



Communication

# Improving the Food and Nutritional Security of Smallholder Farmers in South Africa: Evidence from the InnovAfrica Project

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**Abstract:** This article highlights evidence and lessons learned from the InnovAfrica project conducted by the Agricultural Research Council in collaboration with other international organizations between 2017 and 2021. This project aimed to test and upscale best-bet Sustainable Agricultural Intensification (SAI) practices through Multi-Actor Platforms (MAPs) and improved dissemination strategies across six African countries (viz. Ethiopia, Kenya, Malawi, Rwanda, South Africa and Tanzania). The goal of the project was to improve the food and nutritional security of smallholder farmers in Africa. The article briefly discusses some of the key challenges that smallholder agriculture is facing, results from the agricultural interventions brought in by the InnovAfrica project, evidence-based actions and policy recommendations to improve the sustainable agricultural productivity of smallholder farmers in the South African case study. The study showed that SAI practices increased crop yields and build climate-resilient farming communities. It is recommended that the promotion of SAI practices should be supported by enabling institutions and conducive policies that will enhance access to inputs, market linkages, improved access to credit and good agricultural lands, the establishment of functional farmer groups and participatory learning models. These recommendations can be used by the government and other agencies to develop effective interventions to improve food and nutrition security.

**Keywords:** capacity building; institutions; intensification; policies; sustainability



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## 1. Key Policy Messages

- Sustainable Agricultural Intensification (SAI) practices involving maize-legume inter-crops including rotations and Conservation Agriculture (CA) increased crop yields and build climate-resilience in the farming communities while reducing adverse environmental impacts. Results from on-farm farmer-led field experiments suggest that maize and dry bean yields from improved varieties and CA increased by over 36% compared to conventional monoculture farming practices.
- Capacity-building investments of farmers on SAI practices coupled with innovation platforms and participatory engagements such as Multi-Actor Platforms (MAPs) and Integrated Farm Planning (widely known as PIP in French acronyms) approaches improved the dissemination of skills/knowledge regarding SAI practices. After two years, an estimated 8000 households had been reached out to by the project

through these approaches, while some 70 households were directly engaged in field experimental activities in Phuthaditjhaba. Thus, it is suggested that the government and other development agencies need to strengthen the provision of such farmer support services.

- Evidence from the MAP discussions suggests that the promotion of SAI practices should be supported by enabling institutions and conducive policies that will support farmers with infrastructure, equipment and enhance their access to appropriate information, inputs, market linkages, good agricultural land and credit (capital), the establishment of functional farmer groups and participatory learning models.

## 2. Key Challenges Facing Smallholder Farmers in South Africa

Rainfed crop production is the major source of food security and livelihoods for the majority of South African smallholder farmers who are often located in remote areas, particularly in the former homelands [1]. However, agricultural productivity remains low in smallholder settings and this has been a serious concern to the government and other development agencies [2]. This low agricultural productivity is often due to low soil fertility, degraded soils, lack of farm equipment, limited income, poor access to land, credit (capital), extension services, farm inputs (improved seed and fertilizers), markets and weather information, as well as the lack of knowledge and awareness of effective SAI practices [3]. For example, the majority of South African smallholder farmers often practice monoculture (maize and dry beans) with little or no application of either organic or chemical fertilizers, which often leads to a decline in yields over time and adverse environmental impacts such as soil erosion and loss of soil fertility [4]. Low agricultural productivity is further worsened by climate-related risks such as a rise in air temperatures, high variability of rainfall onsets and amounts, long dry spells, and the occurrence of extreme weather-related hazards such as floods, droughts, hailstorms and frosts that are expected to increase in terms of frequency and intensity as a result of predicted climate change [5]. Low productivity triggers food and nutrient insecurities amongst the majority of smallholder farmers, who are largely dependent on rainfed agricultural production for their livelihoods and have a limited adaptation capacity [5]. Although South Africa is generally a food-secure nation, the majority of rural households are food insecure with chronic challenges of poverty and malnutrition [1]. Consequently, these poor smallholder farmers fail to feed themselves and rely on buying food with social grants as their main source of income [3].

## 3. Why Sustainable Agricultural Intensification?

In South Africa, previous attempts to increase food production to meet food demands have predominantly been the result of the increased use of inorganic fertilizers accompanied by large applications of synthetic chemicals to control weeds, pests and diseases [6–8]. However, unsustainable and intensive use of external inputs has resulted in severe environmental impacts such as increased greenhouse gas emissions, groundwater depletion and toxicity, soil fertility degradation, soil erosion and loss of nutrients [4,6,7,9].

Sustainable production of sufficient, diverse and nutritious food at a local scale using available resources efficiently has become more urgent than ever before to alleviate poverty in smallholder settings without further degrading the environment [4]. Consequently, there is an urgent need for uptake and use of pathways to sustainably intensify the food production systems of smallholder farmers [10]. However, SAI practices are not a “one size fits all” solution package. Therefore, there is a need to identify the possible SAI options for South African smallholder farmers based on their local context in terms of the available resources, institutions and policies. These SAI options should be feasible and affordable to improve their productivity, increase adaptive capacity and reduce their vulnerability to climate variability. The options for smallholder farmers should be a low-cost system that uses the readily available resources efficiently to improve productivity, biodiversity and ecosystem services with minimal use of external inputs such as pesticides and herbicides [10]. In

some instances where the application of external inputs such as chemical fertilizers is of paramount importance and could not be avoided, these inputs should be applied at the required rate and at the right time and conditions. Moreover, the inputs should be applied using good agronomic practices that are environmentally-friendly and cost-effective to prevent excessive applications that could result in wasteful expenditure and environmental pollution. The selected combination of SAI options should demonstrate the economic value at a local scale and in a short-term duration in order to be viable for smallholder farmers. Therefore, there is a vital need to test and promote the best-bet combination of SAI practices at a local scale to generate evidence-based policy recommendations to enhance the food and nutrition security of smallholder farmers in South Africa. These recommendations can be used by the government and other agencies to develop effective interventions to improve food and nutrition security as well as rural development, not only in the study area but also in other regions that are facing similar challenges.

#### **4. Key Interventions Brought in by the InnovAfrica Project**

##### *4.1. Brief Description of the InnovAfrica Project*

The InnovAfrica is a multi-disciplinary project that aimed to test and up-scale best-bet sustainable agricultural intensification practices through innovation platforms and improved dissemination strategies across six African countries (viz. Ethiopia, Kenya, Malawi, Rwanda, South Africa and Tanzania). The goal of this project was to improve the food and nutritional security of smallholders in Africa. This project is funded under the European Union (EU) Africa Research and Innovation Partnership and is implemented by a consortium of 16 institutions from Africa and Europe continents. This project is cooperatively coordinated by the Norwegian Institute of Bio-Economy (NIBIO) and the Bioscience eastern and central Africa-ILRI (BecA-ILRI) Hub. The detailed information about this project and its different activities across different case countries could be found on the project website ([www.innovafrika.eu](http://www.innovafrika.eu): accessed on 16 August 2021).

##### *4.2. Farmer-Led Experiments*

In the South African case study, the project sites are located within Maluti-a-Phofung municipality, situated in the eastern part of Thabo Mofutsanyana district in the Free State province (Figure 1). Farmer-led trials were established in five villages for three planting seasons (2017/18 to 2019/20) to demonstrate, validate and upscale the best-bet SAI practices based on locally available maize-legume varieties for improved food and nutrition security. These villages were within a radius of less than 40 km and were purposely selected to represent the agro-ecological and socio-economic conditions of this local municipality. A total of seventy smallholder farmers (including women and youth) were given seeds and fertilizers to carry out farmer-led trials up to a scale of 1 ha per farmer. The selection of beneficiary farmers was done jointly with local government extension officers and traditional leadership based on their known passion and enthusiasm about agriculture they had demonstrated over years. The main treatments evaluated were monocropped maize or dry beans and maize-legume intercropping combined with improved seeds and good agricultural practices using a split-plot design with no replicates. The selection of improved seeds was done through a consultative process with the different stakeholders such as researchers, local extension officers and agro-dealers based on their suitability under the agro-ecological and socio-economic conditions of the study area. Although intercropping and crop rotation are not new technologies in South Africa, the key innovation behind this project was the integration of these SAI practices with innovation platforms and improved dissemination strategies for wide uptake, and the use of these practices to enhance the food security and climate resilience of smallholder farmers.

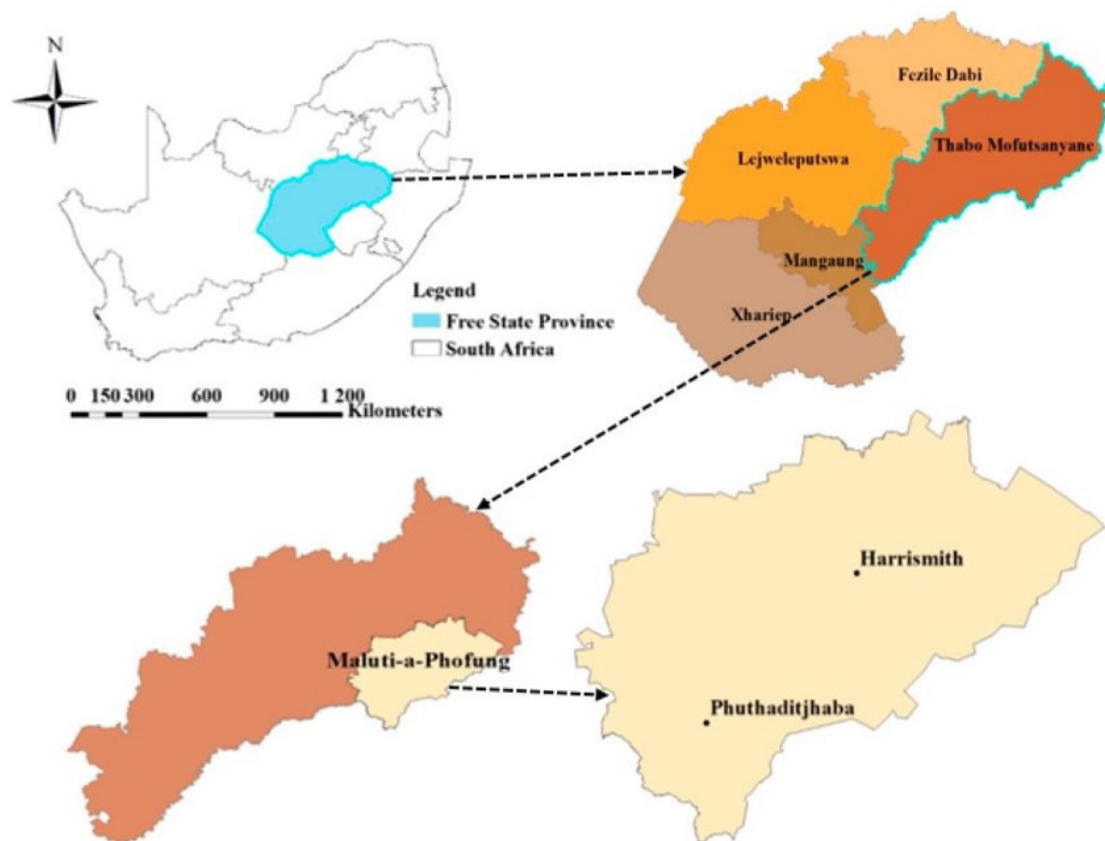


Figure 1. Location of the study area [3].

#### 4.3. Multi-Actor Platforms

The farmer-led experiments were supported by Multi-Actor Platforms for wider adoption of the project's results and the dissemination of outputs. The MAP members consisted of multiple stakeholders such as farmer organizations, public sectors, NGOs, private organizations and traditional leadership. MAP meetings were held regularly, where different stakeholders shared the project's progress, results, lessons learned, challenges and planning of the various activities. For a better understanding of the project activities and to be able to make informed recommendations, these stakeholders were involved in field visits to the project sites and training meetings.

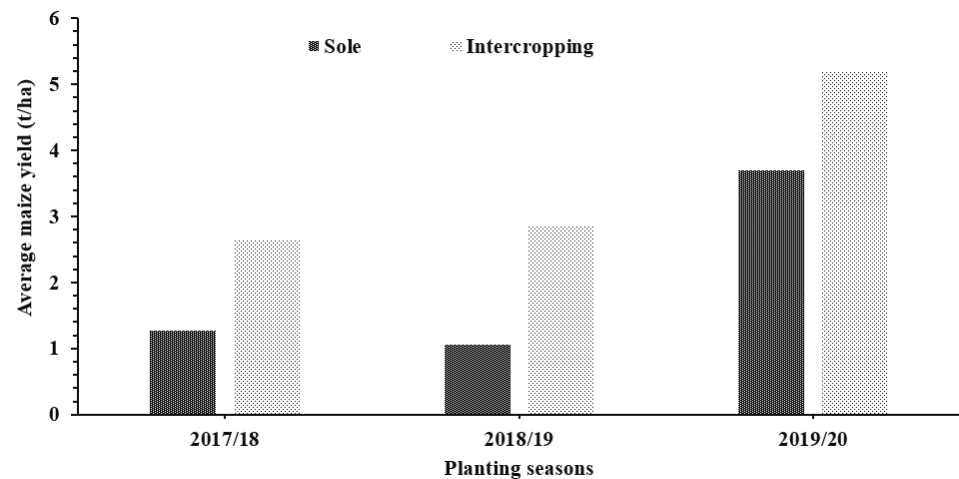
#### 4.4. Integrated Farm Planning

For wider dissemination of the most promising SAI practices to reach more farmers, particularly women and youth, the InnovAfrica project used the Integrated Farm Planning (PIP) approach for extension and advisory services. This approach is based on encouraging smallholder farmers to improve their productivity, profitability and nutritional security through sustainable use of resources by motivating them and changing their mindsets. The implementation of PIP involved the identification of farmers who were motivated, passionate and enthusiastic about agriculture to be "farmer innovators" or progressive farmers. The farmer innovators were trained by researchers together with local extension practitioners on different SAI practices as well as good farm management practices such as soil testing, land preparation, fertilization, selection of cultivars, planting, spraying of herbicides and pesticides, monitoring, harvesting and keeping records. In turn, these innovators subsequently trained other farmers as a new generation for wider dissemination of SAI practices.

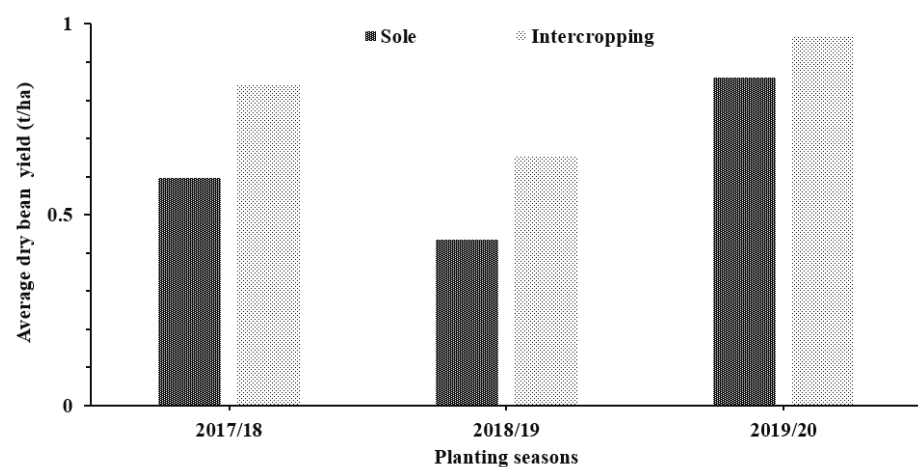
## 5. Key Results and Lessons Learned from Interventions Brought in by the InnovAfrica Project

### 5.1. Sustainable Agricultural Intensification Practices Increase Crop Yields and Enhance Climate Resilience

Results showed that intercropping combined with improved seed varieties and good agricultural practices increased maize and dry bean yields by over 36% compared to conventional practices (Figures 2 and 3; Table 1). The analysis of variance showed that maize yields were significantly higher (at a 10% level of significance) under intercropping compared to conventional practices while dry bean yields showed a non-significant difference, thereby suggesting that intercropping increases maize yields without compromising dry bean yields. Furthermore, the use of intercrops had total land equivalent ratios ranging from 1.1 to 1.4, indicating more intensive and productive use of land resources in land-constrained smallholdings. On average, maize yields from the farmer-led trials were 49% higher than the local district averages from smallholder farm communities in the 2019/20 planting season. These findings suggest that intercropping combined with improved seed varieties and good agricultural practices such as rotations and integrated fertilizer management systems have a high potential to improve maize-legume productivity, profitability and nutritional benefits through diet diversification (proteins and vitamin A).



**Figure 2.** Average maize yields under different cropping systems evaluated over the period of three planting seasons in the Maluti-a-Phofung municipality, Free State province.



**Figure 3.** Average dry bean yields under different cropping systems evaluated over the period of three planting seasons in the Maluti-a-Phofung municipality, Free State province.

**Table 1.** Descriptive statistics for average maize and dry bean yields (t/ha) under different cropping systems evaluated over the period of three planting seasons.

Crop	Cropping System	<i>n</i>	Min	Max	Mean	Std. Dev
Maize	Sole	3	1.062	3.694	2.011	1.461
	Intercropping	3	2.640	5.179	3.560	1.406
Dry beans	Sole	3	0.435	0.859	0.630	0.214
	Intercropping	3	0.655	0.967	0.820	0.157

where *n* is the number of observations (planting seasons), Min is minimum, Max is maximum and Std. dev is the standard deviation.

The studies also revealed that the intercropping and rotational cropping systems exhibited greater potential to reduce adverse environmental impacts associated with greenhouse gases, soil erosion and leaching of nutrients (data not presented here). Crop rotations in turn are expected to break pest and disease life cycles and, hence, prevent pests and disease carry-over from year to year. The research also showed that lower crop yields were obtained in the 2017/18 planting season while improved crop yields were obtained in the 2019/20 planting season. These findings suggest that seasonal climate variability had a significant effect on crop production in the study area. Drought, prolonged dry spells, frost and hailstorms were the major weather-related risks that significantly affect crop production in this study area. The need for the promotion, uptake and use of affordable and feasible adaptation and mitigation strategies is more urgent to improve food and nutrition security in the area.

### 5.2. The Innovation Platforms and Participatory Engagements Improved the Dissemination and Adoption of the Sustainable Agricultural Intensification Practices

The MAP meetings provided a stage for interactive learning, empowerment and collaboration amongst the various stakeholders who, despite their different interests, had interconnected agricultural-related problems and ambitions. The MAP members, researchers and local extension practitioners have been capacitating farmers on tested technologies within and beyond the project sites through training efforts, awareness-raising campaigns, field days and farmer open days. After two years, an estimated 8000 households had been reached out to by the project while some 70 households were directly engaged in field experimental activities. The engagement of local MAP members as the key local informants in meetings and field visits improved the access of farmers to extension services, inputs and markets.

After the 2019/20 planting season, feedbacks from the beneficiary farmers and local extension officers regarding the project activities were collected through household interviews and focus group discussions. Project participants were asked open-ended questions centered around their knowledge and skills of SAI, their feedbacks and the status of InnovAfrica's interventions. The results revealed that the PIP approach improved cooperation amongst farmers, enhanced their willingness to work in the fields and improved their knowledge and skills transfer. PIP was found to be a good approach to enhance integrated planning and efficient use of available resources for sustainable agricultural production. The extension officers were excited by the PIP approach and saw great value in it. They voluntarily incorporated the principles of PIP in their work, which assisted them to plan better with the farmers (a major challenge in the study area). The PIP approach enabled extension officers to learn from farmers and understand their backgrounds, mindsets and experiences which improved the effectiveness of the extension services.

### 5.3. Good Examples: Telling Success Stories

#### 5.3.1. Feedback from Extension Officers

The extension officers from the Free State Department of Agriculture and Rural Development indicated that the innovation platforms and participatory engagements such as MAPs and PIP were highly promising approaches to increase the enthusiasm and interest of farmers to work in their fields to improve their food production, profitability

and livelihoods. For example, the feedback from one of the extension officers (selected randomly) was, “PIP was introduced to us in the year 2018 by the Agricultural Research Council and the international partners of the InnovAfrica project. Since then, I have been using the PIP approach to raise awareness amongst farmers to produce food for themselves and sell surplus from their fields. We had a first PIP group at Dinkweng village (28.615933° S, 28.892006° E), where we engaged and discussed with farmers the different sustainable management practices for crop production, particularly maize and dry beans. I am very proud as a local extension officer because PIP has assisted me in teaching my farmers to plan better their cropping activities and management practices for sustainable agricultural production. I am also proud that we started the PIP group here in Dikweng village while field farms were initially abandoned but since the introduction of PIP, farmers have been able to work together and planted more than 85 ha of their field farms. This is a great achievement while looking at the fact that the government only assisted farmers with the inputs of only 33 ha and the rest of the fields have been planted by farmers themselves without any assistance. Those farmers that had financial capacity were able to buy their own farm equipment such as tractors and planters. I am very happy about the idea of PIP and we wish that more groups of PIP should be initiated across different villages so that farmers can improve their food production”.

### 5.3.2. Feedback from a Farmer

The interventions brought in by the InnovAfrica project improved knowledge on sustainable agricultural production amongst smallholder farmers as well as their crop yields and livelihoods in the study area. For example, the feedback from one of the farmers (selected randomly) was as follows: “I am a female farmer here at Lejwaneng village (28.645021° S, 28.842777° E) at Phuthaditjhaba. I am practising mixed crop-livestock farming. I have been growing maize and dry bean crops for a long time but my production was very low and I didn't know what the cause of this was. Since the introduction of the InnovAfrica project through the Agricultural Research Council, my knowledge and skills in crop production have improved. This project has been providing us with training on different cropping systems as well as good farm management practices such as soil testing, land preparation, planting dates, fertilization and selection of cultivars etc. After this training, I was able to identify the major cause of my low crop yields in previous years, which was soil acidity, and I corrected this issue through the application of lime. Since the introduction of this project, I have managed to produce high yields and of good quality. I am very happy because now I can produce enough food for my family and also feed my livestock. This is all thanks to the interventions brought in by the InnovAfrica project in this area”.

This positive feedback from the project participants indicated that the interventions brought in by the InnovAfrica project have a great potential to improve the agricultural productivity, profitability and climate resilience of smallholder farmers. Therefore, SAI is a vehicle through which national food and nutrition security as well as the sustainable development goals could be achieved in South Africa under expected weather-related risks attributed to climate change. At this point, it is worth mentioning that the South African government has already developed a climate-smart agriculture strategic framework and many other policies to strengthen sustainable agricultural production but a lack of coordination is the key challenge hindering implementation success. The following section provides the evidence-based actions and policy recommendations from the lessons learned from the InnovAfrica project on how to improve the sustainable agricultural productivity of smallholder farmers in the study area and any other regions that are facing similar challenges. At this point, it is worth mentioning that these policy recommendations are drawn from all datasets collected throughout this project including the data collected through MAPs meetings and focus group discussions with key informants (data not presented here).

## 6. Policy Recommendations

### 6.1. *Strengthen Stakeholder Engagement through the Innovation Platforms and Participatory Engagements*

The innovation platforms and participatory engagements such as MAPs and PIP improved the dissemination and adoption of SAI practices. These interventions should be encouraged and institutionalized in the government system to ensure their sustainability in the development and promotion of new technologies beyond the lifetime of this project. Evidence from these innovation platforms and participatory engagements suggests that the stakeholder engagements need to be strengthened more at a local scale because there are no formal organizations for smallholder farmers.

### 6.2. *There Is a Need for Demand-Driven Agricultural Research*

Although agricultural research has evolved in recent times in South Africa, there is low involvement by the commodity groups in shaping the key thematic research areas at a given point. The research efforts are clouded by a drive to publish high-impact scientific articles with less emphasis on solving the existing challenges that are faced by the sector. A lack of funding from the government to support farm-led experiments at the local level due to budgetary constraints is one of the key challenges that limit the conducting of meaningful community-based research. Therefore, the national and provincial departments of agriculture need to engage the farming community and give direction to key research organizations to embark on research that has the potential to make a significant impact in the agricultural sector. Moreover, the provision of funding that supports community-based research is of paramount importance to generate meaningful information to assist smallholder farmers to produce enough food in their local context despite the threat of climate variability.

### 6.3. *There Is a Need to Control the Use of Chemicals with Potential Harm to the Environment and Accelerate the Adoption of Low-Carbon Technologies*

The increased use of chemicals to fight plant diseases and pests as well as weeds has helped improve agricultural productivity. However, many of these chemicals are now known to be detrimental to our ecosystem. Pesticides and herbicides contaminate soils, groundwater and vegetation, if not applied properly while taking responsible care of the environment. The elevated use of chemicals in agriculture needs to be reduced, applied responsibly and highly controlled. Evidence from the participatory engagements with local informants suggests that the promotion of SAI practices that follows the principles of Integrated Pest Management (IPM) such as planting of trap crops, natural enemies including intercropping and rotations that improve biological pest and disease suppression and ecosystem services should be prioritized. Alternatively, in some instances where the application of chemicals is of paramount importance to improve agricultural production, farmers need to be well trained in proper chemical management.

The agricultural sector is among the highest emitters of greenhouse gas emissions in South Africa with over 7% of the total emissions [9]. The main contributors are enteric fermentation in ruminants, emissions of methane and nitrous oxide from manure management and cultivation of agricultural lands [7]. Currently, the emphasis of agriculture intensification is on elevating productivity per unit area and this has led to ever-increasing application rates of nitrogen fertilizer, which is key towards nitrous oxide emissions. Thus, a reduction in emissions from agricultural production needs to be prioritized. The promotion of SAI practices such as an integrated fertilizer management system, crop rotation and intercropping that are environmentally friendly and cost-effective is crucial to prevent environmental contamination while improving agricultural productivity. Moreover, these SAI practices have the potential to reverse climate change through soil carbon sequestration and restoring degraded soil biodiversity.



#### *6.4. Farmers Need to Be Assisted with Knowledge of How to Lower the Production Costs and Improve Access to Credit (Capital) and Markets*

A lack of farm equipment and the limited use of improved seeds, fertilizers, pesticides and herbicides due to financial constraints prevents smallholder farmers from achieving sustainable agricultural productivity. The government is encouraged to provide subsidized mechanization services such as tractors, rippers and planters. The provision and accessibility of both formal and informal financial resources such as agricultural grants, loans and saving groups as well as incentives that are inclusive for youth and women are critical. Evidence from the PIP groups suggests that farmers should be encouraged to work together so that they can buy inputs in bulk at reduced purchasing and transportation costs. Farmer groups will also enable them to share the cost of hiring farm implements, as well as their skills and personal experiences. They could also market their produce together.

#### *6.5. The Government Is Encouraged to Improve the Quality and Outreach of the Extension Services*

The lack of knowledge, awareness and information is a key constraint to smallholder farmers achieving sustainable agricultural productivity in the study area. Bearing in mind that farming is a knowledge-intensive industry, the availability and accessibility of information on sustainable agricultural production enable farmers to make informed decisions to improve their crop production under the threat of climate variability. The extension services could raise awareness, capacitate farmers and provide up-to-date and reliable information on SAI practices, weather forecasts, adaptation strategies, input supply, access to markets and credits to improve the agricultural productivity, profitability and climate resilience of smallholder farmers. Therefore, the government is encouraged to improve the quality and outreach of the extension services. To achieve this, the extension practitioners should be provided with resources, infrastructure, training and workshops. Capacity building through training efforts, awareness-raising campaigns, field days, farmers' days and farmer-led trials via participatory engagements with smallholder farmers, extension practitioners and researchers is recommended to overcome knowledge constraints and improve sustainable agricultural production. Moreover, the need for extension practitioners with a wide range of expertise to provide farmers with relevant and reliable information on different farming commodities, according to their interests, is critical in order to improve the quality of extension services rendered by the government.

#### *6.6. The Involvement of Youth in Agriculture Needs to Be Enhanced*

The lack of interest of youth in agriculture despite the high unemployment rate in this country is one of the major challenges that is hampering sustainable agricultural production. The youth could play a significant role in sustainable agriculture as they can provide a more efficient workforce and are more easily trained on the new technologies and innovations. Initiatives and campaigns aimed at luring the youth into farming are recommended. They need to be motivated and encouraged to make their living out of sustainable agriculture through the provision of inputs, market access, funding schemes, incentives and training. Moreover, there is a need to promote the use of modern technologies such as the KIPUS knowledge platform that was used to collect and store data online for the InnovAfrica project (<https://kipus.ki-ag.com/innovafrica/SAI/#!>; accessed on 16 August 2021). These modern technologies could be a tool to encourage and motivate youth to perceive agriculture as a preferred career choice.

#### *6.7. Gender Inequalities in the South African Agricultural Sector Need to Be Addressed*

In practice, the quality and amount of extension services, training, funding and marketing opportunities as well as the distribution of land is often skewed towards men compared to women. Furthermore, women can only inherit land from the Traditional Authority if they are related to men either through marriage or family linkages. This is a major set-back for sustainable agriculture since women are the main workforce in smallholder farming. Therefore, policies and programs that are supportive and inclusive

of women are recommended. The provision of modern technologies, inputs, market access, funding schemes, incentives and training that are inclusive to women is crucial.

#### 6.8. Access to Good Agricultural Lands Needs to Be Prioritized

The majority of smallholder farmers own very small plots of land (<2 ha). Most rural lands are communally shared and available for farming communities through the Traditional Authority issuing a Permission to Occupy (PTO) as there are no title deeds. Consequently, the majority of smallholder farmers are reluctant to invest in such a land tenure system as a result of the high uncertainties involved. The communal ownership of land impedes the use of land as collateral and this further limits farmers from accessing loans in order to invest in their farms for sustainable agricultural production. Therefore, the existing government land reform policies should urgently address the issue of fair land redistribution and ownership at a high level.

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