a potent platform for incubating/nurturing sustainable development. A rural community that achieves an ongoing balance across these needs can be said to be sustainably developing. Sustainable development for such rural communities is crucial towards addressing the push factors that result in high levels of emigration and urbanisation. The major economic outcomes of such development would include job creation; the development of small, medium and micro-enterprises (SMME) and local economic stimulation. Social and improved quality of life outcomes would include access to basic services such as water and electricity, food security, adequate housing and enhancing human dignity through social cohesion.

The study is centred on sustainable rural development and anchored on the three pillars of sustainability (social, economic and environmental wellbeing) especially through the opportunity of diffusion of innovation based on urban-rural technology transfer. The study substantiates on this goal based on insights from the case study of Tshwane Food and Energy Centre (TFEC, Gauteng) project which was implemented by the City of Tshwane in Gauteng Province. The insights on innovative sustainability practices are twofold. The first part involves a holistic approach through integration of sustainability interventions in multiple service areas especially renewable energy, groundwater abstraction, rainwater harvesting, and affordable housing, with small-scale agricultural production as the key livelihood opportunity. The second part deals with product value-addition and economies-of-scale benefits which emanate from the utilisation of shared facilities, bulk input buying, combined bulk selling and access to secure market through a central farm business model (innovative cooperative business model). The integration of these two insights into one basket therefore constitutes what is referred to as an "innovation" in this study. The innovation/insights are then applied towards an understanding of how related principles of sustainable development can be diffused for adoption and practice in kwaSwayimane which is a rural area located within uMshwathi Local Municipality (KZN). A map of South Africa showing the national geographic context of the two case study locations of the TFEC and kwaSwayimane is presented in Figure 1.

Figure 1. Map of South Africa showing the national context of the TFEC and kwaSwayimane locations (Source: adapted from www.places.co.za)

Emanating from this study is an innovation-diffusion guide that informs and guides the development of the conceptual innovation-diffusion model proposed for recommendation to the TFEC and kwaSwayimane community as well as related actors, and especially their respective municipalities. The innovation-adoption guide emanating from the study must not be confused with the conceptual innovation-diffusion model. The former acts as guidelines towards the conceptualisation of the model (not of the diffusion process) which is for recommendation to the two case study communities. The conceptual model provides a logical two-stage process that outlines how the innovative practices in the TFEC could be tapped for scaling up from prototype to a national practice. Partnership is conceptualised as the first stage. This would entail the establishment of partnership and cooperation between the two communities. At a later stage, once the relationship is strong, the partnership can expand to other role players in order to form a network. Among the important partnerships, is partnership with institutions possessing technical agricultural expertise such as Department of Agriculture and Rural Development (DARD), Department of Local Economic Development (DLED) and extension service organisations. The objective of the partnership and network would be to share

existing knowledge, develop further knowledge, transfer skills, build capacity, and provide training. In addition, joint activities and exchange programmes would constitute other characteristics of this stage.

Modern communication channels using online platforms are recommended as the more effective communication method and should be complemented with face-to-face channels. Following the successful undertaking of the first stage, the second stage of trialling the innovation for adoption in the KZN community is proposed. It emanates from the lived experiences of the interviewees from the TFEC; with the aim of improving the trial and success of the innovation adoption. This stage is centred on the implementation challenges that were observed in the TFEC. From these lessons, the study then recommends what can be done better, "how" and "what" to avoid in the piloting of the innovative practices. Apparent in this stage is that the innovative practices must be adapted and reinvented in order to optimise for effectiveness/adoption in the local environmental and socio-economic context. The study concludes by asserting that through collaborative approach between the two case study communities, diffusion of innovative interventions would be enhanced thus expediting sustainable socio-economic development for the rural community while empowering the urban community to improve on the existing project gaps and thus innovate further through reinventing.

1.2 Background/ Rationale for the Research

The study was provoked by the urban-agriculture/livelihoods innovations in the TFEC project which was therefore purposely selected as one of the case studies of the research. The project is located 65 km to the east of the City of Tshwane (the capital city of South Africa, and near Bronkhorstspruit, next to Ekangala Township - Figure 2). The City of Tshwane created an agropolitan village (known as TFEC) which is located on a 200Ha plot under the city's ownership. The agropolitan village produces and sells agricultural produce, generates its own renewable energy and provides jobs to the low income residents of the neighbouring townships. Its design aimed to achieve the multiple objectives of sustainable food production, poverty reduction, renewable energy generation, employment creation, SMME development, local economic development, water use efficiency/optimisation and sustainable human settlements (Dimmer, 2016).

The municipality established a central farm that serves both as an active farm for livestock production, as well as a business support hub delivering agricultural extension/support services

to 25 small-scale farmers. Each of the farmers was supplied with vegetable tunnels (greenhouses) and chicken coops on which to manage production with the aim of becoming commercially viable within a cooperative business model. However, the benefits of economies-of-scale are achieved through a cooperative-based ownership of and access to an abattoir, hatchery, vegetable processing, seedling production, crop farming and feed-mill facilities.

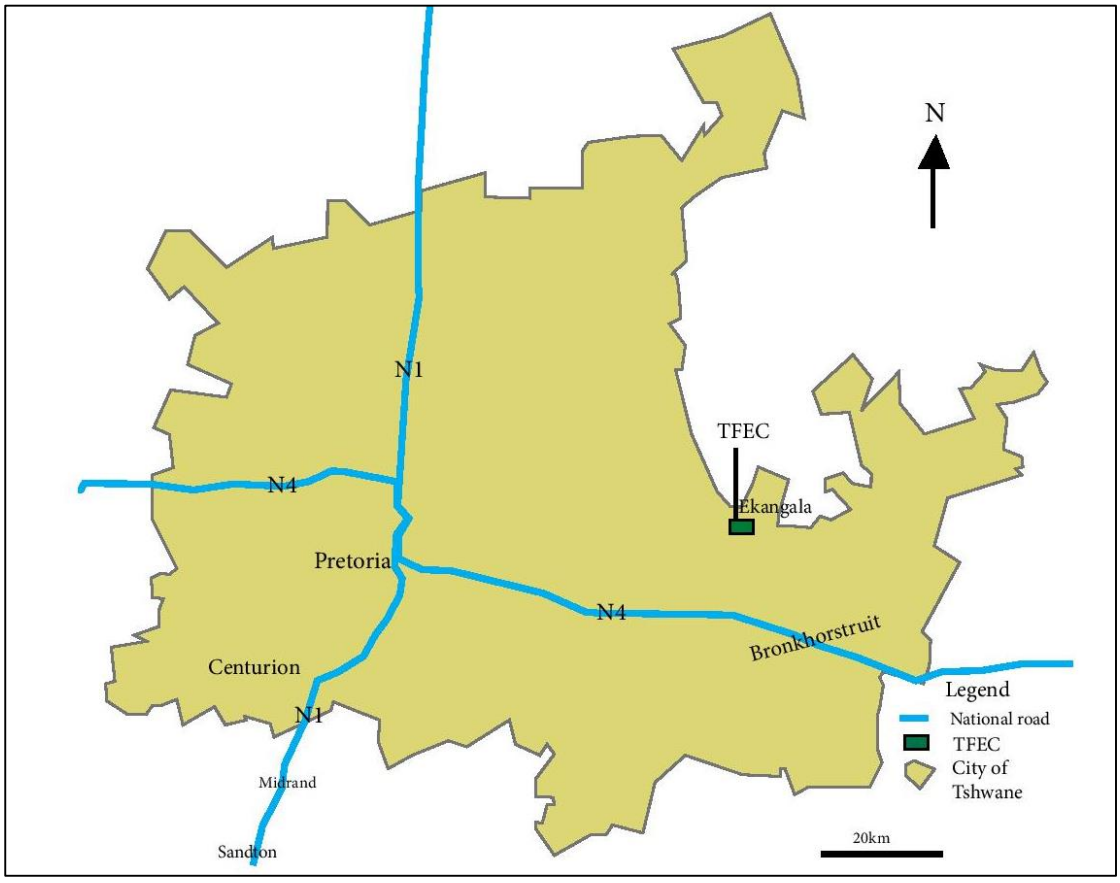

Figure 2. City of Tshwane highlighting the geographic location of TFEC (Adapted from google map)

The TFEC strives for self-sufficiency in both supplying the necessary infrastructure to make use of rainwater, groundwater and renewable energy. The construction and commissioning of the 150kV biogas generator facility and 100kV solar power plant would supply renewable energy for farming operations, which includes groundwater pumping. Each farming unit has been equipped with 5m³ rainwater tank which augment the groundwater supply. The biogas plant is powered by a combination of own cultivated sorghum and livestock waste as feedstock fuels. The dwelling unit of each farming unit comes equipped with a 120 litre solar water heater. Apart from income from husbandry, the collective farm earns dual income from a share of revenues from the energy generation arm of the TFEC. This consists of bio-compressed natural bio-gas power plant for sale of green biofuel to Tshwane buses and industries; large-scale

production of energy crops; and utilisation of digestrate as fertiliser for maize and energy crops. The study assesses how these sustainability-guided innovations and related practices could be tapped to expedite similar innovations for sustainable development for kwaSwayimane community in KZN.

The TFEC project was widely reported on online platforms such as online magazines/news and in online-shared presentations following its official launch by the City of Tshwane in 2016. The period of wide sharing of the TFEC project information coincided with the two months of the initial practices that reflected the well-functioning of the planned basket of sustainability interventions and cooperative business model innovations as asserted by the respondents of this study under Section 4.1. After the launch period, there is hardly any information on the project available on online platforms/internet and this probably coincided with the project implementation challenges that were experienced after the two months of initial practices (also discussed under Section 4.1). In addition, there were/are no online platforms designed to track/trace the project progress/functions following the launch in 2016 which would enable the beneficiaries to update their project experience and allow interested parties to observe/learn the project progress. An opportunity for establishing and sustaining a live online platform for TFEC to capture and share learning-curve experiences and innovation adaptations over time, arises as a step towards improving the effectiveness of the innovations.

The TFEC case study is one among a growing spectrum of case studies focusing on urban agriculture in South Africa, especially in large cities like Johannesburg, Tshwane (the hosting city of the TFEC), Durban and Cape Town. In its nature, urban agriculture is integrated into the urban economic and ecological system, such that it is embedded in - and interacting with – the urban socio-economic and natural ecosystems. Such interactions include the engaging of urban residents as the workforce/entrepreneurs, use of typical urban resources (like organic waste as compost, municipal waste as biogas input, and urban wastewater for irrigation), direct links with urban consumers as the markets, direct impacts on urban ecology, being part of the urban food system, competing for land with other urban functions as well as being influenced by urban policies and plans among others. Urban agriculture is therefore no longer viewed as a relic of the past that will fade away once progress/development takes effect (urban agriculture is actually expected to increase as the cities grow) nor as a survival/coping strategy brought to the city by rural immigrants who will lose their rural habits over time. Instead it is now viewed to be an integral part of the urban system.

The high flow and exchange of agricultural information/knowledge, innovations, skills, financial resources, and favourable policies (policy shift) in urban areas are some of the reasons why urban agriculture persist as an integral part of the urban system and also likely to survive in the future of cities. These reasons also make urban agriculture more open and fluid compared to the conventional rural agriculture in terms of knowledge, technical skills, innovations and technologies. This create increasing opportunities for rural agriculture to learn adaptable practices from the more innovative urban agriculture, especially with regards to sustainability and innovative business models, in order to improve on sustainable rural development.

KwaSwayimane is a rural area located on the southeast of uMshwathi Local Municipality in KZN (see Figure 3). Areas to the southeast of uMshwathi Municipality, including kwaSwayimane are mainly dominated by household operated subsistence and cash-crop farming. The uMshwathi Integrated Development Plan 2016/2017 (hereafter referred to as IDP) notes that the majority of the population resides in the south-eastern part of the jurisdiction under Gcumisa Tribal Authority of kwaSwayimane rural settlement (uMshwathi, 2017). This is a highly dense settlement within uMshwathi Tribal Land areas. The IDP identifies kwaSwayimane land as currently under the ownership of uMshwathi Municipality. According to Statistic SA (2011), the unemployment rate in uMshwathi was at 75.1% and the dependency ratio at 61.2%. Youth unemployment was at 31.5%. Those that are employed are mainly working in the nearby commercial timber plantations and sugarcane fields. The agricultural sector contributes 41.5% to the GDP (*ibid.*) and this mainly comes from timber plantations and sugarcane.

The IDP notes that agricultural land is being lost to non-agricultural activities (such as housing projects, tourism and manufacturing) especially due to non-competitive agricultural activities and production. Forestry has for many years been the major economic operation, with sugarcane, cattle farming and poultry as complementary production (uMshwathi, 2017). Crop production, crocodile farming as well as game farming operate as alternative/niche industries, where crop farming is primary geared for subsistence and cash-crop farming, and normally complemented by livestock such as cattle and poultry (*ibid.*).

As a rural area whose economy is based on agriculture, a strong connection/interdependence exists between the municipal DLED and provincial DARD. Partnership and networks between KwaSwayimane and these institutions could open opportunities for tapping into their technical agricultural expertise, resources and extended network which would be useful in the diffusion

of the integrated basket of sustainability practices in agriculture and innovative cooperative business model for the community.

uMshwathi (2015) asserts that vegetable production is key in the agricultural sector in the municipality (see Figure 4). However, the report notes that support structures across the value-chain do not exist and as a result, this leaves farmers burdened with high production costs and a lack of cohesion, absence of agro-processing, as well as inadequate access to profitable markets.

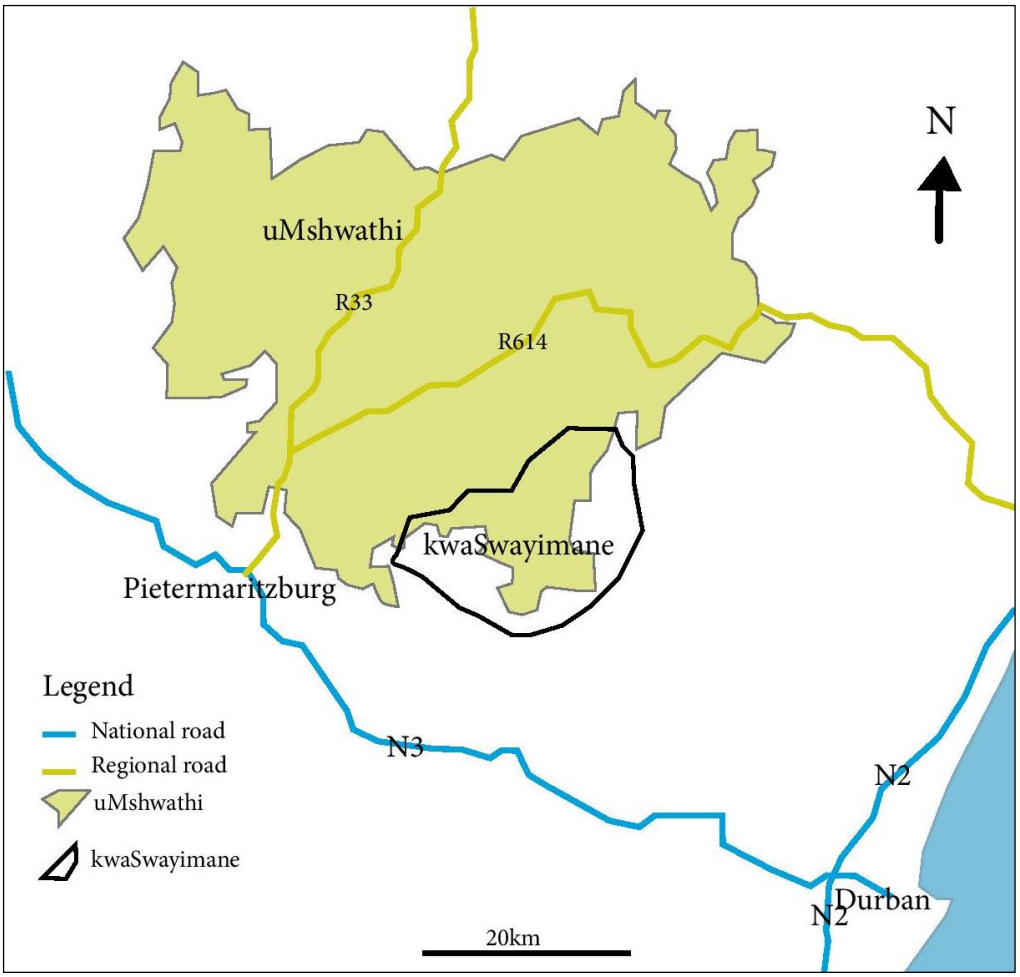

Figure 3. Geographic location of kwaSwayimane in uMshwathi local municipality (Source: Google map)

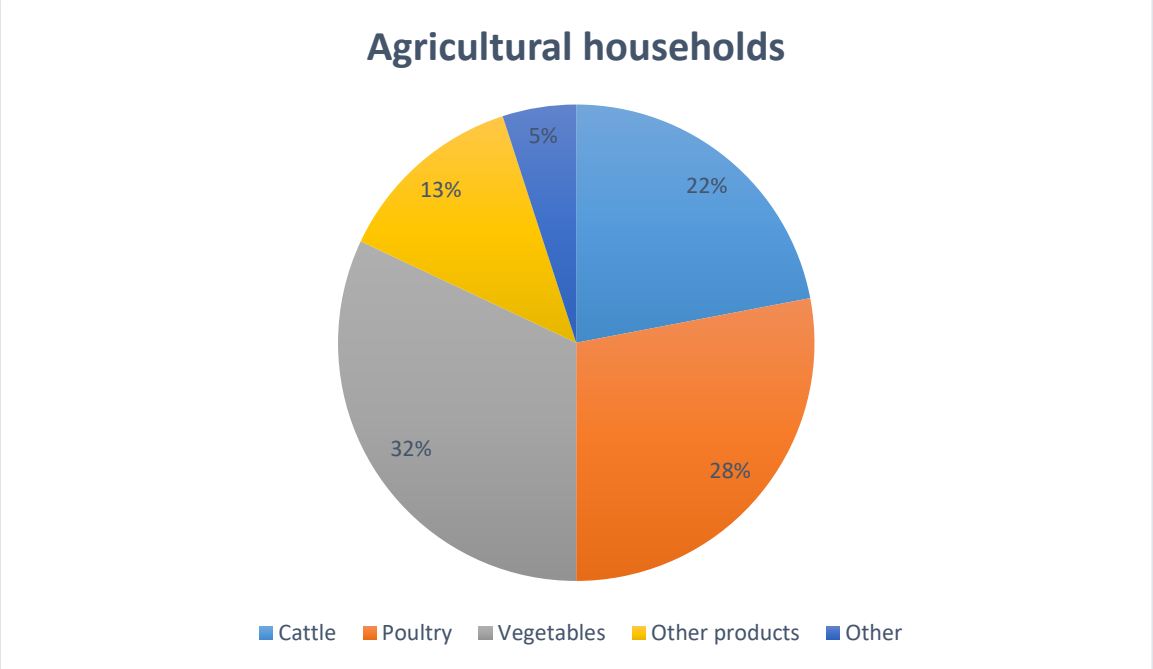

Figure 4. Agricultural households in uMshwathi municipality (adapted from: uMshwathi, 2015)

The IDP shows that about 800Ha of prime land for agricultural production has been identified in the Swayimane/Gcumisa tribal area. Furthermore, uMshwathi (2015) notes that areas like kwaSwayimane have high concentration of households engaged in subsistence and cash-crop farming, zero access to value-enhancing markets and hence the lack of value-adding, poor education on agrarian activities and general management of their own farm holdings as well as inadequate exposure to operating within a cooperative system. This motivates for the exploration of an innovative business model that can be adapted to kwaSwayimane in order to resolve these challenges in a manner similar to the approach applied in the TFEC project. Such communities, as well as others living in former tribal land settlements, require municipal intervention programmes designed to improve development prospects/outcomes through easily adaptable practices/innovations. The municipality is currently reviewing its agri-business strategy, with the aims of specifically supporting previously disadvantaged farmers and especially focussing on opportunities for SMMEs, youth and women. As part of the agri-business strategy, and the agri-hub project, the municipality is also appraising/evaluating the feasibility of establishing pack house(s), a fresh produce market as well as market stalls. Furthermore, the municipality plans to create jobs through agro-processing for value-adding to agricultural produce. However, the agri-business strategy is generic and vague on how it would achieve the set goals. It is therefore the purpose of this study to try and substantiate on how the strategy could be effected. Nevertheless, the strategy provides an opportunity for integrating

innovative business model into agriculture practices in order to achieve sustainable rural development.

In kwaSwayimane community, there has been initiatives by the DARD in partnership with the Enterprise Development Project, an agri-business segment of Potato South Africa, to equip farmers with ins and outs of potato farming through providing agricultural training (Agribusiness Development Agency, 2014). In the process, farmers were also taught how to organise themselves and sell their products as a collective. The municipality tries to organise the subsistence/cash-crop farmers into cooperatives so that they can benefit from government support and economies-of-scale, such as bulk buying and selling. However, this is a challenge since they fail to cooperate with each other or even follow on the requirements/principles of cooperatives. For instance, one of the cooperative was equipped with potato processing equipment which however has never been operational due to a number of challenges. The bottom line is that initiatives to improve agriculture/farming practices in the community have been explored and attempted, however, there seem to be challenges with matching the interventions with the cooperative model or social structure such that most interventions fail because there are not appreciated by the cooperatives/community or the cooperatives have their own internal dynamics. This provides an opportunity for the kwaSwayimane diffusion process hypothesised in this study for linking with processes/initiatives already underway as noted by the Agribusiness Development Agency (2014) and in the Agriculture Strategy of the municipality.

KwaSwayimane community is still lagging behind in sharing their farming practices using online platforms. However, there is evidence that several organisations in KZN are involved in using local newspaper in order to disseminate innovative agriculture-practices in general with communities/farmers (see for example Agribusiness Development Agency magazine of 2014 in Appendix A).

A SWOT analysis was performed by the municipality and the findings are summarised in Table 1 (uMshwathi, 2015). The SWOT analysis provides weaknesses and threats that could be managed/resolved by the basket of innovations under integrated sustainability practices within an innovative cooperative business model. The basket of innovations would make use of the already existing strengths and identified opportunities. Through a comparison of the basket of innovations practiced in the TFEC with the agricultural potential that exist in kwaSwayimane; this study evaluates the opportunity where the latter could utilise insights from an innovative

urban agricultural case study towards responsive interventions for sustainable development with a focus on its rural areas and communities.

Table 1. SWOT analysis for agriculture in uMshwathi municipality (uMshwathi, 2015)

STRENGTHS	WEAKNESSES
➢ 2400 hectares of land ➢ Massive farming population ➢ Existing key industries and agrarian structures ➢ Presence of industrial support ➢ Intellectual support (UKZN/CEDARA) ➢ Proximity of industrial/Retail markets ➢ Proximity of major metropolitan markets ➢ Well established farming environment ➢ Identifiable crops produced ➢ Positive youth involvement	➢ Low production yields ➢ Absence of value-add activity ➢ Low levels of education and training in farming ➢ Lack of cohesion and organization ➢ Poor farm management ➢ No monitoring systems in place ➢ No farming implements ➢ No harvesting implements ➢ No financial knowledge ➢ No sustainable markets ➢ No targeted sector for commercial development ➢ Lack of irrigation systems ➢ Lack of fencing
OPPORTUNITIES	THREATS
➢ Establishment of organisation ➢ Development of a farming calendar ➢ Value-adding facilities ➢ Objective-driven approach ➢ Establishments of implementation and monitoring systems ➢ Cooperatives engagement model ➢ Capital funding on key bottleneck areas in the value-chain ➢ Cooperatives and SMME incubation ➢ Local Economic Development results-driven funding ➢ Seed manufacturers nearby	➢ Current drought conditions ➢ Costs of farming inputs ➢ Sustainability of initiatives ➢ Quality of produce ➢ Invasive parasites and animal husbandry threats ➢ Quantity of produce ➢ Restrictive barriers to 1st world trade markets

1.3 Research Problem

The urban agricultural communities are innovating relatively faster while at the same time incorporating sustainability practices and interventions in their day to day farming practices. These sustainability innovations are facilitated by high flow of information in urban centres, coupled with better access to information and presence of improved skills and actor networks. In contrast, rural communities are endowed with land of high-agricultural potential and supposed to be conducting their farming practice in a sustainable manner. However, lack of

information flow and weak connectivity to the rest of the world or cities mean that rural communities are the last to hear about sustainable innovative practices and consequently they end-up as the late adopters of innovation or laggards. This discrete boundary between urban and rural communities constitute a stumbling block to successful innovation diffusion and to the extensive adoption of sustainability practices across the two categories of practice-communities. Communication between the two practice-communities through partnerships and collaborations for the purpose of knowledge sharing remains unexplored in literature. This study therefore seeks to address this gap by applying insights from an urban agriculture and sustainability intervention within a community in Gauteng Province towards the conceptualisation of interventions for sustainable development within a rural community in KZN.

1.4 Objectives of the Research

The goal of the study was to appraise the opportunity of diffusion of innovation/business model based on urban-rural technology transfer for sustainable development through interventions in food, energy, water/sanitation infrastructure and services.

1.5 Research Question

The study was guided by the following research question:

How could innovative practices in urban agriculture be tapped towards expediting the diffusion of innovations for sustainable development for communities within rural areas endowed with land of high-agricultural potential?

1.6 Sub-questions

The sub-questions of the study were conceptualised as follows:

- What are the status-quo agriculture, energy and water practices within source (urban) versus host (rural) communities?
- What are the key insights from practices/models of diffusion innovations and technology transfer across various sectors locally and internationally?
- How could insights from models of diffusion innovations and technology transfer inform/guide the hypothesised diffusion process across the case study communities identified for the study?

- What would be the conceptual models emerging from the study for recommendation to the various actor-networks hypothesised in this study?

1.7 Working Hypothesis

With insights from diffusion of innovations and technology transfer models/practices, the study expected to find that collaborative/twining approach between the two case study communities (both through joint activities as well as information-sharing through online platforms) would enhance the diffusion and transfer process of interventions thus expediting sustainable socio-economic development for the rural community while also empowering the urban community to innovate further.

1.8 Conceptual Approach and Theoretical Framework

Strictly, the study falls under translational research, which denotes a study that looks at how evidence-based interventions, practices, innovations and programs can best be communicated for adaptation by intermediaries, communities and program staff for the benefit of their constituents (Dearing and Meyer, 2006). It is in this respect that this study substantiates on how the sustainability interventions in food, water and energy together with the cooperative business model implemented in the Tshwane Food and Energy Centre (TFEC) could be communicated and diffused for potential adoption and adaptation in kwaSwayimane.

A qualitative case study approach which combines primary and secondary data as well as direct observations guided by the diffusion of innovation models constitute the key approach of the study. Sustainable agriculture and cooperative business model form the secondary framework. The integrated basket of sustainability interventions practices and the innovative cooperative business model which have been adopted in the TFEC project constitute the innovation appraised in the study with a focus on how it could be diffused for adoption by kwaSwayimane community.

A conceptual framework that establishes the relationship between the theoretical aspects and case study aspects, as well as how the innovative practices in the case study informed the conceptualisation of the theoretical framework/approach is presented in Figure 5. The relationship between sustainable agriculture as a theoretical sub-theme and sustainability interventions as practised in the TFEC case study is conceptualised under environmental protection, economic viability, social improvement, clean energy, water efficiency and food security. Similarly, the relationship between the business model as a theoretical sub-theme and

the innovative cooperative business model as applied in the TFEC case study is conceptualised under products/services offered, value-chain/value-addition, economies-of-scale, access to market/marketing, business ownership, management and business network. Lastly, diffusion of innovation as the overarching theme of the study is conceptualised relative to the potential innovation adoption of the host community. Key elements of this relationship include communication channels, social systems, partnership/cooperation, information technology, innovative-decision process, innovation-diffusion process and adaptive diffusion/adoption. These relationships between the theoretical and case study perspectives undergo an innovative process that have been conceptualised above using key elements of the research design. As a result, the case study aspects mirror the theoretical perspective.

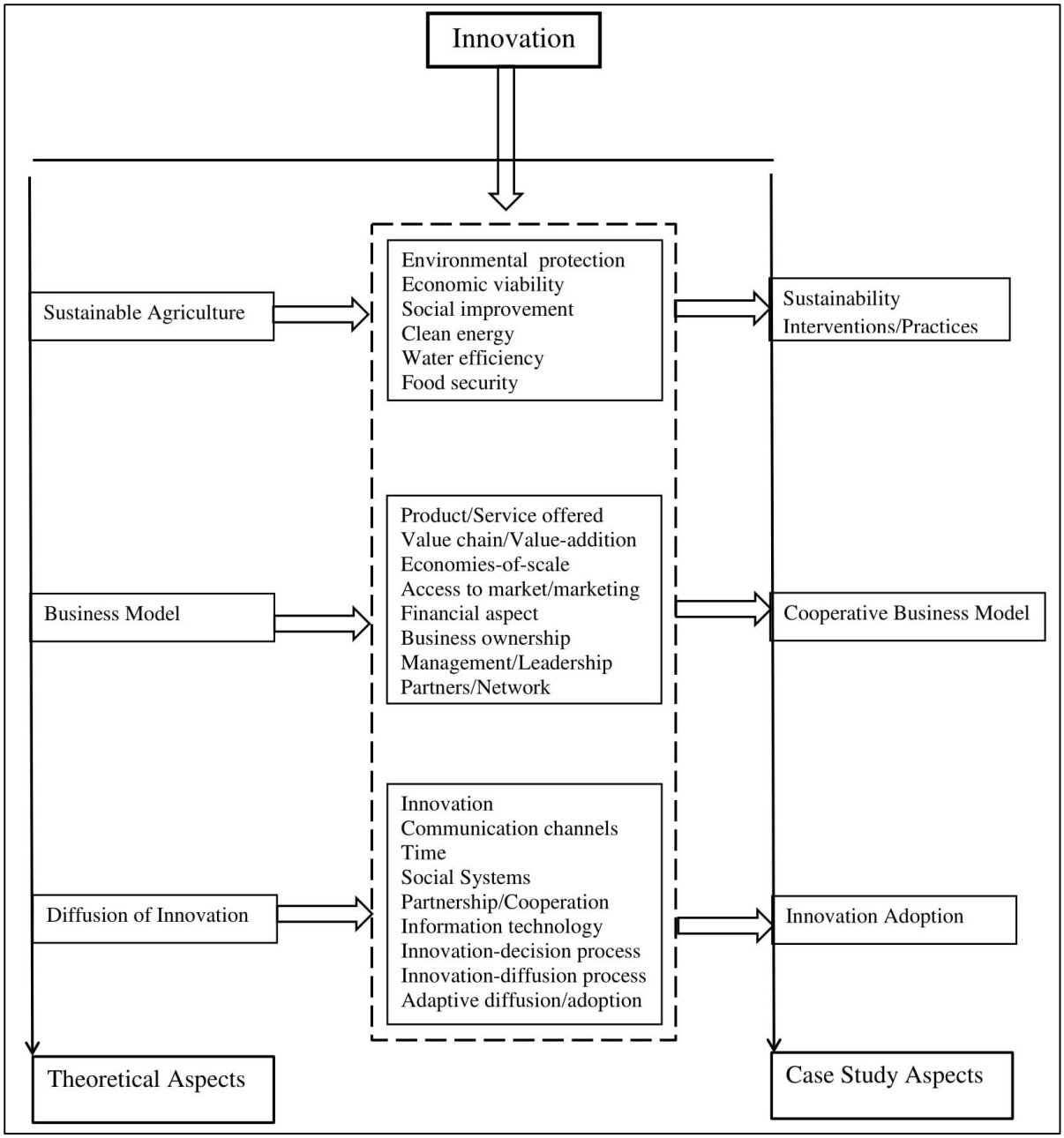

Figure 5. Conceptual diagram showing the key research design elements that define the relationship between the theoretical and case study aspects.

1.9 Definition of Key Concepts

Communication Channels: the means by which messages get from one individual to another (Rogers and Shoemaker, 1971). The channels can be categorised into mass media channels and interpersonal channels. The first one involves transmitting message through mass media, such as radio, television and newspaper; while the latter involves face-to-face exchange between two or more individuals. The latter allows a two-way exchange of ideas and persuades receiving individuals to form or change strong-held attitude.

Cooperative Business Model: a business owned and run by and for its members (Petersen Jr., 2016). The focus is on maximising member benefits rather than maximising shareholder-returns. The benefits are conceptualised in economic, environmental, social and psychological terms. In the context of this study, the collective ownership of the TFEC operations by its members/beneficiaries who in turn lease/operate separate plots of land in the project, together with the establishment of the central farm as the business support hub, cooperative-based ownership of and access to shared facilities, coordinated access to markets/marketing, as well as benefits from the economies-of-scale and value-adding mechanisms, constitute an innovative cooperative business model.

Diffusion of Innovation: a process in which an innovation is communicated through certain channels over time in pursuit of adoption by targeted members of a social system (Rogers, 2003). In the context of this study, partnership and collaboration between the two case study communities was hypothesised and substantiated as the core innovation diffusion mechanism.

Innovation: an idea, practice, or project that is perceived as new by an individual or other unit of adoption (Rogers, 2003). In the context of this study, innovation is the integrated basket of sustainability interventions and practices as well as the improved economies-of-scale benefits arising from the cooperative business model which has been prototyped/adopted in the TFEC project. In principle this constitutes focus on innovation at the level of a business model rather than on the associated technological interventions in isolation.

Sustainable Agriculture: improving efficiency in agricultural production based on sustainability interventions (see next term definition) which protect and improve the natural environment, the socio-economic conditions of farmers, their employees and local communities and safeguard the health and welfare of the farmed species (Sustainable Development Solutions Network, 2013). The commonly understood interventions in sustainable agriculture include practices such as no-till farming, permaculture, ecological farming, biodynamic farming, low-input practices and organic farming (no use of pesticides, herbicides or artificial fertilisers etc.). In the context of this study, the focusing of multiple non-agriculture interventions towards facilitating sustained agriculture production is viewed as enhancing sustainable agriculture practice.

Sustainability Intervention/practice: a discrete, intentional and often non-conventional intervention/action with a measurable and enduring improvement on the levels of impact on the natural environments or environmental media as its principle objective. Such interventions

also seek to use less of the finite natural resources (in order to mitigate depletion) and more of the renewable resources. In the context of this study, this includes biogas energy plant, solar energy plant, solar water heaters, rainwater harvesting system and groundwater abstraction as prototype interventions at the TFEC-site project.

1.10 Delimitation of the Scope of the Study

The TFEC was chosen as the source-urban case study because of its unique innovation of integrating sustainability practices using an innovative cooperative business model into one basket of practices. However, the conceptual stage (planning and implementation stages) of the project could not be established due to limitations within the secondary and primary data sources. In particular, the targeted interview participants could not provide such data. This component was therefore exempted from the scope of the study. On the other side, kwaSwayimane was chosen because of its untapped high potential in its agricultural/arable land as well as its strategic location/position in the province of KwaZulu-Natal and its capital city, Pietermaritzburg. In kwaSwayimane, the scope of primary data collection was limited only to Ward 11 because of time constrains. However, similar agricultural practices across all the municipal wards was assumed, especially with regards to innovations similar to those observed at the TFEC.

The purpose of the study was to appraise the opportunity of diffusion of innovative business model at the TFEC based on urban-rural technology transfer for sustainable development with interventions in food production/security as well as energy and water/sanitation infrastructure and services. In terms of technological sustainability interventions, the study only focused on three key components of food, energy and water. The overall concept of sustainable agriculture as the sub-theme of the study is based on the general understanding of sustainable agriculture as the efficiency in agricultural production in a manner that also protects and improves on the natural environment, the socio-economic conditions of farmers, their employees and local communities as well as safeguarding the health and welfare of the farmed species (Sustainable Development Solution Network, 2013).

The TFEC project was primary funded by the City of Tshwane and therefore the study assumes that uMshwathi Municipality would fund the piloting/adoption of the innovations within the kwaSwayimane community and probably could also utilise the extended network created in the partnership stage (Stage 1) of the conceptual innovation-diffusion model to source the

funding. The funding model for the implementation of the innovations is therefore not addressed in this study.

This study also adopted a specific delineation of the term "innovation", which defines innovation as the integrated basket of sustainability intervention and associated practices as well as the incorporated economies-of-scale benefits of a cooperative business model which have been prototyped/adopted in the TFEC project. As a result, the study does not focus on the appraisal of the specific technologies or technological interventions in isolation. Even though the study prioritised the diffusion of the innovative business model as an integrated whole, the scope of the study strongly emphasises on the cooperative business as initially planned for practice within the TFEC. In the diffusion process as substantiated in Rogers (2003) diffusion model (see Section 2.1 for details), the study was more interested in the knowledge stage and communication channels. The adoption stage under the diffusion of innovation model has therefore not been substantiated in the study.

Lastly, the scope of the study was also limited to a conceptual level and therefore did not get into the core of the exact practices suitable for adoption in the host rural community. However, the study has substantiated on adaptive diffusion in order to provide for the process of aligning the adoption to the local socio-economic and environmental context of kwaSwayimane.

1.11 Structure and Organisation of the Report

This section explains the structure of the research report by presenting the chapter overview as shown in Table 2 below. The report comprises seven chapters, of which the first three are the preliminary chapters and the subsequent four chapters are the substantive chapters. The first chapter introduces the report by providing the background and motivation of the study. The second chapter appraises previous studies/literature related to the theme of the study. The third and last preliminary chapter explains the methodology used for the study. The substantive chapters are structured in a way that allows each sub-question to be addressed in a specific chapter and the main research question to be addressed in the last concluding chapter. For instance, Chapter 4 presents the data capture and analysis as well as derivation of sub-findings for sub-question 1, which addresses the status-quo practices within source versus host communities. Chapter 5 presents the data capture and analysis as well as derivation of sub-findings for sub-question 2 and 3, which seek to explore local and international insights of diffusion of innovation models, and how these insights can inform/guide the hypothesised diffusion process. Chapter 6 addresses the last sub-question which explores the

conceptualisation of an innovation-diffusion model for recommendation to the two case study communities identified in the study. The last chapter consolidates all the sub-findings towards the overall finding which addresses the main research question on tapping practices in urban agriculture towards expediting diffusion of innovation for sustainable development for communities within rural areas endowed with land of high-agricultural potential.

Table 2. Structure and organisation of the research report by means of chapters

Chapters	Chapter Heading	Chapter Overview
Chapter 1	Introduction	The introduction chapter presents the motivation and scope of the study rationale and background, problem statement, objectives, research questions and the expected findings as the working hypothesis as well as the delimitation of the scope of the study. The study was provoked by the urban-agriculture/livelihoods innovations in the TFEC project which was therefore purposely selected as one of the case studies of the research. These innovations are the integrated basket of sustainability interventions and practices as well as the improved economies-of-scale benefits arising from the cooperative business model which are applied in order to achieve sustainable agriculture. This basket of innovations is what this study explore how it could be diffused to a rural community (kwaSwayimene) endowed with land of high-agricultural potential but not enjoying access to similar innovations. In its purpose of appraising the opportunity of diffusion of innovation/business model, the study was guided by four research sub-questions which were along the following themes. The first theme was about establishing the status-quo agriculture, energy and water practices in the two communities. The next theme was about establishing key insights from practices/models of diffusion innovation across various sectors locally and internationally. Linked to this theme, is the theme exploring how insights from models of diffusion could inform/guide the hypothesised diffusion process. The last theme was centred on the conceptualisation of the innovation-diffusion model for recommendation to the TFEC and kwaSwayimane community. The delimitation of the scope includes that the conceptual stage of the TFEC project could not be established; in kwaSwayimane, the scope of primary data collection was limited only to Ward 11; the study adopted a specific delineation of the term “innovation”; and lastly, the scope of the study was also limited at a conceptual level.

Chapter 2	Literature Review	The chapter appraises specific readings on the key theoretical issues of the study. They included diffusion of innovations and sustainability interventions in agriculture, with communication channels, sustainable agriculture and business model as the key themes. The study falls under translational research, which denotes a study that looks at how evidence-based interventions, practices and innovations can best be communicated for adaptation or adoption (Dearing and Meyer, 2006). The key theoretical framework of the study is diffusion of innovation. Seven models of diffusion are therefore appraised under this chapter in Section 2.1. These models are the traditional model of diffusion of innovation, trading model, technology transfer model, evolutionary model, rhetorical model, dissemination model and decentralised model of diffusion. The innovation diffusion models are all tied to the traditional model developed by Rogers (2003), therefore the study adopts and focuses on the traditional model. In the traditional model, the study can be argued to fall under the early stage of the innovation-decision process (the knowledge stage). In addition, the study also cuts across the three types of knowledge fields proposed by Rogers (2003) which are awareness-knowledge, how-to-knowledge and principles-knowledge. The traditional model also argues that effective and efficient communication channels are central in the diffusion process. The chapter also appraises studies on sustainable agriculture and its practices. The commonly understood interventions in sustainable agriculture include practices such as no-till farming, permaculture, ecological farming, biodynamic farming, low-input practices and organic farming. In the context of this study, the focusing of multiple non-agriculture interventions (such as using renewable energy, solar water heaters, rainwater harvesting system and groundwater abstraction) towards facilitating sustained agriculture production is viewed as enhancing sustainable agriculture practice. The last section of this chapter appraises studies on cooperative business model and its principles. The principle behind this business model is that a business should be owned and run by and for its members (Petersen Jr., 2016). The focus is on maximising member benefits rather than maximising shareholder-returns. The benefits are conceptualised in economic, environmental, social and psychological terms. One of the common advantages of a cooperative business model are

		economies-of-scale benefits through access to shared facilities, coordinated access to markets/marketing, bulk buying and discounts.
Chapter 3	Research Methodology	The chapter explains the processes, procedures and tools used for the study, and further expands as well as a motivation of their selection and application. Based on a qualitative study approach and case-study method as well as interviews with purposely selected respondents, the study appraised and compared status-quo practices in the TFEC and kwaSwayimane communities. Primary data were also collected through direct observation based on field visits to the two case studies. Secondary data on purposely-selected reported cases on diffusion of innovation models/processes in various sectors were also captured and analysed. Data analyses were guided mainly by a comparative approach where status-quo practices across both case studies were compared, variations in practices were applied as the guide to diffusion opportunities, and secondary data on models guided the conceptualisation of the diffusion model.
Chapter 4	Status-quo Practices	The chapter presents the data capture and analysis as well as derivation of sub-findings for sub-question 1, which addresses the status-quo practices within source versus host communities, in order to substantiate on the extent/nature of innovation at source as well as the need or opportunity at host community. The results obtained from the interviews and direct observations indicate the status-quo practices in the TFEC and kwaSwayimane case studies. For TFEC, the study finds that the status-quo practices are not aligned to the initial project plan that inspired diffusion of the project innovations in the case study. This misalignment arose due to significant implementation challenges experienced in the project process which compromised the planned practices into the coping practices which now prevail. The initial/planned practices which lasted for about two months following the commissioning of the project are characterised by functioning biogas and solar plants to generate electricity. This was subsequently used to pump groundwater from two

		boreholes. The water was then utilised to support farming (irrigation) and domestic consumption. Rainwater harvesting tanks are in place to supplement water supply. The sustainable and reliable water supply resulted in effective farming, high production and better quality of life for the beneficiaries. The quality of life was further improved by the presence of reliable electricity. At this point even though the central farm was not operational, beneficiaries were getting enough support from the municipality in terms of inputs and sale of their produce. These are the practices that inspired diffusion of the project innovations in the case study. Due to theft of solar panels, electricity cables, backup generators and water pipes, and the withdrawal of municipal support, the current status-quo practices are characterised by energy poverty, water challenges and access to market challenges. On the other side of kwaSwayimane, the status-quo practices are primary characterised by a prevalence of cash-crop farming (of sugarcane, potatoes, white maize); subsistence farming (of cabbage, spinach, tomato and other vegetables); poultry farming; and livestock farming. These farming practices happen at a household scale/level and are hindered by lack of water infrastructure, value-adding practices, municipal-support or access to market.
Chapter 5	Practices of Diffusion of Innovation	The chapter presents the data capture and analysis as well as derivation of sub-findings for sub-question 2 and 3, which seek to explore local and international insights of diffusion of innovation models, and how these insights can inform/guide the hypothesised diffusion process across the case study communities identified in the study. Four studies were prioritised for secondary data and analysis on key diffusion innovation insights. The first one involves the diffusion and adoption of hybrid corn seed in the United States of America. The second one looks at the business innovation and diffusion of off-grid solar technologies in India. This is followed by the third study which investigates how grassroots innovations enhance the use of renewable energy sources and proposal for a conceptual framework to analyse emergence of grassroots innovations and their diffusion. The fourth study uses Technology Innovation System as an analytic framework to examine the diffusion of solar PV systems and emergence of associated PV TIS in Ethiopia.

		Based on insights from the analysis, an innovation diffusion-adoption guide for kwaSwayimane is conceptualised within four stages which are innovation knowledge, partnership, skills development and piloting of the innovation. The first phase involves access to information, knowledge sharing, creating communication networks and channels, and knowledge development. The second phase entails the creation of partnership with other actors, in order to develop knowledge, share knowledge and provide support to each other. The third phase is about developing skills and creating capacity in preparation for piloting the project. Lastly, piloting and testing the innovative practices would allow kwaSwayimane to evaluate innovation compatibility with the local context, and further assess the benefits and relative advantages that the innovation brings. All these four phases combined are guidelines for the conceptualisation of the innovation-diffusion model for recommendation to the two communities identified in the study.
Chapter 6	Conceptual Model for Recommendation	The chapter presents the data capture and analysis as well as derivation of sub-findings for the last sub-question on the development of a conceptual model for recommendation to the various actors hypothesised in the study. The chapter first captures the data overview and analysis of the challenges and improvement gaps that emerged in the interviews from the TFEC. Above all the challenges experienced at the TFEC, a lot of lessons are learnt and a number of recommendations were proposed by the interviewees. These recommendations include investing in security service in order to protect the property and assets as well as life in the project and its beneficiaries. Before beneficiaries start operating, all components of the project should be in place and functioning satisfactorily. This includes the functionality of electricity from renewable energy source, efficiency of sustainable water systems, secure market for produce and operating common property facilities such as abattoir, hatchery and feed mill facilities. Also during the feasibility study and recruitment of beneficiaries, land to be used must be identified and secured by the municipality in consultation with community. Identifying beneficiaries with a drive and dedication to agriculture-based business is important for project success. The recruitment process therefore needs to be more thorough and systematically cognisant of context. The beneficiaries must then be equipped with necessary and adequate agricultural training including the business model of the project.

		A conceptual innovation-diffusion model for recommendation to both the TFEC and kwaSwayimane community is conceptualised and substantiated. The model is guided by the innovation-adoption guide and is structured into two stages with the first stage focusing on partnership between the two communities and the second stage concentrating on piloting of the innovations in kwaSwayimane. For the first stage, establishment of partnership and cooperation between the two communities should be focused with the possibility of expanding to other role players to form a network once the initial relationship has gained strength. The objective of partnership and network is to share knowledge, develop knowledge, transfer skills, build capacity, and facilitate training. In addition, joint activities and exchange programmes would be at the core of this stage. The second stage of trialling the innovation emanates from recommendations provoked by the lived experiences of the interviewees from the TFEC project, and would aim at improving trialling and success of the innovation adoption. The key objective of the second stage would therefore be to test the compatibility of the innovation with local context of the adopter, assess the adaptability and compare the relative advantages against the former practices. This would be done in order to inform whether the innovation can be successfully rolled-out or fully adopted in kwaSwayimane community at a bigger scale.
Chapter 7	Consolidation of Sub-findings and Conclusions	The last chapter consolidates all the sub-findings towards the overall finding which addresses the main research question on tapping practices in urban agriculture towards expediting diffusion of innovation for sustainable development for communities within rural areas with land of high-agricultural potential. Conclusions and recommendations constitutes the key content of the chapter. The first section of the chapter consolidates all the key findings derived in Chapter 4, 5 and 6 towards addressing how the basket of innovations found in the TFEC could be tapped for diffusion for kwaSwayimane rural community. Based on the findings, the study argues that through a partnership and collaborative approach between the TFEC and kwaSwayimane community that utilises online communication platforms, the diffusion of innovative interventions would be enhanced thus

		expediting sustainable socio-economic development for the rural community while empowering the urban community to improve on the existing project gaps and thus innovate further through reinventing. The study further envisaged that the innovative practices need to be contextually adapted in order to suit and optimise outcomes within the local socio-environment context. Following on the derivation of the key finding of the study, the second section presents a cross-referencing with the theories of diffusion as appraised under literature review in Chapter 2. In the process, the proposed innovation-adoption guide and the conceptual innovation-diffusion model is linked back to how other scholars view diffusion of innovation. Furthermore, the cross-referencing ensures that the emerging guide and conceptual model are applied towards re-appraising of existing theories of diffusion. The third section provides a summary and overall conclusion based on the key findings and the emerging conceptual. Recommendations for future studies/research and investigations are captured in the last section. These include how the basket of innovations could be adapted in the local context; investigating suitable agricultural activities, renewable energy technologies and water system in kwaSwayimane; assessing the status-quo agriculture, food and water practices across all municipal wards in kwaSwayimane; and commissioning a study that probes and categorises all the implementation challenges of the TFEC project.

CHAPTER 2: LITERATURE REVIEW

This chapter is sub-divided into four main sections which cover the key theoretical fields which underpin the study. The first section appraises studies on diffusion of innovation theory. The second section focuses on studies covering communication channels under the diffusion of innovation model, followed by the third section which appraises studies on sustainable agriculture and its practices, while the last section covers studies on the cooperative business model and its principles. The studies appraised under the last two sections explores literature on the practices to be diffused and the potential benefits they could bring for the source and host communities identified in this study.

2.1 Diffusion of Innovation

Diffusion of innovation and technology constitutes the key theoretical framework of the study. This section therefore appraises studies on diffusion, transfer and dissemination of technologies and innovations. As discussed under Section 1.8 under the theoretical framework theme, the study falls under translational research, which denotes a study that looks at how evidence-based interventions, practices, innovations and programs can best be communicated for adaptation by intermediaries, communities and program staff for the benefit of their constituents (Dearing and Meyer, 2006). It is in this respect that this study substantiates on how the sustainability interventions in food, water and energy together with the cooperative business model implemented in the Tshwane Food and Energy Centre (TFEC) could be communicated and diffused for potential adoption and adaptation in kwaSwayimane.

The process of diffusion and adoption of new innovations has been extensively studied and the most widely used theoretical model is the one conceptualised by Rogers in his famous book, 'Diffusion of Innovation' (Rogers, 2003; Sahin, 2006). Dearing and Meyer (2006) refer to this model as the *traditional approach* in the understanding of diffusion innovation. Alternative approaches to the traditional model include the trading perspective on diffusion (Hippel, 1987), technology transfer model (Bozeman, 2000), evolutionary perspective on diffusion (Douthwaite *et al.,* 2002), rhetorical perspective on diffusion (Green, 2004), decentralised and hybrid-orientated diffusion (Dearing and Meyer, 2006) and dissemination science (Dearing, 2008). The trading perspective on diffusion was first developed by von Hippel (1987), and subsequently refined by Carter (1989) and Schrader (1991). They refer to this model as the 'know-how trading' between two or more professionals (engineers) or members of a network.

This is the enactment of social capital, whereby adopters access information through extant relational contacts, on a need-to-know basis.

The theoretic importance of the trading perspective is its evidence of asynchronous reciprocity (Schrader, 1991); that actors play the roles of sources and receivers at different times, according to the interpersonal request and supply for innovations. The implicit promise of engaging in exchange networks is the attendant obligation for reciprocal behaviour, a strongly felt norm deriving from informal and tacit agreement (*ibid*). This sense of obligation, of sisterhood, or brotherhood facilitates bilateral diffusion, not just from A to B but from B to C to A. The informality, multiplicity, and strength of interpersonal work-based relationships means that the high value information usually required for successful technology transfer - tacit knowledge - is precisely the type of knowledge that know-how trading facilitates (Carter, 1989). The trading perspective on diffusion is about the creation and maintaining of important relationships in order to facilitate knowledge sharing and subsequently diffusion of the prioritised innovations. This model therefore argues that relationships facilitate and drive the spread of the desired innovations.

In his study on domestic technology transfer from universities and government laboratories, Bozeman (2000: 629) defines technology transfer as the "movement of know-how, technical knowledge or technology from one organisation setting to another". The term has also been applied to explain and analyse a wide range of organisational and institutional interactions involving some form of technology related exchange. Rogers and Shoemakers (1971) link the term to innovation and diffusion, while to an extent that Rogers (2003) uses technology transfer almost interchangeably with innovation diffusion. Bozeman (2000) describes five determinants of effectiveness in technology transfer. The first one is the characteristics of the transfer agent, for instance, how does the institutional culture of university or government laboratory affect its ability to conduct technology transfer, would be a question pertinent to this determinant. Characteristics of the transfer media is the second determinant. This is similar to the communication channels in Rogers (2003) traditional model. The third determinant is the characteristics of the transfer object. He argues that transfer of tacit knowledge has major impact on the effectiveness of technology transfer (*ibid*.). In addition, the study proposed that knowledge transfer must precede technology transfer because the acquired knowledge should inform and guide the understanding and implementation of the technology. In line with this, this study recommends that "how-to" and "innovation knowledge" must be transferred/diffused first before trialling/piloting the innovation in kwaSwayimane. The fourth and fifth

determinants are the characteristics of the demand environment and characteristics of the transfer recipient, respectively. In the context of this study, the characteristics of the demand environment would include socio-economic status, current farming, energy and water practices. While the characteristics of the transfer recipient would be concerned with whether host recipient is a community, government agency, NGO or a private-sector business operation.

Douthwaite *et al* (2002) studied what agricultural adopters did with six post-harvest technologies in the Philippines and Vietnam. In a cross-case analysis they concluded that learning and cycles of adaptation characterised how adopters interacted with technologies as a result of their social and work environments. Their study argues that the key force in the evolutionary perspective model of diffusion that determines the adaptations that adopters make to innovations is the context/environment, which both enables and constrains the prosperity of any one "species" or innovative solution. Adopters change or adapt innovations to exploit a perceived niche in which they want to operate. In other words, evolutionary perspective on diffusion is about adjusting the innovation's immediate context fit so that an opportunity made possible by the environment can be exploited.

As an example in the context of this study, this would mean that kwaSwayimane needs to assess the suitable crops and livestock for their environment, rather than copying exactly the ones produced at the TFEC. The same applies to the sources of renewable energy and water practices. Dearing and Meyer (2006) argue for the decentralised diffusion theory which differs slightly with the evolutionary model even though sharing several principles. This includes innovation adaption, innovation reinvention and adopters creativity. They argue that such attributes would result in a different and unique innovation compared to the initial general innovation. This process would produce a number of decentralised innovations that can be diffused along separate cycles relative to that of the initial innovation.

Green (2004) conceptualised the rhetorical theory of diffusion for the diffusion of managerial innovations. Based on a number of propositions, he argues that diffusion rates will differ depending on whether justifications for adopting the innovation are based on "pathos" (emotion), "logos" (effectiveness) or "ethos" (norms and molarity) (*ibid*. : 659,660). Pathos-based appeals, he argued, would result in rapid diffusion and rapid discontinuance while logos appeals would most likely lead to moderately rapid diffusion and moderately rapid discontinuance. Ethos appeals would be characterised by slow uptake and gradual discontinuance. The study reasoned that by combining the three types of justifications in this

sequence (pathos arguments, then logos arguments, followed by ethos arguments), diffusion would be both accelerated and prolonged. This approach is motivated on the basis that most diffusion models assume that adoption of new practices is driven by intrinsic merits of the innovation and/or characteristics of its potential adopters. Furthermore, actors are assumed to adopt new practices based on their effectiveness. He argues that these models underestimate the role of rhetoric in the diffusion process. In addition the study asserts that managers championing the adoption of new practices provide discursive justifications that rationalise and legitimise the new practices (*ibid.*). In a nutshell, Green (2004) posits that justification rationales and processes can drive or hinder diffusion and adoption of an innovation.

This study adopts and focuses on the traditional approach of diffusion of innovation as articulated by Rogers (2003) based on its clearly defined diffusion process in a manner that fits and addresses the needs of this study. Furthermore, the working hypothesis of this study is well categorised under communication channels in the traditional approach. This demonstrates the core relevance of the model towards answering the research question. However, the other four models discussed above will still be used to guide this study where applicable, since they are also relevant to the topic in discussion.

In the traditional model of diffusion of innovation, Rogers (2003:5) defines diffusion as the "process in which an *innovation* is communicated through certain *channels* over *time* among the members of a *social system*" (*my emphasis*). The four elements emphasised above form the main components of diffusion of innovation and are appraised and critiqued in all diffusion research studies and in diffusion programs. Innovations and related communication channels are the fundamental components of this study. The integrated basket of synergetic sustainability interventions in the TFEC (solar PV power plant, biogas plant, rainwater harvesting tanks, groundwater abstraction, solar water heaters, creation of an agricultural village, economies-of-scale and business support hub) constitutes the innovation for this study in line with Rogers' innovation definition - "idea, practice, or project that is perceived as new by an individual or other unit of adoption" (*ibid.* :12). It is on the bases of this integrative meaning/understanding that the sustainability interventions are new to the kwaSwayimane community and therefore qualify to be an innovation in their context.

The manner in which the innovation is diffused is largely dependent on the communication channels that exist between the source/urban and host/rural communities. Therefore, communication channels as the means of sharing information from the urban to the rural

communities in order to exchange innovation knowledge, is the main focus of this study. Rogers (2003: 200) classifies communication channels as “cosmopolite” and “localite”, with cosmopolite channels linking an individual of the social system with/to outside sources. Inversely, localite channels link individuals within the same social system. The former channel-category constitutes the main focus of this study as it links municipalities in two different social-economic systems, the urban and rural communities. While interpersonal channels can be local or cosmopolite, almost all mass media channels can be viewed as cosmopolite. Because of the characteristics of these communication channels, mass media channels and cosmopolite channels are more significant at the knowledge stage and localite channels and interpersonal channels are more important at the persuasion stage of the innovation-decision process (Rogers, 2003). The effectiveness of communication channels is facilitated through partnership and cooperation between actors in the diffusion process.

Rogers (2003) proposed five stages that influence or shape diffusion: knowledge, persuasion, decision, implementation, and confirmation. These stages are assumed to typically follow each other in a time-ordered manner and Rogers refers to the process as innovation-decision process (*ibid.*). This study focuses on the early stage of the innovation-decision process, which is the knowledge stage. During this stage, the individual or potential adopter gets to an understanding of “what the innovation is and how and why it works” (*ibid.*: 21). According to Rogers, the question informs three types of knowledge: (1) awareness-knowledge, (2) how-to-knowledge, and (3) principles-knowledge. This study spans across the three types of knowledge, with a major focus on the awareness and how-to knowledge. The platform for sharing knowledge would be established through the cosmopolite communication channels under a strong partnership between the source and host communities. The persuasion, decision and implementation stages are informed by the effectiveness of the knowledge stage. Furthermore, they can be combined to form the piloting or trialling of innovation. If successful this would be followed by the confirmation stage, meaning full adoption or rollout of the innovation.

Rogers (2003: 232) describes the innovation-diffusion process as an “uncertainty reduction process”, and he proposes attributes of the process that help to decrease uncertainty about the innovation. Attributes of the innovation include five key characteristics which are: relative advantage, compatibility, complexity, trialability, and observability. This study analyses the business model of the sustainability interventions to be diffused in the lens of these attributes in order to form a strong argument for or against the diffusion of the innovation. In addition, Rogers' configuration identifies five adopter categories that indicate the innovativeness of a

social system: innovators, early adopters, early majority, late majority, and laggards (*ibid.* :282-284). The adopter categories are of less interest to this study as the study is limited to communication channels/knowledge sharing and therefore does not extend to the actual adoption phase in the host community. In addition, the adoption stage of innovation is well covered and understood in literature. Inversely, the communication channels and partnership between and within social systems have not been adequately assessed for diffusion of innovation in the diffusion research. Therefore, this study specifically aims to contribute to the vexed issues of communication channels and innovation information sharing with regards to the business model for the sustainability interventions in the agriculture sector.

2.2 Communication Channels in Diffusion

Interpersonal communication and mass media are the main communication channels in the diffusion process (Rogers, 2003). In today's world, information technologies, primarily anchored on the internet, have become a formidable tool in diffusion. Such technologies combine aspects of interpersonal and mass media channels, and they are praised for enabling interactive communication. They therefore constitute a useful resource towards answering the research question which seeks to find out how urban agriculture innovations can be tapped to expedite diffusion of innovation within rural agricultural communities.

However, such channels would need to be embedded within the practice of partnership and cooperation between the two communities. The working hypothesis of the study therefore envisaged a collaborative/twinning approach between the two case study communities, both through joint activities as well as information sharing through online platforms in order to enhance diffusion. Information technology as a communication channel in diffusion of sustainable agricultural practices is not well explored in literature. This study therefore seeks to contribute to this inadequately explored field.

Hyysalo *et al.* (2016) studied the diffusion of consumer innovation in sustainable energy technologies. They examined consumer innovations in ground-source heat pumps, air-source heat pump, wood pellet burning, and solar photovoltaic and solar thermal technologies in Finland from 2005 to 2013. These technologies have all been around for more than three decades and consumers have access to modify them since it is not legally prohibited. They used Finnish online internet discussion forums on renewable energy to identify consumer innovations. Hyysalo *et al.* (2016) bring to the fore that these user-run online forums have evolved into major communication medium among the users of these technologies. They

sampled and stored typical postings in all of the forum sections that they deemed to reveal consumer inventions, most notably the modifications and improvements and technicality. In addition, they conducted 30 – 120 minutes long semi-structured interviews with 47 forum-active inventing consumers and five (5) firms that had collaborated with inventive consumers, focusing on the modifications that these consumers had made and their information-sharing with other consumers and manufacturers. To clarify the diffusion patterns of consumer innovations they used statistical analysis where they used the results of expert evaluations for predicting whether a given consumer innovation should have diffused. Based on prior literature they formulated seven hypotheses regarding the associations between estimated and actual diffusion and examined them through cross-tabulations, bivariate analyses and multivariate analyses. Both predicted and actual diffusion were measured with ordinal scales, but because of a heavy non-detection bias these were simplified to a binary value in terms of: no diffusion or diffusion for purposes of statistical analyses.

In order to understand the diffusion mechanisms, we need to first understand how adopters can learn about the innovation - in other words the interaction arenas through which the originator of an innovation and its potential adopters are in contact. In their study (Finnish cases), the contacts between innovating consumers and their peers were sometimes face-to-face but were predominantly mediated by internet-based discussion forums (*ibid.*). In the adaptation, Hyysalo *et al.* (2016) analytically discern three different types of innovation diffusion pathways. The most straightforward is the one where the second (adopting) consumer adds new features to the first consumer's design on adopting it. Some adapting consumers also removed unneeded features and in so doing ended up with further reconfigurations to make the design work. Finally some consumer designs, for instance those that used an entirely different make of donor unit, ended making a series of changes to adapt the original design. They used the term "adaptive diffusion" to describe the adoption of diffusion through adapting it (*ibid.* : 10). This practice is closely linked to the evolutionary perspective of diffusion and the decentralised diffusion models.

In conclusion they argue that adaption increases the adoption of innovation by making it possible to adjust it to the cognitive, social and material needs of the adopter. They also suggested that attention should be given to the form of innovations and the form in which they are communicated to peers, as well as to the form in which these innovations have been adopted or adapted by peers. Lastly, they call for further research towards a better understanding of the range of roles citizens play as intermediaries in sustainability transition, as well as in the overall

dynamics by which the internet as a communication channel allow proliferating technologies to emerge, grow, thrive, or wither. The latter research concern is partially addressed in this study to a small extent because of the time constraint. It is apparent that the whole range of sustainability interventions in the TFEC cannot be copied and pasted to kwaSwayimane due to environmental, socio-economic and budget constraints as well as related source-versus-host differences. However, this study argues that adaptive diffusion through a pilot stage can be explored in order to allow insights on adaptation priorities/approaches to emerge and hence guide the full-scale implementation/roll-out stage.

Apart from the communication channel/media, innovation can also be communicated through opinion leaders, change agencies, extension agencies, intermediaries and hubs. Feder and Savastano (2005) argue that opinion leaders often have status, expertise, links to external sources of knowledge, or experience that enable them to provide information and advice about diverse innovations to others within their community. Such leadership is therefore reflected in the ability to influence the attitudes and knowledge of others. Tuan *et al.* (2010) studied the role of change-agents/agencies and opinion leaders in the diffusion of agricultural technologies in Vietnam and found that the concerted action and effort of change agencies and opinion leaders led to a successful diffusion of the innovation technologies by sharing and distributing knowledge as well as encouraging the actual adoption of the innovations.

Agricultural extension is one of the most used technic to diffuse agricultural knowledge and skills, especially to/with rural farmers. Altelb *et al.* (2015: 500) define such extension as an "educational process for farmers aimed at the development of agricultural skills and knowledge, as well as to increase agricultural production in quantity and quality". It also involves the transfer of agricultural technologies to farmers and persuading them to adopt improved agricultural technique practices. Howells (2006) uses the term "intermediaries" to define the third party (intermediation) that could get involved in the diffusion process. The main functions that they perform include information-scanning/gathering and communication functions.

Effectiveness of communication of innovation is also influenced by the social network. For instance, Feder and Savastano (2005) showed that communication and information relating to new knowledge is embedded within the general fabric of social interactions among individuals. The pattern of information flow transmitted and received by individuals is therefore related to their social environment, the network of their contacts, and their status within that network.

Tuan *et al.* (2010) argue that without a good understanding of how an innovation and its users interact in their own context before and during an innovation process, an attempt to transfer an innovation to the target adopters would be likely to fail. This sentiment demonstrates the importance of networks, partnership and collaboration in sharing knowledge and skills for the purpose of diffusion. Tuan *et al.* (2010) further found that high level of technical support and the continuous commitment from the national and international networks played an important role in providing a strong platform for innovation diffusion.

In general, there is a growing consensus on the fundamental role of social networks in the way information reaches consumers, channel member, potential adopters and suppliers. Goldenberg *et al.* (2009) investigated the role of social hubs (that is people with a number of ties to other people) in the innovation diffusion and adoption process and concluded that such hubs adopt innovations sooner than other people not because they are innovative but rather because they are exposed earlier to an innovation as a result of their multiple social links. In addition, these social links foster learning from each other mainly through peer-influence as well as knowledge and skills transfer.

When Xiong *et al*. (2016) examined the peer effects in the diffusion of innovations, they found that information transmission, experience sharing and externalities are the basic mechanisms through which peer effects occur. Furthermore, they termed the effects as information-effects, experience-effects and externality-effects, respectively where peer effect is simply defined as the various influences on taking specific action that an individual receives from other individuals in the same network (*ibid.*). This definition can be extended to include social learning, whereby individuals learn from their neighbours' experience in order to achieve a better-informed adoption decision.

Minh *et al.* (2011) identified three main mechanisms of innovation diffusion (namely the "trickle-down mechanism", the "ripple mechanism" and the "network mechanism") with related underlying communication models of *transmission*, *interpersonal communication* and *social network*, respectively. The trickle-down mechanism is a quantity oriented approach employed mainly by the formal extension system which includes public organizations at central, provincial, district and communal levels (*ibid.*). It is assumed that through, this mechanism innovation is developed and transferred following the principles of a linear vertical model and trickling down from the target groups of medium-income and better-off households to other groups of farmers. By contrast, the ripple mechanism is a more quality-oriented

approach to promoting indigenous knowledge and its integration with other knowledge domains, and is mainly employed by international development projects and NGOs (*ibid.*). The ripple mechanism follows a more or less participatory approach to innovation development and transfer, by which innovations are developed and diffused outward from the core area, i.e. the farmer groups or villages specifically targeted under the initial/foundation stages of a development program.

Innovations are developed through the process of knowledge exchange among farmers and between internal and external sources. Knowledge spreads outward from the core target groups to other individuals in the same communities and to other communities through strategic use of farmer-to-farmer exchange. This diffusion mechanism has proved its potential as a communication approach capable of enhancing farmers' knowledge and self-esteem, strengthening social networks, and improving the appropriateness and adoption of innovations (Minh *et al.*, 2011). The network mechanism is the main mechanism for diffusing innovations developed by farmers. It is based on individuals' self-motivation to develop and adopt innovations in order to serve particular needs or to solve certain problems at an individual level (*ibid.*). In the network mechanism, successful farmers develop innovations that are diffused by interpersonal and community communication networks. In many cases, an innovation is spread in communities through the interpersonal communication channel between early adopters and potential adopters, while in other cases, innovation is diffused first from observations made by the potential adopters and additionally by interpersonal communication with previous adopters. The latter mechanism – network – is the most significant to this study, followed by the ripple mechanism while the least important is the trickle-down mechanism.

2.3 Sustainable Agriculture

Sustainable agriculture is established on a "delicate balance of maximising crop (and livestock) productivity and maintaining economic stability, while minimising the utilisation of finite natural resources and detrimental environmental impacts" (Chel and Kaushik, 2011: 92). Sustainable Development Solutions Network (SDSN) uses the term sustainable agricultural intensification to refer to the efficient production of agricultural produce in a manner that protects and improves the natural environment, the socio-economic conditions of farmers, their employees and local communities and safeguards the health and welfare of farmed species (*ibid.*, 2013: 16). In advancing sustainable agriculture, Pretty (2008) calls for the development of agricultural practices and technologies that are environmentally friendly, accessible and

effective for farmers, improves food productivity, and have positive side effects on environmental goods and services. The TFEC is a good example of innovations for sustainable agriculture in that it pursues agricultural produce using renewable energy (solar energy and biogas), rainwater and groundwater, which demonstrate protection of finite recourses. Furthermore, it improves the socio-economic conditions of farmers and communities by providing business opportunities, jobs and food security. It is for these reasons that the TFEC project can be classified as an innovative sustainable agriculture practice project and is therefore prioritised as a case study which the kwaSwayimane rural community can learn from.

While conventional/commercial-driven agriculture has proven highly productive at a large-scale (mass-production), it has simultaneously generated environmental and social impacts of global concern. These ecological impacts include significant greenhouse gas emissions, loss of biodiversity (especially due to deforestation), widespread pollution due to the heavy dependency on fertilisers and pesticides, soil loss and degradation, decline of pollinators, as well as human health risks, among many others. A rapidly growing body of studies, however, suggest that farming systems designed and managed according to ecological principles can meet the food needs of society while mitigating these pressing environmental and social impacts. DeLonge *et al.* (2016) for example argue that farms and ranches based on agro-ecological farming systems (the application of ecological principles to the design and management of agricultural ecosystems) have achieved high levels of environmental performance and productivity while also meeting the targeted food yields. The principle of the agro-ecological strategy is to build innovative technical scenarios relying on biological regulations in an integrated crop production scheme. This strategy involves applying ecological concepts and principles to the design, development and management of sustainable agricultural systems (Lichtfouse *et al.,* 2010). Promoting biodiversity in agro-systems provides ecological services such as nutrient cycling, soil structuration and disease control. Biodiversity can be enhanced by cultural practices such as intercropping, rotation, agroforestry, composting and green manuring. Increasing biodiversity through crop rotations (combination in time), inter-cropping (combination in space) and varietal mixtures has been suggested as an alternative to chemical-intensive practices (Lichtfouse *et al.,* 2010).

Using empirical evidence, Pretty (2008) shows that successful sustainable-agriculture initiatives and projects arise from shifts in the factors of agricultural production (e.g. from use of fertilisers to nitrogen-fixing legumes; from pesticides to emphasis on natural enemies; from ploughing to zero-tillage). He also emphasises the potential benefits that arise from making the

best use of genotypes of crops and animals and their agro-ecological management. According to Menalled *et al.* (2008), sustainable agriculture aims at maximising many ecosystem services including yields, clean water and air, the presence of wildlife and other organisms valued by society, carbon sequestration, and recreation. Clearly, these goals can compete with each other at times. Thus, achieving sustainable agriculture would, in reality, be considered an optimisation process that engages all participants including farmers, labourers, policy makers, retailers, consumers and researchers.

The road to sustainable agriculture is long and complex. Each farm represents a unique combination of biological, climatic, soil and management conditions such that no single "silver bullet" exists to secure sustainability. However, there are principles that can help farmers move in the direction of more sustainable agro-ecosystems. Among the principles, Menalled *et al.* (2008), propose the following: reduce or eliminate tillage in a manner consistent with effective weed control; diversify (your) farming enterprise in order to spread agronomic and economic risk; rotate crops in order to enhance yields and facilitate pest management; use cover crops and green manure and/or animal manure in order to re-build soil quality and fertility; protect water quality; develop ecologically-based pest management programs; integrate crop and livestock production; and increase energy efficiency in production and food distribution.

Wani (2007) adds that various microbial processes encompassed in the soil-root interface (rhizosphere) can be exploited as an alternative to chemical phosphatic fertilisers. These microorganisms colonise the rhizosphere and are actively engaged in phosphorus transformation in soil and they transport phosphate to the plants. The use of phosphate-solubilising organisms in agronomic practices is discussed here for several reasons. For example, the organisms improve soil fertility through their sustained activities in the soil, increase plant growth and crop yield through increased nutrient availability, do not cause environmental pollution, improve soil health and conditioning, protect plants against some soil borne pathogens and involve low-cost technology for their production with a high cost-benefit ratio (*ibid*).

Blignaut *et al.* (2014: 7) advocate for what they call the most sustainable form of an agriculture production system – "Organic Conservation Agriculture" (OCA). This farming system applies three simultaneous principles and these are minimum disturbance of the soil, year round soil cover, and sound crop rotations including legumes. Blignaut *et al*. (2014) argue that to achieve an OCA system several milestones should be reached. These include the reduction in use of

artificial inputs, increased adoption of biological farming principles, and inclusion of cover and legume crops. The inclusion of legumes and cover crops into the crop rotation is beneficial not only towards increased environmental quality, but also for increased net returns and a decrease in the use of synthetic fertiliser. OCA incorporates management tools like precision farming, integrated pest management, improving soil quality by balancing soil attributes through soil nutrient corrections, and promoting biological regulation functions for increased soil fertility and improved weed control (*ibid*). By integrating OCA at the heart of sustainable agriculture, it also automatically incentivises for low external inputs practices/principles as well as cutting out synthetic inputs (especially petrochemicals) where possible and thus moving towards practices based on healthy balanced soils. OCA is therefore not an alternative to sustainable agriculture but rather a key component of it.

Other systematically studied approaches to sustainable agriculture include agro-ecological systems, organic farming, biodynamic, permaculture, and low-input practices (Pretty and Hine, 2001). Agro-ecology farming systems have been discussed in one of the above paragraphs, therefore it would not be repeated here. Organic farming system is primarily aimed at cultivating the land and raising crops in a way that keep the soil fertile and productive by using organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilisers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment (*ibid.*). Biodynamic farming mimics the biodiversity of natural ecosystems towards amplifying the health and resilience of the farm organisms (*ibid*). Permaculture is a system of agricultural and social principles centred on simulating or directly utilising the patterns and features observed in natural ecosystem. Low-input sustainable agriculture strives to minimise off-farm inputs such as fertiliser and pesticides and maximise on the highest levels of efficiency of on-farm resources such as manure and cover crops. All the types of sustainable agriculture are generally concerned with protection/conservation of the environment while improving the livelihood of farmers/people through high production and revenues. This study therefore focuses on the general definition of sustainable agriculture that broadly addresses environmental concerns, economic optimisation for improved livelihoods and improvements in social-cohesion.

The mitigation of fossil-fuel based energy consumption in agriculture is a worldwide concern especially due to the adverse effects of CO_2 emissions of such fuels when generally used as energy source for various applications in agriculture and agro-processing with water heating, groundwater pumping for irrigation and transportation as examples. With the increasing

awareness of climate change and food shortage, sustainable agricultural has emerged as a key societal goal to be pursued by all involved across the comprehensive value-chain of our food systems. Chel and Kaushik (2011) discuss five principles of sustainable agricultural systems which are (1) prudent use of renewable and/or recyclable resources; (2) protects the integrity of natural systems so that natural resources are continually regenerated; (3) improves the quality of life of individuals and communities; (4) produces profitable agri-products; and (5) protects the ecosystem and biodiversity by considering the long-term good of all members in the ecosystem. The scope of this study covers the first four principles. For instance, the TFEC case study uses the biogas plant to provide electricity and pump groundwater for irrigation and domestic consumption. The harnessing of renewable energy systems in agriculture allows for "clean energy farming" practices (Chel and Kaushik, 2011: 110). This is an important advantage of the TFEC as it also uses solar technologies to generate energy for the farming operations.

Sustainable Development Solutions Network (2013) argues that food, energy and water are important aspect of sustainable development. Ozturk (2017) examined the dynamic linkages between agricultural sustainability and food-energy-water nexus on poverty in six selected sub-Saharan African countries, namely Botswana, Ethiopia, Kenya, South Africa, Sudan and Senegal over the period between 1980 and 2013. He investigated the impact of agricultural growth factors and environmental sustainability on food poverty indicators, energy poverty indicator, and water poverty indicators, in a panel of selected countries. The study used six response variables (dependent variables), including three food poverty indicators, one energy poverty indicator, and two water poverty indicators that were separately regressed with the set of explanatory variables in the panel of the six case study countries (*ibid.*). For food poverty indicators he used depth of deficit, per capita household expenditure, and prevalence of undernourished population; for energy poverty indicators he used population without access to electricity; for water poverty indicators he used population without access to sanitation facility and water resources; and for agricultural sustainability indicators he used agriculture-value added, cereal yield and forest area. These variables were selected because of their broader coverage of food, energy, water poverty and agricultural sustainability indicators in a region. Lastly, for the explanatory variables he used CO_2 emissions, fossil fuel energy consumption, GDP per capita and inflation as well as consumer prices to measure growth and environmental reform in the region.

The study observed the following: water poverty indicator increases substantially with an increase in agricultural value added on the cost of environmental degradation. The cereal yields, forest area, and economic growth tend to show a negative association with water poverty, while higher prices are associated with increasing water poverty. Energy poverty significantly decreases agricultural sustainability indicators and economic growth in the region. Agricultural-value added, forest area, carbon dioxide emissions, and fossil fuel energy consumption significantly decrease along with an increase in the food poverty indicators. Inflation and economic growth exhibit a positive relationship with the food poverty indicators in the region. Water poverty significantly decreases agricultural-value added, cereal yields, and economic growth, while it tends to increase carbon dioxide emissions, fossil-fuel energy consumption, and inflation. Energy poverty significantly decreases agricultural sustainability indicators and the economic growth, while it increases the price level across countries.

The study then concluded that for a greater reduction in the food-energy-water poverty nexus, there is substantial requirement to increase agricultural sustainability in sub-Saharan African countries. Furthermore, he argues that food-energy-water resources are the fundamental right for all human beings, i.e., modern food-production techniques, an energy mix, and water productivity are prerequisites for agricultural sustainability across the globe. The energy poverty indicator hinders agricultural sustainability that in turn is linked with water resources needed to provide foodstuff to the common people. This conclusion is in line with the argument of this study which argues that sustainable agriculture is required for food security and socio-economic development (overall improvements on livelihoods and quality of life) of the kwaSwayimane rural community and thus constitutes the rationale of exploring the means of diffusion of sustainable agricultural practices from urban (TFEC) to rural community.

2.4 Cooperative Business Model

Before discussing the innovative cooperative business model, this section initially conceptualises a “business model” in its general form. Braccini *et al.* (2012) define a business model as a conceptual tool that is used to draw together the logic behind a business enterprise that defines how it will create value for its customers, profit for its shareholders, and how it will allocate key resources and employ processes to achieve its purpose. Mazzarol (2009) discusses four key building blocks of a business model which are: the products/services that are being offered including the target market and how these products/services make a competitive value proposition to the customers. Then there is the way in which the firm

interfaces with the market, including channels of distribution, relationships it builds with customers, and how the firm's resources are configured to provide value. Also important is the way in which the business configures its resources and competencies to execute the business model and how it leverages networks with alliance partners in order to add value or gain a competitive edge. Finally, there are the financial aspects of the business model, including the cost structure of the enterprise and how it will generate revenues to meet costs and achieve profit targets (*ibid*).

As a business model, the cooperative model has a different strategic purpose compared to the conventional investor-owned business model. Cooperatives focus on maximising member benefits rather than maximising shareholders' return. According to McDonnell *et al.* (2012), member benefits can be defined in economic, environmental, social and psychological terms; they are usually a mix of these for most members. In addition, cooperatives seek to target the greatest areas of member needs rather than the most lucrative market opportunities. The most widely used definition of cooperatives is the one provided by the International Cooperative Alliance, which defines cooperatives as "business owned and run by and for its members" (Petersen Jr., 2016). Whether the members are the customers, employees or residents they have an equal say in what the business does and a share in its profits. The International Cooperative Alliance established seven cooperative principles that are widely cited as norms and values of the configuration of cooperatives (Mazzarol, 2009; McDonnell *et al.*, 2012; Egziena *et* al., 2014; Petersen Jr., 2016) which are voluntary and open membership; democratic member control; member economic participation; autonomy and independence; education, training and information; cooperation among cooperatives; and concern for community. Central to a cooperative business model are the principles of cooperation.

While the business model of cooperative is clearly different from that of the investor-owned enterprises, there are many different types of cooperative business models. Nilsson (1999) identified four generic types or models which are the traditional, participatory, subsidy and new generation cooperative. The traditional cooperative model is the one described above, which involves open ownership and free membership entry (Nilsson, 1999). Ownership is collective in nature and adheres to the principle of "one-member-one-vote". Share capital is not traded and members cannot realise changes in the value of their shares. There is no external control over the cooperative and any profits are not paid to members as dividends but as a patronage refund based on their use. Such cooperatives generally do not have professional management. The participation cooperative has both members and shareholding investors

(Nilsson, 1999). This allows non-patrons to hold shares, typically in the form of B-shares or certificates. Purchase of shares is voluntary but the cooperative can restrict ownership to specific parties such as members, employees, other cooperatives or local citizens. Shares are tradable and can accumulate value and investors may have voting rights. This creates two classes of stakeholder, the members who benefit from their patronage of the cooperative and investors who earn dividends or capital gains from their shares. While not all cooperatives of this kind have professional managers it is more likely given the existence of investors.

The subsidiary cooperative involves the operation of a large or small part of the enterprise via subsidiaries owned by third parties (Nilsson, 1999). There can be external ownership of shares which can be traded on secondary markets and earn capital gain. These external equity owners are usually granted voting rights on the Board and at the Annual General Meetings. Any profits are distributed in part to the members via the cooperative and to the external shareholders on the basis of their equity control. Such a cooperative can raise external financial capital more easily. It will also have professional management in order to satisfy the interests of its investors.

In the new generation cooperative model, the membership is not open and is usually restricted to individuals who have bought trading rights with the cooperative (Nilsson, 1999). All shares are fully tradable and can realise capital gains over time. Voting is equally distributed but can also be based on equity control. Members make the key decisions but there can be some limited involvement by minority external shareholders. A strict proportional relationship exists between members' investment and members' patronage as specified in contracts. Profits are distributed as patronage refunds, but work like conventional shares with returns based on level of investment. Member contract rights and shares are fully tradable and individual in ownership. Such cooperatives have fully professional management teams.

McDonnell *et al*. (2012) describe four general types of cooperative enterprises based on membership class involved. For instance, producer type is made up of members who are producers of goods/services. Many agricultural cooperatives adopt this model as it allows small-scale producers to achieve economies-of-scale benefits and strength in numbers (Petersen Jr., 2016). The TFEC is a good example of a producer cooperative made of agricultural producers of products such as vegetables and chicken. Consumer type of cooperatives involve members being the customers of the enterprise's goods/services. This model has traditionally being adopted by retail, financial and housing cooperatives (Petersen

Jr., 2016). In the worker cooperative, the members are the employees of the business. Lastly, hybrid type of cooperative has more than one membership class such as consumer and worker.

Agriculture sector is one of the economic-sectors that have substantially adopted a cooperative business model in order to bridge the gap between the formal and informal economic activities (Petersen Jr., 2016). A review of the international literature relating to agricultural cooperatives undertaken by Krivokapic-Skoko (2002 cited in Mazzarol, 2009: 40) found that main benefits identified by members could be grouped into at least five key areas. The first area is market access and market risk reduction. Members join agricultural cooperatives in order to gain access to value-added markets, or to establish a local market for their produce. The second area is financial benefits from enhanced pricing. Members benefit from better financial deals (low input costs collectively pursued through price discounts) and strengthened bargaining power so as to secure premium prices for their produce. They also seek access to better services via the cooperative.

The third benefit is improved productivity where members seek/pursue enhanced productivity through the pooling of marketing resources and bulk purchasing. This could provide access to more value added services, as well as increasing farm income, efficiency and productivity. The fourth area is access to resources. In particular, cooperatives offer invaluable access to enhanced information, knowledge and related resources. This might include access to new technology for the farm, or improved networking in order to help raise individual member's circle of information sources.

The fifth and last area is community building. Cooperative-membership also offer a greater opportunity to develop the local community and engage in self-help. Collaboration via the cooperative could provide new services to the community and increase the benefits to members. A cooperative business model is therefore an entity that seeks to generate benefits to its members in the form of enhanced access to markets or to goods and services. It is also designed to offer its members financial benefits through improved pricing and to achieve increased productivity from greater economies of scale and scope. A cooperative model should also improve its members' access to knowledge and information as well as making a significant contribution to the local community in which it is based.

In the TFEC cooperative business model, economies-of-scale benefits were meant to be achieved through cooperative-based ownership of and access to an abattoir, hatchery, vegetable processing, seedling production, crop farming and feed-mill facilities. These equipment and

facilities were also meant for improving value of the produce, provide members an opportunity to participate in the whole value-chain in order to gain access to value-added markets. In addition, the "central farm" element of the TFEC cooperative business model was established for coordination of agricultural activities. This includes coordinating the purchase of farm inputs (seedlings, chicks, compost etc.). Once outputs (chicken and vegetables) are ready for market, central farm was/is meant to organise slaughtering, packaging, storage and transportation as well as to coordinate sales and offtake agreements. The central farm was also meant to operate as a business support hub delivering agricultural extension services/support to the 25 small-scale farmers who are members of the cooperative. Among other things, extension services included marketing of produce; membership training, capacity building, mentorship and information/knowledge sharing. The presence of the multi-activity central farm in a cooperative business model added an innovative element to the general model thereby mitigating the risks of economic failure by achieving economies-of-scale through the hub as a scale-building structure/anchor.

Even though cooperative model is based on fairness, democracy and equity and it also has a global track record in helping communities become sustainable and achieve more equitable distribution of benefits (McDonnell *et al*., (2012), it has its own challenges that entail model-failure risk if not properly mitigated. The most common model weakness is the lack of common interest among what is often a "highly heterogeneous membership" (Mazzarol, 2009: 41). Because so many cooperatives involve a collective of smaller entities (e.g. farm business units) that operate independently of each other, it is usually impossible for the cooperative to leverage fully the potential synergies of the collective membership (*ibid*). The heterogeneity in membership can arise because of the lack of clear common goals, lack of commitment, lack of participation, poor communication, poorly managed personalities, and incompetence/inadequately-capacitated management/leadership.

Mazzarol (2009) further argues that cooperatives suffer from three key weaknesses and therefore need several solutions to overcome their weaknesses. Firstly, a cooperative is owned by its members who also use it as patrons. Second, the benefits to members are based largely on patronage rather than investment returns as in the case of conventional investor-owned enterprises. Third, the cooperative enterprise is controlled by those who also are its suppliers or customers. In consolidation, it can therefore be argued that, as a business model, the cooperative is not without key weak points to be systematically addressed. But all the same, it is a valid business model where, in specific circumstances, and with competent management

as well as the ability to maintain the support of its members, it can be highly successful. Cooperatives have been viewed as offering a "third way" between government control and free market capitalism (*ibid*).

In anticipation of some common challenges of a cooperative business model, the City of Tshwane (as the administrator/custodian of the TFEC project) directly selected the beneficiaries or cooperative-members in order to pilot the cooperative business model using sustainable agriculture. This allowed the City of Tshwane to use certain selection criteria (such as level of agricultural knowledge, socio-economic status, gender and age) which it deemed important for the selection of cooperative-members. As much as this was a good approach, at a later stage most members lost vision of the common/long-term interests and were not equally committed to the project, thus resulting in 18 cooperative-members quitting the project. Other contributing factors to members quitting included project challenges such as premature (unexpected/sudden) withdrawal of municipal support, impairment of security system, dysfunctional electricity and resultant absence of water which made farming difficult.

In a traditional farming cooperative business model operating in Johannesburg, farmers own and jointly farm on the same plot which presents problems such as some members working harder while others are lazy, logistic/transport challenges become excuses, and common personality conflicts which can escalate to a crisis point (Twalo, 2012). Learning from these joint farming challenges, the TFEC cooperative business model allocated each farmer/cooperative-member a vegetable tunnel/greenhouse, chicken coop, and an on-site dwelling unit which is equipped with rainwater harvesting tank, solar water heater and bio-septic tank.

Cooperative-members own and work their individual plots separately and at their own schedule. However, they buy inputs and sell their produce together through the central farm in order to benefit from economies-of-scale such as bulk buying and discounts. The innovative TFEC cooperative business model where farmers work separately and procure inputs and market their produce together is based on the successful Danish cooperative model which eliminates the problems of infighting over profits and free-ridership that is common in the traditional cooperative such as the one for the Johannesburg case.

Tefera *et al*. (2017) investigated the evolution, functionality and impact of agricultural cooperatives in Ethiopia and noted that one of the key elements of agricultural transformation towards more commercial agriculture is that the market mechanism becomes more important

for many aspects of the farming business; not just for selling farm products but also for obtaining proper inputs, credit, equipment and seasonal labour, such that markets become the dominant coordination mechanism. As the cost of using the market mechanism is relatively high for smallholders, collective action may be a beneficial strategy for realising economies-of-scale and scope (*ibid*). Providing inputs like fertilisers, feed, agrochemicals and seeds has traditionally been one of the main economic functions of agricultural cooperatives. They facilitate farmers' access to inputs through bulk purchase at lower prices (bargaining for higher discounts) and even potentially through affiliation with other cooperatives. Given that physical availability of inputs is often an important constraint to access, with thin and unreliable rural distribution networks in most African countries, Tefera *et al*. (2017) claim that cooperatives act as a vehicle for input distribution and emphasise the effectiveness of cooperatives in coordinating the provision of related services to smallholder farmers.

Many empirical studies on African agrifood markets have shown that high transaction costs are a serious constraint on smallholders' market participation (Tefera *et al*., 2017). These transaction costs result from the small size of the farm, lack of market information, weak bargaining position and perishability of many agricultural products. Collective action through structures or entities such as producer cooperatives allows smallholders to pool resources to mitigate the risks related to asset specificity, to realise economies-of-scale benefits and to gain countervailing power in sales transactions. This problem of transaction costs in selling farm products is even more critical in modern (or high value) supply chains. When the quality requirements go up and additional investments in quality improving assets and activities are needed, farmers' vulnerability to market risks increases. For many farmers, this development towards more strictly coordinated value-chains is an incentive to set up collective action organisations.

Tefera *et al*. (2017) found that cooperatives are successful in improving countervailing power and linking smallholders to modern value-chains. Improving smallholder agriculture productivity is important for enhancing farmer livelihood, reducing rural poverty and increasing food security. Through cooperatives, smallholders may obtain inputs, adopt new agricultural technologies, access technical assistance and have access to output market. Cooperatives can also provide credit services to member-farmers which thus eases production constraints. This has comprehensively led to the claim that cooperatives have a positive impact on farm incomes in particular and on food security in general.

Tefera *et al*. (2017) acknowledge that cooperatives face a number of internal and external conditions that make their transformation to more market-oriented businesses a challenging task. External factors are particularly related to a lack of working capital, which leads to delayed payment and reduced member commitment, and a high state interference in the strategic decision making process/outcomes (*ibid.*). Internal challenges relate to poor managerial capabilities and a lack of accountability and transparency (*ibid.*). Twalo (2012) investigated the state of cooperatives in South Africa and specifically noted that there are about 22 030 registered cooperatives of which only 2 644 were confirmed to be operational/active by the Department of Trade and Industry (*ibid*). This is a meagre 12% survival rate which signal challenges in cooperative model application in South Africa. The study argued that the potential of cooperatives towards contributing to the country's challenges of job creation and poverty alleviation are compromised by several internal and external factors which include how they are organised, perceived and managed. The challenges include a lack of capacity (including skills and training) to operate cooperative enterprises efficiently, limited availability of start-up and expansion capital, limited access to markets and information on business opportunities, lack of accountability, lack of commitment, absenteeism and theft (*ibid*).

Egziena *et al.* (2014) conducted a study to assess the extent to which cooperatives in Mekelle City (Ethiopia) adhere to cooperative values and principles; to examine the causes of deviation from the universal cooperative identity; to find out the impact of deviation from cooperative values and principles on the performance of a cooperative business model; and to analyse the implications for future development of cooperatives in Mekelle. The study depended mainly on primary data collected from randomly selected cooperative-members and persons in the management committee of the cooperatives and guided by semi-structured interview schedule. Focus group discussions were also administered to supplement the information obtained from interviews and ensure its adequacy. Open-ended questions were included in the administered questionnaire to capture some of the causes of violating cooperative values and/or principles. Complementary secondary data were also abstracted from the archive documents of the selected cooperatives. The study considered 23 cooperative societies which were selected from three types of cooperatives operating in the city which are service cooperatives, metalwork cooperatives, and construction cooperatives. They were selected on the basis of a proportionate random sampling technique. The collected data were analysed using indices, OLS regression and binomial regression.

The study found that the average adherence for the 23 sampled cooperatives was 89%. This value shows the overall extent to which cooperative values and principles were adhered to. None of the cooperatives managed to record a 100% adherence. Therefore, any percentage less than 100% indicates existence of deviation/non-adherence to certain values and/or principles. Some cooperatives showed a significant deviation from universal cooperative values and principles (as demonstrated by the International Cooperative Alliance) upon which the business model is founded.

Based on the survey findings, the most commonly violated values and principles were solidarity; voluntary and open membership; member economic participation; and education, training and information. The most frequently mentioned reasons for the deviation were: lack of awareness of the characteristic features of cooperatives; lack of member commitment; external interference; low levels of effort made to promote the cooperative; negative/biased perception of cooperatives among the community; excessive promise from the cooperative organisers; membership not based on free will and keen interest; and low support and follow-up by cooperative promoters.

In an attempt to examine the impact of adherence on performance, four variables were used as proxies for performance: capital growth rate, membership growth rate, member satisfaction, and performance. Firstly, the study found that as adherence level increases, capital growth rate (a proxy for performance) also increases. Secondly, it observed that as the cooperative gets older, its capital growth rate decreases and the higher initial capital a cooperative has, the lower its capital growth rate become. Thirdly, it noted that the more cooperative values and principles are adhered to, the better the cooperative performance, which in turn, leads to member satisfaction. Fourthly, the age of the cooperative, age of the members themselves and member patronage have a negative impact on member satisfaction levels. The sixth finding was that member duration, member education, chairman's educational level and chairman's year of experience have a positive impact on satisfaction. The seventh finding notes that only the chairman's years of experience have a significant positive relationship with membership growth rate. Lastly, their results indicate that as the level of adherence increases, performance increases, and all other independent variables turned out to be insignificant.

The implication of adherence to the universal cooperative values and principles for future development of cooperatives in the study area seems to be straightforward. The study assumed that the development of cooperatives depends on member satisfaction, capital growth,

membership growth, and overall performance of the cooperative under consideration. Figure 6 below depicts the causal relationship among variables that ultimately would have a bearing on future cooperative development and perfomance.

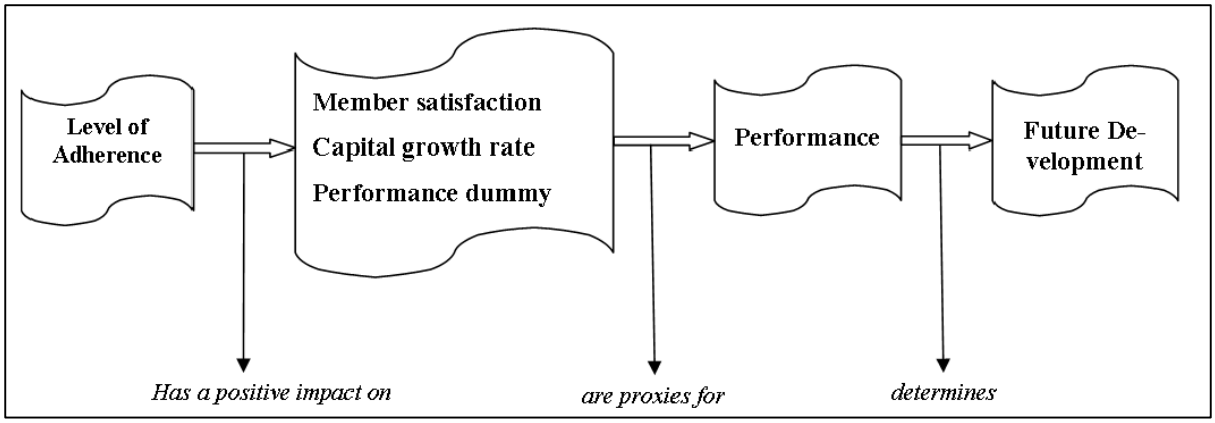

Figure 6. Future implication for cooperative development: Causal relationship among variables (Egziena *et al.*, 2014: 164)

Any variable that has a bearing on the above-mentioned performance factors is therefore likely to determine future cooperative development. As the results above revealed, level of adherence had a significant positive relationship with member-satisfaction, capital growth rate, and performance dummy. By implication, the results show that the stronger the level of adherence of a cooperative to the universal cooperative identity, the better its performance and the more satisfied its members are likely to be. Therefore, the odds are very high that such a cooperative would develop for better in the future if it performing well in the present. The study concluded by advocating for adherence to the values and principles of a cooperative business model, and thus arguing that this would be the first step in mitigating membership divergence-of-interests and related apathy within cooperatives.

2.5 Consolidation and Overall Relevance for the Study

According to the study, the innovation to be diffused is the integrated basket of sustainability interventions and practices as well as the improved economies-of-scale benefits arising from the cooperative business model which has been prototyped/adopted in the TFEC project in pursuit of sustainable agriculture. The appraised studies on a cooperative business model explain how cooperatives maximise member benefits which can be conceptualised in economic, environmental, social and psychological terms. These benefits and advantages include access to market; better financial deals; market risk reduction; improved productivity; and access to resources which are achieved through economies-of-scale. The initial/planned

practices in the TFEC as appraised under Section 4.1, aimed to achieve these benefits through a central farm model of a cooperative business model. Agriculture sector is one of the economic-sectors that have substantially adopted a cooperative business model in order to bridge the gap between the formal and informal economic activities (Petersen Jr., 2016) as well as to pursue sustainable agriculture. The TFEC is a good example of a producer cooperative enterprise which utilises sustainability interventions in order to increase yields and sustain agriculture production.

In the study, sustainable agriculture is understood to mean improving efficiency in agricultural production based on sustainability interventions which protect and improve the natural environment, the socio-economic conditions of farmers, their employees and local communities and safeguard the health and welfare of the farmed species (Sustainable Development Solutions Network, 2013). The commonly understood interventions in sustainable agriculture include practices such as no-till farming, permaculture, ecological farming, biodynamic farming, low-input practices and organic farming. In the context of this study, the focusing of multiple non-agriculture interventions towards facilitating sustained agriculture production is viewed as enhancing sustainable agriculture practice. The non-agriculture interventions are often non-conventional and intentional with a measurable and enduring improvement on the levels of impact on the natural environments or environmental media as its principle objective. Such interventions also seek to use less of the finite natural resources and more of the renewable resources. The initial/planned practices of the TFEC as appraised under Section 4.1 which include biogas energy plant, solar energy plant, solar water heaters, rainwater harvesting system and groundwater abstraction are good examples of non-agriculture sustainability interventions which enhance sustainable agriculture practice.

The appraised studies of innovation diffusion therefore seek to explore how the integrated basket of sustainability interventions and cooperative business model as adopted in the TFEC could be tapped for potential diffusion for kwaSwayimane rural community endowed with land of high-agricultural potential. In the traditional diffusion model, the study is argued to fall under the early stage of the innovation-decision process (the knowledge stage). In addition, the study also cuts across the three types of knowledge fields proposed by Rogers (2003) which are awareness-knowledge, how-to-knowledge and principles-knowledge. This emphasises the importance of knowledge development, knowledge sharing, and training for the hypothesised diffusion process. Therefore, the first stage of the conceptual innovation-diffusion model discussed under Chapter 6 seeks to expedite knowledge development and sharing through

creating partnership and cooperation between the TFEC and kwaSwayimene as well as extending the network to other role players. The diffusion innovation insights from the four selected studies under Chapter 5 also play an important role in conceptualising the hypothesised diffusion process.

From the appraised studies of communication channels which is part of Rogers (2003) innovation diffusion model, it emerged that information technologies, primarily anchored on the internet, have become a formidable tool in diffusion. Such technologies combine aspects of interpersonal and mass media channels, and they are praised for enabling interactive communication. They therefore constitute a useful resource towards answering the research question which seeks to find out how urban agriculture innovations can be tapped to expedite diffusion of innovation within rural agricultural communities. Accordingly, modern communication channels using online platforms are recommended for the diffusion process as the more effective communication channel, because of their ability to enhance instant communication, promote interactive engagements and overcome geographic communication barriers.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter is sub-divided into six main sections which cover the research methodology and data collection as well as data analysis tools which underpin the study. The first section introduces the research methods and approach which are qualitative methods and inductive design approach. The second section focuses on data collection and analysis process with semi-structured interviews, direct observation and archived documents as the key data collection tools. The interview guide questions and direct observation tool for both communities are presented in Appendix B. The third section deals with the specific data needed in order to substantiate on the research sub-questions as well as the overall research question, followed by the fourth section which summarises the data analysis processes. The fifth section appraises the ethical considerations, while the last section covers research methodology limitations.

3.1 Research Methods

This study is based on two purposefully-selected case studies that were analysed through inductive qualitative methods. Yin (1994: 13) defines a case study approach as an "empirical inquiry that investigates a contemporary phenomenon within its real life context". The innovative TFEC was used as a case study in order to understand how its integrated/basket-of-innovations in sustainability interventions and cooperative business model could be diffused to the non-innovating case of kwaSwayimane. The two case studies were compared and cross-analysed (May, 2001). It was therefore imperative to determine the status-quo practices within source versus host communities in order to address the main research question.

According to Creswell (2009), decision to choose a qualitative methodology rather than a quantitative one should be motivated on its suitability towards answering the research questions. For example, qualitative data sources include observation and participation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impression and reactions (*ibid.*). The sources of data chosen for this study were primary and secondary data sources as described in detail under the data collection section. Based on the adopted research design and approach which utilise narrative and picture/object data and the adopted open-ended semi-structured interview guide questions, qualitative research was the most suitable research method for this study.

The research approach adopted is an inductive design which starts with collecting data guided by the theory of innovation diffusion model, rather than the testing of a theory (deductive). This approach allowed the researcher to be a key instrument throughout the research process,

especially by collecting data himself through direct observation, interviewing participants and appraisal of relevant documents (*ibid.*). The philosophical premises underlying the research comes from the interpretive tradition which holds a subjective epistemology perspective and an ontological world-view that reality is socially constructed rather than objective and fixed (*ibid.*). The interpretive paradigm is underpinned by observation and interpretation such that to observe entails the collection of information about the socio-economic and sustainability interventions in the TFEC and kwaSwayimane, while to interpret is to make meaning of what has been observed on both case studies as well as secondary data sources and linking that to how the innovations of the TFEC can be diffused to kwaSwayimane.

3.2 Data Collection and Analysis

The data were collected using three data collection tools which are: semi-structured interviews, direct observation and archived documents for secondary data. These data-tools were chosen because of their suitability towards answering the research sub-questions. The selection of interview participants was planned to be purposeful and guided by commonality of profile, such as demography, success of the farmer and agricultural knowledge. However, the reality on the ground significantly influenced the final choice on who could be interviewed. For example, in the TFEC, only seven beneficiaries are currently working on the project, of which only six were available for the interviews. This happened after 18 of the initial 25 beneficiaries had resigned from the project due to various reasons that could not be identified during data collection.

The interview responses were the primary source of data and took place both in the source and host communities. The interview responses were complemented with data from direct observation of activities and phenomena in their respective contexts/environments. The data from the two processes helped to answer the first research question about the status-quo of agriculture, energy and water practices as well as the business model within both the urban and rural communities.

In the TFEC the project manager was the first interviewee and subsequent to the interview, he provided the researcher with production, literacy and demographic information which served as the criteria to guide the selection of the six farmers interviewed. Unfortunately as already mentioned above, there are only 7 beneficiaries in operation and only six of them were available for interviews. This left the researcher with no choice of selecting the interviewees but to

interview those available. The limitation of time constrained the opportunity to follow-up on those who had left the project in order to gain insight on why they gave up.

On the host community (kwaSwayimane), the manager was the first interviewee and he assisted in selecting seven local farmers/residents to be interviewed on the basis of their farming knowledge/experience, literacy and interest in agriculture. The criteria used were to get gender balance and age representation in the purposely selected sample. It is important to note that the study was unable to determine the number of farmers in the community, because kwaSwayimane Ward 11 is a large community characterised by extensive subsistence and cash-crop farming such that each household partakes in one or both form of activities. Field data collection in the community was further constrained by the limited time the researcher had to conduct the fieldwork component of the study.

Practices/models of innovations-diffusion and technology transfer in various sectors locally and internationally were explored based on secondary data sourced from reported case studies, pilot projects and other innovation diffusion programs. Key secondary data were also extracted from the Integrated Development Plans of the respective municipalities as well as agricultural strategies/plans, journal articles, books, case studies and other documents. The data were then subjected to innovation analysis and interpretation. Insights from practices in diffusion of innovations and technology transfer from various sectors locally and internationally were also derived in order to inform/guide the envisaged diffusion process across the case study communities of the study. The data needs, collection and analysis process of the study are summarised in Table 3 below.

Table 3. Summary of data collection and analysis process in relation to sub-questions

Research sub-question	**Data needed; collection tools and processes**	**Data analysis and processes**
Sub-question 1: What are the status-quo agriculture, energy and water practices within source (urban) versus host (rural) communities?	***Primary Data:*** In order to answer this question, semi-structured interviews were undertaken in both source and host communities. Direct observation also gave experience of the agriculture, water and energy practices as well as the business model in the respective communities. ***Secondary Data:*** Integrated Development Plans (IDP) for both communities were analysed to get insight of the envisaged/planned strategies in agriculture, water, energy and sustainability practices and socio-economic dynamics of the larger context of each community.	Both data sets obtained from the interviews and IDPs were compared and cross-analysed across the two communities with the aim of determining commonalities and differences that can facilitate or hinder the diffusion process.
Sub-question 2: What are the key insights from practices/models of diffusion innovations and technology transfer across various sectors locally and internationally?	***Secondary Data:*** Study of innovation diffusion models and related case studies across the globe is central to this question. Such information was gathered from secondary data, particularly journal articles on report case studies, programmes and related evaluations/assessments of outcomes.	The secondary data were analysed and summed up into key practices that this study needed to learn and draw from in order to conceptualise/hypothesise on the diffusion process across the case study communities for this study.

Sub-question 3: How could insights from models of diffusion innovations and technology transfer inform/guide the hypothesised diffusion process across the case study communities identified for the study?	***Secondary Data:*** This question was addressed through the use of data gathered in sub-question 2, as a result these two questions are addressed under one chapter.	Analyses of the diffusion practices adopted in other projects and case studies across the globe informed, guided and gave direction to the conceptual model that emerges from this study.
Sub-question 4: What would be the conceptual models emerging from the study for recommendation to the various actor-networks hypothesised in this study?	All data collected to this point, both primary and secondary were used to answer this sub-question.	Data were compared and analysed in order to hypothesise on a conceptual model that could be recommended to the various stakeholders identified in study.
Overall research question: How could innovative practices in urban agriculture be tapped to expedite diffusion of innovation for sustainable development for communities within rural areas endowed with land of high-agricultural potential?	By addressing all the sub-questions, the data gathered and the derived sub-findings were consolidated to address the main research question.	

3.3 Data Needed: Collection Tools and Processes

The study required specific data in order to substantiate on the research sub-questions as well as the overall research question. The status-quo sub-question utilised interviews, direct field observations and secondary data. On the TFEC case study, the interviews sought to gather data on agriculture, energy and water practices as well as environmental, social and economic benefits. Data on the former is in the form of what is cultivated, what animal stock is kept, how energy is generated, where water comes from and what the water and energy uses are. This information was conceptualised in terms of vegetable tunnels (greenhouses), chicken farming, crop farming, solar water heaters, solar power plant, biogas plant, groundwater uses and rainwater tanks as the current practices in the TFEC. Information on the latter is in the form of the environmental/sustainability benefits of the agriculture, energy and water practices as well as how these practices improve the economic and social conditions of local communities. This includes data on how many women or men and youth own the farms or are employed, literacy levels, and social benefits of solar water heaters. The study also sought to gather data on the functionality of the vertically integrated business model through a cooperative structure. These data were conceptualised around the central farm functions and cooperative-based ownership/use of processing equipment/facilities, since they provide economies-of-scale benefits and value-adding opportunities.

All the primary data were accompanied by data sourced through direct field observation in order to experience and verify the effectiveness and efficiency of these sustainability interventions as well as the business model. Integrated Development Plan provided secondary data on the context of the agriculture, energy and water practices as well as the socio-economic conditions of the local community.

On the kwaSwayimane case study, the interviews provided data on the prevailing agricultural practices, plan/strategy and challenges; sustainability practices; literacy level; and socio-economic status/condition. Given that there is not much happening in kwaSwayimane in terms of innovative commercial scale agriculture, sustainability interventions or socio-economic empowerment except for subsistence and cash-crop farming, this study hypothesised the diffusion of sustainable agricultural practices using an innovative cooperative business model in order to improve on the lives of kwaSwayimane community. Data on agricultural and socio-economic aspirations were further derived from the Integrated Development Plan and agri-business strategy.

In order to understand practical principles of diffusion of innovation and practices, the study derived and evaluated the principles from various published case studies across several sectors globally. However, the study noted the rich literature/field of diffusion of innovation practices in agricultural innovations, technology innovations, and in the medical practice fields. Most of the sources on diffusion model/practices were therefore purposely selected/identified from these sectors/fields. These kind of data were viewed as secondary data (data collected and reported in other published studies or statistical archives, including peer reviewed journal articles, books, internet and other similar documents). The consolidated data-pool formed the core input towards the derivation of the conceptual model of the study for recommendation to the various stakeholders/actors in the two case studies.

3.4 Data Analysis Processes

Data from the interviews in the two communities were compared and cross-analysed with the aim of determining commonalities and differences that could facilitate or hinder the diffusion process. The study used age range, gender and literacy level to analyse the TFEC project in order to assess if there are any gender-and age-based challenges or socio-economic impacts. Furthermore, secondary data abstracted from published case studies and other documents were analysed and summed up into key diffusion of innovation practices that the study learned and drew from. Analyses of the practices adopted in other projects across the globe informed and guided the conceptual model that emerges from this study. It is the resultant conceptual model that is then recommended to the various actors in both case studies.

3.5 Ethical Considerations

Given the qualitative case-approach of the study, the researcher had to interact deeply with the participants and thus requiring that critical ethics issues be addressed, especially with regard to the following:

- Informed consent (Do participants have full knowledge of their participation?)
- Honesty and trust
- Privacy, confidentiality, and anonymity

Appropriate steps were taken to adhere to strict ethical guidelines in order to uphold participants' privacy, confidentiality, dignity, rights, and anonymity. The researcher informed the participants of the purpose, nature, data collection methods, and extent of the research prior to commencement. In addition, he explained to each participant his/her expected contribution

and obtained their informed consent through signing on consent forms. The information given by the participants has been kept confidential throughout the study process. Furthermore, the information is made anonymous in the report before it is made available to the public through this report and its availability under Wits library services. This ensures that the identity of participants remains anonymous and that participants are not identifiable in the final report. Participants were also assured that the research is strictly for academic purposes and their participation is voluntary. In confirmation of adherence to these ethics commitments, ethic clearance certificate for the study was obtained from the University of the Witwatersrand (see Appendix C).

3.6 Methodology Limitations

This research relied on interviews as one of the primary sources of data which thus entails significant levels of subjectivity. The socio-economic and land-use data available were not detailed for small scale localities, such as wards and community level. The use of the generalised local municipality scale data as secondary data on these factors was therefore critical. The data were extracted from the Integrated Development Plan of the municipalities.

The fact that the researcher interviewed participants from the source and host communities which are geographically far apart (Gauteng and KZN provinces respectively), he encountered financial costs and time constraints which he had to resolve adequately in order to ensure the integrity of the study. Finally, despite this being a public project, access to formal documents and data detailing the TFEC project planning/implementation process could not be granted by the City of Tshwane as the records were deemed/cited not to be the property of the municipality but of the respective parties involved in the business operations.

3.7 Consolidation and Linking Over to the Next Chapter

The primary data were collected using semi-structured interviews and direct observation in both the TFEC and kwaSwayimane communities complemented with archived documents for secondary data. Seven interviews (with the project manager and six beneficiaries) were conducted in the source community while eight (with the agriculture manager and seven farmers) were conducted in the host community. Data collected from the interviews complemented with data from direct observation of activities and phenomena were used towards answering the first research sub-question which seeks to understand the status-quo agriculture, energy and water practices within source versus host communities which is discussed in the next chapter (Chapter 4). Data from the interviews in the two communities

were also compared and cross-analysed with the aim of determining commonalities and differences that could facilitate or hinder the diffusion process. The next chapter discusses in detail the data overview and analysis for the two communities identified in this study.

CHAPTER 4: STATUS-QUO PRACTICES

This chapter presents data capture and analysis as well as derivation of sub-findings for sub-question 1, which addresses the status-quo practices within source versus host communities. The chapter therefore substantiates on the extent/nature of innovation at source and assesses the need or diffusion opportunity at the host community based on two major sections starting with source versus host communities followed by the derivation of sub-findings. Initially, the first section discusses the status-quo agriculture, energy and water practices together with the business model in the TFEC while the second section focuses on kwaSwayimane Ward 11 community. The main sub-findings are that the practices on the ground in the TFEC have deviated from the initial project plan that inspired diffusion of the project's innovation. This is mainly due to implementation challenges experienced during the project implementation stage. On the other hand, another sub-finding confirmed that kwaSwayimane has agriculture potential which is currently utilised for household-based subsistence and cash-crop farming. The availability of productive land motivates for the exploration of new innovative agricultural practices in order to maximise production in an environmentally friendly manner.

4.1 Tshwane Food and Energy Centre

4.1.1 Data Overview

Findings on the status-quo practices in the TFEC were derived on the basis of data collected through interviewing seven participants (the project manager and six beneficiaries) and direct site observation. The demographics of the participants are presented in Table 4. 50% of the interviewed beneficiaries were male and the other 50% were female. Furthermore, the average age of the male beneficiaries is slightly higher than that of their female counterparts (48 and 44 years, respectively). In terms of education level, majority of the female beneficiaries were relatively more educated than their male counterparts. There is a correlation between the age and education level, where the oldest beneficiaries are the least educated. However, despite these demographic differences, all participants had received equal opportunities and support through the project process.

Table 4. Demographics of the participants in the TFEC

Participant	**Gender**	**Age**	**Education level**
Project Manager (PM)	Male	-	-
Beneficiary 1 (B1)	Male	55	Grade 9

Beneficiary 2 (B2)	Male	58	Grade 8
Beneficiary 3 (B3)	Female	39	Grade 12
Beneficiary 4 (B4)	Female	42	Grade 12
Beneficiary 5 (B5)	Female	50	Grade 10
Beneficiary 6 (B6)	Male	32	Grade 12

According to the Project Manager (PM), TFEC aimed to demonstrate practical sustainable agriculture interventions on the land which was/is owned by the City of Tshwane, with beneficiaries leasing their portions (with related infrastructure) from the municipality as one of the project incentives. Basically, the project has five main components that are linked to each other, namely: energy, water, food, housing components and the cooperative business model (see Figure 7). The energy component comprises solar PV and biogas plants which are used to generate electricity to support all the farming and residential activities. However, the former (solar plant) is no longer in operation due to theft of solar panels and cables. The biogas utilises chicken waste as the input to generate electricity and it is the main source of electricity. Any additional electricity needs are achieved through the solar plant which has now been rendered dysfunctional. Subsequent to the theft of solar panels, the biogas generation is insufficient to supply electricity to the farm and the City of Tshwane/ Municipality is negotiating with Eskom to reconnect electricity from the grid.

The water component comprises two boreholes as the primary source of water supply which are supplemented by rainwater harvesting system using jojo storage tanks installed in all the dwelling units. Groundwater from the boreholes is abstracted using electricity generated through renewable energy in order to pump water into two big tanks and then distribute the water to the dwelling units and to the vegetable tunnels for irrigation. However, since this practice is dependent on electricity supplied by the biogas and solar PV plants; the theft of electricity cables and solar panels contributed to dysfunctional electricity system which meant groundwater can no longer be abstracted as originally planned.

The food component includes chicken and vegetable farming. Each beneficiary was allocated a chicken run, vegetable tunnel (greenhouse) and a dwelling place/house of 70 m^2. According to PM, all the 25 beneficiaries have each received 1 000 chicken over 3 cycles, such that each beneficiary has in total received at least 3 000 chicken. Beneficiaries were given an opportunity to also bring their own chicken in order to improve on their revenues.

All beneficiaries also have an opportunity to work on their respective vegetable tunnels and generate some form of income through the sale of vegetables, (the vegetable tunnels serve as greenhouses but constructed with a more affordable technology of steel-framing with heavy duty plastic cover). The dwelling unit is the fourth component and was accompanied by solar water heaters and rainwater harvesting tanks for every beneficiary. The last component of the TFEC project is the innovative cooperative business model that utilises the central farm as a business support hub in order to ensure cooperative-based ownership of and access to farming and processing equipment/facilities, economies-of-scale benefits, access to markets and product value-addition. This model also allows each beneficiary/cooperative-member to own, work and manage his/her own individual vegetable tunnel and chicken run while cooperating with other members/beneficiaries (through the central farm) in order to benefit from bulk input buying, access to markets as well as from other economies-of-scale opportunities.

Figure 7. Main components of the TFEC from field observation: (a) biogas plant (b) chicken in a chicken run (c) vegetable tunnel - cabbage (d) dwelling units with solar water heater and rainwater tank

PM further added that the integration of the three main components into the project had significant benefits to the surrounding community through improved income within the community through generating employment and business opportunities. Furthermore, it supplied fresh and cheaper food to the community in terms of vegetables and chicken. This resulted in many community members seeking to be part of the project, with some expressing a need for capacity building through training.

As in most innovation diffusion projects, this project was not exempt from implementation and rollout challenges, even though the various interventions (in terms of energy, water, housing and food nexus as well as with regards to the business model) entailed proven technologies. The project manager explained these challenges and referred to them as “improvement gaps”.

All the interviewed beneficiaries acknowledged the allocation of chicken runs, vegetable tunnels and dwelling units. However, because of the implementation challenges, the project was not fully operational in the manner initially envisaged. For instance only 7 beneficiaries out of the initial 25 are currently working on the project and all of them are operating on their private arrangement. This shifted the status-quo analysis to focus more on project challenges, with own secondary emphasis on project operations. Even though spinach, onion, tomato and cabbage are the most commonly planted vegetables, others include green pepper, maize and butternut. Only four of the six active/interviewed beneficiaries are currently focusing on vegetable tunnels as their form of business and source of food. The other two were less interested, with one beneficiary claiming that the water shortage discouraged him this year and the other one asserting that she want to focus on poultry farming of which she has good background knowledge and experience.

All the beneficiaries agreed that poultry farming is the main source of income in the business, citing the short-period of six weeks required to grow the chicks to chicken, ready for sale. Other beneficiaries cited the readily available market for the chicken. However, poultry farming comes with its own challenges. The most common one among the beneficiaries is the shortage or high cost of chicken feed, high mortality especially in winter, chicken sickness including stress, irregular availability of water and power outage - electricity is critical in ensuring warmth and lighting (especially during feeding). From direct engagements with PM, it was noted that the TFEC project had an ineffective relationship/network with the provincial DARD who would be deemed to possess the technical-know-how (skills/expertise) in agriculture.

What is interesting with the six interviewed-beneficiaries is that they all have some sort of agricultural knowledge, either through prior experience/activities or through training after recruitment (see Figure 8). About 50% of the beneficiaries have prior poultry and vegetable farming experience, while 33% got their training when they arrived in the TFEC in the form of workshops, and the other 17% got their knowledge from both prior experience as well as post-recruitment training and workshops. According to the PM, agricultural knowledge/experience and willingness to learn was a criteria of the selection process.

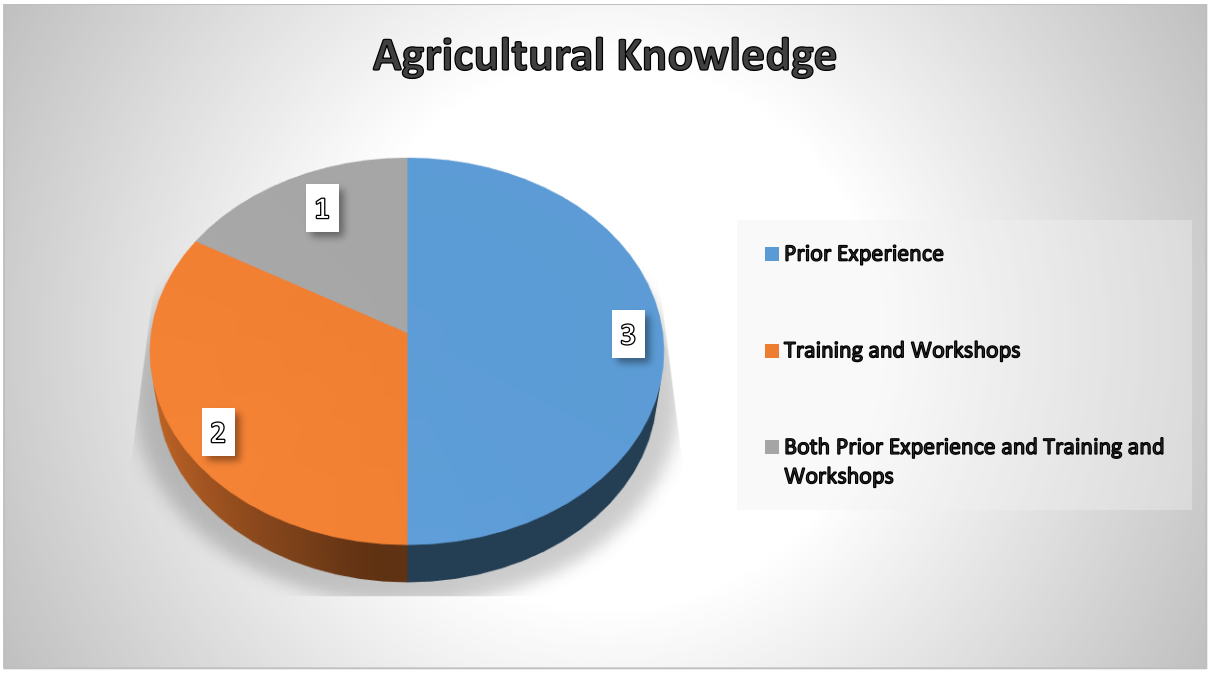

Figure 8. Source of agricultural knowledge from TFEC respondents

The four main challenges voiced by the six beneficiaries in the TFEC are crime, electricity, water and marketing/access to market. They reported that initially, security staff were deployed to the project but were later withdrawn without prior arrangement of alternatives measures. This resulted in accelerated theft of electricity cables, water pipes, chicken, chicken feed, solar panels and backup generators. The isolated location of the project site as well as the presence of old-age beneficiaries meant more susceptibility and vulnerability to crime. The beneficiaries believe that most of the implementation challenges began when crime became rife in the project such that the theft of electricity cables from the biogas and solar plants meant electricity would no longer be available and subsequently implied that borehole groundwater would no longer be abstractable due to the absence of electricity to pump the water. In addition, it resulted in increased crime rate because of darkness. Close to 83% of the beneficiaries said the biogas plant only operated for about two months and in that period the project was going well and their businesses were profitable but the other 17% contradicted this view and claimed that the plant never became fully operational.

Electricity is vital in the project because it is needed to pump borehole water; support household functions such as lighting, cooking, heating and television; and also provide lighting and warmth in the chicken run/coop. As a result, the absence of electricity forced the beneficiaries to collect and buy wood to make fire in order to warm the chicken and cook; to buy paraffin for lamp lighting, cooking and warming (see Figure 9); buy candles; and pay R100 every two

weeks to the generator owner in order to buy petrol for pumping water and filling the jojo storage tanks. Even then, the water is never enough given the irregular supply of electricity. The water is mainly utilised for irrigation, chicken drinking, solar water heaters, and for domestic purposes such as cooking, bathing and drinking. Unfortunately the TFEC depended mainly on the two boreholes as their water source and partially on the inconsistent rainwater (see Figure 10). For these reasons the absence of water meant that the beneficiaries now have to go collect water in the river (valley) using wheelbarrows; hire a van to collect water; or heavily rely on rainwater. Some beneficiaries have resorted to planting vegetables in their backyards (outside the tunnels) because the tunnel cannot be opened up to the rainwater now that irrigation water is no longer available consistently.

Figure 9. Field observations: paraffin lamps and wood-fire heaters borehole for water abstraction and large tanks for borehole water storage

Figure 10. Field observations: borehole for water abstraction and large tanks for borehole water storage

According to the six respondent-beneficiaries, marketing and access to market has become a critical stumbling block to selling their agricultural produce and chicken. They claim that the central farm which was meant to serve as the business support hub delivering agricultural extension services to the farmers never became operational (see Figure 11). The project manager attested to this, adding that the central farm is still in the construction stage. As a result, beneficiaries sell their produce and chicken directly to people who then sell in townships. They only have a few customers who come buy at the TFEC. These customers buy at a low negotiated price such that their price is below the township market price. The price is further reduced by the high competition among the beneficiary farmers themselves which brings down the price below commercial viability levels. One of the beneficiaries added that they sometimes fight over customers because no one want his/her chicken left unsold as this would mean s/he would have to spend more money on chicken feed. He further claimed that when they still had the market secure, they knew exactly when and where their chicken would be sold. Another respondent-beneficiary asserts that when everything was in operation and still had water and electricity, their chicken were taken to the abattoir to be slaughtered then put in fridges and sold (value-adding mechanism of a cooperative business model). “People used to come place orders”, buy the chicken and sell cut chicken in the townships.

Figure 11. Stalled central farm

4.1.2 Data Analysis and Interpretation

The previous subsection of data overview provides the status-quo assessment of the project as at the 11th of October 2017 when the fieldwork part of the study was undertaken. In analysing and interpreting this data, the status-quo of agriculture, energy, water and housing practices as well as the cooperative business model in the project is discussed. Firstly, it is important to acknowledge that the status-quo of the project is mainly characterised by the challenges rather than the successes of the operation. This is because the project was primarily a 'pilot project' and therefore a "very-first" of its kind. As a result, several mistakes and implementation challenges were encountered. Nonetheless, based on responses of the interviewed beneficiaries and the project manager, there is a common appreciation of the innovativeness of the project, its successes and improvement gaps with regards to further diffusion of the related interventions/innovations.

Zooming into the energy practices of the project, TFEC was intended to get electricity from biogas complemented by the solar PV plant. However, these are not common sources of electricity in South Africa's power generation. From the interview data, one gathers that the most used biogas input (feedstock fuel) in the project is chicken wastes. Given that water, agricultural and dwelling practices adopted in the project rely on electricity, electricity generation must be up and running at all time in order for the project to fulfil its objectives. As

part of the implementation challenges, it was reported that the biogas generation plant only functioned for about two month because electricity cables were stolen.

In addition, the solar panels were also stolen. In the absence of grid-connection, the project no longer enjoys electricity supply of any kind. This has completely changed the planned and envisaged energy practices which had inspired the diffusion of the innovations prioritised for the project. Now we are left with coping energy practices that have resulted into a new status-quo which entails collection and buying of wood to make fire in order to keep the chicken warm and also for cooking; buying and utilising environmentally unstainable paraffin for lighting-lamps, cooking and warming; buying candles for lighting; and buying diesel to power the generator in order to pump groundwater and fill the big tanks. These coping practices display characteristics of energy poverty and deprivation and therefore cannot be viewed as the practices that kwaSwayimane community would aspire to.

On the water practices of the project, TFEC gets its water from two boreholes supplemented by rainwater harvesting. With guaranteed electricity supply, boreholes were expected to serve as the primary source of water because of its reliability. The two boreholes were therefore drilled within the project-site boundaries in order to safeguard water supply. In a nutshell the planned and envisaged water practices was that electricity generated through renewable energy would be used to abstract groundwater from the boreholes, pump water into two big tanks and then distribute the water to the dwelling units and to the vegetable tunnels for irrigation. However, since this practice is dependent on electricity supplied by the biogas and solar PV plants; the theft of electricity cables and solar panels contributed to dysfunctional electricity system which meant groundwater can no longer be abstracted as originally planned. This gave birth to a new/coping status-quo, characterised by collecting water from the nearby river using wheelbarrows; hiring vans for water collection; strong reliance on rainwater; using generators to pump water into the tanks and planting vegetables in the backyard and thus outside the tunnels in order to make use of naturally available rainfall. This new status-quo is a symbol of water challenges and would therefore not be what kwaSwayimane community would aspire to. However, the originally envisaged practices remain innovative and inspirational.

The second water practice adopted in the project is the provision of rainwater harvesting tanks to every beneficiary in order to make use of rainwater. This practice remains in place and it is part of the status-quo. However, because of the inconsistence and unpredictable rainfall patterns, this practice is not reliable and cannot serve as the prime source of water to the project,

even though it provides supplemental water for irrigation and domestic purposes. The water challenges have therefore become a major stumbling block to the agricultural production and attainment of improved standards of living for the beneficiaries.

Food production through agricultural activities such as vegetable and poultry farming constitutes the core activity of the TFEC project. This was done in a sustainable way through providing sustainable support components such as renewable energy, borehole and rainwater utilisation and on-site housing. Vegetable farming heavily relies on the presence of water and especially on water circulation to the tunnels. Despite the water challenges, most beneficiaries prioritise their vegetable tunnels for the little water they get from the emerging water practices discussed above. This leaves the planned and envisaged status-quo for agricultural practices primarily modified even though significantly compromised by water and electricity challenges. However, a new agricultural practice status-quo is emerging, whereby beneficiaries are planting vegetables in their backyards.

Some beneficiaries argue that they have adopted the backyard garden practice because vegetables are not growing well in the tunnels due to the unavailability of rainfall in the tunnel coupled with the water challenges they experience. They add that in the backyards, they are able to optimise rainfall fully. One beneficiary asserts that she plants in the backyard because her vegetable tunnel is far from her dwelling unit, and because of her age, she struggles to actively walk back and forth every day. The other beneficiaries report that they engage with the practice because they want to increase their production in order to earn higher revenues.

Poultry farming practices also remain less modified. However, the high mortality rate and reduction in chicken stock for most beneficiaries reflect some of the negative/detrimental impacts of electricity and water challenges. The chicken are still raised in their chicken runs even though chicken theft is also increasing. All the interviewed beneficiaries report that they still make most of their revenues from poultry farming.

The food production component was built and planned around the functionality of the central farm (the hub). This was meant to be the business support hub responsible for product marketing, buying of bulk inputs and bulk selling of the produce. One of the main innovation target/outcome for the project was the benefits from the economies-of-scale through a cooperative business model, which were supposed to be achieved through cooperative-based ownership and access to an abattoir, hatchery, vegetable processing, seedling production, crop farming and feed-mill facilities. But the lagging construction of the central farm meant many

of these benefits were never and are not being fully ripped by the beneficiaries. This further led to beneficiaries planting different vegetables thus compromising the economies-of-scale benefits as well as hindering bulk buying, production and selling/access to market.

All the six beneficiaries reported being constantly concerned with the marketing of their produce and access to market while noting that such activities divert their time from focusing on the actual farming. Market challenges have led to a new status-quo characterised by beneficiaries going to townships to sell their produce, customers coming to buy from the TFEC at lower negotiated prices, competition for customers among beneficiaries which further reduces the price and results to "fighting" over customers. Whereas such status-quo practices would not be the envisaged outcome that kwaSwayimane community would aspire to, economies-of-scale benefits through a cooperative business model would remain as an important part of the innovation diffusion priorities with regards to food production and marketing, as well as supply of inputs.

The purpose of the on-site dwelling units is to accommodate beneficiaries close to their farms so that they can work on the farm anytime of the day without travel/commuting challenges. The units were all equipped with solar water heaters, wired for electricity services and plumbing for piped water. Even though the units still provide shelter to the beneficiaries, the basic standard of living has been compromised by electricity and water challenges, with the latter further compromising the functionality of solar water heaters. It is most likely that these challenges might have contributed to some of the beneficiaries quitting the project. The absence of effective relationship/network between the TFEC and DARD which possess the technical-know-how skills/expertise of agriculture can be factored in as one of the factors that compromised the project, as far as training and skills development/transfer is concerned. This can be categorised as a missed opportunity for the TFEC to tap into the department's vast skills and experience in agriculture and also to exploit available partnership relations.

Despite all the implementation challenges discussed above, the project idea and the related innovation is still noble and call for diffusion with additional insight and care. The project relatively improved the lives of the beneficiaries, most of whom were previously unemployed. In addition, it provided agricultural training through workshops along with sound practical experience. Overall, the project piloted the diffusion of environmentally sustainable agriculture through innovatively incorporating sustainability interventions based on an integrated model rather than on a piecemeal/fragmented approach.

4.2 KwaSwayimane

4.2.1 Data Overview

Findings on the status-quo practices in kwaSwayimane Ward 11 were derived through primary data collected through interviewing eight participants (agriculture manager and seven subsistence/cash-crop farmers) complemented with data from direct site observation. The demographics of the respondent farmers are presented in Table 5 with 57% of the interviewed farmers being female and 43% male. The age of the participants ranges from youth to senior citizens. It is important to clarify that these farmers practice on the basis of individual households since there is no community garden or project established in Ward 11 as yet, and hence the objective of this study is to investigate how cooperative-based models such as the TFEC can be established in kwaSwayimane Ward 11 in order to improve on the quality of life for the community.

Table 5. Demographics of the participants in kwaSwayimane

Participant	**Gender**	**Age**
Manager (AM)	Male	-
Farmer 1 (F1)	Female	62
Farmer 2 (F2)	Male	56
Farmer 3 (F3)	Female	52
Farmer 4 (F5)	Male	33
Farmer 5 (F6)	Female	38
Farmer 6 (F6)	Female	29
Farmer 7 (F7)	Male	24

According to the agriculture Manager (AM), uMshwathi municipality has developed an agri-business strategy (2015 - 2020) which focuses on supporting emerging/smallholder farmers (at no cost to farmers) with agricultural inputs, materials, equipment, capacity building and access to market in line with the Agri-park programme (a networked innovation system of agro-production, processing, logistics, marketing, training and extension services, located within a District Municipality). The objective of the strategy is to address the dichotomy that exists within the municipality between subsistence/cash-crop farmers and well-established commercial entities (uMshwathi, 2015).

Furthermore, the strategy aims to tackle the balance between food security and economic sustainability within the subsistence and cash-crop farming communities and the overall development of value-adding industries (*ibid.*). AM discusses the main agricultural activities in kwaSwayimane and its challenges where subsistence and cash-crop farming are the dominant activities, and mainly characterised by the farming of white maize, potatoes, cabbages and sugarcane (see Figure 12). Considering that crop farming takes place at a small subsistence scale, lack of fencing is a serious challenge with animals easily eating and destroying the crops. Lack of reliable water system in the area and the long distance to water bodies such as rivers and lakes make crop farming a difficult activity. Furthermore, access to market remains a major challenge to an extent where farmers end up selling their produce to hawkers and individuals who come with vans to stock at a very low prices.

Another crucial challenge pointed out by the AM is the lack of formal training programmes, and especially business management skills. According to AM, the municipality tries to organise the subsistence/cash-crop farmers into cooperatives so that they can benefit from government support and economies-of-scale, such as bulk buying and selling. However, this is also a challenge since they fail to cooperate with each other or even follow on the requirements/principles of cooperatives. The municipality has been given a directive by the provincial Department of Agriculture and Rural Development (DARD) to develop a facility known as "farmers production support unit" which will provide storage facilities for inputs, produce, processing; offices for extension services; as well as training venues (AM). In addition, DARD mandated the municipality to focus on maize and potato production. However, the municipality is not at ease with this prescriptive approach, and has instead called for a "research day" to discuss the suitable crops for their jurisdiction. This research day would bring together all stakeholders including the farmers, academics, municipality and even DARD itself. A close working relationship between the Department of Local Economic Development (DLED) in uMshwathi (which incorporates/is responsible for agricultural and rural development activities of the municipality) and provincial DARD (responsible for provincial agricultural activities) was noted during direct engagements with the AM.

Figure 12. Crop farming in kwaSwayimane (above: maize; below: cabbage, onions and beetroot)

AM asserts that about 30% of households in kwaSwayimane are involved in poultry farming, and this would constitute part of their strategy for future support and development (see Figure 13). Currently there is a local hatchery that is closed, but the municipality is working to resuscitate it in order to ease the supply of chicks to the farmers. In addition, the municipality has awarded R7.5 million to the hatchery owner to use his farm as a "training centre" in order to train poultry farmers (AM). There is also a newly established privately owned abattoir in kwaSwayimane that is meant to assist add value in the poultry value-chain. Despite the small

scale of the poultry industry, there is a potential for growth especially if market challenges can be overcome.

The last agricultural activity taking place in kwaSwayimane is husbandry for the larger livestock, particularly goats, sheep and cows. However, the cattle are not kept for commercial purposes but for domestic and traditional values. The cattle are normally kept in the kraal (at night) and produce enough dung that can be used as biogas feedstock. This waste together with dry maize stalks motivate for biogas without the need to cultivate additional feedstock such as sorghum which was intended as the feedstock at TFEC. Animal husbandry has its own challenges. For instance, communal grazing land suffers from the "tragedy of the commons" because of overgrazing. Another challenge is that the animals wonder around people's yards and eat the crops especially due to inadequate fencing.

Figure 13. Poultry farming in kwaSwayimane

In order to ensure the success of the Agri-park project (a networked innovation system of agriculture value-chain located in a District Municipality), AM highlighted that the municipality has ordered each ward community to identify land area of at least 100Ha that the municipality can assist with fencing, installing water infrastructure and piloting vegetable tunnels. This is possible since land in kwaSwayimane is under the ownership of uMshwathi Municipality (uMshwathi, 2017). The purpose would be to intensify agriculture and allow for full commercialisation through optimising economies-of-scale. Looking into possible agricultural innovation in the area, the agriculture manager has noted that most people in

kwaSwayimane make their living from farming and are interested in improving their skills. However, their main challenges remain access to market, getting inputs and equipment (such as tractors). To overcome these challenges, the municipality is open to partnerships as a learning opportunity.

The seven farmers interviewed make their living mainly from agricultural activities involving white maize and sugarcane (cash-crops) because these have better organised customers and the region is well known for its maize and sugarcane production. Other important crops farmed include potatoes, beans, butternut, spinach, cabbage, beetroot, sweet potatoes and cocoyam. Three of the farmers are also involved in poultry farming as a secondary source of income after crop farming.

According to the farmer-participants there are four main/pressing challenges that hinder farming in the community and confirmed from the data provided by the participants when asked what hindered or made their farming difficult. The first one is water. In general the community does not have a piped-water system (infrastructure or related services). Even in places where there is water, periodic water shortage is common. Most of the participants (5) reported that they collect water from the nearby river using wheelbarrows and this is often undertaken by children. Sometimes the water truck delivers water to some households (the frequency is about once a month) but only allows for about 40 litres per household. The water challenges have led to one of the farmers to buy several water tanks to harvest rainwater. He is further planning to drill a borehole in order to abstract groundwater.

The second challenge is the tractor. Farmers hire the tractor for about R2 000 to R3 000 depending on the size of their farm. This is capital intensive and a majority of them normally do not have the money and often do the hire on credit, of which they sometimes struggle to pay. Out of the seven interviewed farmers, only one farmer did not report on the tractor challenge because he owns two tractors bought by his father.

The third challenge is the high cost of agricultural inputs. The participants expressed concern about the high prices of seeds, manure, fertiliser and pesticides, claiming that the costs are unaffordable. Currently, most farmers are using freely available animal manure. Lastly, marketing and access to market is a stumbling block to the participants' farming activities. All the participants reported that they rely on customers who come to their farms to buy the produce. In addition, every month they go to social grants payment stations to sell their produce.

Other important but less common challenges include access to land, where one participant reported that he is experiencing land-access challenges, such that he has to rent land/farm from others who can allow him take over the whole operation. In general, each household owns about a hectare of land which is normally utilised for both dwelling and farming purposes. Those who need extra land are normally required to approach the municipality (uMshwathi) for land application, since the municipality is the owner of the whole kwaSwayimane land. Another participant reported that she does not have a fence and as a result cows and goats wonder around the farm and eat/damage crops. Theft of maize was raised by one participant as another challenge. Even though homes are grid-connected, electricity is not directly connected to the agricultural activities of the community. Prepaid electricity is distributed/supplied by the municipality and mostly used for domestic purposes.

Most of the participants have agricultural knowledge (see Figure 14) with 57% reporting they have prior hands-on agricultural experience, 29% reporting they have knowledge through training and the remaining 14% have none. One of the farmers who went for training was able to transform his land into highly productive potato farm (see Figure 15). This effort attracted municipal support due to the scale of the farm and the high output achieved. This unique outcome demonstrates the capability of the farmers to be economically productive when systematic support becomes available.

Figure 14. Source of agricultural knowledge of participants, kwaSwayimane

Figure 15. Potato farm owned by one of the participants in kwaSwayimane (Source: participant's photo archive)

4.2.2 Data Analysis and Interpretation

The data overview presented in the previous subsection gives a sense of practical agricultural activities taking place in kwaSwayimane, Ward 11. In order to analyse and interpret these data, the status-quo of agriculture, water and energy practices prominent in the community is substantiated further in this sub-section.

Agriculture is the largest employer in the community and most of the community members are involved in subsistence and cash-crop farming to provide for their families and generate income through sale of surplus produce and cash-crops. For instance, the farmers plant vegetables such as potatoes, cabbages, onions, beans, butternut, spinach, beetroot, sweet potatoes and cocoyam for subsistence and also farm sugarcane and white maize (cash-crops) to generate income. In addition, poultry farming is practiced mainly for income purposes as well as for subsistence.

Even though most of the farmers mainly carry out their activities within their backyards, each household has access to additional land that can be utilised for agriculture where close to a hectare of land can be available/utilised for agriculture by each household. It was observed that

a big chunk of this land is mostly utilised for extensive sugarcane and white maize farming, with one unique case where a big chunk was used for potato farming. A reasonable portion of land is typically utilised for other vegetables.

Since the household-scale farming is contributing a lot in providing income and ensuring food security in the community, the municipality, through its agricultural strategy, is calling for the commercialisation of these small scale farms, by opening community gardens and working through cooperatives. This would assist in reaching out for government support and also optimise on the economies-of-scale. Land in kwaSwayimane is owned by the municipality and therefore the utilisation of land for empowering the community and alleviating poverty is in the best interest of the municipality and its constituency. Access to land on the basis of right-of-use (rather than direct ownership) should not be a critical challenge.

Furthermore, DARD is extending its support to the community by directing the municipality to establish/operate "farmers production support unit" which would provide storage facilities for inputs, produce, processing; agricultural extension services; and training. Because of the close link between rural agricultural activities and rural economic development, kwaSwayimane must capitalise on their relationship with the DARD in order to tap into their technical agricultural expertise and derive economic development and improved livelihood for the community. The scale of poultry farming in the community is still low with each household raising an average of 100 chicken in small chicken coops.

Farming activities especially crop farming are compromised by unreliable water supply. Even though piped water is available in many households, consistency and reliability is unsatisfactory. Households adapt to the shortfall by collecting water from the nearby river using wheelbarrows and vans. In addition, some households are now harvesting rainwater using small water tanks of about 750 litres each. Sometimes the municipality's water truck delivers water for domestic-consumption to households. All the households visited have good reliable electricity supply from Eskom. However, the electricity is primarily used for domestic purposes and hardly used in agricultural activities.

All the participants reported on the production challenges posed by the high cost of agricultural inputs such as seeds, manure, fertiliser and pesticides. Unaffordability of such input costs leads to inconsistency in their use and thus undermines productivity. The challenge of unaffordability also arise with regard to the hire costs for the tractor, which often result in delayed farm preparations. The challenge of roaming livestock feeding on crops and theft of yields from

farms is primarily due to the absence of fencing in some farms. Access to secure and reliable market is still a challenge as reported by all the participants. Even though they manage to sell most of their produce from home and in social grant payment stations, the process is time consuming and financially risky in that most customers buy on credit with some not paying on time and others not at all. This affects the cash flow of the farmer and the sustainability of the overall business.

4.3 Key-findings and Conclusion

Before presenting findings on the comparative appraisal of the practices observed in both communities, it is important to briefly discuss the land-access structure for both communities. This is a crucial aspect of the diffusion of innovation process, because “no land” “no farming”, therefore “no innovation diffusion”. The study finds that in the TFEC land is owned by the City of Tshwane and leased (at no cost) to the beneficiaries. Because the project is owned and administered by the City of Tshwane, beneficiaries are not required to pay rent. This arrangement acts as an incentive to make the pilot project more financially viable for beneficiaries. In kwaSwayimane, land is owned by uMshathi Municipality. This land structure is deemed appropriate for the proposed diffusion process because the proposed sustainable agriculture using innovative cooperative business model is in the best interest of the municipality and its constituency. Leasing land to the identified beneficiaries without any payment could therefore be explored as an incentivising mechanism. However, thorough consultation between the community and the municipality is recommended. In addition, the consultation process would assist in reaching a consensus on land suitable for the prioritised farming activities.

The results obtained from the interviews and direct observations indicate the status-quo practices in the TFEC and kwaSwayimane case studies. For TFEC, the study finds that the status-quo practices are not aligned to the initial project plan that inspired the diffusion of the project innovations in the case study. This misalignment arose due to significant implementation challenges experienced in the project process which compromised the planned practices and thus transformed into the coping practices which now prevail. Nevertheless, the footprints of the initial project plan are still there, and all the interviewed beneficiaries believe that the project plan was good and that if the existing challenges are resolved with speed, the project can be restored to its initially targeted performance/outcomes.

Given that the purpose of the study is to substantiate on how the innovative sustainability practices with the related business model can be diffused, one can separate the planned from the coping practices of the TFEC. The initial practices (which the beneficiaries claim did not last for long – and possibly only effective and efficient for about two months) was anchored on the functioning of the biogas and solar plants to generate electricity. The electricity was subsequently used to pump groundwater from the two boreholes in order to support farming (irrigation) and domestic consumption. Rainwater harvesting tanks are still in place and do serve as supplementary water source/supply. The sustainable and reliable water supply resulted in effective farming, high production and better quality of life for the beneficiaries.

The quality of life was further enhanced by the reliable supply of electricity. At this point, even though the central farm was not yet in operation, most beneficiaries reported that they were getting enough support from the municipality in terms of inputs and marketing their produce and therefore they continue to benefit from the economies-of-scale of a cooperative business model. The municipality used to arrange for access to customers for the farmers. In a nutshell, the initial practices is what provoked this study and resulted in the researcher exploring how such practices can be diffused to a rural community endowed with land of high-agricultural potential but not enjoying access to similar innovations. How sustainability interventions were incorporated into the project process and how the farmers benefited from access to commonly shared facilities/resources and economies-of-scale is what inspired this study. A flow chart diagram of the initial practices reflecting the pattern/interactions of the systems is presented in Figure 16.

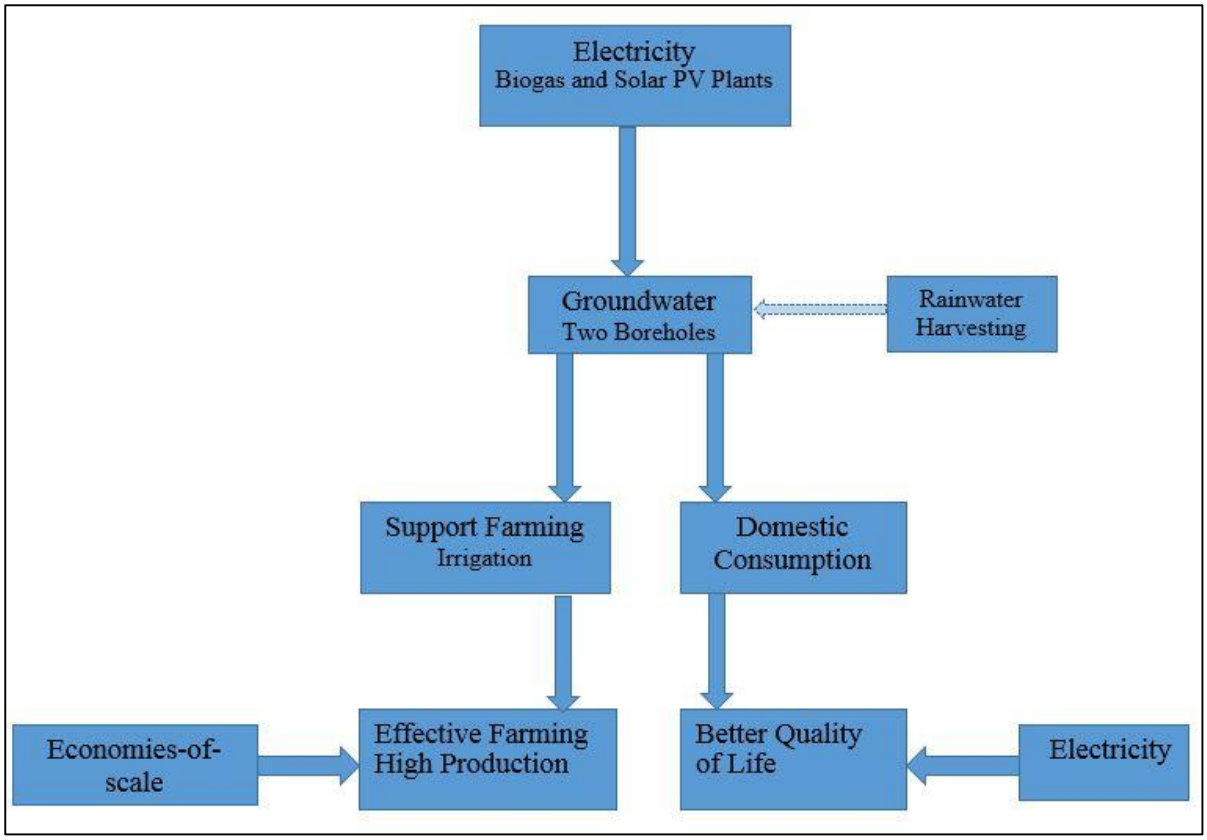

Figure 16. Initial practices reflecting the pattern/interactions of the systems

As a result of the interconnected operational challenges, new coping practices emerged in the TFEC. This started when outsourced security services were withdrawn from the project (due to reasons which were not disclosed to and by the beneficiaries) and crime became rife. Electricity cables and solar panels were stolen thus resulting in dysfunctional electricity system which ended up with discontinuity of supply. This meant that groundwater could no longer be abstracted, which in turn resulted to water supply constraints that hindered agricultural production and thus undermining the farmers' productivity and quality of life. The municipality became discouraged while trying to resolve these challenges and subsequently scaled back its support for the project. The supply of agricultural inputs and chicks as well as access to market were suddenly/prematurely left for the private arrangements by the beneficiaries. As a result of all these challenges, the number of beneficiaries working on the project declined from 25 to 7.

The prevailing status-quo practices are now characterised by energy challenges, with farmers collecting and buying wood to make fire in order to keep the chicken warm and for cooking purposes; buying and utilising paraffin for lighting, cooking and warming; using candles for lighting; and buying diesel to power the generator in order to pump groundwater. Water challenges also became significant, with beneficiaries now collecting water from the river;

hiring vans for water collection; strongly relying on rainwater; and planting vegetables in their backyards (which means outside the tunnels). Even though the rainwater harvesting system is still in place, it is not consistent, reliable or adequate to support all the water needs of the project.

These new practices affected overall production and especially the chicken farming and revenues, mainly due to unaffordable costs and time commitment. The farmers now have to go to townships to market and sell their crop produce as well as chicken. Even though these new practices are not what inspired the TFEC diffusion project they offer invaluable lessons on the "what" and the "how" of better implementation. Rather than merely taking them as failure, one could view them as improvement gaps to be addressed further both within the project as well as in subsequent diffusion opportunities elsewhere. Also, the lack of effective partnership with the DARD in order to tap into their technical agricultural expertise and their networks have been noted as a missed opportunity that other diffusion opportunities can learn from. In this regard, there is a possible learning opportunity from kwaSwayimane in terms of getting the DARD and other organisations possessing technical expertise/skills to be part of the project.

In view of diffusion of initial practices from the TFEC, the study also needed to establish the status-quo practices in kwaSwayimane in terms of energy, water and farming. Guided by the research sub-question the study finds that kwaSwayimane is characterised by extensive cash-crop farming of sugarcane and white maize supplemented with subsistence farming of potatoes and other vegetables. For the large cash-crop farms, the farmers normally hire-out tractors for ploughing and planting. In a few households, poultry farming is also practised. In the absence of the cooperation structures for the farmers in the area as well as insufficient municipal/government support, the farming activities are piecemeal and also lack systematic/strategic support infrastructure.

Currently, water is a challenge and farmers mostly collect water from the river while also employing rainwater harvesting techniques using small water tanks of about 750 litres each. Sometimes, the municipality's water truck delivers limited volumes of water to households, since tap water system is unreliable and supply is often interrupted. This negatively impacts on the farming activities taking place in the community. In terms of energy, the community gets its electricity from Eskom. The study finds that electricity is mainly used for domestic purposes and it is hardly used for the agricultural activities. Farmers sell their produce at the social grant

payment stations, to hawkers or customers who come to procure at the farm. This is a very unreliable market which is further weakened by credit-sale and at unprofitably cheap prices.

Because of the agriculture potential in kwaSwayimane, these small household farming activities can be integrated into large-scale community gardens based on cooperative structure/model in order to make their farming more commercially viable. uMshwathi agricultural strategy aims to make this possible by providing access to land and value-adding support. One way towards implementing the strategy could be mirrored from the TFEC project, especially if guided by what was envisaged through the initial practices. Furthermore, several lessons can be learnt from the TFEC project towards better implementation of interventions for kwaSwayimane. The key practices that kwaSwayimane can adapt from the TFEC project include: generating electricity from renewable sources; utilising clean energy to pump groundwater; implementation of rainwater harvesting system; providing better quality on-site housing for farmers (sustainable housing interventions); bulk input buying and produce selling; utilisation of shared or common facilities; secure market for produce and provide marketing assistance to farmers; formal agricultural training; and optimisation of benefits through economies-of-scale (with a cooperative business model). It is through the adaptation of the above practices that the sustainable and environmentally friendly agricultural farming that the municipality seeks to achieve for kwaSwayimane community could be pursued. However, there are possible failures discussed in detail under Section 6.1 that kwaSwayimane would have to mitigate from the beginning to ensure success. An opportunity also arises for the TFEC to use the recommended diffusion process towards improving on the existing project gaps and innovate further based on peer-learning experience. The next chapter distils the key insights from practices of diffusion of innovation in various sectors and then explores how such insights could inform/guide the envisaged diffusion process across the two identified communities.

CHAPTER 5: PRACTICES OF DIFFUSION OF INNOVATION

This chapter presents the data capture and analysis as well as derivation of sub-findings for sub-question 2 and 3, which explore local and international insights of diffusion of innovation models, and how these insights can inform/guide the envisaged diffusion process across the case study communities identified in the study. Four studies were prioritised for secondary data and analysis on key diffusion innovation insights. The first one involves the diffusion and adoption of hybrid corn seed in the USA. The second one looks at the business innovation and diffusion of off-grid solar technologies in India. This is followed by the third study which investigates how grassroots innovations enhance the use of renewable energy sources and proposal for a conceptual framework to analyse emergence of grassroots innovations and their diffusion. The fourth study uses Technology Innovation System as an analytic framework to examine the diffusion of solar PV systems and emergence of associated PV TIS in Ethiopia. Based on insights from the analysis, an innovation diffusion-adoption guide for kwaSwayimane is conceptualised within four stages which are innovation knowledge, partnership, skills development and piloting of the innovation. The initial part of the chapter discusses the four studies (data overview and analysis of each) followed by the concluding section which consolidates the innovation diffusion insights of relevance to the two case studies of this study.

5.1 Study 1: Data Overview and Analysis on Hybrid Corn

Greenhalgh *et al.* (2005) notes that the most commonly cited diffusion of innovation study is the diffusion and adoption of hybrid corn seed in Iowa communities (USA) in the 1930s by Ryan and Gross (1950). The diffusion of innovation model by Rogers (2003) emanated from the Iowa case study. Ryan and Gross (1950) analysed the conditions and processes under which hybrid corn seed innovation was diffused and adopted in two Iowa communities who became prosperous through agriculture. The data for that study were derived from interviewing farm operators in the two communities in 1941.

About 257 farm operators provided data that was analysed by Ryan and Gross (1950). All the farmers participated in the diffusion process period. Secondary data such as census and other records were also used to understand the context in which diffusion took place. The data on farm operators first hearing of hybrid corn and adopting it are presented in Figure 17. The data demonstrate that the dissemination of information was highly concentrated in 1929, 1930 and 1931 period, during which about 60% of the operators first learned of the innovative seeds.

The adoption pattern displays a lengthy period of slow growth, succeeded by a great wave of acceptance, which was then followed by a short period when the laggards also accepted the new seed.

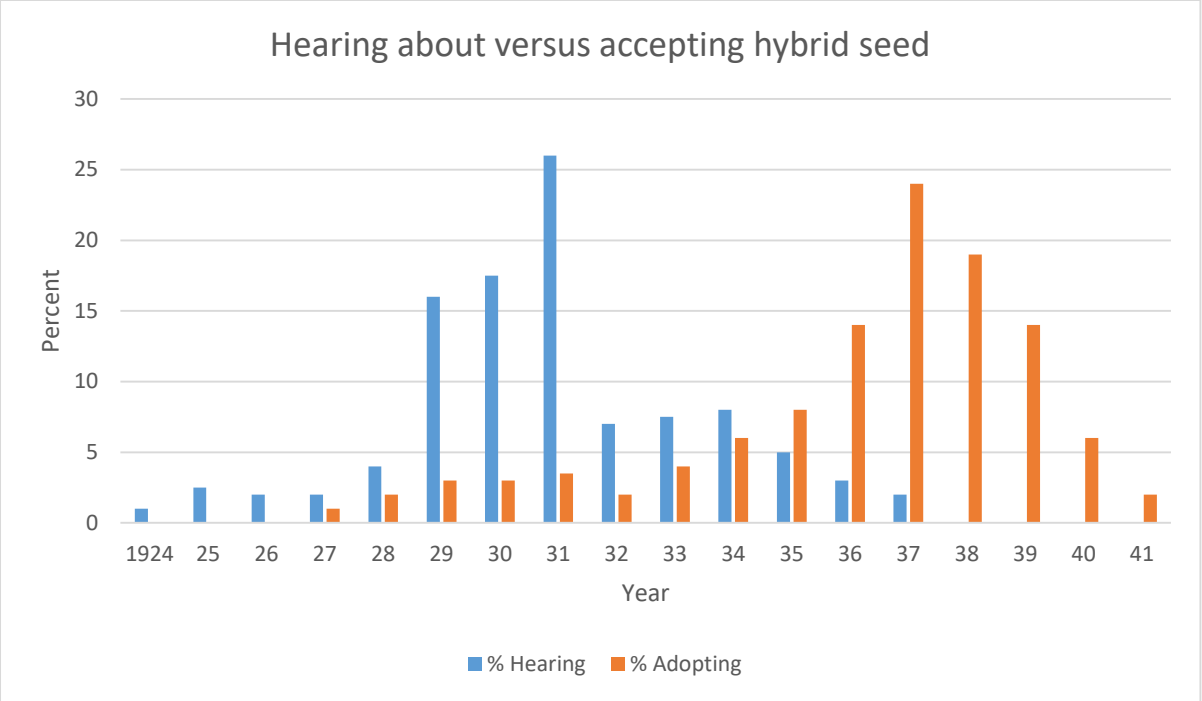

Figure 17. Operators' first hearing versus operators accepting or adopting hybrid seed in the given years (adapted from Ryan and Gross, 1950: 678)

According Ryan and Gross (1950), operators adopting before 1934 waited an average of 1.6 years after initial information and before acceptance. For those adopting from 1934 to 1936 the lag rose to 4.4 years; while for those adopting in 1937 through 1939 the delay was 6.4 years; and lastly for the laggards the delay extended to 9.2 years. This results to an average lag of 5.5 years between first hearing the information and first adoption for all operators.

It can therefore be deduced that inadequate access to knowledge was not the determining factor in late adoption of most operators. Ryan and Gross (1950: 681) argue that early adopters provided a "community laboratory" from which other operators could gain vicarious experience with the innovation over time. The significance of the local laboratory is reflected by operators weighing neighbours as influential toward adoption. However, the alternative is that some operators may prefer personal experimentation before complete adoption, and this can only happen at a small pilot scale. About 70% and 27% operators learned about the innovation from salesmen as their initial source in 1930 and 1933 respectively (*ibid*). While on the other hand, 6% and 60% of the operators named neighbours as their initial source in 1931 and 1933, respectively (*ibid*). The unimportance of neighbours before 1932 is in line with what

is depicted in Figure 17 where only a very small portion of operators (5%) were using the seed before that period. Hence observation of neighbouring farms would have had minimal effect. Neighbours were rated by 45% of operators as the key medium that influenced them towards adopting the practice. It was followed by salespersons (which received 32%) as the second key influential medium for adoption. 7% of the operators believed that it was their personal experience that led them to adopt the hybrid seed (*ibid*). The findings present a strong case that salespersons were highly influential in "informing" most operators, while neighbours were more influential in "convincing" them. It was noted that none of the operators attributed any adoption-delay to the lack of finance or credit to purchase the seeds or to the unavailability of seeds. However, the difference in the extent of knowledge about the hybrid seed was cited as the most likely delay-factor.

In conclusion one can draw some unique insights from the practices of diffusion of innovation in the Iowa case study. Firstly, there can be a huge time lag between initial access to information and the actual adoption of an innovation. This is demonstrated by the two different 6 years apart peaks of getting information and adopting innovation as shown in Figure 17. The time lag increased from earlier adopters to laggard adopters. Secondly, the innovators and early adopters create a context of "local laboratories" from which the next adopters can learn from. It was observed that most late operators only became convinced through these local laboratories or neighbours. Lastly, the extent of innovation knowledge is important towards reducing the innovation diffusion time lag. Furthermore, personal experience and pilot constitutes an invaluable way of testing the innovation by oneself. The implications of these insights for this study are consolidated under Section 5.6 of this chapter.

5.2 Study 2: Data Overview and Analysis on Off-grid Solar Technologies

Signh (2016) studied the business innovation and diffusion of off-grid solar technologies in India. He captured data from 69 respondents working in the formal off-grid solar market in India using online questionnaires. Most respondents were from private companies, followed by non-profit organisations, then financial institutions and others at percentages of 72%, 15%, 3% and 3% respectively. In addition, the study conducted 14 one-on-one semi-structured interviews with off-grid solar companies' CEOs working in the formal market. Moreover, the study also collected data using telephonic survey of 170 government-permitted retailers of off-grid technologies countrywide.

The study reports that most respondents largely provide solar home lighting systems (SHS), followed by micro-grids and lanterns, respectively, as their off-grid solar energy products (see Figure 18). These data reveal that private sector is focused on SHS, followed by micro-grids and then lanterns. While non-profit organisations are concentrated firstly on lanterns, the SHS, followed by other products (such as solar street lights and solar water heaters) then micro-grid.

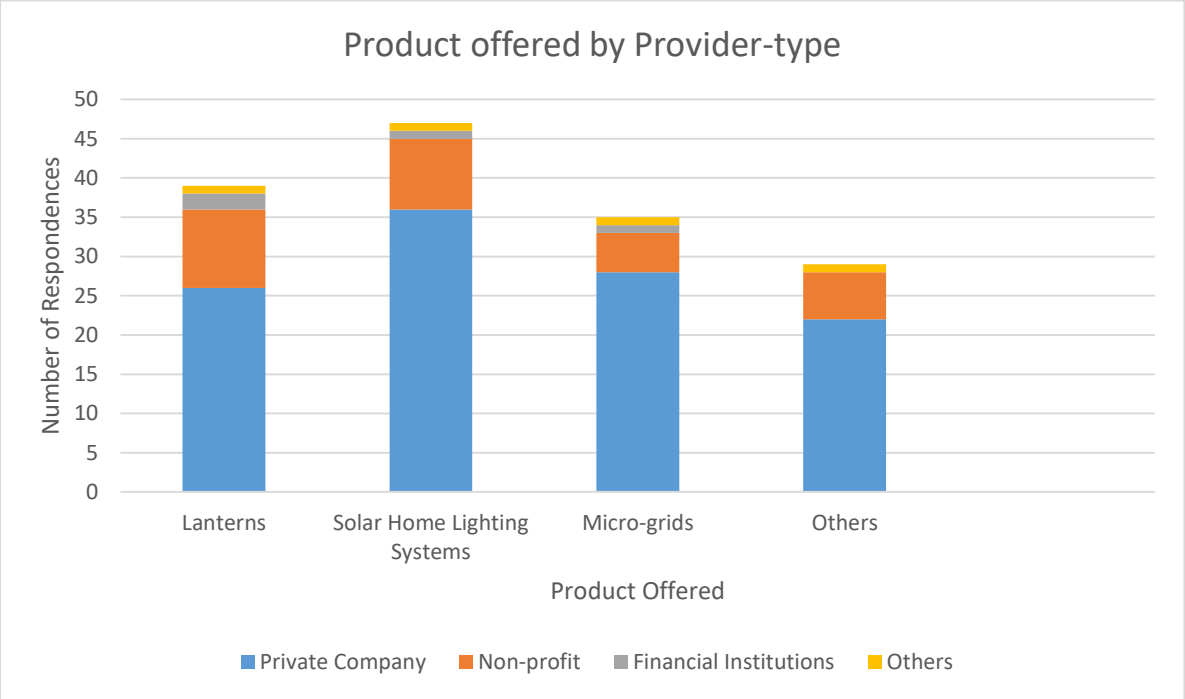

Figure 18. Distribution of product offered by type of provider (adapted from Signh, 2016: 7)

Among the respondents, 90% provide after-sales support maintenance of products with warranties ranging between one year (36% of respondents), to two and three years (19% and 45% respectively (Signh, 2016). One of the key findings is that financing was an important element of energy technology innovations and the diffusion of such innovation cannot be complete without factoring in this element. About 72% of the respondents reported that they do not use government subsidies in operating their businesses (*ibid*). Given that the procedure for accessing government subsidies for renewable energy project is normally too complicated and time consuming, this is not surprising. In addition, 65% of the providers did not provide consumer-financing for their products, while the rest provided a mix of financing from rural banks, self-help groups, and micro-finance institutions. Moreover, 82% of respondents operated their business through direct sales, while the others depended on disaster relief funds, social corporate responsibility investments, bilateral aid and other grant funding.

When Signh (2016) asked the respondents, on the kind of partnerships respondents were seeking to better diffuse their innovations, the study found that the majority of them wanted cooperation with financial institutions, followed by non-profit organisations, then distributors and agri-business (see Figure 19). It is not surprising that the respondents would like to work with financial institutions that can extend loans to customers who wish to purchase their renewable energy products.

Furthermore, micro-finance institutions can be helpful to small-scale enterprises because they can give out loans to entrepreneurs to set up franchises and also facilitate micro-payment collection for products like solar lanterns. Non-profit organisations can provide valuable networks for small-scale enterprises towards gaining community trust when purchasing their solar products from the enterprises. Equally, agri-business partnership would be helpful for marketing to rural farmers who require off-grid products for outdoor use. Lastly, distributors can strengthen the supply chains and further enhance after sales service networks.

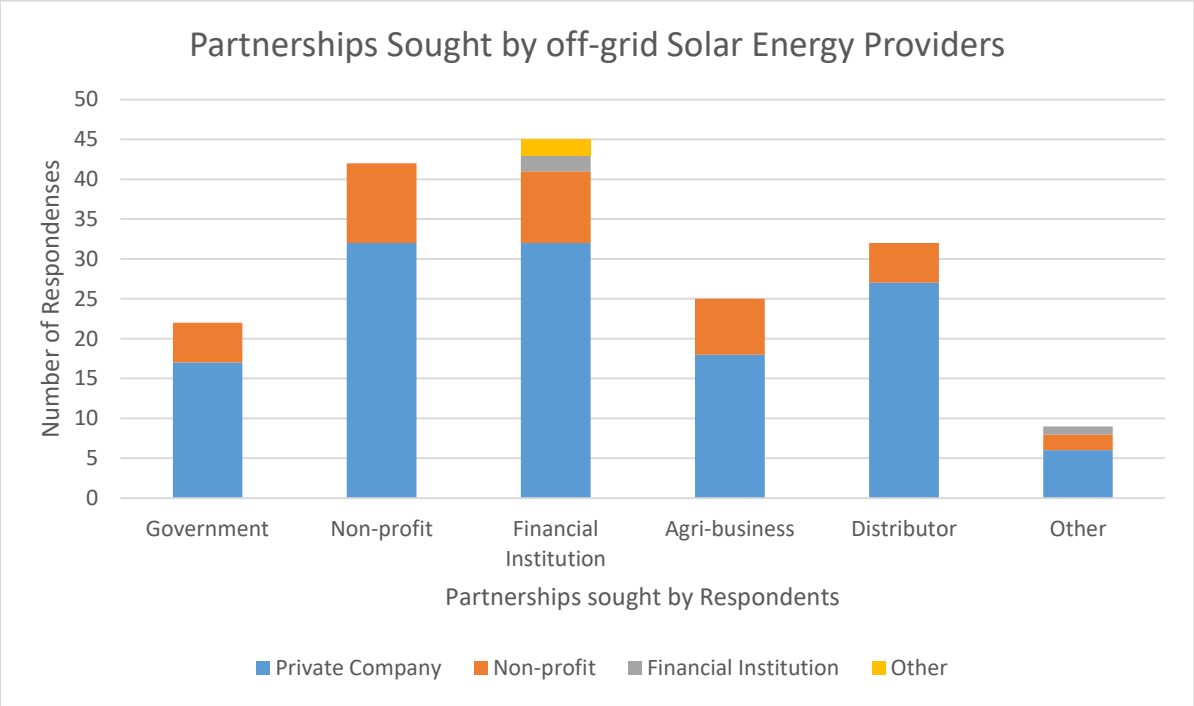

Figure 19. Partnerships sought by off-grid solar energy providers by provider-type (Adapted from Signh, 2016: 10)

When asked about the number of technologies/systems they had sold since they started operating, only 57 enterprises responded to this survey item thus bringing the sample size down from the initial 69. The study reported that 77% of the responsive providers have per home access or per unit sale of 20 000 or less, while 14% has sales between 20 000 and 64 000. The remaining 5% and 4% has sales between 120 000 and 160 000, and over 3 million, respectively.

For such a large potential market as India, these results reveal that the number of off-grid technology products sold per enterprise remains quite small compared to the number of people suffering from energy poverty. In addition the unit sales indicate that the business size of many enterprises is small.

For the purpose of this study, a number of conclusions and insights can be drawn from these data on factors affecting scaling up and diffusion of off-grid solar technologies in India. The first one is that the technology being diffused must have a warranty and after-sales support and maintenance. Signh (2016) argues that technology deployment is more likely to be unsuccessful when it is not accompanied by proper supply chain to provide maintenance and replacement of parts. Secondly, availability of finances to finance the technology and innovation is crucial for adopters. For instance, Harish *et al.* (2013 in Signh, 2016: 5) posit that "the viability of SHS market is critically dependant on the role that banks play as intermediaries between consumers and solar firms in rural areas". Signh (2016) further states that improvement in the business models that assist in the diffusion and adoption of technology might address the difficulties linked with lack of supply chains, finance and after sales support. Thirdly, partnership with financial institutions, non-profit organisations, distributors and agri-business is the effective and efficient way of diffusion and adoption of technologies and innovations. Lastly, access to and flow of technology information is an important element. Signh (2016) noted that most respondents using direct market approach adopted a tactic whereby a village head or someone of high social stature considers adoption first. Based on the role and respect of the early adopters within communities, this would significantly influence the rate of adoption. In addition, it is the responsibility of the innovator to conduct assessment and choose the technology for the community/market based on sound analysis and what s/he discerns to be appropriate.

5.3 Study 3: Data Overview and Analysis on Grassroots Innovations

Korjonen-Kuusipuro *et al.* (2017) investigated how "grassroots innovations" enhance the use of renewable energy sources. Grassroots innovations is defined as innovative products or processes created at the bottom of the pyramid, usually due to necessity, hardship and challenges, for example community-initiated innovations (Hilmi, 2012). Korjonen-Kuusipuro *et al.* (2017) proposed a conceptual framework to analyse grassroots innovations emergence and their diffusion. Seyfang and Longhurst (2013) emphasis that grassroots innovations diffuse in a different way compared to traditional innovations (top-down approach in a pyramid

model). They further raise an important question of what makes these innovations diffuse differently compared to other innovations such as technology innovations. It is because of the different diffusion requirements that this study seeks to extract important insights from the reported case.

Korjonen-Kuusipuro *et al.* (2017) based their study on two preliminary studies from Finland coupled with previous research on grassroots innovations. In the first study, a survey based on online questionnaires was undertaken. It was characterised by open-ended questions that seek to understand the adoption of household energy solutions and a total of 287 open-ended responses were obtained. According to Korjonen-Kuusipuro *et al.* (2017) majority of responses revealed the adoption of a wide range of energy solutions and consumers' interest in sustainable development. Furthermore, the answers revealed ways of reducing consumption and above all emphasised the desire to be more environmentally friendly. With some responses saying: "I will reduce electricity consumption by using air source or geothermal heat pumps, by replacing refrigerator and freezer with energy efficient ones, by replacing lamps with LED-lamps etc."; "I use green electricity, and heat with wood"; "Solar power, smart heating and lightning systems, energy efficient domestic appliance, low-energy house"; "I am a producer of solar energy and I am interested in producing wind energy as well. Also, I am involved in wood chip heating company". It is clear that renewable energy technology innovations are widely adopted and several households have changed their energy production and consumption behaviour.

For the second preliminary study (study 2) data were collected in three phases. The first phase involved semi-structured interviews with 12 households (*ibid*) with the aim of understanding why these people wanted to invest in solar panel system and also becoming producers rather than merely being consumers (they would thus become prosumers). The objective of the second phase of data collection was to follow up on four workshops organised by researchers and prosumers (*ibid*). These workshops provided platforms for producing and sharing knowledge about renewable energy innovations. In the last phase, direct observation and learning took place in two solar panel learning sites (*ibid*). About 25 prosumers were present in this learning site. Study 2 demonstrates that the key factors in grassroots innovations is working together and sharing information in a manner that promotes innovation through learning, and adoption following on sustained observing.

In conclusion, one can draw important insights from grassroots energy innovations and their diffusion. Firstly, Korjonen-Kuusipuro *et al.* (2017) observe that grassroots innovations suffer

less from technical challenges but more from geographic challenges and communication channels that pass information from one community or person to another. Therefore, spatial diffusion model can be applied to offer insights about community-based conditions, scale and practices for the development and success of innovations. In addition, effective and efficient medium of sharing information is critical for innovation adaptation and adoption. Secondly, in further development and diffusion of innovation, communities experience certain limitations due to factors such as limited knowledge, technological expertise and wide-scale influence. Communities can therefore not operate in isolation, but instead, systematic linking with other actors in the energy field becomes a prerequisite for grassroots energy innovations to develop and diffuse successfully. Thirdly, understanding of decision-making of the energy-sector actors and communities as well as their shared mental models is crucial when it comes to diffusion and development of innovation. Lastly, analysis of human behaviour and everyday practices is essential towards understanding and further supporting the development and diffusion of grassroots innovations.

5.4 Study 4: Data Overview and Analysis on Diffusion of Solar PV

Kebede and Mitsufuji (2017) use Technology Innovation System (TIS) as an analytic framework to examine the diffusion of solar PV systems and emergence of associated PV TIS in Ethiopia. Their study focuses on what they call "diffusion-based TIS" which describes:

> "The technological innovation system construction (building) in least developed countries (technology recipients) focusing on diffusing an existing technology. And diffusion-driven TIS can be defined as a set of network of actors and institutions that interact and contribute to the diffusion of an existing technology along with building absorptive and innovative capacity to further improvement and diffusion of the technology in focus." (Kebede and Mitsufuji, 2017: 243)

The presence of well-operating TIS is considered to expedite the diffusion of technologies through fulfilment of key processes and activities collectively known as "system-functions" (*ibid.* :242). These activities and processes contribute to the development, diffusion and use of technological innovations. Their case study in Ethiopia investigated a PV solar system in construction and identified system-functions which in turn correspond to the diffusion rate of the solar system. The study gathered data from desktop sources, focus group discussions, interviews (35 interviews were conducted) and field observations (three field trips were undertaken). Subsequently, a database encompassing the list of events in a chronological order,

starting from the early solar PV days in 1980s to current time (2012) was created. After listing the events in a historical order, the events were matched to seven system-functions (F1 to F7 as captured in Table 6).

Table 6. System-functions and indicators (Adapted from Kebede and Mitsufuji, 2017: 244)

System-functions	**Descriptions**	**Indicators**
F1: Entrepreneurial activities	Such activities form the core of any innovation system and involve trials of innovative commercial and/or demonstration experiments.	Entry of firms to PV market; Launching pilot PV projects; Experimenting with/on new applications of PV
F2: Knowledge development	Involves learning by doing and searching and addressing the socio-economic, technical and market related issues about the new technology.	Conducting feasibility studies; PV market research, appraisal and evaluation studies; Testing new models
F3: Knowledge diffusion	Involves learning by using and interacting through networks and/or communication of knowledge among actors in networks.	Trainings of PV technicians, entrepreneurs, users; Organising seminars, workshops & conferences; Conducting promotion campaigns
F4: Guidance of the search	Encompasses activities that positively affect the visibility and clarity of specific wants among technology users.	Formulating policies, rules & regulations; Planning targets; Publicising expectations; Showing interest
F5: Market formation	It involves the creation of markets, where new technologies have a possibility to grow.	Providing subsidies, tax exemptions, and other incentives; government procurement programs; Standardisations
F6: Resource mobilisation	Involves mobilising material and nonmaterial resource inputs to the innovation system development.	Providing R&D budgets; Launching PV related educational programs; Providing financial grants and loans for companies; Funding scale up PV projects

F7: Creation of legitimacy	This function encompasses advocacy efforts for enhancing stakeholder support to the new technology.	Conducting lobbying and advocacy programs

Table 7 provides a summary of data on the number of events relating to system-functions for a given period. The data are drawn from solar PV technology innovation related events that took place in Ethiopia from early 1980s to 2012 (see Appendix D for details of the events and their categorisation into seven system-functions). In order to analyse these data, Figure 20 is adopted from Kebede and Mitsufuji (2017) and it clearly depict the relationship between the functions, number of events and the period of which the data was collected.

Table 7. Dynamics of functions in the Ethiopian solar PV TIS from 1980 to 2012 (Kebede and Mitsufuji, 2017: 252)

	1980-1990	1990-2000	2000-2005	2006-2010	2011-2012		Number of events	Colour cell
F1: Entrepreneurial activities	2	1	2	5	4		1	
F2: Knowledge development	2	1	6	13	8		2 to 3	
F3: Knowledge diffusion			3	12	5		4 to 7	
F4: Guidance of the search	1		5	9	4		8 to 12	
F5: Market formation			1	1	1		>12	
F6: Resource mobilization			1	5	3			
F7: Creation of legitimacy				5				

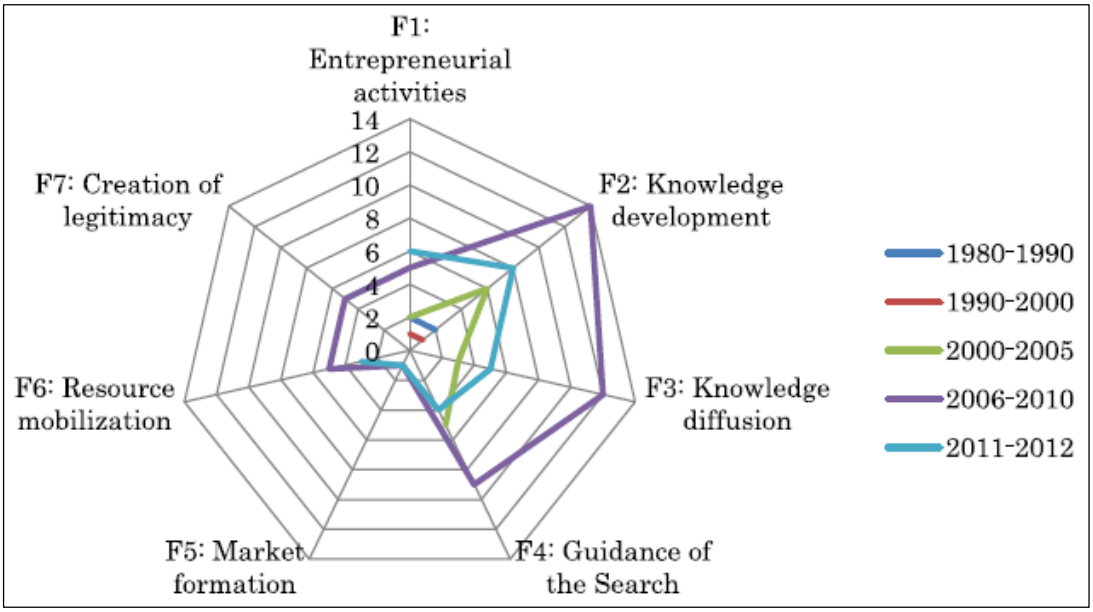

Figure 20. System function dynamics of solar PV TIS in Ethiopia (Kebede and Mitsufuji, 2017: 249)

From the above data, one observes that in the early 1980s, the need for solar PV technology was briefly noted and the early attempts could not prompt more entrepreneurial PV projects. As a result, only F1 and F4 functions appeared in this period. The 1990s to 2000 was a quiet period, probably because Ethiopia was undergoing change of government which resulted into the reformation of policies and organisations. In the early 2000s international funding supported few projects resulting to the resuscitation of the PV market. The government of Ethiopia also demonstrated some commitment towards adoption of solar PV and other rural technologies, by establishing an energy development and promotion centre and rural electrification fund. Such commitment enhanced the rehabilitation of the PV market.

The period between 2006 and 2010 inspired a relative boom in the PV market in Ethiopia. It is during this period that all seven system-functions were fulfilled. The period from 2011 onward is characterised by the establishment of the first solar panel assembly plant, which is regarded as a remarkable shift in the PV value-chain in Ethiopia (Kebede and Mitsufuji, 2017).

From these data, one can also establish that the solar PV TIS in Ethiopia began by operating through early *entrepreneurial activities* and *guidance of the search* in the 1980s. Early *entrepreneurial activities* (F1), *guidance of the search* (F4) and *knowledge development* (F2) functions are consistently recognised since the introduction of PV technology in the country. The full set of systems functional development is noted between 2006 and 2010, thus fulfilling all the system-functions for the first time. Lastly, it is noted that *market formation* (F5) remained the least served function until 2012.

Kebede and Mitsufuji (2017) noted the high number of installations in 2005 to 2010, and further observed that the promising PV market, mainly the solar home systems sprung up during this period. This period coincides with the build-up towards the fulfilment of all system-functions (F1 to F7). The study further argues that the matching of system-functions with diffusion rate can lead to a provisional conclusion that the system functional build-ups at that time boosted the diffusion of solar PV systems in Ethiopia.

This tentative conclusion is important because it allows us to look at how such system-functions can enhance diffusion/adoption of any other innovation. From the respondents, Kebede and Mitsufuji (2017) gathered that lack of proper promotion and awareness campaigns and poor linkage among solar actors were the key factors (among others) that hampered the diffusion of PV systems. Developing the right skills (absorptive capacity) through research and academic institutions and training, is proposed as an important element of innovation diffusion

and adoption thus concluding that *knowledge development* is "situated at the heart of any innovation system" (Kebede and Mitsufuji, 2017: 250). In addition, the study recommends the building of TIS for faster diffusion and development of PV systems in developing countries.

In summary, a number of insights on facilitating innovation diffusion can be drawn for this study. Firstly, the establishment/emergence of an effective technology innovation system characterised by the network of stakeholders that interact with institutions and contribute to diffusion of innovation is a good start. Secondly, the build-up of system-functions was crucial in the diffusion of PV TIS, and therefore this study can draw insight from the systems-function model/theory.

5.5 Online Communication Channels

Communication channels are a crucial element of any innovation diffusion process. For any innovation/technology to be diffused it must be communicated through certain channels from the innovator to the potential adopter. The effectiveness of the communication channels determines the speed of information/knowledge flow and subsequently, this has an effect on the diffusion process. The different types of communication channels have already been discussed under Section 2.2 of Chapter 2 (literature review).

Online/internet-based communication channels are of key interest in this section and are recommended in this study as the more effective communication method. Fensel *et al*. (2012) assert that online communication channels which use internet to exchange information have freed the communication geographic barriers that formerly limited the speed for information/knowledge expansion/sharing (time-effective). This presents an opportunity for the identified case study communities which are geographically apart (Gauteng versus KwaZulu-Natal) but both enjoy good telecommunications network that could enhance online communication. The ability of online communication channel to overcome geographic barriers, reach large population; its efficiency, reliability and interactive communication attributes motivate for the utilisation of internet-based communication in the diffusion process. The channel is also recognised for its ability to exchange classified and confidential information/knowledge in a reliable and protected way. However, the absence of the know-how to use online communication applications and technologies; and unreliable telecommunication-network signal which are often prevalent in rural communities could hinder the effectiveness and efficiency of online communication channels. In addition, face-to-face

channels are recommended as complementary channels because of the intimate/personal-relationship building strength they possess, despite being time consuming and expensive.

There are different types of online communication/knowledge-sharing platform such as e-mail, online forum, website, online newsletter, YouTube, google drive/drop-box, messenger (WhatsApp), social media (Facebook, Twitter, Instagram and LinkedIn), video conferencing (Skype), blog and software. Their most important attribute is that they also support Applications (Apps) that can be installed in mobile phones and thus allow for mobile utilisation. The types of online channels can be chosen based on the diffusion process needs, depending on the type of information/knowledge being exchanged, the frequency of information exchange, the preferred medium, the target recipient as well as the size of information being exchanged, to mention a few (Fensel *et al*., 2012). The crucial factor is that online channels can be tailor-made/adapted to service the diffusion process needs within specific contexts. For example, google drive/drop-box could be used to share large data such as training manual and videos between the TFEC and kwaSwayimane communities.

Such information could be engaged in a highly interactive and effective way using online discussion forum. Distance training/practical demonstration could also take place using video conferencing and/or YouTube videos. Confidential information or high level communication could be exchanged and managed using e-mails. For urgent communication, messengers-Apps such as WhatsApp can be used to communicate in any time of the day, as long as it is convenient for both parties. Such messengers-Apps also allow group discussions and information sharing. Documents and reading materials are also speedily and directly exchangeable using e-mails, WhatsApp, google drive, and social media.

It is for the above reasons, as well as time effectiveness, that modern communication channels using online platforms are recommended as the more effective communication method for the diffusion process within the two case study communities. However, face-to-face channels such as meetings, workshops and field visits for direct observations are also recommended as complementary channels in order to strengthen communication and partnership/relationship. The effectiveness and efficiency of communication between the two identified communities would enhance the diffusion and transfer process of interventions thus expediting sustainable socio-economic development for the rural community while also empowering the urban community to innovate further.

5.6 How Could the Insights Guide the Envisaged Diffusion Process?

The previous sections of this chapter have drawn insights from models of diffusion and technology transfer in various sectors across different countries in Africa, Europe and Asia, as well as in the USA. The objective of this section is to further appraise these insights with regards to how they could inform and guide the envisaged diffusion process across the case study communities identified for this study (TFEC and kwaSwayimane). It is therefore important to recapture the innovative practices proposed for diffusion from the TFEC to kwaSwayimane. The first innovative practice is the integration of sustainability interventions (renewable energy, groundwater abstraction, rainwater harvesting, and on-site housing) with the primary goal of supporting agricultural production as the new form of livelihood. The second one is optimisation of economies-of-scale-benefits which emanate from the utilisation of shared facilities, bulk input buying, combined bulk selling and access to secure market through the central farm concept/model (cooperative business model). It is the integration of these two categories of practices (sustainability interventions and cooperative business model) that constitutes an innovation for diffusion in this study.

Since such innovations at TFEC are new to the kwaSwayimane community, the insights are mostly focused on how the latter community can better understand the innovations and better learn from the case studies appraised in this chapter. In principle, the study adopts the view that it is not the duty of the TFEC or City of Tshwane (as Project Sponsors) to diffuse the innovations but rather the role of kwaSwayimane to learn the relevant innovations from TFEC. Fostering of municipal-level partnerships would thus enable the City of Tshwane to play an appropriate role in the diffusion process through guiding uMshwathi Municipality on the diffusion strategy.

In Chapter 4, the study investigated the current agriculture, energy, electricity and marketing practices in kwaSwayimane. It is clear that this community is still lagging behind in terms of adopting new practices in order to improve agriculture. Based on the insights from innovation diffusion studies appraised in this chapter, the innovation-adoption guide in Figure 21 was conceptualised for innovation diffusion facilitation for kwaSwayimane community. The innovation-adoption guide must not be confused with the conceptual innovation-diffusion model. In the context of this study, the guide facilitates the conceptualisation of the model (but not for the diffusion process itself) which is for recommendation to the two case study actors. The guide first recognises the lack of information and knowledge about the innovative practices

within the kwaSwayimane community. The initial phase that could enhance the diffusion process would therefore be the creation of communication networks that would allow access to information through different channels. The TFEC project could therefore serve as a local laboratory from which kwaSwayimane can practically learn from and observe the innovations in practice. In this initial phase, knowledge development is important for the adopting community. Such knowledge would enable good understanding of the innovation, its application; challenges; socio-economics; technical and market related issues as well as possible improvement gaps. This study can therefore be viewed as the first step to knowledge development for the adopting community. This knowledge must be complemented with generally available information from the internet and other media. Feasibility studies and innovation market research would also be important additional tasks in this initial phase.

The second phase would entail the development of partnerships with all stakeholders involved in the innovation diffusion process/value-chain. The first step for kwaSwayimane is to build a working relationship with the City of Tshwane who were incubators for the TFEC project. This relationship would enhance knowledge diffusion through effective communication channels and thus allow learning from the local laboratory (the TFEC project). Successes, challenges and failures of the TFEC can therefore be better understood in order to effectively diffuse the innovations into kwaSwayimane either by full adoption or varying levels of adaptation.

In addition, the relationship would foster peer influence, which might be useful to change the status-quo practices in kwaSwayimane. Partnership with other role-players (such as innovation developers, non-profit organisations, financial institutions, retailers, suppliers, provincial agriculture departments, and other actors) would also be crucial in the innovation diffusion process. The interaction of these actors and institutions in order to implement the diffusion and adoption of innovation is what was referred to as technology innovation system under Section 5.4. This partnership is very important and will be revisited briefly in the section on the pilot phase. As substantiated in one of the above studies (Study 4 Section 5.4), partnership would strengthen the development of policies in support of sustainability and agriculture (such as IDPs, strategy documents, municipality plans) through interaction with different role players. This has a potential of laying a good foundation for adoption of the innovation.

One aspect of the partnership to focus on would be skills transfer. This implies a stronger working relationship/network with organisations that possess technical agricultural expertise, where the DARD (agricultural extension services) could be one of the priority organisations.

A network between DARD and DLED already exists in uMshwathi/kwaSwayimane and it seeks to explore opportunities in rural farming activities. This network could be optimised to foster synergetic benefits.

One of the best ways of developing skills would be through "learning-by-doing" and learning from those who have "walked-the-path". The partnership created in Phase 2 would have a role to play in skills-development mainly through providing training to kwaSwayimane, including learning from their own local laboratory. This role can be played effectively by the City of Tshwane (TFEC), DARD.

In addition, providing financial support for training and fieldwork would be crucial in skills development, while bearing in mind the key role of management-capacity building. All these three phases would be focused on knowledge and skills development in the kwaSwayimane community. After uMshwathi municipality (kwaSwayimane) has developed adequate knowledge and skills, then it can embark on the last phase which involves testing and piloting the innovative practices (practical demonstration and experimenting through doing). It would also require resource mobilisation towards financing the project and possibly leveraged to the partnership network created under Phase 2.

An additional purpose of this phase would be to test compatibility with the local context (such as climate-soil environment, socio-economic and political dynamics) and evaluate the relative advantage compared to the status-quo practices or even other alternative innovations. The extent of the expansion and full rollout of the innovative practices would depend on how adaptable, compatible and affordable the innovation is. Furthermore, factors such as human behaviour and every day practices would also influence the extent of adaptation as part of the diffusion process.

Ghadim and Pannell (1999) assert that the value of such trial (pilot) would be geared towards the development of skills as well as reduction of uncertainty about the innovation's long-term viability. This guide would assist in informing the diffusion process between the source and host communities, and therefore serves mainly as guidelines for the development of a conceptual innovation-diffusion model. The guide takes the form of a linear (phase) but connected and interrelated approach which means that the different phases depend on each other, such that the previous phase informs the succeeding one and therefore skipping of any phase would undermine the success-potential of the diffusion project. Furthermore, should there be challenges in any stage; the preceding stages should be revisited and readjusted.

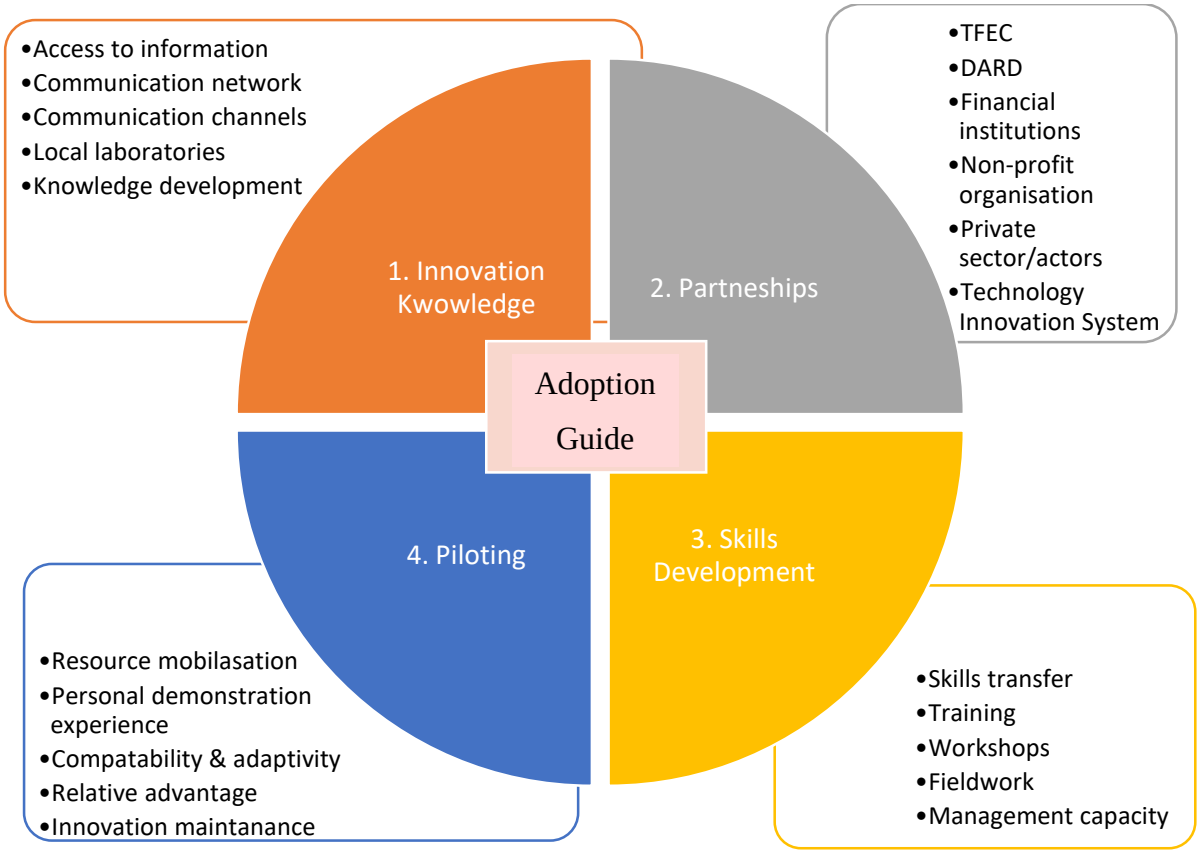

Figure 21. Innovation-adoption guide for kwaSwayimane community

5.7 Key-findings and Conclusion

The key finding of this chapter is that the diffusion and adoption of innovation in kwaSwayimane should be guided by the four proposed phases as summarised/conceptualised in Figure 21. The first phase involves access to information, knowledge sharing, creating communication networks and channels, and knowledge development. The second phase entails the creation of partnership with other actors, in order to collaboratively develop knowledge, share knowledge and provide support to each other. The third phase is about developing skills and creating capacity in preparation for piloting the project. Lastly, piloting and testing the innovative practices would allow kwaSwayimane to evaluate innovation compatibility with the local context, and further assess the benefits and relative advantages that the innovation brings. All these four phases combined are guidelines for the conceptualisation of the innovation-diffusion model which is discussed in the next chapter. Modern communication channels using online platforms are recommended as the more effective communication method and should be complemented with face-to-face channels.

CHAPTER 6: CONCEPTUAL MODEL FOR RECOMMENDATION

This chapter presents the data capture and analysis as well as derivation of sub-findings for the last sub-question, which aimed to substantiate on a conceptual model for recommendation to the various actors identified in this study. The chapter first captures the data overview and analysis of the challenges and improvement gaps that emerged in the interviews from the TFEC. A conceptual innovation-diffusion model for recommendation to both the TFEC and kwaSwayimane community is then conceptualised and substantiated. The model is guided by the innovation-adoption guide and is structured into two stages with the first stage focusing on partnership between the two communities and the second stage concentrating on piloting of the innovations in kwaSwayimane.

6.1 Tshwane Food and Energy Centre Challenges and Improvement Gaps

In the process of developing a conceptual model for recommendation to both the City of Tshwane and kwaSwayimane, it is important to look at the primary data collected through the interviews and direct observations in the TFEC. The data provide a perspective on the challenges experienced in TFEC as well as the recommendations suggested by the respondents (project manager and beneficiaries). These recommendations are important in reaching an understanding of what went wrong in the project and how it could be done better in the adopting community of kwaSwayimane.

6.1.1 Data Overview

The TFEC project was clouded by implementation and rollout challenges, as discussed in Chapter 4 (see Section 4.1 in particular). These challenges constitute a learning opportunity which provides insights for further improvements. The PM noted that "lack of resources for implementation was not a problem but the biggest problem was actually the beneficiaries themselves". Given that they did not have a good understanding of the model, once the resources (chicken and vegetables) started flowing into the project, then personalities/personal issues emerged or manifested into a major problem. PM believes that social issues constitute the main project challenge. Training was also cited as a stumbling block. PM posits that even though most of the beneficiaries were trained, some of them were not fully committed to the goals/objectives of the project. For future projects, the biggest challenge would revolve around how to identify the right beneficiaries with long-term interest/commitment for the project goals. Given these challenges as well as those raised by the beneficiaries, most of the beneficiaries

are no longer working on the project (only 7 are still working and they are operating on an individual basis – buying their own chicken and vegetable seeds using their own resources).

For the purpose of diffusing such innovative projects in future, the project manager gave suggestions/recommendations which are crucial for future success. The first one is to identify the land space and assess what type of agriculture is suitable for that specific farm (comparative advantage of production). This would be followed by conceptualising the selection criteria for the beneficiaries. These criteria would significantly influence on whether the project will succeed or not. The next suggestion was negotiation for the cheapest supplier of farm inputs which includes vegetable seeds and chicken - and agree on bulk buying of the inputs. This enables price negotiation that would allow for improved financial viability. As a further suggestion, PM noted that: "Our mistake, we started giving each beneficiary 1 000 chicken thinking it will be easier for the project manager/municipality". The suggested insight is that a beneficiary should be given room to progressively learn along the way. They can therefore start with about three hundred chicken each and increase the number to six hundred if mortality rate is low (within a set threshold such as 5% limit). For the purpose of this study, the two communities can learn from each other's learning-curves and also encourage each other through peer-to-peer influence.

Before joining the TFEC project, all the six respondent beneficiaries were unemployed. Four of them depended on subsistence farming for survival and selling of surplus produce. For the other two, one was a traditional healer and still practices in her spare time, while the other was doing domestic plumbing for his livelihood. There is general consensus among all the interviewed beneficiaries that this project changed and improved their lives by providing consistent source of income. They all reported that being part of the project is much better than staying at home in the township, since they now can buy food, send their children to school, send money to their children, buy them clothes, and in overall, support their families. One beneficiary asserted that she was able to renovate a house at home, while another one said she was able to provide employment to her unemployed child, and another beneficiary revealed how farming had been her dream and she is glad to see it becoming a reality.

Despite the implementation challenges of crime, electricity, water and access to market, all the beneficiaries applauded the innovation and the initiative of the TFEC for improving the wellbeing of people while staying on the sustainability tangent. They expressed the view that if all components of the project functioned well as initially planned, their lives would have

significantly improved and the project would have had extensive benefits to the surrounding communities. The beneficiaries were quite impressed on how electricity was generated from renewable sources and then used to pump underground water to support the household and farming activities. Most importantly, they were inspired by the way in which all the interventions combined to produce agricultural produce and chicken for survival and business purposes. One beneficiary even said “there is life here, chicken bring survival”. Hence they all recommended the diffusion of such innovation to other areas, and particularly rural areas, provided that the challenges they experienced are resolved and dealt with in advance.

From their lived experience, the respondent beneficiaries made some recommendations on “what” can be done better as well as “how” in the diffusion and adoption processes. Their first recommendation is that the project must be properly fenced and have 24 hours security service. Secondly, they suggested that beneficiaries must be well trained because people who had no prior experience were taken and they struggled to adapt and cope with the project demands/practices. One beneficiary added that “the project must only absorb people who are serious and willing to work in order for the project to be progressive”. Marketing and access to markets must also be secured - one beneficiary argues that this must be accommodated in the inception stages before operation to ensure that farmers know where the produce would be going and when.

Another beneficiary believes that in rural areas, land and scale of the project can be increased to more than 200Ha because of land availability and, according to another participant, the chicken coop must be enlarged to accommodate close to 5 000 chicken because just a few chicken would not generate satisfactory income. Most respondents also recommended that biogas and electricity generation must be functional before operation begins because they believed that their challenge was that they wanted to start farming before the biogas plant had been fully functional.

In contrast, another beneficiary argued that in the adoption of such innovations, adopters must remove or avoid the biogas because of its unreliability to generate electricity. He further asserted that they must be sure that it will work and “not just pilot it in their project”. In addition he proposed that metered or prepaid electricity can be adopted rather than the holistic approach of the standardised electricity bill, since individuals have different consumption patterns and rates. Lastly, one beneficiary recommends that the project manager must carefully choose the

hatchery supplying them with chicks, because they experienced a problem whereby the previous hatchery was supplying them with sick/unhealthy chicks.

6.1.2 Data Analysis and Interpretation

Above all the challenges experienced at the TFEC, a lot of lessons are learnt and a number of recommendations were proposed by the interviewees. Whereas the PM argues that incompatibility of beneficiary personalities emerged as a major problem, the beneficiaries themselves seem to attribute most challenges to the technicalities of the project. Based on interview responses and direct observations, both arguments have merit and, if combined, could provide a more holistic view of the challenges and improvement gaps. Crime is the key factor in all the challenges experienced in the project. Investment in security service is therefore important in order to protect the property and assets as well as life in the project and its beneficiaries. Before beneficiaries start operating, all components of the project should be in place and functioning satisfactorily. This includes the functionality of electricity from renewable energy source, efficiency of sustainable water systems, secure market for produce and common-property facilities such as abattoir, hatchery and feed-mill factory.

During the feasibility study and recruitment of beneficiaries, land to be used must be identified and secured by the municipality in consultation with the community/beneficiaries. On the more socio-psychological aspect that deals with human behaviour, identifying beneficiaries with a drive and dedication to agri-business would be crucial for project success. The recruitment process therefore needs to be more thorough and systematically cognisant of context.

The beneficiaries must then be equipped with necessary and adequate agricultural training including the business model of the project. What is interesting from the six beneficiary participants is that they had prior agricultural experience, they are passionate about farming and are always willing to learn better ways of conducting their business. Probably it is these features that made them so resilient that even when it came to operating their farming activities on the basis of individual model (without support from the municipality) they have managed to continue farming even though at a relatively weaker levels of operation.

Most of these recommendations have to do with the practical implementation of the project and can therefore be categorised under the pilot stage of the innovation-adoption guide proposed in the previous chapter. Even though many beneficiaries had prior experience coupled with some training, the PM recommends that agricultural training and related business model

still needed more attention. This can be classified under skills development phase in the adoption guide. PM respondent pointed out the possibility of exchange programmes in order to facilitate training opportunities and learning by doing through partnership. This is motivated by the view that two communities can learn from each other's mistakes (peer-to-peer learning), share information and encourage each other to be more progressive through a virtuous-cycle of peer influence. This can be categorised under the partnership phase of the adoption guide. Three of the four phases of the innovation-adoption guide are therefore evident in these recommendations. As a result, the conceptual innovation-diffusion model for recommendation to stakeholders/actors constitutes a synthesis of the insights from the guide with the recommendations from the TFEC participants.

6.2 The Conceptual Model

For the formulation of a conceptual model that would enhance the diffusion process, it is important to first recapture the innovative practices to be diffused from the source to the host community. The innovative practices in the TFEC involve the integration of sustainability interventions in order to facilitate/support sustainable agriculture. Furthermore, it entails economies-of-scale benefits through the collective use of shared infrastructure/facilities, bulk buying and selling and access to market which all can be collectively categorised under the innovative cooperative business model.

These practices are suitable for adoption by kwaSwayimane which is currently endowed with land of high-agricultural potential, extensive subsistence and cash-crop farming, and experienced farmers but totally lacking in innovations. The connection between the two communities would be through diffusion of innovation which would be characterised by partnership, communication and information transfer between the source and host community as illustrated in Figure 22 below.

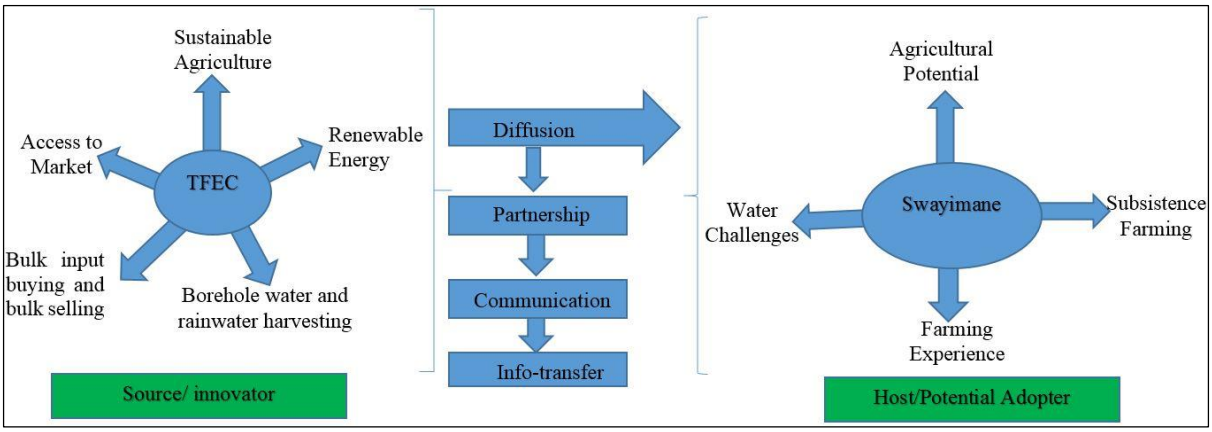

Figure 22. Relationship between the source and host communities

The partnership relation would constitute the first stage of the conceptual model emerging from this study, and substantiated in the subsequent subsection. The second and last stage is piloting or trialling of the innovation. This study therefore introduces a framework that conceptualises adoption as a multi-stage decision process involving information collection, learning-by-doing and testing. The two stages of the conceptual model are presented in the following subsections. The conceptual innovation-diffusion model must not be confused with the innovation-adoption guide. The former has been specifically conceptualised for recommendation to the two case study communities as the outcome of this study, while the guide is a more abstract framework for conceptualising and shaping the development of the conceptual model (see Figure 23).

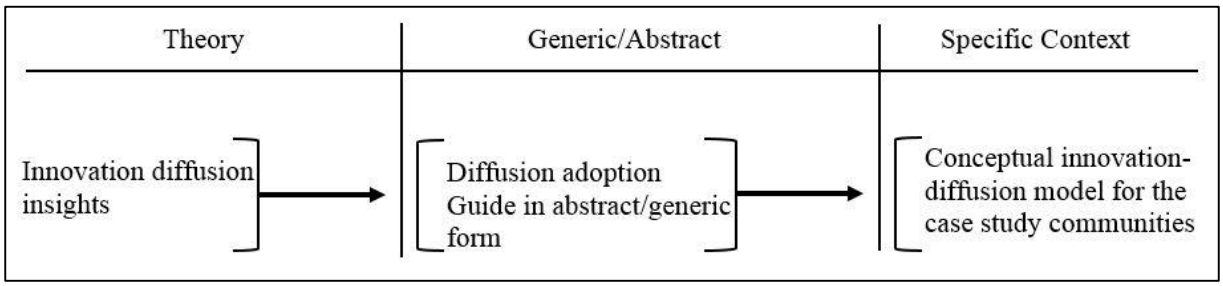

Figure 23. Relationship between innovation diffusion insights, diffusion adoption guide and the conceptual innovation-diffusion model

6.2.1 Conceptual Model: Stage 1

The first stage of the conceptual model is for recommendation to both source and host communities. The first step to diffusion of innovative practices is partnership between the two communities and their associated actor-networks. The objective would be to first diffuse the knowledge, learn from a local laboratory, further develop the knowledge, participate in joint activities, establish exchange programmes and create a network of role players as demonstrated

in Figure 24. According to Greenhalgh *et al.* (2004), innovation adoption is mostly influenced by the structure and quality of the potential adopter's social networks. The proposed partnership constitutes the incipient stage of creating effective structure and quality social network that would positively prepare the adopter in relation to adapting the innovations.

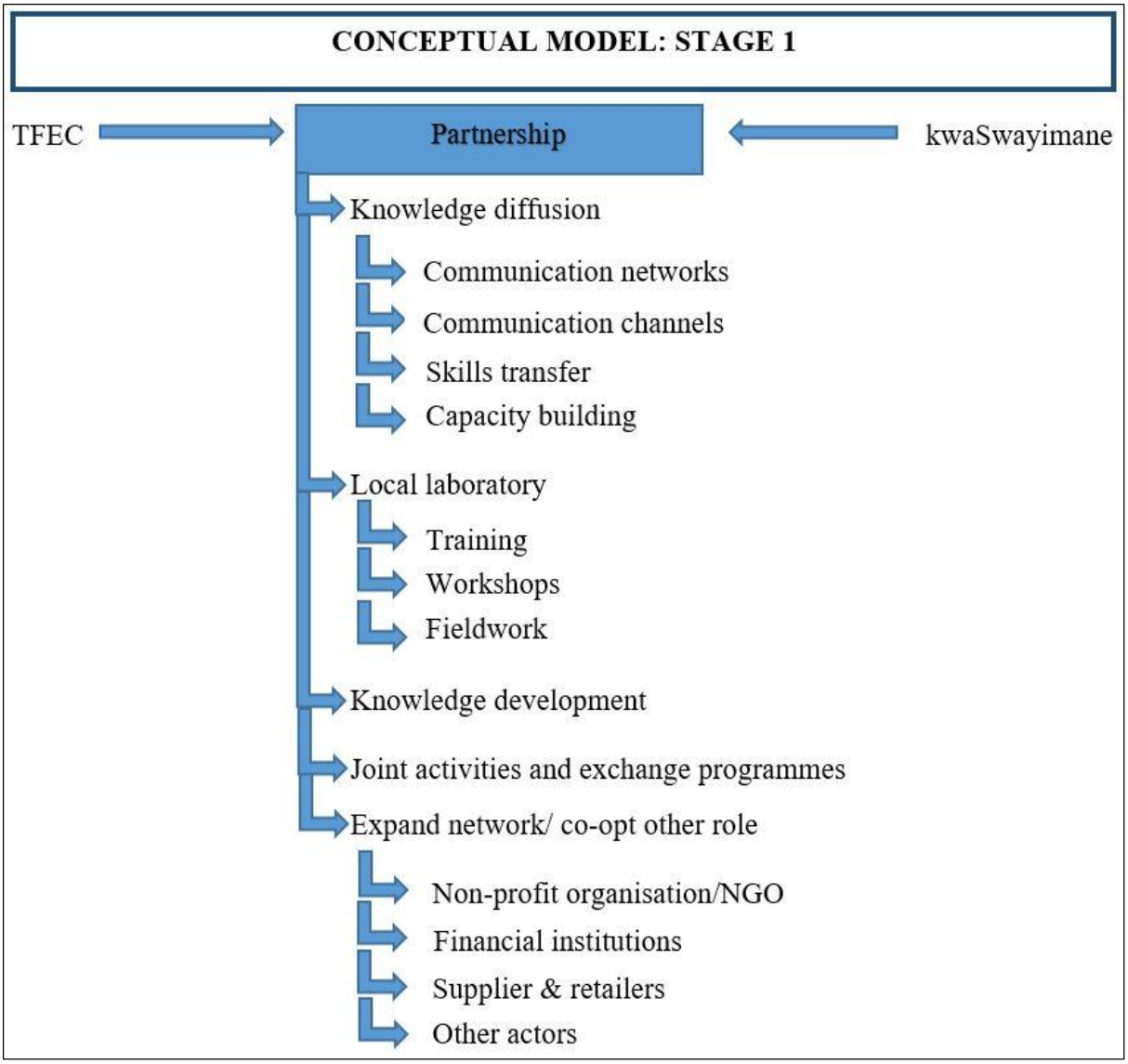

Figure 24. First stage (Partnership) of the conceptual model

The partnership stage has five important components to be fulfilled in order to smoothly transit to the piloting stage. The first component is knowledge diffusion, which involves the understanding of the innovative practices, sharing of the information within the network through effective communication channels, skills transfer and managerial capacity building. Rogers and Shoemaker (1971) conceive knowledge function as the beginning of the innovation-decision, and it commences when the individual is exposed to the innovation's existence and gains some knowledge of how it functions. They conceptualise three types of

knowledge important in the diffusion process. Namely, "awareness-knowledge", "how-to-knowledge" and "principles-knowledge" (*ibid:* 106, 107). Furthermore, they argue that when adequate level of how-to-knowledge is not obtained prior to trial and adoption, rejection or discontinuance is likely to result. The principle knowledge deals with the functioning principles underlying the innovation. It is important when it comes to adapting and reinventing the innovation without losing sight on the innovation principles. According to Greenhalgh *et al.* (2004), knowledge would best be developed and shared through formal networking initiatives between the two communities and utilising effective communication channels.

For the purpose of this study, interpersonal channels involving modern online technology and means of communication is preferred. This is likely to ensure effective distance communication and intimate relationship between the TFEC and kwaSwayimane community, thus resulting in effective skills transfer and capacity building. In their study, Greenhalgh *et al.* (2004) noted that the success factors for health-care-quality improvement collaboration included the capacity and motivation of participating teams; the motivation and receptivity for change for the organisations they represent, the quality of facilitation (particularly the provision of opportunities to learn from others in an informal space), and the quality of support provided to teams during the implementation phase. These factors are equally important for the proposed social network between the TFEC, kwaSwayimane and other actors in the diffusion process. Technical skills and project management capacity building are important in this stage. Partnership/networks with institutions like DARD which possesses technical agricultural expertise is therefore crucial for successful diffusion.

The second component in the partnership stage is the local laboratory, which can be translated into a local practical example/experiment. The TFEC project appraised in Chapter 4 represent the local laboratory from which kwaSwayimane community can learn and train from. Ghadim and Pannell (1999) observed that farmers/adopters require observations of implementation or success by other farmers before trialling an innovation. They further assert that the distance of adopter and the frequency of contact that the adopter maintains with the innovation and/or innovator influence the adoption of the innovation. This emphasises the importance of direct field observation and keeping touch within the network. Innovation visibility is one of factors (among others), cited in Williams (2014) as a major contributor to adoption of agricultural innovation.

The local laboratory provided by the TFEC would assist kwaSwayimane with innovation visibility/observability, fieldwork and practical learning. The TFEC would serve by providing practical training to kwaSwayimane, including learning from their local laboratory. This role can be effectively facilitated by the City of Tshwane (TFEC). Managerial capacity building would also be important for the successful implementation of the innovation and should therefore not be underestimated.

At the centre of the first two components – knowledge diffusion and local laboratory - is the third component which is knowledge development. This knowledge is important for both source and host communities in that it helps to identify gaps for improvement in the former and knowledge for innovating and adopting in the latter community. Knowledge creation is therefore central in the partnership stage of innovation adoption or conceptual model, especially given that joint activities and exchange programmes component aims to facilitate learning from each other, partnership and ultimately knowledge development and exchange.

The last component of the partnership stage is network expansion or collaborating with other role players. This is referred to as "interorganisational network" (Greenhalgh *et al.,* 2004: 608). An organisation that is well networked externally (cosmopolitan) is more susceptible to peer-influence and enhanced learning. Collaborating with non-profit organisations, NGOs, financial institutions, suppliers, retailers, extension service organisations and other important actors is therefore important in the social network between TFEC and kwaSwayimane.

When holistically combined, the components would assist kwaSwayimane community to assess the feasibility of piloting and adopting the TFEC innovation into their local context. Before the full adoption or innovation rollout, it is crucial that the piloting/trialling stage is done in order to practically test the innovation within a reduced/controlled scale. This stage of the conceptual model is discussed in detail in the following subsection.

6.2.1 Conceptual Model: Stage 2

The second and last stage of the conceptual model is the piloting of the innovation. After uMshwathi municipality (kwaSwayimane) has developed adequate knowledge and skills from the previous stage, it can then embark on innovation trialling. The purpose of trialling the innovative practices in kwaSwayimane would be to further assess the compatibility of the innovation with the local context, evaluate the relative advantage against the status-quo practices and assess capacity of local/host actors to adopt the innovations. If an innovation

meets all these requirements it is more likely to be successfully implemented and routinized (Greenhalgh *et al.*, 2004). Based on data collected from interviews and recommendations provided by the interviewees from the TFEC case study, the recommendations are subdivided into three aspects which are: those to "avoid", "to-do" and "possible challenges" (see Figure 25).

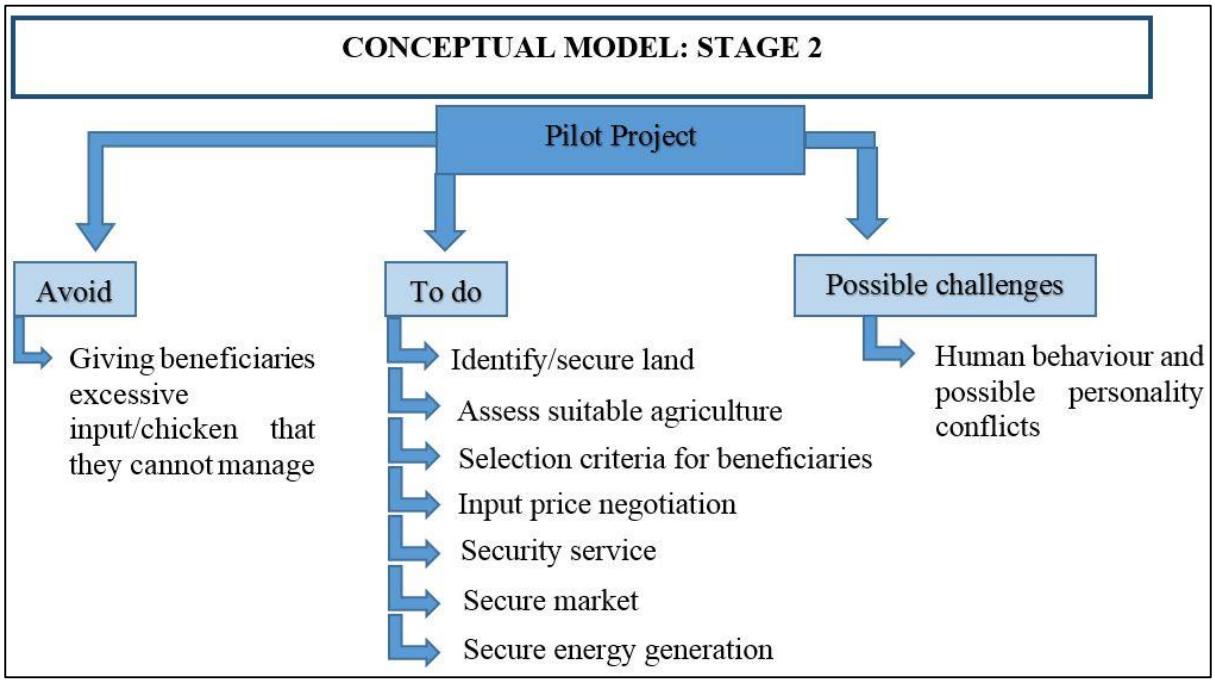

Figure 25. Second stage (Pilot) of the conceptual model

Subsequently, the study recommends the following pilot process. uMshwathi Municipality would identify and secure arable land in consultation with the KwaSwayimane community, which is strategically located with regard to road infrastructure and proximity to a river but not excessively large in scale/size (number of piloting beneficiaries should be limited). The municipality would then assess the suitable crops for the chosen land and also likely to enjoy an easy market-access. It would also be critical that the chosen crops are planted by all beneficiaries for the pilot project in order to optimise on economies-of-scale. In addition, the stakeholders have to decide on whether to include poultry and livestock farming as part of the project.

Beneficiary selection criteria must be established and take into cognisance farming experience, training as well as the person's long-term interest in farming/agri-business operations. PM of the TFEC asserted that the chosen beneficiaries would be the key determinants of the project's success. Careful attention must therefore be directed towards the selection of beneficiaries. Immediately after the selection, the beneficiaries would have to be equipped with all the

necessary farming and project training required in order to successfully execute their respective roles and activities. The municipality can utilise the partnership created with the TFEC as proposed under Stage 1. It would be the responsibility of the municipality together with the beneficiaries to find the least-cost but acceptable quality agricultural-inputs and plan/negotiate for bulk buying.

Bulk buying is important in the negotiation of prices and optimising on economies-of-scale benefits. This can be anchored on the expanded network created under Stage 1 of the conceptual model. Before infrastructure-build is completed and equipment is brought to site, effective 24 hour-security service is important in order to ensure the effective protection (for all property and people). In the TFEC, it was the compromise of security that set everything unravelling. Fencing and all-day security system therefore constitute important components in both the piloting and full-scale roll-out stages of the project.

A key objective for the project should be to allow the beneficiaries focus most of their time on the actual farming. Marketing activities should therefore be undertaken by a marketing hub/central farm. Furthermore, access to market and negotiating with potential buyers would ideally be concluded before the commencement of the project. This can be anchored on the expanded network created under Stage 1 of the model. Important infrastructure installations such as renewable energy plants and water reticulation must be functional before the project is fully commissioned or launched.

Implementation challenges should be anticipated, especially where mitigation and response plans are ignored or lacking. It is therefore important that the project take-off in an incremental manner which allows for progressive learning which would minimise or mitigate critical mistakes which would stall progress during the roll-out. An example of this would be to give each beneficiary 300 chicken rather than 1 000, and progressively monitor outcomes in order to determine when it would be suitable to expand. If a beneficiary is managing the few chicken successfully and the mortality rate is within the acceptable limit, the beneficiary can then be allowed to manage 600 chicken in the next cycle.

Given that human behaviour was cited as an influential element in implementation challenges, plans to mitigate fall-out among beneficiaries (with measures such as teamwork and team-building exercises) could be put in place in advance, followed by progressive implementation. The success of the pilot stage would then inform the full implementation/adoption of the innovations. Given that learning gaps would be expected in this stage, they should be

systematically appraised and addressed as they emerge in order to effectively guide the full roll-out stage.

6.3 Key-findings and Conclusion

This section presents the concluding insights based on the two-stage conceptual innovation-diffusion model for recommendation to the two communities identified in this study. For the first stage, the focus should be on the establishment of partnership and cooperation between the two communities, with the possibility of expanding to other role players to form a wider network once the initial relationship has gained strength. The objective of the partnership and network is to share knowledge, develop further knowledge, transfer skills, build capacity, and facilitate training. In addition, joint activities and exchange programmes would be at the core of this stage. In complement to the envisaged face-to-face interactions, modern communication channels using online platforms would be recommended as the more effective communication method.

Following the successful undertaking of the first stage, the second stage of trialling the innovation is conceptualised. It emanates from recommendations provoked by the lived experiences of the interviewees from the TFEC project, and would aim at improving trialling and success of the innovation adoption beyond the learning curves of TFEC. The key objective of the second stage would therefore be to test the compatibility of the innovation within the local context of the adopter, assess the adaptability and compare the relative advantages against the former practices. This would be done in order to gain insights on whether the innovation can be successfully rolled-out or fully adopted in kwaSwayimane community at a bigger scale.

In conclusion, the key finding of this chapter asserts that through collaborative approach between the two case study communities and utilisation of online communication channels, diffusion of innovative interventions would be enhanced thus expediting sustainable socio-economic development for the rural community while empowering the urban community to improve on the existing project gaps and so that they can innovate further through reinventing. The TFEC could improve on the existing project gap by deriving external motivation/peer-influence from the inspired rural community of kwaSwayimane. This could further expedite the delayed remedial interventions on the TFEC project. In overall, and because of the highly appreciated integration of sustainability practices and cooperative business model in the TFEC, the City of Tshwane (TFEC) is deemed to have taken a leading/progressive role in terms of sustainability in South Africa. Communities such as kwaSwayimane would therefore be

inspired by the TFEC innovation adoption and in order to keep the City of Tshwane on the edge, the diffusion-process could facilitate further innovativeness through reverse peer-influence.

CHAPTER 7: CONSOLIDATION OF SUB-FINDINGS AND CONCLUSIONS

The goal of the study was to appraise the opportunity for the diffusion of innovation based on urban-rural technology transfer for sustainable development through interventions in food, energy, water/sanitation infrastructure and services. This was pursued through substantiating on the main research question on how innovative practices in urban agriculture could be tapped in order to expedite diffusion of innovation for sustainable development for communities within rural areas endowed with land of high-agricultural potential.

Towards the substantiation on this question, sub-findings on the four sub-questions were derived. The first sub-question focused on the status-quo agriculture, energy and water practices within the TFEC and kwaSwayimane communities while the second sub-question was concerned with key insights from practices/models of diffusion innovations and technology transfer in various sectors locally and internationally. Linked to this sub-question is the third sub-question, which addresses how these insights could inform/guide the envisaged diffusion process across the case study communities identified in this study.

The sub-findings were then applied to guide the conceptualisation and substantiation of innovation-diffusion model. The derived two-stage model entails the first stage on partnership and second stage on the piloting of the innovation. The key sub-findings of each of the above sub-questions are consolidated in the following section and then re-contextualised in relation to the reviewed literature. The summary, conclusions and recommendations of the study are then presented in the last section of the chapter.

7.1 Consolidation of Key Research Findings

The purpose of the study was to appraise the modalities of how the sustainability practices in one innovating case study (the TFEC) could be diffused to another non-innovating case (kwaSwayimane) with regard to sustainable agriculture. The innovative practices of TFEC fall into two categories, with the first one involving the integration of sustainability interventions (renewable energy, groundwater abstraction, rainwater harvesting, and onsite housing- to support agricultural production) while the second one deals with economies-of-scale benefits which emanate from the utilisation of shared facilities, bulk input buying, combined bulk selling and access to secure market through a central farm model (the cooperative business model). Semi-structured interviews together with direct field observations were undertaken in the TFEC in order to verify and confirm the relevant/status-quo practices. The same was done

in kwaSwayimane in order to identify opportunities for potential adoption of the innovative practices.

The study finds that in the TFEC, land is owned by the City of Tshwane and leased to the beneficiaries at no rental-cost. This acts as an incentive to make the pilot project more financially viable for every beneficiary. Similarly, in kwaSwayimane, land is owned by uMshathi Municipality. This land structure is deemed appropriate for the proposed diffusion process because the proposed sustainable agriculture using innovative cooperative business model is in the best interest of the municipality and its constituency. Leasing land to the identified beneficiaries without any payment could therefore be explored as an incentivising mechanism. However, thorough consultation between the community and the municipality would still be critical in the diffusion process. In a nutshell, the TFEC land leasing and incentive mechanism could be adapted in kwaSwayimane in order to formalise land access.

The study also finds that in the TFEC, innovative practices on the ground (status-quo practices) have changed significantly from the initial/planned practices that inspired the diffusion of the project. This is due to the implementation challenges experienced during and after the project-launch. The initial practices and the subsequent adaptive/coping responses are separated for the purpose of demonstrating which practices kwaSwayimane would aspire to. Given that the latter adaptive practices have already been discussed in detail in Chapter 4, the key sub-findings in this chapter focus on the initial/planned practices.

The initial/planned practices are characterised by functioning biogas and solar plants to generate electricity. This was subsequently used to pump groundwater from two boreholes. The water was then utilised to support farming (irrigation) and domestic consumption. Rainwater harvesting tanks are in place to supplement water supply. The sustainable and reliable water supply resulted in effective farming, high production and better quality of life for the beneficiaries. The quality of life was further improved by the presence of reliable electricity. At this point even though the central farm was not operational, beneficiaries were getting enough support from the municipality in terms of inputs and sale of their produce (the municipality arranged for the customers and for delivery as well). In contrast in kwaSwayimane, the status-quo practices are primarily characterised by a prevalence of cash-crop farming (of sugarcane, potatoes, white maize); subsistence farming (of cabbage, spinach, tomato and other vegetables); poultry; and large livestock farming. These practices happen at

a household scale/level and are hindered by lack of water infrastructure, value-adding practices, municipal-support or effective access to market.

The contrasts between practices in the two communities indicate an opportunity for kwaSwayimane rural community to innovate, especially through learning from the urban-agriculture driven practices of TFEC. How this could be done effectively constitutes the important question substantiated in the study through exploring insights from practices/models of diffusion innovations and technology transfer in various sectors and in other countries. These insights were then applied to inform and guide the hypothesised diffusion process across the TFEC and kwaSwayimane. The insights derived from case studies of other innovation diffusion, resulted in the development of an innovation-adoption guide (with 4 phases) which is then applied towards the conceptual model proposed for the actors in both communities. Since the guide incorporates all the insights in a systematic and logical format; the insights were substantiated in detail in Chapter 5.

The innovation-adoption guide recognises that kwaSwayimane currently lacks information and knowledge about the innovative practices such as those applied in the TFEC. Therefore the initial phase would enhance the diffusion process through the creation of communication networks that would allow access to information and knowledge through different channels. The TFEC project can then serve as a local laboratory from which kwaSwayimane beneficiaries can practically learn and observe the innovative sustainability practices. Under this phase, knowledge sharing and development would be important for the adopting kwaSwayimane community. It would enable good understanding of the innovation, its application; challenges; socio-economics; technical and market related issues as well as improvement gaps. This study can also be viewed as the first step towards knowledge development for kwaSwayimane and can therefore be used to complement other sources of information such as the internet and mass media.

The second phase would be the development of partnership and collaboration with all stakeholders involved in the innovation diffusion and value-chain of sustainable agriculture. The first step for kwaSwayimane would be to build a working relationship with City of Tshwane who were responsible for the incubation of the TFEC project. This relationship would enhance knowledge diffusion through effective online communication channels and complemented with face-to-face channels. It would further allow learning from local laboratory. Successes, challenges and failures of the TFEC can be better understood in order

to improve implementation of the project in kwaSwayimane either through full adoption or by adaptation. Furthermore, the relationship would foster peer influence, which might be useful to change the status-quo agricultural practices in kwaSwayimane. Partnerships with other role players such as innovation developers, non-profit organisations, financial institutions, retailers, suppliers and other actors would also be crucial in the innovation diffusion process. The interaction of these actors and institutions would increase information flow and contribute to the diffusion and adoption of innovative practices. Networks with institutions possessing/managing technical agricultural expertise such as DARD and extension service organisation would incorporate both the knowledge/skills development and partnership phases and thus its importance cannot be overemphasised.

Partnership also plays an important role in the third phase of the innovation-adoption guide, which deals with skills development and transfer. One of the effective ways of developing skills is through learning-by-doing as well as learning from the insights of those who have been through some of the adoption experiences. The partnership created in Phase 2 would be central to the success of Phase 3 mainly through provision of training to kwaSwayimane (including learning from their local laboratory). All the three phases as discussed above are centred on knowledge and skills development in the kwaSwayimane community based on a complementary perspective/approach.

After uMshwathi Municipality and the kwaSwayimane community have developed adequate knowledge and skills, then they can embark on the last phase which involves trialling and piloting the innovative practices where practical demonstration and experimenting-by-doing would be the components. It would also require resource mobilisation towards the financing of the project which can be mobilised from the partnership network created under Phase 2. The main purpose of this phase would be to assess compatibility with local context – the natural environment (especially climate and social conditions), socio-economics, politics – and also evaluate the relative advantage compared to the status-quo practices (especially skills, markets and costs) in kwaSwayimane. The extent of adapting, compatibility and economic viability of the innovation would therefore influence the expansion and full rollout of the innovative practices. The different phases of the innovation-adoption guide depend on each other, such that the previous phase informs the succeeding one.

The innovation-diffusion guide informs and guides the development of the conceptual innovation-diffusion model proposed for recommendation to the TFEC and kwaSwayimane

community as well as their respective municipalities. The conceptual model has two stages, namely the partnership stage and piloting stage. The first stage constitutes the establishment of partnership and cooperation between the two communities. This partnership would, at a later stage, (especially once the relationship has matured), be expanded to other role players to form a support network. The objective of the partnership and network would be to share knowledge, develop further knowledge, transfer skills, build capacity, and provide training. Joint activities and exchange programmes would therefore be the key characteristics of this stage. Modern communication channels using online platforms are recommended as the more effective communication channel, because of their ability to enhance instant communication, promote interactive engagements and overcome geographic communication barriers. However, should be complemented with face-to-channels in order to improve personal relationships.

Following the successful undertaking of the first stage, the second stage of trialling the innovation would be conceptualised as guided by responses emanating from the lived experiences of the interviewees from the TFEC. The purpose of the second stage is to test the compatibility of the innovation with local context of kwaSwayimane, assess the adaptability and compare the relative advantages against the status-quo practices within the rural community. This is done in order to evaluate if the innovation can be successfully rolled-out or fully adopted in the kwaSwayimane community at a bigger scale. The reinvention and adaption of the innovative practices would also be expected to take place under this stage.

For the piloting of the innovative practices adopted from the initial/planned practices of the TFEC, the study recommends the following process. uMshwathi Municipality would first identify and secure arable land (in consultation with the kwaSwayimane community) which is strategically located with regards to road infrastructure and proximity to a reliable water source. The municipality would also assess the suitable crops for the chosen land and preferred livestock farming in consultation with the beneficiaries in the pilot. The selection criteria of beneficiaries would take into cognisance farming experience, training and personal interests in farming.

Subsequently, successful beneficiaries would be equipped with all the necessary farming and project training. The municipality can utilise the partnership created with the TFEC as proposed under Stage 1 for the training of the beneficiaries. Bulk buying would be arranged by the municipality in order to enable price negotiation. This can be anchored onto the expanded network created under Stage 1. Effective and reliable 24-hours security service prioritised in

order to ensure the protection of the property and assets of the project. Marketing activities would be undertaken by a marketing hub/central farm.

Furthermore, access to market and potential buyers network would be explored and assessed before the commencement of the project especially based on Stage 1. Innovative/supportive infrastructure interventions such as renewable energy plants, from which farming infrastructures are to be connected would be installed and commissioned before project operations commence. Given that human behaviour constitutes a critical threat to the project success, a proper plan to manage relations (such as teamwork and team-building exercises) would need to be in place prior to commencing operations and be progressively executed and monitored.

Based on the above findings, this study argues that through a partnership and collaborative approach between the TFEC and kwaSwayimane community that utilises online communication platforms, the diffusion of innovative interventions would be enhanced thus expediting sustainable socio-economic development for the rural community while empowering the urban community to improve on the existing project gaps and thus innovate further through reinventing. The study further envisaged that the innovative practices need to be contextually adapted in order to suit and optimise outcomes within the local socio-environment context. This constitutes the process of adaptive diffusion, with the pilot stage as a critical component for both communities.

7.2 Connection Between Findings and Diffusion Theories

Following on the derivation of the key finding of the study, this section presents a cross-referencing with the theories of diffusion as appraised under literature review in Chapter 2. In the process, the proposed innovation-adoption guide and the conceptual innovation-diffusion model is linked back to how other scholars view diffusion of innovation. Furthermore, the cross-referencing ensures that the emerging guide and conceptual model are applied towards re-appraising of existing theories of diffusion. It is therefore important to initially locate the study and its propositions within Rogers (2003) diffusion model. Under the five stages that shape diffusion (knowledge, persuasion, decision, implementation, and confirmation); this study can be argued to fall under the early stage of the innovation-decision process (the knowledge stage). In addition, the study also cuts across the three types of knowledge fields proposed by Rogers (2003) which are awareness-knowledge, how-to-knowledge and principles-knowledge. It is because of the location of this study in the “knowledge stage” that

‘innovation knowledge’ forms the first step of the innovation-adoption guide and that ‘knowledge diffusion’ is the first component of the first stage of the conceptual innovation-diffusion model.

von Hippel (1987) developed the ‘know-how trading’ perspective on diffusion of innovation, which is an enactment of social capital, whereby adopters access information through extant relational contacts, on a need-to-know basis. The informality/formality, multiplicity, and strength of interpersonal relationships means that the high value information usually required for successful technology transfer - tacit knowledge - is precisely the type of knowledge that know-how trading facilitates. The “trading perspective” on diffusion is about the creation and maintenance of important relationships/networks in order to facilitate knowledge sharing and subsequently diffusion of an innovation. von Hippel (1987) further argues that social networks and relationships drive the spread of innovation. In the innovation-adoption guide ‘partnership’ (as a critical form of relationships) is the second step and facilitates for knowledge sharing, skills transfer and social network creation. Furthermore, in the conceptual innovation-diffusion model ‘partnership’ is the first stage of the model and calls for joint activities and exchange programs on top of the elements mentioned in the innovation-adoption guide partnership step (partnership step in the guide informed/guided the development of the partnership stage in the model). This shows a strong correlation between the key findings of this study and the trading perspective model.

Bozeman (2000) presents a technology transfer model and also argues that movement of know-how, technical knowledge from one organisation setting to another is the first step to technology transfer. The study described five key attribute-categories which influence effectiveness of technology transfer which are the transfer agent; the transfer media; the transfer object; the demand environment and the transfer recipient. The transfer agent category refers to attributes of a third part or intermediaries such as opinion leaders, change agencies and extension services that play an important role in the technology transfer. Such intermediaries’ attributes can significantly influence the diffusion of innovative practices for the two communities.

Transfer media is synonymous with communication channels in Rogers (2003). Whereas this study has prioritised both interpersonal and mass media communication channels, the former channel is deemed to be the most relevant to this study because of its intimate nature. Furthermore, these channels would have to utilise information technology in order to make

communication more effective and efficient. The "transfer object" would initially be the knowledge, and subsequently the technology or the innovation. In line with Bozeman (2000), this study recommends that "how-to" and "innovation-knowledge" would be transferred first (during the partnership stage of the conceptual model) before the actual piloting of the innovation.

The fourth and fifth attribute categories are the demand environment and the transfer recipient attributes respectively. In the context of this study, the demand environment category includes socio-economic status, status-quo farming, energy and water practices in the kwaSwayimane community. While the transfer recipient category means the host kwaSwayimane community, these attribute categories are considered in this study in order to guide the conceptualisation of the innovation-adoption guide and conceptual innovation-diffusion model.

Within the evolutionary perspective diffusion model, Douthwaite *et al* (2002) argue that the host environment determines the adaptations (modifications) that adopters make to the initial innovation. Adopters change or adapt innovations in order to exploit a perceived niche in which they want to operate. In other words, evolutionary perspective on diffusion is about adjusting the innovation and its immediate context fit so that the opportunity presented by the host environment can be optimised. This is exactly what this study proposes, in that among other issues, kwaSwayimane would have to assess the suitable crops and livestock for their environment, rather than copying exactly what is farmed in the TFEC. The same would also apply to the renewable energy and water practices/technologies.

Dearing and Meyer's (2006) argues for decentralised diffusion which slightly differs from the model of this study while keeping within the same principles which include innovation adaptation, innovation reinvention and adopters' creativity. They argue that reinvention and adaptation would result into a different and unique innovation compared to the initial innovation. This process would result into several decentralised innovations that could diffuse separately relative to the initial innovation from which they originate.

Most of the previously appraised diffusion theories focus on specific aspects of the more widely used Rogers (2003) traditional model of diffusion. The innovative practices in the TFEC which are sustainability interventions and optimisation of economies-of-scale benefits through a cooperative business model do qualify as innovation under Rogers (2003) model of innovation. The manner in which an innovation diffuses is largely dependent on the communication channels that exist between the innovating and adopting stakeholders/communities.

Communication channels (as the means of sharing information from the urban to rural communities covered in this study, in order to exchange innovation knowledge) was therefore the main focus of the study.

Under Rogers (2003) classification of communication channels, this study would fall under the "cosmopolite" channels which cover the linking of an individual of the social system with outside sources of information. The effectiveness of the communication channels under this study is therefore enhanced through the proposed partnership and cooperation between actors in the diffusion process. Rogers (2003) describes the innovation-diffusion process as an uncertainty reduction process, and therefore proposes attributes of innovations that help to decrease such related uncertainties. This entails five characteristics of innovations which are: relative advantage, compatibility, complexity, trialability, and observability. The 'pilot' step as proposed in this study (the last phase in the innovation-adoption guide) and the second stage of the conceptual model provides the opportunity for assessing the relative advantage, compatibility and trialability of the innovative practices within the host community. The observability characteristics are discussed along the local laboratory under knowledge development and skills transfer. The ability to reduce most, if not all, of the innovation uncertainties means a high potential for the full adoption or rollout of the innovation.

From the appraised theories and models on the diffusion of innovation and technology transfer, it is apparent that knowledge development and transfer; partnerships and collaborations, communication channels, skills transfer and social networks constitute the initial step to any diffusion of innovation programme. This is followed by the trialling and piloting stage of the innovation in order to test its viability against the local socio-cultural and environmental context. As argued under the evolutionary perspective of diffusion (Douthwaite *et al*, 2002), the innovation adopted would require some adaptive modifications, invention and creativity within the host-context in order to fit and optimise on the local/host context opportunities and challenges. This demonstrates the critical significance of the adaptive innovation diffusion model. These crucial insights from the different theories/models have been sensitively embedded/integrated into the innovation-adoption guide and the recommended conceptual innovation-diffusion model emerging from this study.

7.3 Summary and Overall Conclusion

The substantiated on the opportunity of adaptive diffusion of the innovative sustainability practices and cooperative business model of the Tshwane Food and Energy Centre in kwaSwayimane rural community. Key findings of the study indicate that the sustainability practices adopted in the TFEC are currently experiencing implementation challenges as would be expected with most pilot stages of any innovation diffusion process. This comes after the practices were effectively functional for about two month subsequent to the commissioning of the project, with consequence that the project now presents two sets of practices. The first one covers the initially planned sustainability interventions that lasted for about two months. The second set covers the adaptive or survival/coping practices adopted by the beneficiaries as a result of encountering the implementation challenges. It is the first set of sustainability practices that provoked this study and remained as the focus set of innovations considered for diffusion to kwaSwayimane. The practices include the integration of sustainability interventions (renewable energy, groundwater abstraction, rainwater harvesting, solar water heater and on-site housing) to support market-based agricultural production and for domestic consumption. The innovations also entail optimising economies-of-scale benefits through utilising shared facilities, bulk input buying, combined bulk selling and access to secure markets (cooperative business model).

The study finds that kwaSwayimane rural community is characterised by a hybrid of household-based subsistence and cash-crop farming of vegetables and livestock. In addition, the study finds that the farming is characterised with multiple challenges such as inadequate water infrastructure/supply, high cost of inputs, lack of access to markets and minimal government support. These challenges continue to prevail despite the fact that the municipality has identified agriculture as a strategic sector towards tackling unemployment, stimulating the economy and implementing sustainability interventions in uMshwathi municipality.

The review of the municipality's agricultural strategy (which aims to specifically support emerging farmers, SMMEs, informal sector, youth, women and the previously disadvantaged) is a sign of hope for subsistence/cash-crop farming households in the municipality. As part of the agri-business strategy, the municipality is also exploring the feasibility of establishing pack house(s), fresh produce market, market stalls and community gardens. IDP also identifies about 800Ha of prime land for agricultural production within the kwaSwayimane area.

Arising from this need of kwaSwayimane to stimulate its agriculture, create jobs, empower SMME's and incorporate sustainability intervention; the study hypothesised that the TFEC project would be a good innovation case study to learn from especially from a local laboratory perspective. The main question for the study therefore focused on how the innovative practices in the TFEC could be tapped in order to expedite diffusion of sustainable development for rural kwaSwayimane which is endowed with land of high-agricultural potential. The study therefore focused on substantiating how the envisaged innovation diffusion process could be conceptualised and communicated to the actors in both the source and host communities.

Given that no awareness of TFEC innovations was to be expected among the kwaSwayimane or uMshwathi actors, the study begins with developing an innovation-adoption guide that would bridge this awareness gap. The objective of this guide was to guide kwaSwayimane on how it can tap into the TFEC sustainability practices in order to expedite the diffusion of sustainability interventions. The guide is structured into four phases. The first phase recognises the lack of information and knowledge about the TFEC innovative practices. It therefore prioritises access to information, effective communication networks, learning from local laboratories and knowledge development as the initial step. This study can therefore be viewed as the first component of the knowledge development process for kwaSwayimane and would be used in complement with other information available online and in the local newspapers.

The second phase encourages partnership and cooperation with other actors involved in the innovation diffusion and the related value-chain. This relationship should begin with partnership between kwaSwayimane and City of Tshwane/TFEC. The relationship would enhance knowledge transfer through effective communication channels which would further permit learning from the TFEC local laboratory. Successes, challenges and failures of the TFEC can then be better understood in order to guide effective implementation/diffusion in kwaSwayimane. Furthermore, it would foster peer influence and learning as well as partnership with other role players, such as innovation developers, non-profit organisations, financial institutions, retailers, suppliers and other actors who would expand the network and improve on information flow.

The third phase, which is also linked to partnership would be skills development and transfer where the City of Tshwane can play an important role in the process of transferring skills and managerial capacity to kwaSwayimane through training, workshops and field activities.

Partnerships with institutions possessing technical agricultural expertise is also important for reaping synergies between the community, municipality, and DARD.

The last phase entails piloting and would involve the testing and trialling of innovation in kwaSwayimane. The main purpose of this phase would be to test compatibility within the local context and evaluate the relative advantage compared to the status-quo practices. The level of adaptability, compatibility and economic viability of the innovation would significantly influence/guide the expansion and full rollout of the innovative practices.

The innovation-adoption guide informs and guides the conceptual innovation-diffusion model that is recommended to the City of Tshwane and uMshwathi Municipality. The conceptual model provides a logical two-stage process that outlines how the innovative practices in the TFEC could be tapped for diffusion to kwaSwayimane. Partnership is the first stage and would entail the incubation of partnership and cooperation avtivities between the two communities. At a later stage when the relationship is strong, the partnership would expand to other role players in order to form a wide/diverse network. The objective of the partnership and network would entail knowledge sharing, developing knowledge, transferring skills, building capacity, and providing training. In addition, joint activities and exchange programmes would constitute the key elements of this stage. Modern communication channels using online platforms are recommended as the more effective communication method and should be complemented with face-to-face channels.

Following a successful undertaking of the first stage, the second stage of trialling the innovation is proposed. This would be informed/guided by the lived experiences of the participant-beneficiaries from the TFEC project with the aim of improving the chances of success of the trial/pilot and overall innovation adoption. This stage would therefore be sensitive and responsive to the implementation challenges observed in the TFEC diffusion process. From these lessons, the study then recommends what could be done better, as well as what could be avoided in the piloting of the innovative practices in kwaSwayimane (see Section 7.1 under the consolidation of key research findings). Apparent in this stage, is that the innovative practices would have to be adapted and reinvented in order to optimise their fit onto the local social and environmental context.

The key research findings (particularly the innovation-adoption guide and conceptual innovation-diffusion model) captured in the previous sections not only substantiate on the research questions, but also predominately support the working hypothesis that:

‘With insights from diffusion of innovations and technology transfer models/practices, the study expected to find that collaborative/twining approach between the two case study communities (both through joint activities as well as information-sharing through online platforms) would enhance the diffusion and transfer process of interventions thus expediting sustainable socio-economic development for the rural community while also empowering the urban community to innovate further’.

In conclusion, it is through partnership and collaborative initiatives that kwaSwayimane would be able to tap into the innovative practices in urban agriculture in order to expedite diffusion of innovation for sustainable agriculture practices. Furthermore, trialling and piloting of the innovative practices would be critical towards ensuring the successful implementation of the diffusion project. In turn, the TFEC could be empowered by the diffusion process towards improving on the existing project gaps and thus innovate further through reinventing.

7.4 Recommendations

Emanating from this study, the two-stage conceptual model constitutes the key finding of the study and therefore anchors the study recommendations. The first stage calls for partnership and cooperation between the two communities for the purpose of enhancing communication, sharing information, developing knowledge, transferring skills, building capacity and forming an extensive innovation-diffusion network. In addition, joint activities and exchange programmes are also important. This would require effective and efficient communication channels between the two communities. Intimate interpersonal communication channels that utilise information technology such as online platforms are recommended and should be complemented with face-to-face channels. Furthermore, the incorporation of opinion leaders, change agencies/agents and extension services into the social network would enhance communication and information sharing and is therefore also recommended. The second stage involves the piloting of the innovative practices in order to adapt them for compatibility and optimise for benefits before full adoption or rollout. This study therefore recommends that the innovative integrated sustainability practices and cooperative business model must be evaluated against the local context so that the local environment can be optimised for meaningful/effective adaption and reinvention of the basket of innovations. An opportunity to incorporate some of the findings and recommendations emanating from this study in the current review of kwaSwayimane agri-business strategy is therefore recommended. In addition,

kwaSwayimane diffusion process hypothesised in this study should be linked with processes/initiatives already underway in the community.

Due to the delimitation of the scope of the study, which is primarily at a conceptual level, it did not precisely address the exact interventions/practices which would be most appropriate for adoption in kwaSwayimane. The study, therefore recommends that suitable agricultural activities for kwaSwayimane as well appropriate renewable energy technologies and efficient water systems for the area must be established through a study that involves collaboration with the DARD, DLED, and kwaSwayimane community. Within the leadership of the DLED, the practical adaptive-adoption of a cooperative business model would require additional investigation in order to ensure optimisation of local sustainable development. The possibility of economies-of-scale benefits, value-adding mechanisms and access to markets brought by this business model calls for additional and thorough appraisal of the opportunities and methods. A brief study in the whole of kwaSwayimane (all municipal wards) assessing the status-quo agriculture, food and water practices must be established in order to investigate the diversity of the practices across kwaSwayimane in order to guide on a more context-responsive diffusion approach. uMshwathi Municipality must also investigate the funding options for the financing of the pilot project or implementation of the innovations. The extended network with financial institutions created under Stage 1 of the conceptual model could be explored for potential funding models.

Along with findings of this study, the TFEC should commission a study in order to probe and categorise all the implementation challenges of the project. The study could be extended to include the former/ex-beneficiaries of the project as respondents. The purpose of the study would be to draw risks that would be mitigated after all the current project implementation gaps have been addressed. Furthermore, such an appraisal could assist in the strengthening of internal governance as this is a common challenge with collective action organisations. The study also recommends that partnership with provincial DARD and extension service organisations who would be deemed to possess/manage the technical-know-how (skills/expertise) in agriculture, should be established by the City of Tshwane for the purpose of improving the TFEC project gaps. An opportunity for establishing and sustaining a live online platform for TFEC to capture and share learning-curve experiences and innovation adaptations over time is recommended as a step towards improving the effectiveness of the innovations.

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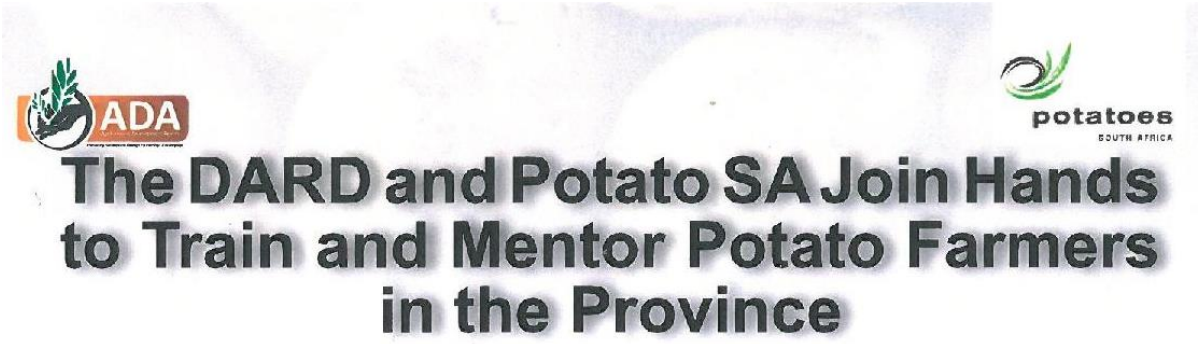
Appendices

Appendix A: Agribusiness Development Agency Magazine



The DARD and Potato SA Join Hands to Train and Mentor Potato Farmers in the Province

The Department of Agriculture and Rural Development's recent partnership with the Enterprise Development Project, an agribusiness segment of Potato South Africa, helped to equip farmers in KwaSwayimane with the ins and outs of potato farming.

Recently, the Department of Agriculture and Rural Development (DARD) and the Enterprise Development Project (EDP) visited KwaSwayimane, around Pietrmaritzburg, in the KwaZulu-Natal midlands, to share information about developmental programmes in their calendar this year.

The purpose of the stopover was to educate the residents about the effective and practical methods of potato farming and how proper application of this knowledge can go a long way in helping them alleviate poverty and ensure that their food reservoirs do not dry up. DARD's educational programmes are designed to equip communities living below the breadline with farming skills, in this case potato farming, so that they can actively participate in the fight against poverty and, in the process, create job opportunities for other unemployed community members.

The DARD prioritises agricultural training of farmers and farming communities. The department's advisors and extension officers are also trained rigorously in the latest agricultural farming methods to ensure that the training they provide to farmers remain relevantt and efficient.

Mr Morgan Naidoo of the DARD said farmers were trained in modern ways of cultivating and nurturing their potatoes before they could harvest them. He emphasised the importance of putting in hard work and extensive preparation of the soil before planting their seeds.

Mr Luis Pretorius from Potato SA cautioned the farmers about the hurdles they might endure after harvesting, the challenges of entering the trade market and being able to sell their produce. Farmers were taught how to organise themselves and sell their products as a collective to communities that reside near their farms and other potential markets.

Also, Dr Webetu Legesse of the Agriculture Research Council warned the farmers about the gems found in potatoes and how this could be prevented or dealt with should it occur. "Nurturing the produce is the main principle because it is the produce itself that says how it will be accepted in the market", Dr Legesse said. Farmers were also reminded about their duty to maintain food security in the country because it was of national importance. The officials from the DARD and Potato SA were excited to see a large number of farmers who turned up at the skills-and information-sharing gathering.

The meeting also showcased the latest high-tech potato-harvesting machines, which ensure that all potatoes are extracted from the ground, causing minimal damage to the produce in the process. Members of the farmers' organisations, such as Baxoleleni, enthused about the information on potato farming they gained at the gathering, and said they were now well-armed to become prosperous potato farmers.

The KwaSwayimane farmers – most of them are well-looked after by Mr Wiseman Ndlovu, the department's advisor – applauded the interventions and the role that the DARD plays in improving their farming operations.

This was not the first time that such a meeting took place. Another gathering was held at Cedara Agricultural College, an agricultural college and research station near Howick in the Umgungudlovu District, Pietermaritzburg. The meeting was attended by farmers from other countries who shared knowledge and certain agricultural skills with their South African counterparts. ADA

Appendix B: Interviews Guide Questions and Direct Observation Tool

B1. Tshwane Food and Energy Centre (TFEC) Manager

Can you please brief me on the innovative operations of the TFEC project?

- Follow up questions will focus on the unique innovations

What is the impact of the innovations on the surrounding areas?

How many SMMEs/ Farmers and employment opportunities have been created?

How do the surrounding communities view the innovations?

What are the challenges of rolling-out/ diffusing the innovations and where would you like to improve?

Can you please share some statistic data on the production, revenues, literacy and demography of the project? *(PM could not provide such data)*

How could similar innovations be diffused to rural communities endowed with land of high-agricultural potential?

Any possibility for innovation diffusion partnership?

B2. TFEC Beneficiaries

What do you think about your experience and challenges with chicken farming and vegetable tunnels in the TFEC?

What did you do to address the challenges?

What helped/assisted you to be able to do chicken farming and vegetable tunnels (modern farming)?

How easy or difficult was it is to adjust to this kind of farming?

What were you doing before you came here (former source of income)?

How has you being part of this project improved your wellbeing?

How have these innovations improved your farming business and your life?

Where do you get your water, electricity and support?

How has this helped you to do your farming business more effectively and efficiently (better)?

What is your comment on the integration of solar water heaters, renewable energy, rainwater tanks and the business support hub in the project?

Would you encourage the adoption of such innovations in rural communities endowed with land of high-agriculture potential?

Do you think that the same thing (overall farming and support) can happen in other places?

If so, how and what could be done better?

B3. KwaSwayimane Manager

What is your agricultural strategy or plan for the municipality, particularly for rural communities like kwaSwayimane?

What are the current agricultural activities in the communities and how does these impact on the surrounding communities? Agricultural practices status in the area

What do you think are the challenges or factors hindering agricultural activities in the area?

To what extent do you think people of kwaSwayimane are interested in agriculture and want to pursue agriculture for their socio-economic improvement? Examples…

What is the general profile of the people interested in pursuing agricultural activities in your community (experience, literacy, gender, age-categories, level of education etc)?

Is the municipality willing to learn agricultural innovations and initiatives that are applied in urban agriculture?

Would the municipality be open to possible technology transfer partnership?

B4. KwaSwayimane Farmers

What do you do for a living?

Are you currently or ever been involved in any agricultural related activities - be it subsistence farming or employed?

If Yes, what are you currently farming or have farmed previously?

What were or are your challenges?

What did you do to address those challenges? Or What do you think can be done to address such challenges?

Have you undergone any formal agriculture related training or workshop?

Where do you get your water, electricity and support for your farming purposes?

What technologies are currently used in your agricultural activities?

How efficient and effective are the technologies you are currently using?

Would you be interested in adopting innovations and new technologies in your agricultural practice?

To what extent would you be interested to learn new innovations through training and workshops?

How could technology transfer/innovation diffusion in agriculture be facilitated within your community?

B5. Direct Observation Tool

	TFEC	Swayimane
Photos • Biogas production facility • Solar power plant • Rainwater tanks • Solar water heaters • Vegetable tunnels (greenhouses) • Chicken coops • Subsistence farming • Other agricultural activities and practices		
Maps • Location and sizes of the agricultural practices and activities (including sustainability interventions)		
Notes • How are the sustainability interventions integrated to agriculture/farming • Sources of energy and water • Farming processes, quantities produced • Status-quo agricultural practices • Community benefits from agricultural practices • Functionality of the business support hub		

Appendix C: Ethics Clearance

SCHOOL OF ARCHITECTURE AND PLANNING
HUMAN RESERCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE
PROTOCOL NUMBER: SOAP070/06/2017

PROJECT TITLE:	Urban -rural interactions for diffusion of sustainability interventions in food, energy and water: The case of Tshwane Food and Energy Centre (TFEC Gauteng)
INVESTIGATOR/S:	Sphelele Khanyile (Student no #1740092)
SCHOOL:	Architecture and Planning
DEGREE PROGRAMME:	Master of Architecture -SEEC (MArch SEEC)
DATE CONSIDERED:	14 September 2017
EXPIRY DATE:	14 September 2018
DECISION OF THE COMMITTEE:	APPROVED

CHAIRPERSON _____
(Professor Daniel Irurah)

DATE: 15- 09- 2017

cc: Supervisor/s: Daniel Irurah

DECLARATION OF INVESTIGATORS

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to endure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature **Date** 18/09/2017

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Appendix D: Study 4_Events and associated system-functions (Kebede and Mitsufuji, 2017: 251, 252)

Year	Events	Function
Early 1980s	The government urged and welcomed energy technology proposals to address the energy problem as a follow up to oil crisis	F4
Early 1980s	University professors, expert and consultants were urged and invited to submit proposals	F6
1986	The first Solar PV stand-alone system (10.5 kW) introduced to Mito village in Central Ethiopia	F1
1986	A study on solar radiation distribution in Ethiopia was conducted and released by the Ethiopian National Energy Commission and CESEN, Italian consulting company	F2
1989	Technical appraisal of the Mito village pilot project was carried out by an Ethiopian professor	F2
1989	Mito II project was expanded to 21 kWp system	F1
1994	UNESCO funded PV-powered solar pumping for a village	F1
1998	Two small system of 55 Wp module installed in AAU for climate research/feasibility study	F2
2000/1	IGAD conducted market study and supported demonstration projects training of solar technicians	F2
2002	Establishment of Ethiopian Rural Energy Development and Promotion Center to support RE	F4
2003	Establishment of Rural Electrification Fund through the support of World bank, IFC and UNDP	F4
2003	World Bank(WB)-GEF provided loan to energy project of GoE	F6
2003	The WB Program set a minim 6 000 solar system installation	F4
2003	Study on the commercialization of solar PV conducted	F2
2003	More private companies joined PV market	F1
2004	UNEP-GEF funded a SWERA (Solar and Wind Energy Resources Assessment) project in Ethiopia released	F2, F4
2004	Barefoot College started training farmers from Ethiopia	F3
2004–2005	Tukul, solar village, was visited by Donors, NGOs, UNDP staff and it was talked about	F4
2004–2006	Additional 34 trainees of Barefoot College by the fund support from UNDP	F2
2005	Trainees promoted and installed systems in their villages	F2
2005	A solar home systems pilot project kicked off, by Solar Energy Foundation(SEF), about 30 SHS were in installed in Kechemober	F1
2005	Inspection of Kechemober installations for techncial problems and community acceptance study conudcted	F2
2005	Visit of Kechemober by other rural communities including Rema villagers	F3
2006	Establishment of the Solar Training and Competence Centers in Addis Ababa	F6
2006	EEPCO power system expansion b/n 2006–2015 focused on Hydro power; no mention of solar	F1
2006	Universal Electricity Access Program released	F6
2007	1100 SHS installed in Rema-1100 huts (around 6 000 people inside) including Police and Adminstration Offices; Church and Mosques	F1
2007	National mass media reported widely about Rema SHS installations	F3

2007	SEF launched further plan (1675 signatories received from Dire and other villages) to solarify a vilalge in 2007/2008 and established a training center	F5
2007	International Solar Energy School (ISES) established at Rema	F6
2007	Seminar on "Photovoltaics: Technology and Practical Applications" was given to Electrical Engineering Staff of Ethiopian Universities	F3
2007	Public Panel Discussion on "Solar energy in Ethiopia", with participation of Senior Officers from Ministry of Mines and Energy	F3
2007	Training course on "Rural Solar energy manager" aimed at Electrical Engineers, focused on Solar technology, management and practical, 3 month training started	F3
2008	Local assembly in Rema was started	F2
2008	Japan Embassy released a study both in Japanese and English on Energy Sector and Investment Potential in Ethiopia	F2
2008	SEF made agreement with Rema, Rema ena Dire for installation of 1 000 SHS	F7
2008	24 first graduates from ISES followed by practice b/n April and August in installing in Rema &Dire	F3
2008	Rema became a member of Worldwide One Laptop Per Child Project and teachers given training on how to use the small pc (soar using laptop)	F6
2008	Bill Clinton visited Rema, the solar village	F7
2008	Training of 25 members from Regional Energy Bureaus at ISES	F3
2009	GTZ conducted PV market assessment in Ethiopia	F2
2009	Market study indicated potential up to 52 MW PV market in Ethiopia	F4
2009	A number of PV systems were installed on rural health centers and primary schools by GTZ	F3
2009	PV system design and installation (ES 3482:2009) code of conduct published by Ethiopian Quality and Standards Authority	F4
2009	Private companies were joining the market	F1
2009	A study on "Diversity and Security in Ethiopian Power Reform" funded by Heinrich Boll foundation and Forum for Environment, Ethiopia released	F2
2009	Sahay Solar initiated the first activities at AMU in 2009 by installing the AMU solar laboratory	F1
2009	Ethiopian Solar Development Society (ESDS) established for lobbying and advocacy	F7
2009	The first manual (handbook) on "Rural electrification with PV" for developing countries launched by SEF	F2
2009	Solar energy and the refrigeration of medicine training held in cooperation with WHO in Addis Ababa by trainers from ISES	F3
2009	Ashden Award granted to SEF	F4
2009	ISES with ECBP gave a one week training for Ethiopian Lecturer (Department heads of Electrical Engineering) in Further training Adama	F3
2009	ISES's course, Rural Solar Energy Technician Course recognized by Amhara Regional State Education Bureau	F7
2009	Feasibility study for 120 MW grid connected PV system in Afar region by EEPCO	F2
2009	Power outage plagued the country	F4
2009	The Ethiopian Minister of Energy visited Rema, impressed and promised to ease import bars	F4
2009	Ministry of Finance and Economic Development (MoFED) lifted the import duty fees on PV modules and balance of system (BOS)	F5
2009	EnDev budgeted 6Mio Euro for Bio-energy, solar PV and private sector development	F6

2009	GTZ-ECO through EnDev programme installed 55 solar PV systems (1.43 kWp) on health centers	F1
2010	Training for Ethiopian Microfinance providers, Banks and public authorities representatives	F3
2010	UNDP with its partners conducted a study on and showed capacity on Local Manufacturing of Renewable Energy Technology Components in East Africa (in Ethiopia and Uganda)	F2, F4
2010	A number of institutional PV systems were installed by GTZ and other NGOs	F3
2010	Inauguration of the Solar Valley Ethiopia and ceremonial initiation of the solar system under the dena Solar Roofs Program. International guests, the Ethiopian Minister of Energy and a representative of the German Embassy attended	F3,F7
2010	SEF met the Gold Standard quality criteria on climate change for its Ethiopian PV projects	F4
2010	The Growth and Transformation Plan (GTP: 2010/11–2014/15) mentioned RE including solar as source of energy for the nation	F4
2010	GTP set goals on SHS and Lanterns dissemination to electrify 153 000 households with SHS and to supply 3 million solar lanterns by 2015	F4
2010	Indian Government sponsored and trained Ethiopian University staff on Designing and Implementing Solar Energy Projects for Rural Communities	F2
2010	Renewable Energy related Master Programs launched at least in two universities	F2
2011	Ethiopia Solar – The initiation of a solar trade in Ethiopia, 2005–2011 report published	F2
2011	Adama Institute for Sustainable Energy established in Adama University	F6
2011	ACP-EU Energy Facility Grant of the 10th European Development Fund a project of HoA-REC&N entitled "An Integrated Approach to Meet the Rural Household Energy Needs of Ethiopia" – kicked off	F6
2011	A number of institutional PV systems were installed by different organizations	F3
2011	Lighting Africa conducted a study and released a policy report on solar PV and modern lighting in Ethiopia	F2
2011	Lighting Africa also released a study report on Off-grid market in sub-Saharan African countries including Ethiopia	F2
2011	The study of Lighting Africa showed over 24 million households in Ethiopia are potential off-grid market	F4
2011	HoA-REC&N started to organize 20 SMEs for establishing renewable energy centers	F1
2011	ETV news coverage on Solar and Wind Energy investment of Ethio-German Konnect Event	F3
2011	Training of Trainers for Solar PV conducted in Adama University by the support of GIZ-ECO	F2
2011	Training of Trainers on Solar Business Management in Adama University by the support of GIZ-ECO	F2
2011	Staff and students trainings on solar PV systems in different Universities including AMU	F3
2011	A Master Plan Report of Wind and Solar Energy in Ethiopia conducted by a Chinese Corporation	F2
2011	GoE developed Climate Resilient Green Economy (CRGE) strategy	F4
2012	Installation of solar system at a Hotel Lodge in the Arbaminch area-commercial project	F1
2012	Inclusion of PV-teaching modules into existing curricula in Arbaminch University	F2
2012	World Bank provided soft loan for REF 25 000 SHS installation throughout the country	F4

2012	Market Development for Renewable Energy and Energy Efficient Product Fund made available	F6
2012	Solar PV system promotion through REF projects	F3
2012	REF disseminated PV systems to regional bureaus for training and demonstration purpose	F5
2012	SEF and ESDS conducted a national workshop on solar PV industry in Ethiopia and released a study report	F2
2012	GIZ and Selam Vocational school provided 8 days training to cooperatives on solar PV installation and maintenance	F3
2012	A national feasibility study indicated that 50 000 jobs can be created in solar sector	F4
2012	Federal Democratic Republic of Ethiopia (FDRE), Scaling Up Renewable Energy Program Ethiopia Investment Plan, 2012	F4
2012	The first Solar Kiosk launched in Langano area	F1
2012	1st Solar PV modules Assembly plant launched by METEC	F1