

## USEFULNESS OF SEED SYSTEMS FOR REVIVING SMALLHOLDER AGRICULTURE: A SOUTH AFRICAN PERSPECTIVE

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## ABSTRACT

South Africa is considered a food-secure nation; however, food insecurity is still a major challenge for many poor rural households that rely on cash incomes and government grants for survival. Furthermore, these grants are not always adequate to meet households' basic needs, and fail to provide them with the food required for food and nutrition security. Some of these households rely on agriculture to supplement their food needs, and an important aspect of this agricultural production is the seed system. Smallholder farmers in rural areas rely on informal seed systems, and use traditional knowledge and methods to produce, harvest, store, and sell their produce. This research combined quantitative and qualitative methods to assess the role of informal seed systems in promoting food production in rural smallholder agricultural households in South Africa. The narrative review showed reword that while smallholder farmers acquire seed from informal seed systems, they face numerous challenges that affect their production activities. These challenges include poor seed quality and assessment, poor storage and harvesting facilities, which limit proper seed production, and affect crop yield and marketing. Due to these challenges, the ability of rural smallholder farmers to access mainstream markets is limited and as a result, they are confined to local markets that offer lower prices. Moreover, South African policies do not recognize the informal seed system as one of the contributors to food security. This is a major limitation as farmers may not receive the support and assistance they require. Formal recognition and support for informal seed systems would go a long way in improving smallholder farmers' access to quality seed. This would have ripple effects on their yields and productivity. When properly implemented and given recognition by the government, informal seed systems have the potential to contribute to rural food security and livelihoods.

**Key words:** Informal, Seeds, Quality, Security, Smallholder, Production, Challenges, Policies



## INTRODUCTION

The agricultural sector is a major contributor to the livelihoods of many rural South Africans [1]. It accounts for approximately 2.3% of the country's GDP, 40% of export earnings, and 4.6% employment in the country [2]. Over 70% of people in rural areas depend on agriculture, and it plays a crucial role in job creation, food security, and poverty alleviation [2]. About 43.7% of the agricultural households in South Africa practice agriculture as the primary source of food, while 37.5% list agriculture as a source of extra food [3]. Therefore, the importance of agriculture to rural livelihoods and food security in the country cannot be ignored. However, the sector is facing unprecedented challenges such as population growth, natural resources degradation, energy scarcity, climate variability and change, and market globalization. This emphasizes the need to rethink policies and institutions that support food security initiatives.

Seed systems, particularly the informal seed system, have received little research attention. The informal seed system involves the selection, management, improvement, multiplication, storage, planting, and exchanging of seeds using smallholder farmers' own experiences, knowledge, and skills [4]. Unlike formal seed systems, informal seed system generally excludes governmental, institutional, or private control of seed activities. Nowadays, informal seed systems provide more than 80% of all the seeds utilized by smallholder farmers and communities in sub-Saharan Africa, the majority of whom are women [4]. These seeds are well known for producing biodiverse, ecologically resilient cultivars which can withstand changing climate and other challenges. They are also an important source of neglected and underutilized species (NUS), a primary source of food and nutrition security in many rural households. Additionally, they can contribute to sustainable food systems under climate change [5]. Therefore, the importance of informal seed systems cannot be understated.

South Africa is food secure at the national level, while most rural households are still food insecure. Smallholder agriculture is meant to improve rural food security yet, it is currently faced with numerous challenges. These include seed quality and poor access to technology or machinery due to inadequate capital [6]. As a result, smallholder farmers are forced to rely on indigenous knowledge for crop production as they do not have the means to access formal agricultural production systems. For example, seed quality is heavily dependent on seed production practices such as seed assessment. Seed assessment enables the selection of viable and vigorous seeds and the seeds can only be properly assessed under laboratory conditions which are generally found within the formal seed sector [7]. Smallholder farmers do not have the means to assess seeds in a laboratory and are forced to use traditional methods to select quality seeds. These methods include, inter alia, assessing the quality of seed based on seed size and colour, and this can result in inadequate production and low yields [7]. Despite these challenges, the informal seed system is a cheap source of seeds due to the fewer costs required for production, and the seeds are easily accessible [8]. Hence, farmers prefer to source their seed from these systems. Therefore, there needs to be an investment to improve the quality and yield of seeds in this system at no extra cost to the farmer.



In South Africa, the Department of Agriculture, Land, Reform and Rural Development (DALRRD), formerly Department of Agriculture Forestry and Fisheries (DAFF) is responsible for governing seed systems. The country has several acts and policies governing the commercial seed industry. The overall aim is to retain the international standard for the sector. There is a need to review the system to accommodate the small-scale informal seed producers. The informal seed production is an important component of rural economies and has a direct link to food security [9]. It is, therefore, important to understand how seed systems influence farmer productivity. An understanding of rural smallholder farmers' production systems can allow for the development of technologies, strategies and policies that are tailor-made to farmers' production capabilities. The aim of this study was to determine the potential role and impact of the South African informal seed systems regarding food availability and access. The South African legislative framework relating to the linkage of seed systems and food security was reviewed in order to suggest required improvements.

## METHODOLOGY

Noting that according to Flick [10], neither qualitative nor quantitative analysis provides a complete picture regarding a situation analysis relevant to this study, data were gathered through a comprehensive process that involved identifying, recording, understanding, meaning-making and transmitting the information. Five databases used to search for literature were Google R and Google Scholar, Scopus, ScienceDirect, and SpringerLink. The key words used to query the literature databases were "seed quality" or "seed quality factors" and "seed markets" and "food security" and "seed systems." The search focused on South Africa, a sub-Saharan country whose seed systems are under scrutiny to improve food security. The study also drew on available data from a wide variety of grey literature, including published and unpublished reports, national, regional and international documents from reputable organizations such as the Food and Agriculture Organization of the United Nations (FAO), Statistics South Africa (Stats SA) and the Department of Agriculture, Forestry and Fisheries (DAFF). The selection of documents analysed in this research was based on Scott-Little C [11] criteria for assessing the quality of documents for use in literature research [10]. These include: (i) Authenticity - is the evidence genuine and of unquestionable origin? (ii) Credibility - is the evidence-free from error and distortion? (iii) Representativeness - is the evidence typical of its kind? (iv) Meaning - is the evidence clear and comprehensive? The crucial benefit of this method was that it prolonged the search to include articles that would usually be inaccessible for the audience outside the research purview.

## CRITICAL REVIEW AND ANALYSIS OF FINDINGS

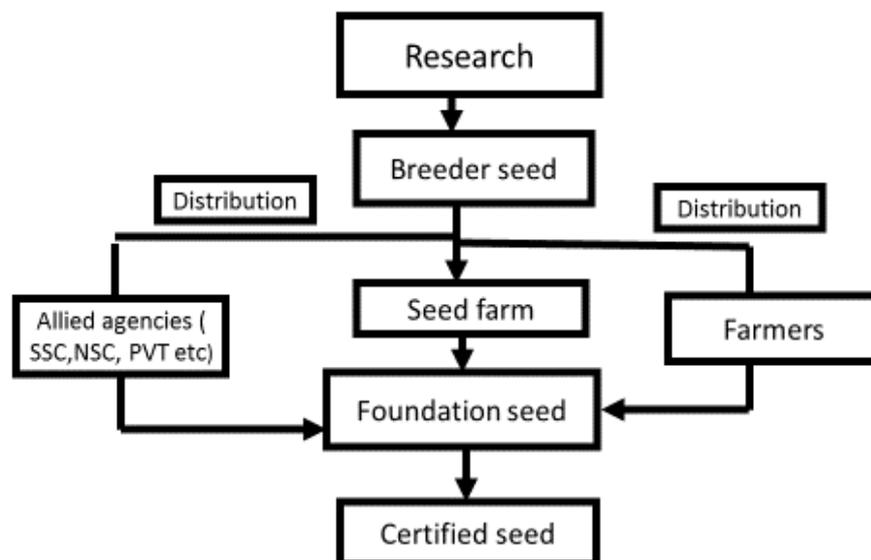
### Seed production systems and smallholder farmers

A seed is the first determinant of future plant development. It is an important and crucial input for crop production. Seed supply occurs under formal, informal and integrated agricultural systems. Informal systems are generally subsistent, while formal systems are mostly commercial, and integrated seed systems are a combination of the two systems.



### Formal seed systems

Formal seed systems are where seed production and distribution are vertically organized, and there is the use of tested and approved cultivars [4]. De Schutter [12] explained formal seed systems as the commercial seed system with a clear chain of activities. It can also be defined as a comprehensive system that includes plant breeding, certified seed, and marketing, which has been established in an industrial world [13]. According to the South African National Seed Organization SANSOR [13], “certified seed is the seed of an often high and recognized quality (physically and genetically), produced according to the rules and regulations of an official Seed Certification Scheme and for which proof of certification is accessible”. Figure 1 illustrates a general seed certification scheme.



**Figure 1: A generalized commercial seed certification process (Adapted [13])**

The formal seed system principle is that there is a need for a clear difference between seed and grain [14]. Seed production using a formal system is more useful when seeds are grown for commercial purposes, where seed quality and seed uniformity need to be guaranteed. The process of formal seed production starts with plant breeding, where desired characteristics of a particular variety are used to produce quality seeds. Maintenance of variety purity and identity and the assurance of physiological, physical, and hygienic quality occur under regulations. After plant breeding, the seed needs to be certified [14]. Seed certification aims to maintain and ensure the accessibility of high-quality seeds and to make sure that seed materials and varieties comply with safety measures and are labelled clearly to ensure genetic identity and purity [14]. Seed companies and commercial farmers adopt the formal seed system and examples of these companies include Pioneer/DuPont, Syngenta, Corteva AgriScience, Limagrain, Pannar and McDonalds. Pioneer/DuPont is one of the most dominant international seed

companies in the industry, and it specializes more on certified Genetically Modified Organisms (GMO). The United States grows about 40% of the world's GM crops, and Pioneer/DuPont control about 80% of the GM corn market worldwide [3]. The formal seed system occupies about 46, 4 million hectares, which is 37, 9% of the total land area of South Africa [3].

Although commercial farmers under the formal seed system benefit most from the seed industry, they are also faced with challenges. The costs of producing seed are high. There are different costs involved before the seed can be delivered to the end-user; this includes seed production costs such as processing, procurement, storage, quality control and certification, and seed marketing costs (market research, advertising, promotion, sales and distribution) and administration costs. These costs force commercial farmers to sell their seeds at high prices, making them less accessible to the poor. There is also high competition in the sector as farmers compete with international seed companies. Competition decreases commercial farmers' market share and can also lessen their customer base. A competitive market can also force farmers to reduce prices to stay competitive, reducing their return on each item they sell and produce.

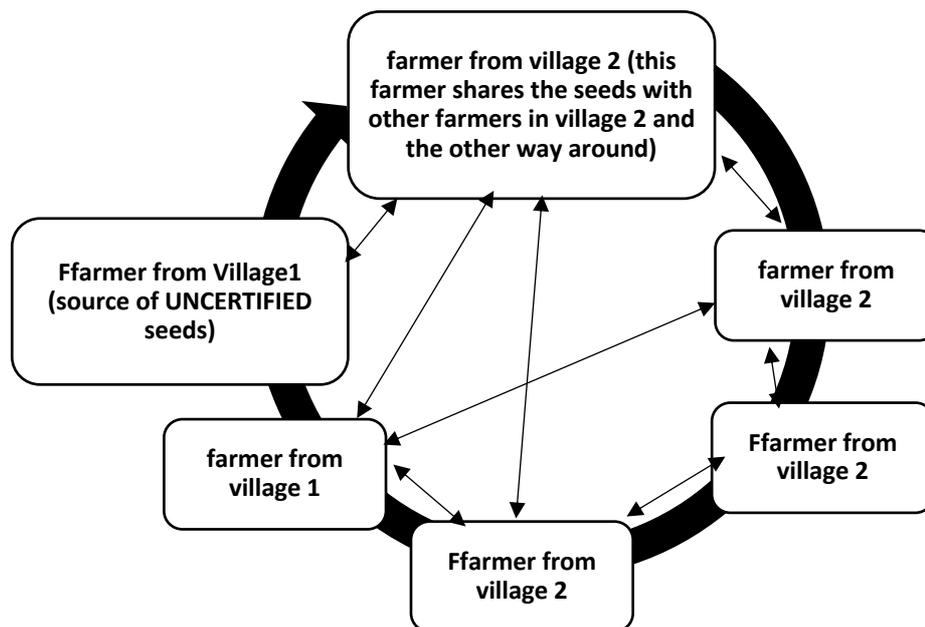
### **Informal seed system**

The informal seed system is categorised by individual farmers who save seeds from harvest and use them for the next production. They exchange seeds with other farmers or neighbours in the same communities and buy seeds from the local market [5]. The system uses varieties such as landraces, traditional vegetables, mixed races, and vegetatively propagated crops. It is essential to recognize the dynamism and flexibility of the system. It can change through time and responds to external changes. This is essential for a demand-driven seed market systems [2]. The system can be divided into three different categories: farmer-based seed systems, community-based seeds systems, and relief seed systems [15]. These categories are not different, but they sometimes overlap depending on the types of crops and seed value chains operating. Informal seed systems are categorized by many components, which include (i) farmer self-saved seed of native crops, (ii) informal seed storage, (iii) informal seed markets and (iv) maintenance of indigenous knowledge base regarding the local system [8]. This system is more concerned with the production of a diversity of food crops to improve dietary variety in the rural areas [8]. Informal seed systems are recognized as a major source of Neglected and Underutilized Species (NUS), such as Bambara groundnut, vegetatively propagated crops (cassava, sweet potatoes), medicinal plants (ginger and garlic), pigeon pea, leaf amaranth, which are important in providing nutrition and dietary diversity in rural households. Neglected and underutilized species are a primary source of food and nutrition security for many rural households and can potentially contribute to sustainable food systems under climate change. Most NUS crops are drought and heat stress-tolerant, and require fewer inputs for growth and adaptation to semi-arid and arid conditions [5]. However, reports on NUS are mainly unreliable with limited research to support their cultivation. This is primarily due to the lack of a clear research purview in agricultural sciences, inadequate funding, and journal apathy toward publishing work on NUS [5]. The promotion of NUS can improve obtainability and access to nutritious foods by rural households and generate opportunities for rural economic improvement through the development of new value chains [5].



In South Africa, several smallholder farmers practise informal seed systems, and more than 90% of their needs are met through these informal channels [14]. Therefore, it is essential to recognise the informal sector as a low-cost source of seed to farmers. The distribution of seeds under the informal seed system occurs among farmers within local communities (Fig. 2). Adetumbi [16] assessed seed supply for vegetable production at smallholder farms in South-Western Nigeria and found that approximately 60% of vegetable farmers sourced seeds from their previously saved harvests, while 30% purchased seeds from dealers. That study [16] further reported that approximately 33% of vegetable farmers selected seeds of varieties based on high potential crop yield and 32% based on consumer preferences, while 25% of farmers would select seeds of a variety only if it is readily available.

Pincus *et al.* [17] assessed the operation of the African indigenous vegetable seed system in Western Kenya. Their findings indicated that African indigenous vegetable seed systems are highly localized, and a combination of strategies are needed to attain seed security for neglected underutilized species crops. Determined efforts to improve the informal seed sector could raise farmers' 'access to seed'; however, these efforts are hindered by a lack of knowledge around the quality of farmer-produced seed and seed growers' incentives for producing seed.



**Figure 2: Distribution of seeds by smallholder farmers in different villages**

### Challenges of informal seed systems

Farmers operating under informal seed systems are faced with several challenges, including lack of access to formal institutions and not functioning under effective laws and policies. They do not have enough financial resources to buy production inputs and improved seeds. As a result, they end up depending on seeds that are produced and stored on-farm. Seed management has a decentralized and local character [15]. Seed

storing, selection and basic breeding is done on-farm or at community level, most often by women. The storage facilities used for informal seed systems are poorly developed, and seed production practices are simple. Smallholder farmers lack information, knowledge, and technologies for quality control and formal certification. Tiftonell and Giller [18] analysed yield gaps in the African smallholder agriculture and found that most of the smallholder farmers were unable to benefit from the current yield gains offered by plant genetic improvement. This was because they lack adequate input, such as fertilizer, to supplement soil fertility and nutrients. This was substantiated by Gildemacher *et al.* [19] who found that in eastern Africa, farmers with better production practices obtained high yields (25 tons per hectare) of potatoes while other farmers were obtaining low yields (5-6 tons per hectare). The author stated that this was because of the use of low quality seed potatoes, poor disease management, and low yielding varieties. Dinham [20] conducted a study on problems that farmers who grow vegetables are faced with. The study found that poor storage facilities forced farmers to sell at peak times when prices are low. Farmers did not have enough information on the type of market they were targeting. They rarely had training on how to use pesticides and had limited access to advice on complex management of pesticides. They did not have the product information they need to determine the application rate of pesticide, and timing. These resulted in poor yields and loss of income.

In South Africa, seed production and distribution are corporate-controlled and mainly serve the needs of a few large commercial farmers [21]. The seed laws and policies at the national level do not recognize, protect, and support or strengthen the production of informal seed systems. Smallholder farmers do not receive any financial, political, or institutional support. The agricultural support policy is oriented towards integrating a fairly thin layer of smallholder farmers into the commercial sector, commonly through integration into large-scale commercial value chains [21]. However, this fails to address continuous inequalities in the country, which require a systemic, structural transformation of the South African seed and food systems. Seed laws that are dismissive of informal seed systems and their accompanying regulations restrict farmer seed systems operations [21]. This will significantly affect rural livelihoods, as well as farmers' abilities to innovate and contribute to the development and maintenance of diversity. It will also lock out possibilities for new discourses, processes, and frameworks to flourish that recognize, protect, strengthen, and support informal seed systems.

Seed quality is one of the main challenges that smallholder farmers are faced with. It is crucial to determine seed quality because seed serves as a pre-requisite to attaining a good crop [22]. Seed quality assessment or control by research is more pronounced under the formal seed sector than the informal seed sector. Seed quality includes health, physiological, and physical attributes [22]. A good quality seed can be determined by many characteristics: high germination capacity, seed size uniformity, genetic purity (including the absence of another seed type, weed or other foreign objects), and freedom from seed-borne diseases. Important aspects of seed quality include viability and vigour [13, 22]. The quality of seeds can be affected by many factors, including production, harvesting and post-harvest factors. Environmental and production factors have been considered to influence the quality and development of the seed. The



environmental factors include soil fertility, moisture supply, and climate change. Variation in weather conditions has a major impact on seed quality as it can influence the degree of dormancy of mature seeds during seed development and maturation [13]. It is also the most relevant factor under informal seed production as the majority of farmers live and produce their seeds in drought-prone areas [23]. Severe shortages of water supply can lead to temporal damages; however, drought can have disastrous effects. Water deficit caused by drought is a major stress in crop production [23]. For example, lack of water during the seed development phase affects seed development, resulting in wrinkled light seeds. Late maturation and harvest periods during seed production are favoured by the arid, dry season, and irrigated areas.

Harvesting factors that affect seed quality include the time of harvest, harvest methods, and maturity stages. Post-harvest quality of seeds is initially affected from the field (pre-harvest factors) until it reaches the final user (post-harvest factors). After harvest, the quality of seeds cannot be easily improved using post-harvest treatment techniques or handling practices but can be maintained. It is essential to understand and manage the different roles of production or pre-harvest factors (such as, cultivar selection, irrigation, maturity stage, and fertilizer application) as they can play important roles in seed quality.

In developing countries, the circumstances under which smallholder farmers live have led them to select storage systems that are cheap and easy to construct, leading to the use of inadequate facilities to maintain high-quality seed [24]. The most commonly used storage methods by smallholder farmers include sacks, cribs, baskets, silos, underground pits, and roof storage [25]. The choice of storage method largely depends on the availability of the materials, cost, and expertise of building the storage facilities, the type of pest problems in the area, and climatic conditions [24]. Mboya [25] conducted a study to assess the effect of storage methods on the quality of maize in the rural areas of Tanzania. The study revealed that farmers commonly used roof and sack storage, and the quality of maize was affected by insect pests. It was recommended that before storage, rapid drying was necessary to avoid moisture associated problems.

Smallholder farmers are faced with numerous constraints that hinder their participation in, and benefit from agricultural market chains. Smallholder farmers lack skills, information, and knowledge in marketing and production to compete in international markets [26]. They also have restricted financial capital for investments and do not have much strength to benefit from opportunities in domestic and international market chains [26]. The Food and Agriculture Organization of the United Nations, FAO [3], compiled findings on experiences smallholder farmers face concerning participation under formal agricultural marketing channels. The results revealed many reasons that limit farmers from participating in modern market chains and seed certification. These reasons include (i), the fact that farmers operate in small or large groups that are not formally licensed or registered (ii), they produce a low volume of products which harm their market incentives (iii), risk aversion (iv), fear of cost and (v), poorly organized business structures. Barham and Chitemi [27] conducted a study to assess how collective action by farmers can fill the gap of market imperfection. Findings showed that collective action can bring new opportunities for smallholder farmers, and

can help by generating entry ways into new markets or introducing improvements to prevailing value chains. Further demand for traditional products can be developed through value-adding strategies and processing such as canning and drying. Adding value is an innovative strategy that will help farmers obtain better prices in the market and help them store their product for a long time.

Smallholder farmers operating under informal production systems depend on traditional social networks and mechanisms for marketing their produce. Some smallholder farmers still use bartering, traditional labour payment, or gifts to exchange or obtain seeds and crops [15]. A lot of seed is also obtained for free or as part of social capital for indirect benefits, such as good relations. Most seed exchange occurs within the community, between members within the same social class and ethnic group. Monyo *et al.* [28] conducted a study to assess farmer-to-farmer seed movements in Zimbabwe. The results revealed that the village seed market trades were of non-monetary exchange. For example, almost 80% of the sorghum and pearl millet were sourced in this manner.

#### ***Recommendations on how to improve informal seed systems***

Farmers' needs can be classified according to the crops they grow, their resource endowments and their risk-tolerance capacities. A flexible and effective seed system is needed that will improve strategies to respond to farmers' challenges [27]. Abay *et al.* [29] outlined three main strategies that can improve the informal seed sector's value. These include: (i) upgrading traditional varieties, (ii) creating a bridge linking the informal and formal systems, and (iii) seeking help from government agencies for funding, extension/technical services, and government policies. Upgrading traditional varieties such as common beans, maize, soya, and cotton includes training farmers for better storage, selection and treatment [29]. The training can assist them in increasing crop production through effective use of their own saved seeds. Farmers involved in some experimentation need to be encouraged to select, multiply, and store quality traditional varieties. Modern varieties at research stations could be used to make quality seeds through informal or formal systems [29]. This strategy allows farmers that use traditional seeds to obtain seeds at affordable prices locally in their communities.

Government agencies can help the informal sector in various ways. They can provide them access to extension guidance on seed production, storage, and treatment, processing, certification of seeds, and legal frameworks that allows marketing of quality approved seeds [13, 15]. The government can help develop farmers' market to enable farmers sell their produce locally or within communities, enabling them to generate income to purchase what they cannot produce. Furthermore, extension officers, non-governmental organisations (NGOs) and nutrition educators need to work together to develop strategies for educating and increasing awareness of smallholder farmers on food security, healthy and nutritious food. More research needs to be undertaken, as well, on the South African informal seed system to develop evidence-based interventions.



### Integrated seed system

Integrated seed systems are mechanisms that supply seed of new, improved varieties to farmers by merging the techniques of both formal and informal seed sectors. The term also expresses the interdependence of informal and formal systems, with multiple links between the systems, each reacting to the other and changing over time [30]. One of the essential principles of the integrated seed sector development (ISSD) concept is to improve a twin-track approach where the efficiency of both the formal and informal seed systems can be developed through a determined exertion to make sure that appropriate integration is encouraged at every element of the seed value chain [30]. The seed value chain among the informal seed and formal systems (multiplication, breeding, gene banks and marketing) in the conventional setting is shown in Fig. 3 [30].

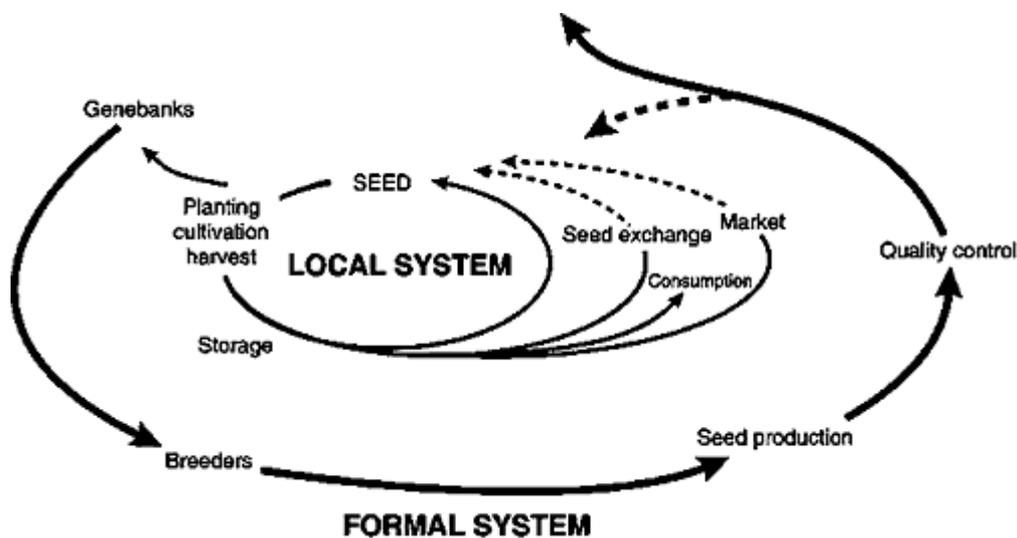


Figure 3: Linkages between formal and informal seed systems in the conventional setting [30]

The uncertainties of climate change and rising population density and food prices have raised more attention to food and seed security in developing countries. The integrated seed system is one of the approaches that has been adopted to address concerns about seed supply [31]. The system has advanced to shift the predominant focus on the formal seed system to include all the various seed systems that exist in certain countries [31]. The system emphasizes the plurality of seed systems because there is evidence that farmers usually obtain seeds from different seed systems, and it aims to support the diverse seed systems with all their strengths and weakness.

The integrated seed system works with the formal and informal seed systems to fully contribute to the primary aims of promoting agricultural entrepreneurship, economic development, food security, biodiversity use and conservation [32]. The system proposes that the delivery of information and the decision-making process are particularly unique in each seed system.

A study conducted by Reddy *et al.* [33] at the Mahbubnagar District in the Andhra Pradesh community project, showed that an integrated seed system could be an

important source of quality groundnut seed for smallholder farmers. The project used an integrated seed system to produce seeds that are innovative and community-based through village seed banks and community seed banks. The village seed banks helped to make post-rainy season groundnut seed available to smallholder farmers. The system integrated formal and informal seed systems to provide quality seed of upgraded groundnut varieties at a reasonable price and on time. The study confirmed that it was first essential to identify farmers' preferred varieties before the system was implemented. Hence, the farmers' participatory varietal selection and formation of village seed banks were the most vital steps in the project.

In another example, Sperling *et al.* [32] reported that vegetatively propagated crops are usually affected by several stresses (perishability of planting materials, relatively low multiplication rates, climate change, susceptibility to virulent pests and diseases, difficulties in transport and relative bulkiness), which compromise the ability of the local or informal seed system to supply or produce the vegetatively propagated crops in ways that guarantee household food security. In Kenya, strategies were adopted to address innovation in the seed quality domain of vegetatively propagated crops (which include cassava, banana and plantain, potato, sweet potato, *taro* and yam) using the integrated seed system. Decentralized and local secondary seed multipliers can show a central link between primary breeder (provide certified input seed) and seed buyers. Commonly trading on their reputation, they are also a vital source of extension advice on the quality of new varieties and clean seeds. The delivery of planting materials of new varieties and clean seeds in small amounts or small bags can raise awareness on the benefit of using the new varieties. This will lead to cost-effective methods of campaign-based distribution, also designing vegetative propagation systems, where the market connections can be created.

The integrated seed system supports different types of entrepreneurship with different types of crop or seed varieties that are grown in certain conditions for particular purposes [34]. Its characteristics are as follows:

- The system has large-scale seed companies that supply commercial crops internationally. These companies help with business skills, including the development of distribution channels. They also provide improved varieties of commercial and cash crops such as cotton, sugarcane, coffee, maize, tea, jute, and ramie. This system targets farmers that can well manage their environmental variation; and have access to fertilizers, pesticides and mechanical land preparation [34].
- The system has local seed businesses established by advanced farmers or a group of farmers with different skills and capabilities. These groups of farmers may primarily produce seeds for their own use, then as they expand, they develop their seed marketing organization. In this set up, farmers may be faced with a number of challenges such as transportation costs, poor infrastructure, and poor storage facilities. Therefore, the local seed companies can deliver a wide range of seed products to local farmers that may not be lucrative to large companies. The type of seeds provided include landraces, local and traditional varieties, staple crops

(maize, rice potatoes), neglected underutilised species (bambara groundnut, cassava, sweet potato, ginger) and traditional vegetables (cabbage, spinach, pumpkin, amaranthus) [34].

- The system also has agro-industries that work with almost all the seed businesses to ensure that they are supplied by the right type of produce. The agro-industries include breweries, cotton ginneries, oil mills, and flower. This type of involvement progresses into rather chain-based seed operations or closed value that focusses on the producers that provide delivery in the chain [34].

### **Contribution of informal seed systems to income generation and food security of smallholder farmers in rural households in South Africa**

The United Nation's definition of food security states "everyone must constantly have adequate access to food to be healthy and thus be actively involved in a sustainable livelihood" [4].

South Africa is considered to be food secure at a national level; however, numerous households are experiencing food insecurity.

Approximately 11.3% of households and 9.7% of individuals in South Africa experienced hunger in 2018 [35]. It is estimated that 20.2 % (11.1 million) of the total households had limited access to food, while 23.8% (13.1 million) of individuals had limited access to food in 2018 [35]. Household food security is highly dependent on income in the country, and 55.5% of South Africans are estimated to be living in poverty, the majority being children, women, and the elderly [35]. In addition, 25.2 % live below the food poverty line (FPL), where the FPL refers to the real income level below which individuals are incapable of consuming or buying sufficient food to provide them with the least daily energy requirement for adequate health [35]. To overcome food insecurity and poverty, rural households use different food and economic security options including agriculture. Smallholder agriculture is an approach largely utilised by underprivileged rural households to reach their all-round yearly nutritional and food requirements [35]. It is also a foundation upon which economically insecure households can develop their food security from improved incomes, food supply, and creating additional income for other household necessities.

Smallholder farmers are the influencers of several economies in Africa, although their potential is limited [35]. The term smallholder farmer has many definitions depending on a particular country, the context, and the ecological zone [36]. The word 'smallholder' can be used with other terms such as 'resource-poor', 'small-scale' and, on occasion 'peasant farmer'. Smallholder farmers can be defined as those farmers who do not have enough resources to produce their crops and rear livestock, and they farm on small areas of land (less than 2ha) [6]. These farmers are mainly involved in subsistence farming, where they produce more for consumption and sell the surplus to their local communities. Conversely, in South Africa, smallholder usually means the total number of individuals or farmers who take part in this kind of agriculture [36]. The smallholder farming production system comprises unique characteristics such as outdated technology, informal seed systems, inadequate access to services and markets,

and low returns [36]. These characteristics make the system more family labour intensive since farmers do not make enough profit to hire external labour. Smallholder farmers face many limitations and the inadequate market participation is a common one for farmers globally. In South Africa's underprivileged rural areas, smallholder farmers find it hard to take part in commercial market places because of the number of constraints they encounter. These include lack of education, poor infrastructure, lack of innovative production implements needed to improve yield, lack of credit access, and inadequate entrepreneurial skills that are essential to improve the success of farmers [6]. According to Statistics South Africa's (StatsSA) 2017 General Household Survey, a mere 15, 6% of South African rural households were part of agricultural production in 2017 [35]. Most crop production occurs in backyard gardens where the majority of households are involved in the production of staple crops [35].

Smallholder farming in South Africa has been known to have a potential through which the objectives of rural development and poverty reduction can be attained [37]. In the 2012 National Development Plan (NDP), the South African government targeted smallholder agriculture to lead improvement in rural areas and to advance the livelihoods of a minimum of 370 000 rural households. The aim was to raise the number of smallholder farmers selling their produce from 200 000 to 250 000 in 2014 and to 500 000 by 2020 [37]. In 2014, the Department of Agriculture, Forestry, and Fisheries also increased the agricultural budgetary allocation to R2.38 billion (\$ 160 million) also to support smallholder agriculture programs [37]. However, while smallholder agriculture has the potential to play a vital role in providing food and livelihoods within rural households, it has failed to meet household food security. A study by Mashamaite [38] found that smallholder subsistence farming has an essential role to play in the majority of rural households' food security. However, the sector is still struggling to achieve food and nutrition security at the household level in the country's deprived rural areas [38]. The rural households in the study had to rely on income from other sources to achieve their everyday household food requirements. The food that they produced was not adequate and nutritious enough to meet their daily needs.

The many challenges farmers face, and the resulting poor yields, have contributed to the reluctance of many farmers to continue to engage in farming, resulting in a decline in the number of farmers. Land for farming decreased from 914,527,657 acres in 2012 to 900,217,576 acres in 2017, while the number of farms and "primary producers" declined from 2,109,303 in 2012 to 2,042,220(49%) in 2017 [3]. Many farmers have opted to find other means to secure their households' socio-economic security, such as migrating to cities and seeking employment in the service and manufacturing industries or the informal sector [37]. Furthermore, while the South African government intends to develop the smallholder sector as part of its broader job creation strategy, research shows that government's attempts to support smallholder farmers can be unproductive and expensive. While budgetary distributions by the government in the agricultural sector have increased, few farmers have benefited and, the overall impact is minor [37]. Therefore, it is important to find other means to improve the production capacity of smallholder farmers to maintain long-term food and socio-economic security. This can be achieved by inspiring smallholder farmers to follow sustainable intensification of

production through better-quality inputs. The recovery of smallholder agricultural production offers the ultimate prospects for rural households to reduce poverty [37]. Enhancing smallholder subsistence farming growth by improving agricultural productivity could generate employment opportunities for rural households [39]. This is due to the fact that increasing on-farm agricultural production creates demand for labour in preparation, weeding, planting, and harvesting in many smallholder farms.

The government needs to support all stages of the value chain that occur in farm production to the end-user. Seed production systems are an important part of the value chain as it is where quality seeds are produced and high yields determined. Informal seed systems, which smallholder farmers rely on need greater support as they may hold the key to addressing numerous socio-economic challenges that are currently plaguing Africa. Smallholder agriculture has the potential to increase food supply, thereby reduce food prices, create employment opportunities for the poor, and improve the income of rural households [39]. These incomes can, in turn, improve the food purchasing power of most households, enabling them to meet their everyday food needs, which subsequently enhances household food security [39].

### **Reflection on legislation that governs seed in South Africa**

South Africa has developed several Acts and policies to govern seed systems in the country. The policies include the Plant Breeders' Rights Act, 1976 (Act No. 15 of 1976), Plant Improvement Act, 1976 (Act No. 53 of 1976), Agricultural Pests Act, 1983 (Act No. 36 of 1983), Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997), the Plant Breeder's Rights Policy (2011), the Plant Improvement Act 2018 (PIA)(Act No. 11 of 2018) and the Plant Breeder's Rights Act 2018 (PBR) (Table 1). The legislation requires seed companies to be registered in order to meet quality standards and have certified seeds before sale [21]. The Acts refer to seed systems, although the focus is on formal and integrated seed systems, with little or no mention of the informal seed system (Table 1).

The framing and scope of the Acts and policies form part of the framework that strengthens historically unequal seed, agricultural and food systems, and reinforces the power of large-scale commercial breeders [21]. Smallholder farmers' role in maintaining and adapting seed is left incomplete, possibly unregulated, but also unrecognized. This is a significant limitation of the literature as the diversity of seeds, crops, and open-pollinated populations are preserved through farmers' knowledge, use, management, exchange, and local sale of their seeds.

The marginalization of smallholder farmers within policy has made it difficult for them to access resources such as credit, land, and technology. The Plant Breeders' Rights Act, Plant Improvement Act and the Genetically Modified Organisms Act outline that it is difficult to work with smallholder agriculture as it is associated with subjectivity and has been connected with non-productive and non-commercially viable agriculture. The problem with smallholder farmers is that they are not a homogenous group, and a number of them cannot be defined as small scale [40]. Farmers do not use or are reluctant to use the same modern agricultural technology, they have credit constraints, do not have collaterals and most of them are illiterate. This has often led to smallholder



farmers being neglected by researchers, plant breeders, and policy makers. There needs to be a systemic and structural transformation of South African seed systems, with emphasis placed on smallholder farmers and their informal seed systems. These production systems are an important tool that can be used to improve rural livelihoods and provide incomes for smallholder farmers [40].

## CONCLUSION

Rural households in South Africa are still facing high levels of poverty and food insecurity. Smallholder agriculture offers a means to address these challenges and contribute to economic development and household food security. However, smallholder farmers still rely on home and communal informal seed systems, which are affected by many challenges. The challenges include compromised seed quality, reduced crop yields, and inadvertent barriers for subsistence and smallholder participation in agricultural value chains rooted in seed gene banks, inability to produce and market nationally and internationally. Despite this, these systems are easily accessible and cheap, enabling rural households to produce food for consumption and sale, supplement their low income, and contribute to food security. In general, informal seed systems in South Africa continue to be largely ignored as an important source of genetic material for seed systems and agriculture. Although small-scale traditional subsistence agriculture is still evident, its role is diminishing because traditional and indigenous crops are neglected and underutilized. The current ramifications and long-term effects of this negligence can be linked to nutritional food insecurity and decimation of indigenous gene bank for posterity.

Since there is little evidence that the South African government policies related to seed production, protection and marketing consider small scale traditional agriculture, the following recommendations are suggested: (i) research institutes and universities will benefit from multidisciplinary studies that link STEM (Science, Engineering, Technology, Mathematics and Engineering) with humanities, law, and business studies to gain a deeper and broad knowledge and skills related to IKS (Indigenous Knowledge Systems); (ii) recording such knowledge and its use as part of the curriculum in all the affected disciplines would promote the status of indigenous and traditional crops and their commercialization in the future, and (iii) production of more and cheaper food for local communities must be the goal of agriculture in Southern Africa to enhance the role of agriculture as one of the three pillars of national and regional Gross Domestic Product (GDP). This approach was a great success in the western hemisphere, particularly the United States of America, since the beginning of the 19<sup>th</sup> century.

### Author Contributions:

All authors contributed equally to this work and preparation of the manuscript.

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**Conflicts of Interest:**

The authors declare no conflict of interest.



**Table 1: Relevance of South African legislation governing seed and its relevance to seed system types**

<b>Policies (year)</b>	<b>Aims of policies</b>	<b>Formal seed system</b>	<b>Informal seed system</b>	<b>Integrated seed supply</b>	<b>Seed system type indications</b>
Plant Breeder's Right Act (1976; 2018)	National plant variety protection	Yes	No	No	Commercial seed certification and marketing norms and standards
Perishable Agricultural Produce Sales Amendment Act 33 (1973)	Market for perishable agricultural produce	Yes	No	Yes	Fresh market favours commercial industry compared with informal sector
Agricultural Pests Act 36 (1983)	Provision of crop protection measures	Yes	No	No	Management of pesticide use
Marketing of Agricultural Products Act 47 (1996)	Intervene in the marketing of agricultural products through National Agricultural Marketing Council	Yes	No	Yes	Formal marketing channels by for registered companies, including informal seed marketing system.
Genetically Modified Organisms Act 15 (1997)	Meet quality standards for certification	Yes	No	Yes	More emphasis hybrid seed and not landraces
Agricultural Research Amendments Act 27 (2001)	Protection of agricultural production systems	Yes	No	No	Research on seeds production and marketing

Agricultural Produce Standards Agents Amendments Act (2003)	Agricultural Produce Agents Council and fidelity fund	Yes	No	No	Marketing of Agricultural Products Act 47 (1996)
International Treaty on Plant Genetic Resources for Food and Agriculture (2009)	Conservation and sustainable use of plant genetic resources for food and agriculture products	Yes	No	No	Reliance on commercial and traditional gene banks
Plant Improvement Act 11 (2016)	Registration of premises for propagation, packing and sale	Yes	No	No	Company registration for national and international marketing

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