S. Afr. J. Agric. Ext. Zwane
Vol. 48 No. 1, 2020: 122 - 134
http://dx.doi.org/10.17159/2413-3221/2020/v48n1a531

THE ROLE OF AGRICULTURAL INNOVATION SYSTEM IN SUSTAINABLE FOOD SECURITY

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ABSTRACT

Much has been discussed about the role of extension within the framework of assisting farmers to improve their productivities. 'Different Task Teams' focusing on environment and food have been established under the banner of the United Nations. In most cases, their membership is restricted to high level delegates such as heads of governments. This paper seeks to fill the gap in literature by discussing the role of Agricultural Innovations System, its meaning, and how it functions. It draws experience from a case study based in the Limpopo Province of South Africa, coordinated by Progress Milling. It specifically discusses the linkage of Agricultural Innovation System with food security. The paper concludes with a few recommendations such as the establishment of a mechanism to coordinate multiple stakeholders, the establishment of measures to stimulate collaboration amongst stakeholders, and to strengthen the development of innovation competence.

Keywords: Agriculture, Food security, ICT, Innovation system

1. INTRODUCTION

The role played by extension within the framework of helping farmers has been discussed by many authors (Barett, 2002; Daane, 2010; Swanson & Claar, 1984; Van Den Ban & Hawkins, 1990), but not much is known about the role of agricultural innovations systems. There is a strong belief that agricultural innovations have a role to play in reducing poverty. The evidence lies in the number of publications that have been published on the subject of innovations and innovation systems, as well as the number of international forums that attract world leaders.

Examples include the Agricultural Innovation & Technology Hold Key to Poverty Reduction in Developing Countries (World Bank, 2019); Agricultural Knowledge and Information Systems and Poverty Reduction (Berdegué & Escobar, 2001); Food and Agricultural Organisation of the United Nations (FAO)'s work on Agricultural Innovation (FAO, 2017); Tackling Poverty and Hunger through Digital Innovation (FAO, 2017); Speaking about Ways Agricultural Innovations Reducing Poverty (Borgen, 2017); Food and Innovations Pathways for Prosperity, (Tomich *et al*, 2019); Agricultural Innovation for Food Security and Environmental Sustainability in the Context of the Recent Economic Crisis: Why a Gender Perspective? (Alarcón & Bodouroglou, 2011). As far as the forums are concerned, they include Conference of the Parties (COP)s and Bricks. The importance of food security and its sustainability has been recognised by all leaders, both in developing and developed countries. A number of mechanisms have been established to facilitate the sharing of information about food security and sustainable use of the environment.

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http://dx.doi.org/10.17159/2413-3221/2020/v48n1a531

Some of the notable examples include the G20 Meeting, United Nations (UN) Climate Change, also known as Conference of the Parties (COP), of which its 17th Conference was held in Durban, South Africa on the 28 November 2011. Another closely related structure is the United Nations Conference on Sustainable Development. Other examples include the Committee on World Food Committee (CFS) and World Food Crisis Meeting. The World Food Crisis Meeting was held on 16 October 2008 in Rome (Golay, 2010). The problem tackled in this paper is that food crisis is experienced in different parts of the world (UN, 2013), hence the crafting of the millennium goals in 2000. Poverty is identified in the millennium development goal (MDG) as one of the problematic areas, hence, the plan was to half it by 2015. Poverty is created by a number of issues at play which leads to food insecurity. The most affected people are the poor and the most vulnerable communities whose situation is aggravated by climate change and this has also lead to degradation of productive land.

Many of the farmers who suffer hunger and food insecurity are farming in small-scale farms and do not have access to information in order to make informed decisions (Alarcón & Bodouroglou, 2011). These farmers need technological upgrading in their agricultural productivity ventures. Different perspectives of innovations systems present a solution in understanding how farmers can improve their productivity, for example, the adoption of technology which is friendly to their environment will promote sustainable food security and proper land management (Alarcón & Bodouroglou, 2011; UN, 2015a). The objectives of this paper are to:

- Explore the concept of innovation systems, its meaning, and its challenges.
- Explore global initiatives of food security.
- Explore the role of agricultural extension in food security.
- Discuss an innovation platform in Limpopo Province.
- Recommend practical steps in implementing a successful innovation platform.

2. BACKGROUND

The world population was 5.2 billion in 1996 and it is predicted that it will grow to 8.3 billion by 2025 and almost 10 billion by 2050 (UN, 2013). However, in October 2017, it was estimated that the world population has reached 7.6 billion people (UN, 2013). It is estimated that 870 million people go to bed hungry every day and 70% of the people are from Sub-Saharan Africa (UN, 2013). The United Nations formulated a resolution which aimed at addressing the issue of poverty, and in the year 2000, they agreed to work towards halving poverty by the year 2015. Observation has shown that the world population continued to increase, and the review showed that it will not reach its target by 2015. It is a known fact that these objectives were not attained, hence, 17 sustainable development goals (SDGS) have been adopted in 2015 by the United Nations (UN, 2015a).

The focus of this paper is made up of two phrases, namely agricultural innovation system and sustainable food security. Tracing the background of agricultural innovation systems is discussed first. The subject of agricultural innovation system emerged as a field of study fairly recently. A number of books emerged with related topics in agricultural innovation, for example, 'Extension Science' carried the title of agricultural information systems (Röling, 1988), 'Technology systems for small-scale farmers' (Kessabe, 1989), and 'Agricultural knowledge and information systems' (Kaimowitz, 1990). The use of the concept of agricultural

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innovations is being promoted by international organisations such as the UN and the Centre for Technical Agriculture (CTA).

In contrast, the background of food security can be traced back to the emergence of the Millennium Development Goals. These consist of eight development goals. Two are linked to agriculture, namely goal 3 which focuses on reducing poverty and hunger, and goal 7 which focuses on sustainable environment. One needs to indicate that there are scholars who criticise the Millennium Development Goals by highlighting the fact that these goals were not analysed deeply and that there are no quantifiable measures to track progress. The goals were officially established following the Millennium Summit of the United Nations held in 2000 after the adoption of the United Nations Millennium Declaration in which 193 member states and 23 international organisations agreed to achieve these goals by the year 2015 (UN, 2015b).

At the World Food Summit in 1996, 185 countries signed a declaration pledging to decrease the number of hungry people by 50% by the year 2015. Since 1996, the number of hungry people in the world has not decreased, but rather increased from 800 million to over 850 million people (UN, 2013). The burden of hunger falls disproportionately on the rural poor (small farmers, farm labourers, and landless rural people), largely due to governments around the world promoting trade, and economic and environmental policies to the detriment of the livelihoods of small farmers and community-based agriculture.

3. RESEARCH METHOD

This paper took a case study approach and made use of literature in order to address some of the specified research objectives. Selected literature was collected through a Google search in order to assist the reader. The next section presents the findings.

4. UNDERSTANDING THE CONCEPT OF INNOVATION SYSTEM

4.1 Agricultural innovation systems

It is important that one should understand the meaning of innovation systems. There are different interpretations about the concept. The concept was further classified and defined by some researchers within the framework of Agriculture and Rural Development (ARD) concepts (Daane, 2010), while others saw it as part of Information Communication Technology (ICT) or other systems of technology generation and dissemination like Transfer of Technology (TOT) streams (Daane, 2004; Engel, 1989; Röling, 1988).

4.1.1 The meaning of innovation systems

A literature review found that a number of scholars have popularised the use of the concept and have used names closely related such as agricultural information system, agricultural knowledge and information system (AKIS) (Daane, 2004).), as well as TOT, ARD, and Participatory Research (Kessabe, 1989). The concept was further taken up by other scholars and it was called Rapid Appraisal Agricultural Knowledge System (RAAKS) (Nagel, 1980) and Farmer First (Chambers, 1990; Daane, 2004). The definition of AKIS is cited here because of its comprehensiveness.
AKIS is defined as “a set of agricultural organisations and/or persons and the links and interactions between them engaged in such processes as the generation, transformation,

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transmission, storage, retrieval, integration, diffusion and utilisation of knowledge and information with the purpose of working synergic ally to support decision making, problem solving and innovation in a given country's agriculture or domain thereof" (Kaimowitz, 1990:10) To give effect of Kaimowitz's definition, the Technical Centre for Agriculture (CTA) organised a workshop in 2004, as well as in 2013, in which the writer participated in Wagenigin, under the banner of Extension Africa, a group of experts of which the writer is a member of.

Amongst others, the workshop clarified the concepts of innovation and innovation systems. In addition, the workshop purported to building capacity to understand and apply the innovation system framework for analysing agricultural science, technology and innovation (ASTI) (Daane *et al*, 2009). A close analysis of the definition reveals that the definition is comprehensive since it includes the linkages, the processing, the generation of information, the transmission or dissemination and storage of the information. It should be noted that this definition encompasses various systems of technology models that were used in the past as a stand-alone concept such as research, extension and farmer subsystems of technology generation and transfer.

The new concept, namely innovation system, displays a complex and dynamic character for linking human activities. From the definition, one can summarise an innovation as a process by which social actors create value from knowledge which may include technologies, processes, and modes of organisation policies. It can be concluded that innovation process involves transformation of knowledge through social learning (Daane, 2010).

Other scholars hold a similar view in which it is argued that there is a difference between information and knowledge. A message can contain information. An extension officer can transfer information, but knowledge is an attribute of the mind and it cannot be transferred (Röling, 1988). It can be indicated that innovation systems are not something which can be touched because it does not exist as an objective entity or in reality. It is argued that it exists in the minds of those who define them (Daane, 2010). There are challenges associated with the implementation of the innovation systems in practical terms.

4.1.2 Types of innovation systems

The concept has received much attention in 2014 and 2015. For example, two important good note practices were written, and these are titled "Innovation platforms" by Posthumus and Wongtschowski (2014) and "Agricultural Innovation System" (Suleiman, 2015). These were facilitated by the global forum for rural advisory services (GFRAS). Figure 1 provides a framework of an innovation system.

Figure 1 has identified nine actors. According to Suleiman (2015), each system assumes a different role to promote the innovation system. For example, under the AIS framework, innovation is not merely concerned with technical innovation (e.g. adoption of a better variety). It also includes organisational innovation (e.g. organisation of farmers as groups) and institutional innovation (e.g. addressing uncertainties in land leasing through policy changes). Donors and national governments currently recognise the importance of enhancing the capacity of all actors in the AIS instead of just research or extension (Suleiman, 2015).

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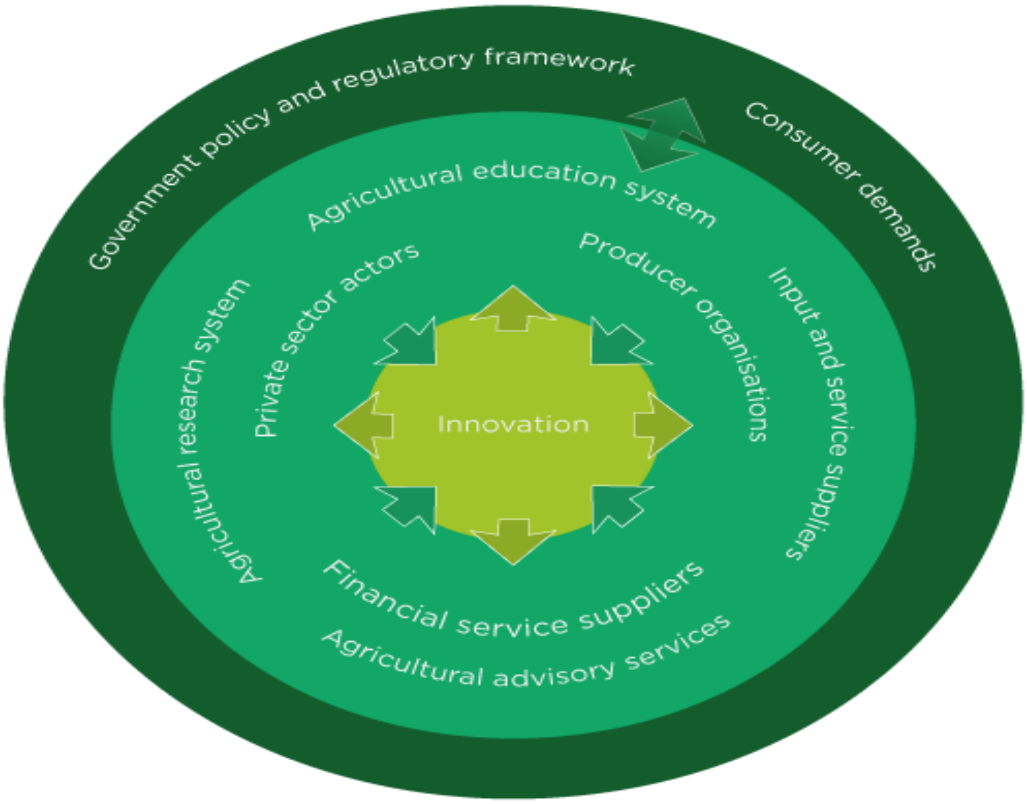

Figure 1: Agricultural Innovation System.
Source: Suleiman, 2015

In the case of the framework, the central theme in innovation can be equated to technology, and in this case, technology is divided into both software and hardware. The software consists of methods and skills whereas the hardware consists of physical objects such as tools, equipment and genetic material (Röling, 1990). Furthermore, the terms 'research' and 'technology transfer' have both functional and institutional meanings (Kaimowitz, 1990). Agricultural research plays an important role in creating knowledge and information which can increase farming productivity. A number of factors determine the rate of adoption of technology. Rogers (1963) identified the following: relative advantage, compatibility, complexity, divisibility, and communicability. Each has particular character which needs to be considered when adoption takes place.

4.1.3 Challenges of agricultural innovation systems

An agricultural information system is believed to be a complex phenomenon since there are various top down, bottom up, and horizontal flows of information and transformation that takes place.

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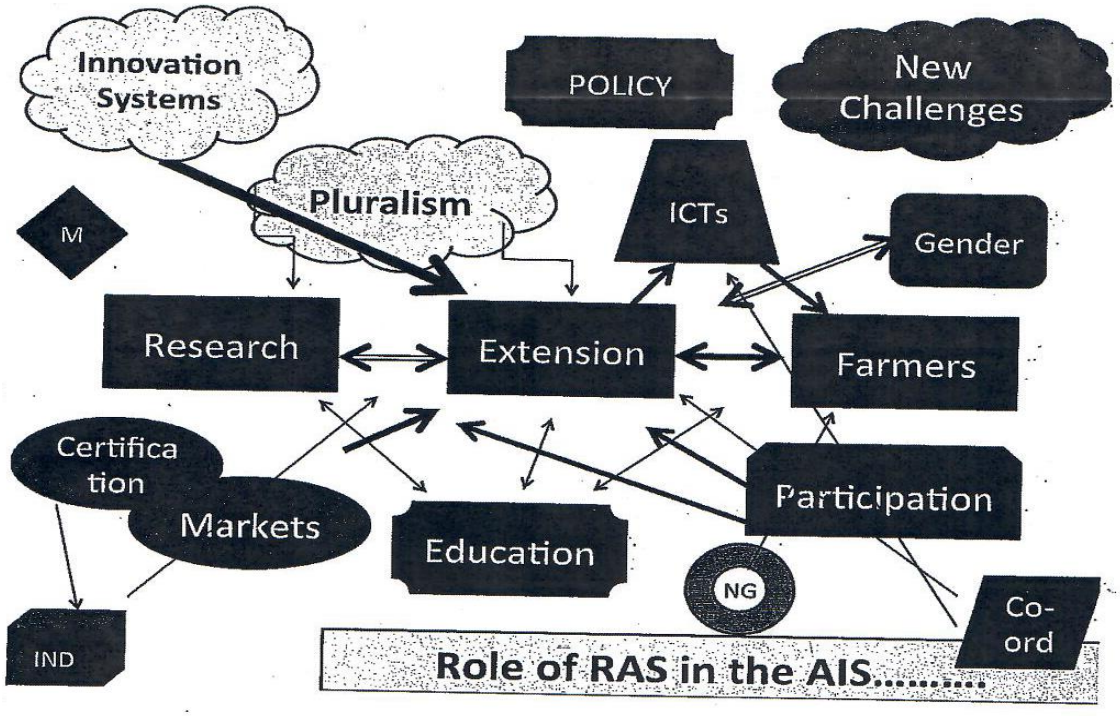

Figure 2: A diagram expressing the complexity within the innovation system
Source: Suleiman, 2015

Figure 2 displays the interactions of rural advisory actors within the framework of agricultural innovation systems. One of the challenges inherent in the framework is the difficulty in coordinating the pluralistic nature of innovation systems. As part of a solution, one author (Daane, 2010) suggested that brokers could be used in information sharing. However, it is noted that where there are brokers of information, it may work, but where there are none, it creates a problem. Information brokers are normally found in countries that have privatised their extension systems, for example the Netherlands (Daane, 2010). Other challenges include lack of linkages to facilitate multi stakeholders.

4.1.4 Implementing demand-driven, participatory approach methodologies

It has been found that top down approaches in extension are not sound pedagogically and not effective when used in democratic societies (UN, 2015a). Effectiveness and sustainability of the agricultural extension effort can be achieved when farmers are organised and involved in the process of the problem identification, planning, executor, and monitory activities. Various extension methods have been developed in recent years which encourages active participation of all parties involved (Gaaya, 1994).

4.2 Understanding food security initiatives

There are many things that need to be understood before sustainable food production is ensured. Some of them include defining the relationship of food security and the extension system that can contribute to increased production. Barrett (2002:2106) defines food security as "access by all people at all times to enough and appropriate quality food to provide the energy and nutrients needed to maintain an active and healthy life." Following this, food security programmes may

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simply be referred to as projects and activities that are meant to empower beneficiaries to have adequate access to quality and nutritious food all the time.

The necessary interventions should be targeted to achieve clear, simple and realistic goals, and performance targets with costs justified by delivering greater social benefits (Integrated Food Security Strategy for South Africa (IFSS), 2002). In order to achieve sustainable food security, extension is seen as one of the tools that can be engaged to deliver the product. Education, including training and extension services, are fundamental needs for human development in rural areas and also for expansion and modernisation of rural economies. Both men and women should be trained to develop and improve skills and to increase productivity and income generation.

4.3 Understanding agricultural extension

One definition of agricultural extension widely used in FAO publications sees extension as "a service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting the social and educational standards of rural life" (Swanson & Claar, 1984:1). The definition focuses on encouraging and involving rural people's own organisations, enhancing individual and collective self-reliance, and environmental issues. The definition focuses on assisting farmers "to help themselves" and building of self-reliance. This self-reliance is key in extension as it helps farmers to challenge handouts. In other words, agricultural extension builds farmers' capacities to be self-reliant. In this understanding, it provides a good platform to assist farmers towards food security. From the innovation perspective, it has already been indicated from the definition of innovation that it is a complex situation. The following section discusses the innovation platform experience in Limpopo.

4.4 Innovation platform on maize production in Limpopo Province

There are several innovation platforms that exist in Limpopo Province. Some have been documented while others have not yet been documented. Different stakeholders and their responsibilities for the Limpopo case are discussed in Figure 3.

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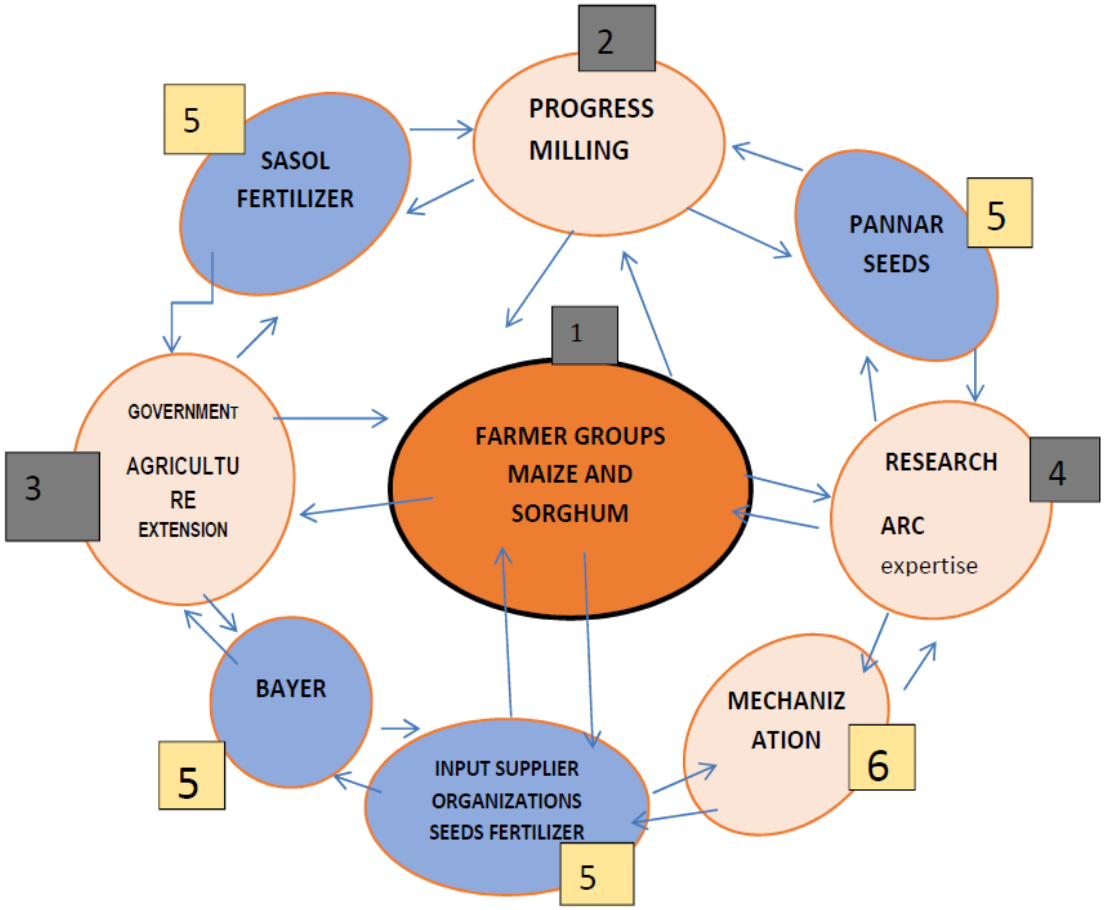

Figure 3: Agricultural innovation platform: Progress milling community development programme on maize production
Source: Author

The platform consists of six main groups of role players as indicated numerically in Figure 3. It was initiated by farmers in 1997. The main reason for the network was to ensure that farmer organisations, depicted as number 1, were capacitated to produce maize, sorghum and dry beans. The platform was triggered by various issues ranging from lack of market access to untimely supply of inputs and the unavailability of maize and sorghum to meet the needs of businesses within the province. One example frequently heard from business organisations was the fact that they were purchasing these products outside the province, resulting in enriching other provinces. In addition, smallholder farmers did not have a reliable market. One private organisation was approached by farmers due to its visibility policy of having marketing outlets in many villages, namely Progress Milling. The company liaised with the Department of Agriculture and Rural Development represented as number 3. The significance of the numbering is for easy reference[2]. Progress Milling, depicted as number 2, was represented by

[2] The numbering of 1 depicts the main beneficiary, number 2 is the custodian of the platform as well as the driver, number 3 is the Limpopo Department of Agriculture, number 4 is the ARC as an expert in research, number 5 is for the four input suppliers, and number 6 is for mechanisation, mainly two donated tractors and tractor contractors.

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its public relations officer[3] and the Department of Agriculture and Rural Development was represented by its provincial extension manager[4]. After much effort and discussion, the two gentlemen conceived a proposal which later brought together the innovation platform. The proposal was initiated to solve the problem identified by the farmers.

The platform consists of stakeholders, namely Pannar as number 5, coupled with other input suppliers or expertise such as Agricultural Research Council, depicted as number 4, Sasol fertilizer as number 5, Bayer, a crop protection supplier represented as number 5. These should not confuse the reader since they provide a service which can be classified as inputs. Progress Milling and the Limpopo Department of Agriculture (Crop and Extension Divisions) were the main drivers of the platform. The extension manager was responsible for the mobilisation of farmers. The seed company provided seeds during the experimentation and Bayer provided the crop protection chemicals. Apart from the experimentation, farmer organisations were assisted to mobilise farming inputs so that these inputs were ready at the time of need. It was very surprising to note that despite the availability of different input suppliers, they needed to be coordinated so that orders were placed timeously before the beginning of the planting season.

Progress Milling co-ordinated the whole network, serving as the secretariat. One of the reasons for why Progress Milling had a permanent status was the fact that it made a substantial donation of funds to the platform which later developed an Educational Trust out of the donation with a hope to sustain the innovation network. Unlike in other countries where the network disbands once the problem is resolved, Progress Milling has become a permanent learning platform. However, it was made clear that in the case where members of the platform were no longer interested, they were free to withdraw.

The network/innovation platform or Progress Milling Community Development Programme (which it has become commonly known as) has yielded the following benefits: 200 extensionists were trained by ARC on technical aspects of maize production, farmers also benefitted from the trained extension officers, farmers were provided with production inputs which were difficult to access in the past at a cost, farmers were also trained on leadership, especially the farmer leaders who shared with their colleagues on coming from the course. The most important aspects of the farmers were also addressed through this community development initiative/platform/innovation system. These needs included ploughing units and securing markets for their products. Another critical need of these farmers was a lack of mechanisation. The platform facilitated the provision of tractors for ploughing their farms.

The Limpopo innovation system as a case study depended on a number of issues to be effective and sustainable. Some of the issues have already been mentioned. Sufficing to indicate that more pressing issues included cooperation among farmer groups, insufficient rainfall, and insufficient ploughing units. Efforts were taken to solve the situation, especially the addition of ploughing units. Progress Milling as a host to the community programme secured additional tractors to assist ploughing of the farmers' fields. However, these tractors were abused and were recalled. An additional attempt was made with two large tractors being donated to the programme. These tractors were not sustainable, exacerbated by the fact that rain had not been

[3] Mr Masenya Masenya was the co-founder of the Limpopo Innovation Platform, and the Trustee of Progress Milling Educational Trust.
[4] Professor Elliot Zwane was the co-founder of the Limpopo Innovation Platform and the Secretary of the Community Development as well as the Trustee of Progress Milling Educational Trust.

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regular in the province to warrant their maximum use in the fields. Furthermore, they too were withdrawn, signalling the collapse of the programme.

Ten sites were identified in the province targeting only three districts, namely Sekhukhune, Mopani and Capricorn. Examples of sites included Ceres, Mashashane, Matlala villages in the former Aganang municipality, Mamabolo/Boyne, and Mothiba/Solomondale villages of Capricorn district. A village in Ga-Sekororo and Ba-Phalaborwa based in Moapani district were selected, and a village in Ga-Masemola, and Veeplaats of Sekhukhune district were also selected. These sites had different potentials and capacity to produce, however, the participating farmers complained of moisture which used to get dry quickly after rain had fallen. In areas where farmers were supported through the Community Development programme, an improvement in food security could be observed because they were able to plant drought resistant varieties, harvested and were offered storage by the Progress Milling. They were able to collect a bag of maize meal per month in exchange of the maize that they had stored. The number of farmers who practice this innovation could not be quantified since at the time of writing this paper, the records could no longer be accessed due to other dynamics.

The Limpopo innovation system depended on a number of issues to be effective and sustainable. The advert of climate change has affected the programme negatively in the last years of its implementation. Nevertheless, it needs to be noted that ICT needs to be taken on board as well as social learning in innovation systems.

4.5 Contribution of ICT and social learning in innovation systems

According to Carlsson *et al* (2002), the concept of innovation system was found to involve the creation, diffusion and the use of knowledge. This was supported by Wintjes (2016) who has added that ICT produces different types of knowledge which includes the design, production, marketing, and distribution of innovations. There is no doubt that this concept of innovation is complex (Organisation of Economic Co-operation and Development, (OECD), 2005), hence, the concept of ICT forms part of this discussion. It should be noted that ICT can contribute to the innovation system (Wintjes, 2016). It is observed that economies in different countries are advancing because they have become knowledge based and as a result of the interactions in the environment and other structures (Seki, 2008). ICT plays an important role because they make contributions in the progress of countries where they ensure that whatever programmes are being used become productive. ICT allows us to learn how to improve policy and performance (Wintjes, 2016). There are two types of knowledge which need to be considered for development, namely tacit and codified. Both knowledges are important for development although their engagement differs. As far as tacit knowledge is concerned, one cannot use it in machineries, but codified knowledge can be used.

While it has been true that ICT has been seen to improve economic benefits, other authors (Türkeli & Wintjes, 2014) are concerned that it should also be used to address problems experienced by society. It is important that ICT should be seen to contribute to social learning by addressing the societal challenges. This is because ICT can be seen as transformational tools which, when used appropriately, can promote a shift to a learner-centred environment (Wintjes, 2016).

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5. CONCLUSION

Agricultural innovation systems as a subject has more to offer. Although there are benefits associated with it, there are also challenges that need to be taken into account. Some of the challenges and benefits have been discussed in the paper. The concept has been fully discussed, followed by some recommendations. A case study for Limpopo has been used and it has indicated both the benefits and the challenges encountered during the implementation of the concept. Extension alone is not a better tool because it needs other role players. However, with reference to the case study, an extension officer who provides technical messages is not enough for the farmer since the needs of the farmer extend beyond information, for example market and inputs.

Working alone as an extension subsystem needs to be considered. It can be concluded that agricultural extension and advisory services is an important component which can empower and strengthen the capacity of rural people and promote innovations to enable them to address challenges, take advantage of market opportunities, create wealth, improve their livelihoods, and ensure food security. The Limpopo platform of agricultural innovations can be used to generate lessons for future engagements, and the recommendations are discussed in the next section.

5.1 Recommendations in implementing agricultural innovation

It was easy in the past to have one sub-section performing the task of development, but the tendency was mainly based on a silo mentality. The units would not always know what each was doing. This often led to duplication of scarce resources. The following are recommended:

- Implementing agricultural innovation platforms requires the development of a mechanism to coordinate the multiple stakeholders. This can take a form of a policy to create an enabling environment. In order to achieve coordination, it requires strong leadership. In Limpopo, food production was being carried out by many organisations, some with no experience, but with sufficient financial resources. Networks are not confused, but have clear pathways and each stakeholder has responsibility.
- Special attention should be given to measures that stimulate collaboration between different actors in agricultural innovation such as seed supplier, livestock, remedies, and market organisation. Progress Milling is one of the existing platforms which people can come to learn how it is run to help farmers.
- Strengthening innovation competency should be given special attention in developing the competency as there are no courses to satisfy this need; it is only action learning on the job which is in existence (Daane, 2010).

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