

Upgrading Strategies and Food Security Implications on Smallholder Farmers in Sub-Saharan Africa: A Value Chain Review

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Abstract The upgrading and value chain literature has tended to focus on the buyers in the value chain such as processors, international retailers and industries as they are the decision makers in the chain ignoring role played by smallholders with regard to food security implications. Recent research has begun to recognize the critical role that smallholder farmers will play in local, regional and global food security in the future. The population in dire need of food is growing rapidly in Africa compared to the rest of the world despite progress in market liberalization and other innovative reforms raising the concern of food security in the continent. It has largely been recognized that there is no one solution that fits all smallholder farmers in Africa. The main conclusions that emerge from the theoretical review and evidence provided in this paper include: Process, product and functional upgrading have different implications in the value chain as interventions with regard to their effect on improved food security and reduction in poverty levels. Smallholder farmers in developing countries are likely to benefit from being members of a value chain in terms of product and process upgrading, but their potential to reap the benefits of increased market opportunities, increased incomes and food security is curtailed by various factors, suggesting immiserizing growth. This paper proposes targeted agricultural interventions based on context specific integrated strategic innovations using tacit knowledge that aims at empowering smallholder farmers to add value to their farm produce using innovative models they participated in developing, while incorporating climate smart agricultural practices, to reduce poverty and achieve sustainable food security and nutrition in Sub-Saharan Africa.

Keywords: food security, innovation, upgrading, value addition, value chain

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1. Introduction

The agricultural sector is the mainstay of many African countries, with the sector experiencing increasing modernization as a result of the innovations that are being introduced in the sector globally. The continent has been experiencing a huge growth in population which is increasingly demanding more food products and therefore food security concerns continue to rank highly on the priorities of many African countries' agendas. The main national policy objectives in Kenya for instance, have focused on themes such as self-sufficiency, food security, improved food nutrition, increased food production and supply, reduction in food prices to ensure affordability, supporting value addition in the food processing value chain, growth in agricultural and rural employment, expansion of exports and resource conservation [1,2]. Africa's population is growing significantly faster than that of the rest of the world: today's global population is 7 billion and is estimated to rise to over 9 billion by 2050,

with Africa's population estimated to grow from the current 1.2 billion to 2.5 billion over the same period [3]. The population of poor and hungry is growing rapidly in Africa despite progress in market liberalization and other innovative reforms, and unless measures are taken to address the underlying problem of structural poverty that faces the continent, the food crisis will worsen [4]. It is noteworthy though that Caron *et al.* [5] in their research indicate that population growth is no longer the main driver of demand in agriculture and food systems.

Research has largely recognized the critical role that smallholder farmers will play in local food security and in global food systems in the future, as they are managers of key environmental services that need to be supported [6]. Agriculture contributes 15% of Africa's total GDP, accounts for 20% of its annual economic growth, with 80% of the food being produced by smallholder farmers and 70% of the continent's population employed in agriculture [7]. Africa has about 51 million farms of which 80% (41 million) are smaller than 2ha in size [8]. However, the continent has a growing import bill for food products of \$35 billion per annum which is estimated to

rise to \$ 110 billion by 2025, despite the continent having 60% of the world's uncultivated arable land and 10% of renewable fresh water resources, indicating massive under exploitation [7]. This raises the concern of food security and the need for sustainable solutions to address the food crisis in the continent. Advocates have recently begun the call for new innovative solutions to solve the food crisis and reduce poverty among smallholder farmers especially in Africa [5,7]. Specifically, Caron *et al.* [5] advocate for a new approach in addressing food systems that is aligned to the achievement of the 2030 agenda on Sustainable Development Goals (SDGs) and the Paris Agreement on Climate: eradicating poverty, increasing resilience, ensuring food and nutrition security, promoting good health, reducing inequalities, contributing to peace, promoting political stability, regenerating ecosystems and mitigating climate change.

The need for sustainable solutions has driven many organizations, institutions and governments at the international, regional and national levels to invest a lot of resources in research on how to improve efficiency and productivity of the agricultural sector. The last two decades have seen increased research being conducted on the state of food security in Africa. This increased focus can be attributed to the fact that despite the need to boost food production in Sub-Saharan Africa (SSA), the world is not currently suffering an overall food shortage [5]. However, research agendas are increasingly driven by the priorities of large scale farmers and consumers in high income countries and hence it has become more difficult for smallholders in low income countries to gain access to productive new innovative technologies appropriate to their needs [9] which can help address food security and poverty concerns in SSA. Innovative interventions are therefore needed to link smallholder farmers to well functioning local or global markets in terms of designing long-term strategies to reduce rural poverty and hunger [6].

Previous studies conducted in SSA highlight various challenges and propose certain solutions to the food security crises in the continent [4,9,10,11]. Among the recommendations that have been proposed is that there is no one solution that fits all smallholder farmers in Africa and that much depends on government policy and investment decisions by international organizations [4,6,9]. AGRA president, while commenting on a report titled, 'Africa Agriculture Status Report: Catalyzing State Capacity to Drive Agriculture Transformation', indicated that, "Governments are definitely central to driving an inclusive agriculture transformation agenda with regard to strengthening country planning, coordination and implementation capacity while supporting the development of an effective private sector and enabling regulatory environment" [12]. Further, it has been recognized that in recent decades, agricultural innovation has tended to promote homogeneity and uniformity, yet the required radical transformation should embrace the virtues of diversity, 'context-adapted' and 'place-based' solutions [5] if food security is to be achieved in SSA. Despite all this research and recommendations proposed by various players and key stakeholders, SSA is still plagued by huge challenges in addressing food security and poverty concerns. Innovative strategies with targeted interventions for the smallholder farmers will help in the

achievement of the Science, Technology and Innovation Strategy for Africa 2024 and Agenda 2063 of the African Union which have prioritized sustained investment in new technologies and continuous innovations for alleviation of hunger, enhanced food security, sustained growth, competitiveness and economic transformation in Agriculture [13].

Questions have however been raised on how smallholder farmers can gain greater access to markets, enhance their value chain position and increase their value added in the face of increasing global concern on food security especially in Africa [14]. This paper seeks to answer this question by providing a review of empirical literature on upgrading strategies in the agricultural sector and their implications on the food security crisis in the continent. Specifically, it focuses on upgrading strategies from a value chain perspective targeting the smallholder farmers, highlighting the enablers, the bottlenecks and proposes interventions and possible solutions to the food security crisis facing SSA. It builds on various recommendations that have been proposed by previous research work, not just to the governments but also to other key players, in order to minimize the adverse effects of the food security situation in the continent. The paper is structured as follows; first is a review of the theoretical framework. Second is a review of upgrading literature in the agricultural sector. Third is a review of literature on the tacit knowledge link. Finally, the paper gives recommendations on possible interventions using a new approach to solve the food crisis in Africa based on context specific integrated strategic innovations, using examples from Kenya.

2. Upgrading and the Value Chain Link

Value Chain has been defined as the successive link of economic activities involving different functions, finally leading to the production of a particular product and linking input suppliers, farmers, processors, distributors and final consumers [15,16]. The value chain perspective has been used to study agricultural value chains in developing countries [6,14,16-21]. However, previous studies on value chains and upgrading in the agricultural sector have focused on the buyers in the value chain such as processors, international retailers and industries [10,15,22,23]. This is mainly due to the fact that they are the decision makers in the chain and governance in buyer-driven commodity chains is usually spearheaded by retailers, processors and importers (Dolan *et al.*, 1999).

Different frameworks have been suggested for studying agricultural value chains in developing countries based on upgrading [6,24]. Specifically, Seville *et al.* [6] recommend that value chain interventions must be integrated with upgrading and wider livelihood strategies. A previous study done on smallholders focused on contradictory outcomes of value chain agriculture and debt relations with respect to food security [14]. While McMichael's study provides useful insights on the aspect of debt relations in favour of corporate markets at the expense of smallholders and its negative implications on local food security, it does not focus on upgrading activities and their implications on the food security

situation in SSA. These previous studies do not provide a clear picture of the enablers and inhibitors of upgrading by smallholders in the value chain in developing countries in relation to the food security crisis in SSA. It has been noted that detailed evidence and quantitative impact assessments on value chains are limited, and hence when sourcing from small-scale farmers, there is need to use additional indicators to track social issues such as number of farmers, incomes, assets and food security, for better assessment of whether benefits arise through participation in the value chain itself [6] or otherwise. This review will seek to extend McMichael's and Seville *et al's* arguments based on a focus on other inhibitors as well as enablers in the value chain in relation to upgrading activities, centered on smallholder farmers and their implications on the food security situation in SSA.

Upgrading has been defined by Porter [25] as a process in which the business environment of a nation evolves to support and encourage increasingly sophisticated ways of competing. It has also been defined in terms of increased productivity and efficiency which plays an essential role in bringing smallholders into higher value markets, as it increases smallholder contributions to value added [26]. For each of the economic activities, upgrading can occur in terms of product upgrading, process upgrading, functional upgrading and chain (inter-sectoral) upgrading [22,27,28]. According to Kaplinsky and Morris ([27], p.39), upgrading involves moving along a hierarchy of a "well trodden path" or trajectory that starts with process upgrading, then moves on to product upgrading, then to functional upgrading and lastly to chain upgrading. The ability with which individual links in the value chain process to meet standards set by the major buyers, with regard to cost, quality, delivery, participation, among other criteria, is the basis of upgrading by several parties [15]. Giuliani, Pietrobelli and Rabellotti [17] summed up upgrading within a value chain to refer to going up on the value ladder, moving away from activities in which competition is of the "low road" type and entry barriers are low. The focus of this study is on innovation and upgrading by smallholder farmers who are the producers at the initial part of the value chain and the impact of these activities on the food security situation in SSA.

Process upgrading involves improvements in the production system, such as acquiring a new machinery, implementing a quality control program, shortening delivery times, reducing waste, increasing the efficiency of internal processes of inputs to outputs such that they are better than those of competitors within and between the links in the value chain [27]. Studies conducted in developing countries indicate that process upgrading is the most common type of upgrading undertaken by smallholder farmers in these countries. A study by Fromm [19] on small scale farmers in Honduras, found that most of them had undertaken process upgrading. Similarly, a study on smallholder banana farmers in Kenya found that farmer groups first concentrated on process upgrading of production technologies before undertaking other upgrading strategies [29].

Product upgrading involves introducing new products or improving existing products faster than competitors within and between individual links in the value chain [27]. With most smallholder farmers seeking to maximize

their profits and remain competitive, enhancing their product quality and therefore moving up the value chain becomes an inevitable option [30]. The underlying argument is that product upgrading involves undertaking innovation in order to stand out of the competition. Functional upgrading involves increasing the value added by changing the mix of activities conducted within the firm or moving the locus of activities to other links in the value chain [27]. According to Giuliani *et al.* [17], the advantage of functional upgrading is in reducing an enterprise's vulnerability to specializing only in production. In a study by Fromm [19], on farmers in Honduras, a developing country, few farmers had undertaken functional upgrading citing huge investments that were required in terms of credit acting as a hindrance. However, it is still possible for smallholder farmers to undertake functional upgrading by exploiting other opportunities available in the chain such as in transportation and storage by gaining knowledge and skills, complying with the high standards required and by gaining the trust of the buyers and other smallholders, which leads to increased incomes [19]. The central argument in these propositions is that by engaging in other functional upgrading activities, smallholder farmers can be able to reduce risks thereby enhance their competitiveness. Chain upgrading also referred to as inter-chain or inter-sectoral upgrading involves moving to a completely new value chain [27]. Chain upgrading is beyond the scope of this study.

2.1. Process Upgrading

Different schools of thought have emerged regarding the role played by innovation with regard to its effect on improved food security and reduction in poverty levels. One strand of knowledge emphasizes the importance of innovation as a necessary goal of any value chain intervention seeking to increase incomes of the poor [31,32,33]. A different school of thought argues that innovation based on the use of modern technology has little impact on household's absolute level of income or absolute poverty rates [9,26] especially if various challenges that are unique to the needs of the smallholder farmers are not addressed.

Evidence from literature suggests that in many African countries, at least 25% of the small-scale farm households are approaching landlessness; a case in point being Malawi where land pressures are so severe, with 70% of smallholder households possessing less than one hectare of land [9]. In Kenya for instance, the traditional culture passed on from generations is based on sub-division of land into small parcels and allocating them among the children born in the household with priority being given to the male heirs. This has resulted in non viable fragmented pieces of land for agricultural farming over decades. The problem has been aggravated by recent trends where such non-viability drives the smallholder owners to further subdivide the land and convert it into real estate property where the returns are much higher. The problem is not just limited to smallholders but is also affecting even large scale owners of land. The size of land that is being left for commercial agricultural farming is therefore diminishing by the day, further complicating the food security situation

in Kenya. The small pieces of land are unproductive with quality of the farm produce being a major concern. In contrast, in Asia where farms were similarly very small during their green revolution, many farms enjoyed higher returns to fertilizer application with irrigation and more than one cropping season per year compared to many African farms which are highly dependent on rain fed agriculture and one cropping season per year [9]. The explanation for the disturbing results in Africa could lie in the small landholding size, lack of diversified crops that have several harvesting seasons per year and heavy reliance on rain fed agriculture.

Evidence from a study conducted by Jayne, Mather and Mghenyi [9] in five African countries: Ethiopia, Kenya, Rwanda, Mozambique and Zambia, found that with the exception of Kenya, for households in the bottom landholding quartile, even a doubling of crop income due to the use of modern technology had little impact on household's absolute level of income or absolute poverty rates. It is therefore important to identify the interventions necessary on relevant innovations needed address food security and poverty in SSA. This is because regardless of how profitable export crops are, various players dealing with smallholder farmers should prioritize food security concerns [31].

Available literature indicates that little is known and recorded about the social dimensions, with respect to gender specific priorities and restrictions, of technology access and adoption and hence its effect on food security in SSA [33]. Emerging evidence seems to suggest that social and gender relations influence different activities in the value chain, for example, women have limited access to processing facilities, technologies and markets compared to men, which consequently leads to higher food losses [34]. The benefits of technological innovation by smallholder farmers in SSA, who mostly comprise of women, in terms of improving food security, have to be weighed against the downside effects. Evidence from research points out that technological innovations such as livestock irrigation projects to increase crop residue and available drinking water for animals results in greater incomes, increased market activities and more milk consumed by children which may indicate positive effects on food security and reduced poverty, but the downside is that it leads to a more labour intensive practice of stall feeding by women and girls [11,34]. This defeats the purpose of technological innovations, which is to decrease labour intensive practices by introducing labour-saving technologies. Support for these findings are provided by Bingen, Serrano and Howard [35] who allude to the fact that across the gender divide, process/technology type of investments by non-governmental organizations and other donor funded projects often limit the opportunities to develop smallholder capacity for problem solving, that could help them learn how to operate as independent economic actors, causing dependency relationships. Further support is provided by IFAD [36] who alluded to the fact that smallholder producers and their institutions can be powerful drivers to scaling up, but they need to be empowered so that they can take charge and sustain the scaling-up process beyond external support from donors. The central argument underlying these propositions is that the benefits of technological innovations on smallholder

farmers across the gender divide, need to be weighed by taking into account a myriad of implications for a conclusive argument to be put across, in terms of its effects on food security, poverty reduction and sustainable development.

Evidence from literature suggests that despite the gains that could be harnessed from the use of technological innovations, smallholder farmers may highly resist their adoption. For example, in the process of introducing better technologies, newer low cost methods have become available in the dairy industry leading to increased productivity, quality and food safety in Uganda [37]. However, the use of improved methods to add value in milk handling, processing and marketing by smallholder farmers was limited or resisted entirely which led the government of Uganda to prioritize the creation of a dairy institution to advice on technology choices [37]. According to a report by FAO [33], research and case studies on labour saving technology adoption by smallholder farmers and their effect on productivity have indicated that there are several constraints that have to be addressed. Key among them are: limited capacity to access technology and services, limited information and complementary inputs as well as access to the inputs to use the technologies especially by women, due to social norms on men's control of technology, fear of loss of employment by women to men, lack of education, household dynamics where men do not see the need to invest in technologies when women can do the work for free or where men manage the women's usage of technology, lack of availability of time by women to learn skills that would enable them adopt technologies to improve their productivity, physical challenges by women on how to use equipment designed for men's physiques, social norms that inhibit women from accessing and adopting technologies, limited access to cash and credit by women which leads to a vicious cycle (where women are unable to develop their skills, which prevents them from earning higher incomes, which further prevents them from affording technologies that will boost their productivity), a high level of informal business that limits their access to markets, low level of cooperation with other enterprises, weak institutions of support and a regulatory environment that is biased against small enterprises [18,32,33].

Various interventions have been proposed to address the challenges highlighted in relation to adoption of technological innovations and process upgrading. Key among them are: introduction of diversified crops such as sunflower and beans that mature early and are disease resistant, which will help smallholder farmers adapt to climate change and reduce the use of pesticides, conservation agriculture using household waste and water, keyhole gardens built in difficult terrain such as rocky areas, integrating fodder production with crops, usage of aquaponics which is a technology that combines fish farming with growing crops in water which improves productivity for families with limited space or land, increasing the skills of women in the techniques as well as access to technologies on harvest and post-harvest processing (to improve product quality, quantity, reduce post harvest losses, save time and enhance their earning capacity), specific agro-processing technologies for silk processing, fish smoking and grinding that are context

specific which save on production time and resources (for example, a unique fish processing technique introduced in West Africa that uses agro-waste such as maize cobs, millet husks and coconut shells in place of wood), information provision on weather forecasts (early warning systems), collective ownership of technologies such as grinding mills through cooperatives and self-help groups to increase access to women and poor smallholder farmers [33]. Among the recommendations made at a recently held conference in Kigali, Rwanda was that smallholder farmers should be equipped with skills on digitalization of records, which can allow them to easily access credit through mobile phone platforms [38]. All these solutions seem to suggest that if various context specific interventions are put in place based on different geographical areas, different agricultural activities and participatory approaches, while addressing the social/gender dimensions to increase and enhance technological innovation adoption, there may be positive effects on sustainable food security in SSA.

2.2. Product Upgrading

Different schools of thought have emerged on the relationship between product upgrading and productivity, its effects on income as well as its effects on food security among smallholder farmers. One strand of knowledge suggests that there is a positive relationship between product upgrading and productivity, increased incomes and food security [39,40]. A study of Norwegian farms found that that product diversity in terms of both crop and animal products had positive consequences on food security, alternative income sources and income stability [39]. Support for these findings are provided by BIRTHAL, Joshi, Roy and Thorat [41] and Feed the Future [42] who indicated that diversification towards high value crops by smallholder farmers had the potential to reduce poverty, with smallholders participating more in high value fruit and vegetable production compared to larger farms. A study by Zylerberg [31] on a horticultural farm in Kenya called Wilmar that partly sourced its flowers from smallholder farmers, found that process upgrading led to positive spillover effects which led to improved quality of other crops (product upgrading) sold in the domestic market as well as for household consumption. This in turn led to improved food security and increased incomes earned from activities besides sales generated through Wilmar; with the increased incomes leading to upgrading to higher value products like carnations [31]. Further support for these findings are provided by McMichael [14] who argued that value chains establish monoculture contract relationships such as production of biofuel where smallholder farmers have no control, hence losing their capacity for diversified farming to sustain local food needs.

Increasing evidence from literature suggests that while 90% of seeds in Africa are local varieties, privatization of seed technologies through hybrid and genetically modified seeds through the value chain, characterize individualized cropping at the expense of diversified cropping, replacing diversified farming with contract farming [14]. For example in the biofuel value chain in Indonesia, planting of oil palm as a biofuel led to a reduction in diversity in customary farming of food crops such as rice and fruit trees which resulted in indebtedness, degradation of the

environment and undermining of community relationships [14]. In yet another report by FAO [40], crop diversification particularly horticultural production and the value chain were touted as important in the feeding of the urban population and contributing to healthy nutrition. However, an alternative view is provided by Dunn [26] who suggested that food security concerns may result in a household planting food crops when higher revenues could be earned by producing higher value crops which could fetch better incomes in the market. Evidence from a study conducted on diversification in Indian agriculture towards high-value crops showed that diversification to riskier high value crops: vegetables and fruits, potentially increased farm incomes among smallholder farmers more quickly than staple food crops [41]. It is noteworthy though that India achieved self-sufficiency in grain production in the mid - 1990's, thereby mitigating the prevalent food security concerns [41].

Questions have however been raised on whether a policy on food self-sufficiency for staple food crops such as maize, would help African countries achieve food security and address poverty, as it fails to address the need for smallholders to produce diversified income generating crops that would move them out of poverty [4]. Evidence suggests that in Kenya for instance, maize is grown by 98% of rural farm households and makes up a large share of households' crop income [42] yet the country is very much food insecure. The fall armyworm infestation of the maize crop in Kenya in 2017 contributed to huge losses for many farmers further raising the question on the whether the country can continue majorly relying on the crop to address food security concerns.

Further evidence from empirical data collected on the dairy sector in three European countries indicated that vertical coordination innovations had positive impacts on small scale farmers in relation to quality of products, productivity and on-farm investments, further leading to improved food security [28]. Specifically, based on their study, milk quality rose rapidly following contract innovations by dairy processors in Poland from less than 30% in 1996 to 80% in 2001, in Bulgaria from 17% in 1997 to 34% in 2003 and Russia from 6% in 2000 to 55% in 2004 [28]. In addition, 76% of all farms, including smallholder farmers made investments after vertical coordination was implemented, of those that invested, 58% used it for enlarging their livestock herd, 30% used the loans to upgrade their livestock and 56% was used it for purchasing cooling tanks [28]. However, they noted that a problem with the vertical coordination approach is the possibility of rent extraction by dairy processors and retailers such that if the processing firm sets the terms of the contract to capture most or all the rents, productivity growth may not benefit the smallholder farmers, and if the processor has monopoly power, the farm's income may not grow despite total income having improved [28]. They suggested that competition was key in preventing processors from exercising monopoly power in the designing of contract conditions and in ensuring that the smallholder farmers share in the benefits [28]. The arguments presented above seem to suggest that different agricultural sectors and even geographical regions may present different results based on a decision to pursue individualized farming activities based on contract

innovations or diversified farming in an effort to achieve increased productivity, reduced poverty and enhanced food security among smallholder farmers. These differing perspectives raise the question on the best strategy that smallholder farmers can pursue to achieve food security and increase their incomes in SSA. Is it diversified farming or is it individualized cropping based on contract farming?

A third perspective holds that product innovation may not necessarily translate to increased productivity. Evidence provided by a study conducted by Fischer and Quaim [29] on collective action by smallholder farmers in banana growing and marketing in Kenya, found that group participation was associated with adoption of tissue culture technology in banana production but there were no positive productivity effects observed. The underlying explanation was that there were unfavourable weather conditions during the study period coupled with the fact that the newly established tissue culture plants were still very young [29]. A fourth perspective holds that upgrading activities do not necessarily translate to better profit margins. A review of literature by Dunn [26] found limited evidence that smallholders are able to earn higher profits from their upgraded farm enterprises. A completely different strand of knowledge argues that product innovation may result in mixed implications with regard to its effect on food security. A case in point is the argument that biofuel crops displace food crops hence threatening food security, while on the other hand mitigates climate change impacts through the use of renewable energy sources [33].

There are certain constraints that hinder realization of the benefits of successful product upgrading in developing countries. Evidence from literature suggests that cognitive institutions may prevent innovations in products and processes and can limit free flow of information and knowledge, mobility of labour and relationships between communities [24]. For example, government legislation, regulations and policies can constrain value chain upgrading by setting trade barriers for production materials and technology, by limiting free flow of information, by imposing unfavourable taxes and denying infrastructural investments that would benefit value chains [24]. However, it has also been argued that where there is potential to embed the 'value' of smallholder sourcing in the product proposition, then there is the potential for building the merits of smallholder sourcing based on what customers value, creating value throughout the value chain [6]. A case in point is Zambia, where estimates suggest that over 50% of seasonally produced fruits and vegetables are wasted between collection and retail points due to lack of processing capacity by small-scale producers, despite the availability of dried mango slices and vegetables in supermarkets and markets indicating that there is a market even for semi-processed products [40]. The underlying argument in these propositions is that if there is a conducive institutional environment that is supportive to smallholder producers, based on a collaborative framework in the governance of the entire value chain, there is the likelihood of more product innovations that have value emerging. This will in turn lead to increased benefits to the producer end of the chain that includes smallholder farmers in terms of food security

and improved incomes, as well as to all other participants in the entire value chain.

2.3. Functional Upgrading

The ability of smallholders in developing countries to benefit from global value chains is ambiguous; in most cases they are unable to meet the high upgrading conformance standards hence find themselves left rapidly behind and excluded, with negative consequences on income and distribution impacts [27]. Available evidence from literature seems to suggest that there are mixed results regarding the extent to which smallholder farmers benefit from functional upgrading. Giuliani *et al.* [17] assert that insertion in a quasi-hierarchical chain offers very favourable conditions for product and process upgrading, but hinders functional upgrading, further indicating that networks offer ideal upgrading opportunities, but they are least likely to occur for developing country producers. A study by Zylberberg [31] found that while smallholders may enjoy increased incomes, lower price volatility and improved food security, they do not seem to progress functionally, as value chain interventions are largely vertical in nature (focusing on increasing value captured by the organization). Their empowerment is hence limited to active participation in producer groups which is compounded by the fact that functional upgrades are too capital and knowledge intensive to pursue alone or even in small groups [31].

The case of Pumpkin Ltd., a horticultural company started in Kenya in 1996, exporting French beans, snow peas, papayas and mangoes exemplifies a situation where innovation strategies do not always translate to better profit margins or food security for smallholder farmers due to exclusion in functional upgrading decisions in the value chain [10]. The company would source its products from smallholders but realized the cost was 50% more than produce grown on large farms, due to the waste of the product that failed to meet European Union quality requirements [10]. A decision to expand its operations by leasing its own farms to control product quality created new challenges. It purchased a refrigerated pack house and the machinery required for pre-packing vegetables and conducted innovation activities on developing pre-packs for the catering industry in the United Kingdom, but the El-Nino rains of 1997 negatively impacted on their ability to meet the volumes required for the export market, with the cost of maintaining the pack house being too high for them to justify the expenditure [10]. They closed the pack house and subsequently became hesitant to invest in cold storage facilities or land improvements without a guaranteed return on their investment [10].

Support for these findings are provided by Bingen, Serrano and Howard [35] based on a study of West African countries which found that, while functional and literacy programmes assured that farmers had the skills on book keeping, fulfilling credit and marketing tasks leading to success stories, in the absence of contract enforcement provisions, and additional investments in the community that might create loyalty to the company, the companies may become economically non-viable due to side-selling problems by the smallholder farmers. This in turn affects not only the companies that invested heavily in training

and input provision, but also the smallholder farmers themselves. Bingen *et al.* [35] assert that the companies are often unable to meet credit repayment and marketing expectations, while the smallholder farmers in an effort to meet their short-term cash needs, are often unable to repay their loans to the companies. Further support for the findings are provided by McMichael [14] who argued that resolving the agrarian and food crisis through a project of contract farming represents a 'spatio-temporal fix' enclosing producers in value chain technologies that are financed through debt dependency. These findings seem to suggest that smallholder farmers in developing countries are likely to benefit from being members of a value chain in terms of improved products and processes, but their potential to reap the benefits of increased market opportunities, increased incomes and food security is curtailed by various factors, suggesting immiserizing growth.

The frequent adverse effects of climate change such as cyclical droughts and flooding are seriously impacting the African continent's food security situation. It is estimated that climate change will cause additional net economic losses equivalent to almost 3% of GDP each year by the year 2030 [42]. Caron *et al.* [5] in a recent study indicate that the agricultural sector has only recently given priority to climate change with regard to the impact on the millions of small scale family farmers and food processors. Empirical evidence suggests that subsidized distribution programmes by well meaning governments, donors and non-governmental organizations, in the face of drought, often use inputs such as seed and fertilizer as a vehicle to improve food security and reduce poverty, yet these programmes have had a negative impact on the market, as it erodes the incentives for local traders to develop markets that can respond to future emergencies [4]. For example, the World Bank's World Development Report 2008 coincided with the 2007-2008 food crisis and recommended the need to increase crop yields in Africa by providing support through new seed technologies, fertilizers and other inputs as part of new value chains [14]. Evidence from five African countries: Zimbabwe, Mozambique, Uganda, Somalia and Rwanda, suggests that where donors resort to rapid input distribution programmes, sometimes beyond the initial emergency, it creates disincentives for local market players [4]. The need to come up with sustainable innovative models to curb the negative effects of climate change through climate-smart agriculture cannot be over-emphasized. This suggests the need to come up with sustainable solutions to the food security situation in SSA in terms of market innovations that empower smallholder farmers.

Kelly, Adesina and Gordon [4] proposed that market innovations can reduce the negative impacts of relief programmes such as the use of empirical data to establish a real need, local purchase of seed by relief agencies, use of affordable mini-packs, promotion programmes at markets, churches and schools, distribution of cash rather than seed, starter packs for seed and fertilizer, or giving vouchers to poor farmers which are redeemable for seed through established seed retailers or at seed fairs, with the model working successfully in Mozambique, Zimbabwe, Uganda, Malawi, Zambia Tanzania and Kenya. Successful implementation of market innovation models have not been without their fair share of challenges; such as

political interference, ineffectiveness of means targeting, leakages, procurement and distribution delays and inadequate farmer training, which have led to little impact on crop productivity, soil quality and farm incomes in the case of Malawi and Senegal [4]. Similar challenges permeate other African countries a decade and a half later. From the preceding arguments, inference can be made that the main aim of market innovation models is to improve food self-sufficiency especially for the staple food crops.

The value chain governance structure has been proposed as a useful tool in identifying possible interventions and opening pathways for generation, transfer and spread of knowledge, leading to innovation to achieve inclusive economic growth that takes care of smallholders [31,26]. Specifically, Zylberberg [31] found that in terms of upgrading capacity, the adoption of a flexible organizational structure is conducive to assimilating new information in order to capture more value for smallholder farmers. By integrating small holder agricultural producers into competitive value chains, a successful smallholder-led strategy for inclusive growth can support a structural transformation whose benefits include increased incomes, as well as multiplier effects on employment and income throughout the rural economy, reducing poverty, improving food security and fueling a process of local and national economic growth [26]. The role of governments cannot be overemphasized in the governance structure. Evidence suggests that economic output in Ghana's agriculture sector driven by the government's new 'Planting for Food and Jobs' program grew by 8.4% in 2017 with countries like Kenya, Burkina Faso, Mali and Zambia gaining political momentum, Ethiopia being a key exception and Rwanda posting the highest score on agriculture transformation, lifting one million Rwandese out of extreme poverty in a relatively short period, due to government support [12].

Multi-stakeholder Innovation Platforms have also been suggested as being instrumental in providing spaces for value chain actors to interact, communicate, improve performance of the value chain and influence policies [36]. Site specific policies can then be crafted to align production with market requirements, resulting in better prices for smallholder farmers [36]. Evidence provided by literature shows that for several years, International Fund for Agricultural Development (IFAD) has successfully supported innovation platforms through various models such as, a programme entitled "Small Ruminant Value Chains as Platforms for Reducing Poverty and Increasing Food Security in Dryland Areas (imGoats)" in Mozambique and India, a model consisting of interlinked poultry enterprises in African and Asian countries, a smallholder goat development model in four East African countries and a hub model in East Africa that is comprised of a chilling plant and a dairy hub around which a network of input and service providers are established, along with credit facilities and livestock insurance [36]. These innovative programmes have had positive effects among smallholder farmers in improving productivity and quality, increasing economic returns, value addition, increasing access to markets, reducing rural poverty, income generation and trading opportunities especially among rural women and hence enhanced food security [36].

Dries, Germenji, Noev and Swinnen [28] suggested that institutional innovations to ensure supplies for processors

or payment for input suppliers help to enforce contracts. As smallholder farmers seek to modernize their procurement systems, manage on-time delivery of their food supplies and meet customer needs, they have adopted organizational innovations and institutional innovation contracts such as shifting from spot market transactions to the use of specialized, dedicated wholesalers [43]. They are however faced with challenges such as lack of well developed institutions for credit and contract enforcement than India did at the time of the Green Revolution, weaker research and extension systems, greater investments required to access quality inputs, lack of irrigation systems such as drip irrigation (hence higher production risk), lack of refrigeration facilities and green houses, lack of knowledge and lack of capital which hinder improved smallholder farmer access to modern market channels [4,33,43]. Other challenges are highlighted by Perez-Aleman [44] who alluded to the fact that standards, norms and regulations set by western retailers, processors, the government, cooperatives, non-governmental organizations, donors and other actors, define the institutional environment of developing country producers. Smallholder farmers are often unable to meet these high standards and regulations, with all these problems negatively impacting food security in SSA.

Fischer and Quaim [29] in their study found that cooperative organization does not improve market access for smallholder farmers, but farmer organizations can act as catalysts for innovation adoption and upgrading of production systems through promoting efficient information flows, which is crucial in ensuring that they remain competitive in rapidly changing environments. Their argument being that price advantages based on market access was product and context specific, depended on the collective activity pursued, and linking farmers directly to emerging high-value chains, which have the potential to increase benefits and make the groups sustainable [29]. Other recommendations that have been made by previous research work on improving market access for smallholder farmers include: adoption of mobile phone based financial transactions which helps in access to a variety of financial services as well as payment schemes in the market (Kenya being a success story) and provision of information communication technology (ICT) to improve access to markets and supply chain management and agricultural outreach [33]. The arguments presented suggest that for innovation and upgrading activities to benefit smallholder farmers in terms of improved market access and the potential gains in terms of competitiveness, improved profits, alleviation of poverty and improved food security, there is need to identify solutions that are context specific.

3. Tacit Knowledge and Food Security in SSA

To achieve the Malabo declaration that resolved that targeting priority geographic areas and community groups for agricultural based interventions was the way to go in Africa [45], there is need to introduce the concept of 'tacit knowledge' to this discussion. According to Giuliani *et al.* [17], tacit knowledge refers to knowledge learned through practice and practical examples; the knowledge can be

freely used by its owners, but cannot be easily expressed and communicated to anyone else. Kaplinsky and Morris [27] indicated that innovation in itself may not be adequate to translate to growth and that it had to be placed in a relative context (how fast compared to competitors), a process referred to as upgrading. Giuliani *et al.* [17] on the other hand also indicate that there is a relationship between innovation and upgrading, but define upgrading as innovating to increase value added. This paper will lay emphasis on the later perspective, based on the use of tacit knowledge. In addition, Kaplinsky and Morris [27] assert that skills development through training programmes is in itself not an adequate way to realize growth in value chains; tacit knowledge and technological capabilities have to be harnessed to meet focused objectives which can be realized in the market. The central argument underlying these propositions is that innovation and upgrading backed by training activities that are not aligned to context specific unique needs of different and dynamic local conditions are not likely to yield much in terms of growth in the market. They are also unlikely to lead to achievement of sustainable objectives, including food security aims in different regions within SSA.

Previous studies and conferences have alluded to the underlying concern for decentralized and participatory decision making processes that create, strengthen and delegate power and economic responsibility to village and local organizations in agricultural development: notably, the 1979 Peasant's Charter at the World Conference on Agrarian Reform and Rural Development, the 1992 Rio Earth Summit and World Development Report 2000/2001 [35]. This study seeks to argue that innovation and upgrading activities that are based on tacit knowledge depending on the unique needs of smallholder farmers in different regions, local conditions, gender responsiveness and different country contexts, will play a key role in helping to reduce the food security crisis in SSA.

Upgrading methods that are context specific to farmers' needs and local conditions must be designed and capacity building of the smallholder farmers undertaken based on these needs. These must be based on collaborative efforts between the smallholder farmers, processors, the government, cooperatives, non-governmental organizations, donors and other actors, to ensure proper training and adoption of these innovations [44]. Lessons learnt from Kenya in the fishing industry can serve as a good example of a success story in the adoption of innovative context specific upgrading, by adhering to safety and hygienic standards required at the international level leading to increased incomes for fish farmers. In this case, local norms, provision of good physical infrastructure, government organized training, inspection personnel, formation of an association of fish processors and exporters, all played a key role in upgrading fishing, which led to successful exports to the European Union (EU) since 2000 [44]. This in turn has led to reduced poverty and possible positive implications on food security.

Evidence from studies conducted in Senegal, Rwanda and Zambia found that an overly generalized perspective of uniformity in addressing smallholder farmers presents challenges on the use of project/technology investment models in improving their capacity to access agricultural markets [35]. Specifically in Senegal and Zambia, village

wealth ranking exploratory studies highlighted the importance of taking time to understand village socio-economic differentiation and its influence on collective action [35]. The studies found that different economic classes of villagers participate in village-level collective activities for different reasons and with a different effect on the contribution of these collective activities to successful input supply and marketing programmes [35]. Among the challenges identified was the lack of an independent space and perpetuation of exclusion of women in expressing themselves or assuming responsibility for collective activities related to input supply and marketing, as well as the focus on individual member benefits at the expense of a “solidarity ethic” as a means to meet needs, as was the case in Rwanda [35].

Targeted interventions will help in the achievement of the Malabo declaration that resolved that all segments in the population especially women and youth as well as other disadvantaged members of the society must participate and directly benefit in gainful and attractive agri-business opportunities as well as facilitate the creation of job opportunities for at least 30% of the youth in agricultural value chains [45]. Research has suggested that in Kenya for instance, women and youth groups are in an excellent position to capture the benefits of the emerging global demand for value added products as well as local and regional fresh commodity markets and hence mitigate against food insecurity and poverty [42] if targeted interventions specific to them are put into consideration. The challenges highlighted present a profound problem in addressing collective action needs such as promotion of community food security through the innovative, sustainable business models. These findings are supported by Giuliani *et al.* [17] who alluded to the fact that the impact of collective efficiency and patterns of governance on the capacity of small and medium enterprises to upgrade differ across sectors. Giuliani *et al.* [17] argue that in traditional manufacturing as well as natural resource based sectors (including the agricultural sector), technology has important tacit and idiosyncratic elements, and hence upgrading depends on the intensity of technological externalities and cooperation among local actors. The central argument underlying these propositions is that for any upgrading interventions in the agricultural sector targeting smallholder farmers to be successful, they should be addressed from a tacit knowledge perspective if food security and poverty reduction objectives are to be achieved.

3.1. Context Specific Integrated Strategic Innovations: A Kenyan Perspective

Increasing evidence suggests that much of the agenda around small-scale producers treats them as passive recipients of agricultural innovation systems in support of ‘inclusive’ markets and hence a chain approach can unintentionally replicate traditional development interventions by failing to see the rural poor as agents in their own development [6,32]. Indeed, in value chains of agricultural products, retailers are not concerned with forward or backward integration with regard to supplying information and monitoring implementation of recommended innovations, leaving this to other actors in the chain, implying that the

producers must acquire knowledge and skills needed to upgrade themselves [18]. Diffusion of the innovations and scaling up therefore becomes a problem once the farmers have been left on their own to run the projects, when these actors leave the scene. Innovative solutions that are context specific and that integrate smallholder farmers may therefore offer practical solutions in addressing food security concerns. Innovation platforms designed in a way that is accessible to farmers have been suggested as a basis of providing a platform for linking rural women to a larger network and providing them with a way of getting involved and making their needs heard through the innovation process [32]. For instance, online knowledge platforms (information provided is place-bound) where farmers are trained in producing videos and sharing them with fellow local farmers and screening them with the help of a facilitator, enable farmers select and adopt relevant innovations, based on an integration of local and scientific knowledge, in turn enhancing knowledge especially among illiterate women [32].

Evidence from research indicates that supply of seeds by commercial markets displaces customary and ecologically driven seeds eroding local knowledge and the resilience and autonomy it provides [14]. The result has been a deepening agrarian crisis around the world manifested in food price inflation, food riots and rural out-migration to peri-urban slums with the elite responding through a ‘spatio-temporal fix’ confining producers to value chain technologies financed through debt dependency [14]. For example, a shortage and a rise in price of maize flour, a staple food crop locally referred to as ‘*unga*’ resulted in protests and demonstrations evidenced in Kenya in 2011 and 2017. Following the food spikes evidenced not just in Kenya but globally, there has been increased awareness of the multiple relationships between agriculture, and key social, environmental and economic issues [5]. For instance, high food prices affect poor families, especially urban poor women who have to reduce their food intake and at times, discriminatory cultural norms may dictate that men and boys eat first, leaving women and girls most at risk of food and nutrition insecurity [46].

Despite the grim findings that have been reported with regard to reduced production of some food products in Africa due to climate change effects, the agricultural sector has also reported bumper harvests for certain agricultural production activities. Farmers are continuously experiencing surplus production due to seasonal gluts with no market outlet for their excess produce leading to post harvest losses. Available evidence suggests that food loss and waste negatively affect food security and require the global agriculture system to produce additional food to compensate for these losses: in SSA, post harvest losses amount to up to US\$ 4 billion per year [34]. In Kenya for example, surplus production has been reported in milk production, green gram production in Kitui, mango production, tomato production, among other crops. This paper introduces the concept of “context specific integrated strategic innovations” through value addition, as an intervention for the surplus produce to complement the tacit knowledge concept. Specific examples are discussed from a Kenyan context based on surplus production that has been reported in the country in recent

times. This will go a long way in the achievement of the agro-processing strategy of the government of Kenya that aims at supporting value addition to agricultural produce across the value chain to enable the establishment of 1000 Small and Medium Enterprises (SME's) and the creation of 200,000 jobs that are focused on food processing [2].

Context specific integrated strategic innovations in this paper refer to upgrading initiatives based on tacit knowledge that aim at empowering smallholder farmers to add value to their farm produce using innovative models they participated in developing, while incorporating climate smart agricultural practices. This therefore means that the upgrading initiatives are only suited and applicable to a particular area and group, and may not necessarily work successfully in a different area. The model should be designed with participation from the smallholder farmers in a certain locality, supported by stakeholders, to encourage creativity and an innovative culture, value addition, enhance ownership, acceptability and diffusion of the innovation, as well as scaling up once the farmers are left on their own. It will also enable smallholder farmers to design innovative ways to solve their own agri-business related problems. This is because most innovative solutions are designed by stakeholders close to the market end of the value chain, with producers being trained on how to use these innovations, with the assumption that they are not able to come up with creative solutions. The intellectual property therefore rests in the hands of the value chain actors in the upper part of the chain based on their interests at the exclusion of smallholders who are the consumers of these innovations.

There is need to design context specific integrated strategic innovative solutions to address the surplus produce among smallholder farmers with an aim of reducing post harvest losses. This will go a long way in helping to close the food gap between food available today and food needed in 2050 to adequately feed the planet's projected 9.3 billion people [34]. Evidence from research indicates that smallholders in Kenya produce over 95% of total national volume of fresh fruits and vegetables and the value chains promise substantial economic gains to women and youth in Kenya: 90% of the products are consumed domestically, with a rise in preference for indigenous vegetables, mostly grown by women, presenting great employment opportunities [42]. Seasonal surplus produce has been reported for various horticultural products in the country. On the domestic front, lack of enforcement of standards such as 'organic', expanded on-farm water capture and storage, drip irrigation, precision fertilizer systems, green houses and other technologies are major challenges that have to be addressed to enhance competitiveness [42]. However, opportunities abound as evidenced in the success of micro-processing of chili and passion fruit juice for both domestic and international markets [42]. Additional evidence suggests that horticulture generates income potential that is 2 to 7 times greater, in terms of revenues per hectare, than that of staple crops such as maize and is therefore among the most attractive agricultural self-employment sectors for Kenyan youth, followed by trade in livestock products [42].

The case of Miyonga fresh greens enterprise, a horticultural company in Kenya that exports its products

to European countries, United Kingdom and South Africa, serves as a good example [47] of such context specific strategic innovative solutions. This paper however proposes that in designing the innovative models, participation from the smallholder farmers is important. The company in an effort to help smallholder farmers sell their excess mangoes that do not meet export standards (rejects), designed a project they called "the wheeling fruits project." Mango has been reported to be one among many fruits that highlights the deficiencies in agricultural waste management, especially in the market place [40]. Miyonga Company together with Kenya Industrial Research Development Institute (KIRDI) processes surplus fruits at farm gate level and have been able to produce powder from surplus mangoes using a semi mobile processing unit that is fitted to a trailer that moves between farming areas with the organization buying the rejects from the farmers directly at an existing aggregation centre [47]. Research indicates that formal markets can have higher risks of rejected products, which translates to financial losses [6]. For example, an organization called 'Africa Improved Foods' rejected 90% of the maize sourced due to poor quality leading to huge losses for the farmers, but interventions made by the company reduced the rejection rate to 20% [38]. The innovative business model by Miyonga is based on the premise that by reducing the volumes of produce to be transported and the option of value addition, additional cost savings can be achieved, with up to 90% volume reductions [47]. An alternative that could be exploited would be to design an innovative model in collaboration with the smallholder farmers on how to upgrade to canned, concentrated juiced, dried mango fruits or mango jam. Farmers would then benefit from additional income, reduced post harvest losses, which in turn would lead to food security and reduced poverty.

Tomatoes have often been referred to as the "red gold" in the developing countries that produce the crop. Countries like the United States of America, Italy and China have continued to reap huge benefits from the crop as a result of mass production, mechanization of production as well as value addition into tomato paste. The products are mostly aimed at the export market with huge competition being experienced in the sector. Some of the companies have begun venturing into the African market, particularly West Africa, with some even establishing processing plants in the countries where they have a large market. The aim is to also benefit from the cheap cost of labour, which can be up to three times higher in their countries of origin. The tomato paste is sold at competitive prices and is beginning to offer stiff competition to locally grown tomatoes with customers preferring the tomato paste over the raw tomatoes. African countries like Kenya (with the region experiencing gluts during certain seasons) can rise up to the challenge and begin small scale processing plants through collective action to add value to the tomatoes in order to fetch better income, reduce post harvest losses and achieve increased food security. Evidence suggests that in some value chains such as horticulture, food loss and wastage sometimes go beyond 50% for products such as tomatoes and onions [3]. Context specific integrated strategic innovative models can be designed to suit the needs of smallholder farmers

in a certain locality, with their involvement, through collective action for bulking purposes.

Pietrobelli and Rabelotti [18] emphasized the importance of collective efficiency, as clustering offers opportunities for powerful externalities that may be appropriated by small and medium enterprises in the cluster and may facilitate the development of joint actions among local actors. The products produced through collective action can be targeted at local and regional markets. Seville *et al.* [6] noted that formal markets, particularly global formal markets are modest in size relative to domestic and regional markets, and markets in the emerging economies such as China and India as well as domestic markets are growing faster than formal global value chains. The World Bank projects that the African food market could triple by 2030 reaching a value of \$1 trillion, which is an indicator of the potential for smallholder farmers in the continent to reap the benefits of their agricultural activities as they produce more than three quarters of the food consumed in the continent [38]. The African continent has a huge market and there is potential for more growth in the future, hence there is justification for tapping into this regional market for smallholder farmers' produce in order to achieve food security and increased incomes.

The "green gram revolution" in Kitui County, Kenya presented enormous potential for the smallholder farmers to reap the benefits from the bumper harvest experienced in 2018. However, the lack of a market from the surplus pulses left most smallholder farmers with a bitter taste in their mouths. A conference on the state of agriculture in Africa held in Kigali, Rwanda recommended that better ways of market access are required as farmers may do the right things only to later realize there was no market for their produce, hence the need to create full value chains [38]. With stakeholder support, potential can be tapped from adding value to the green grams by processing the pulses into gram flour. Since pulses are high in nutritional content, the gram flour can be blended with other flours and used to enrich meals such as porridge targeted at infants and women. The smallholder farmers can also be trained on how to mill the flour and blend it using other locally available pulses and cereals based on collective action, brand it and market it using context specific integrated strategic innovations. This will boost the incomes earned, reduce post harvest losses while also increasing food security, enhancing nutrition and building a healthy nation. The incomes earned can be used to boost production and strategic pulse reserves can be harnessed to cater for drought periods, with the area experiencing erratic rainfall. The programme can be targeted at women as a gender empowerment initiative and if the pilot is successful, it can be rolled out to other areas with similar climatic conditions by modifying it to suit the different locale. Evidence has shown that women are versatile in mitigating and adapting to climate change and possess a wealth of traditional knowledge and skills that can be applied to climate smart agriculture and disaster risk reduction [46].

FAO [32] and Caron *et al.* [5] support the view that innovative local-specific human-driven systems and initiatives in agriculture should aim at addressing local and national expectations through diverse adapted pathways and the capacity to replicate such a transformation at the global

level to ensure orientation and consistency: organic farming and agroecology are notable examples of agricultural innovations recognized by many global leaders. Pulses are regarded as 'women's crops' and are often the only food available during lean seasons or when the main harvest fails and can therefore boost food security in semi-arid regions [42]. Synergetic relationships can also be established and harnessed by collaborating with farmers in counties that produce surplus different pulses and cereals, with these market linkages not only harnessing economic potential in the respective counties, but also creating learning opportunities as well as social benefits by fostering unity among the residents. The respective county governments can then act as facilitators in the value chain by providing the necessary support in terms of governance as well as identifying new market opportunities for the smallholder farmers' value added products.

The Kenyan dairy sector ranks highly in terms of yields against regional averages and nutrition; with the dairy market constituting the single largest food expenditure item across all income classes (average monthly household expenditure on dairy items in Nairobi is Kshs 1211) [42]. The dairy sector is dominated by informal smallholders majority of who are women, with the contribution of small ruminants and poultry complimenting household food security in the region [42]. Women make up a significantly large proportion of food producers in the world and play a major role in household food security and nutrition [46]. Statistics indicate that women make up 75% of the agricultural labour force in Kenya [48] with Republic of Kenya [49] quoting the figure at 60-80% of the labour force being involved in the livestock sub-sector. This is in line with findings by Muriuki [1] that women and school age children contribute greatly to labour for dairy activities especially to milk production and marketing. A report by Republic of Kenya [50] revealed that in terms of gender contribution in the selling of milk, 17.6% were men while in contrast, 33.8% were women and 48.6% involved the contribution of both. According to Republic of Kenya [49], development interventions in the livestock sector and in the agricultural sector as a whole tend to affect women and men differently, though in the dairy sector, there has been a tendency of treating gender in a neutral manner with the assumption that bottlenecks and solutions impact both men and women in a similar way.

The dairy sector presents major opportunities and since Kenya's only major competitor, South Africa, is not a COMESA member, the country has a potential advantage for that and the East African markets, estimated to have a 2 million metric ton deficit, if it makes an effort to improve quality standards from the smallholder to processor level [42]. Supportive frameworks and context specific integrated strategic models are essential to capture the benefits that smallholder farmers will reap from their upgrading initiatives. For example, Feed the Future [42] designed an innovative model similar to a venture capital fund called Kenya Feed the Future innovation Engine (KFIE) activity through which innovative private sector strategies that support food security and nutrition are proactively discovered, incubated and scaled-up for wide-spread impact [42]. These innovative models are

beginning to increasingly focus on sustainable and nutrition sensitive food products especially among women and children, because malnutrition irreversibly hinders many people from reaching their full potential capabilities of living a healthy and productive life and is recognized as social injustice [5,42]. Upgrading initiatives in the dairy sector should be targeted at the smallholder farmers with an emphasis on value addition through collective action based on the economic potential but most importantly for the food security and nutritive value that the respective families will benefit from in the consumption of the products.

Kaplinsky [51] and Seville *et al.* [6] emphasize the importance of the governance roles played by various actors in the value chain who are responsible for the capacities of particular participants to upgrade their activities. The county governments can ensure proper governance of the value chains by ensuring that smallholder farmers adhere to the required quality standards for the value added products to be competitive in the market, which Kaplinsky referred to as legislative governance. They can also review and enact by-laws that are agriculture friendly [40]. Other actors in the value chain such as non-governmental organizations, donors, extension workers as well as other stakeholders can provide assistance to the smallholder producers in meeting the standardization rules required in terms of executive governance; which is proactive governance that ensures adherence to standards required for upgraded seed design, growing practices, phyto-sanitary practices, brand names and marketing [51]. They can also ensure judicial governance which is ensuring compliance with ISO standards [51] such as GlobalGAP 9000 certification for agro-export commodities [14] as well as third party certification such as Fair trade, Rainforest Alliance, Utz certified or organic certification, which is a package made up of best practice requirements, specific trade mechanisms to support smallholders or incentivize sustainable production and provide product value propositions to consumers [6]. Evidence from research suggests that smallholder farmers in Kenya who have Global G.A.P (Good Agricultural Practice) certification are likely to be in a relationship with one of the ten largest exporters in the country, which comes with benefits such as advice and support from buyers, higher price paid per kilogram, more trade and higher income from sale of export crops, the flipside is that the certification requires higher levels of capitalization than smallholder farmers can afford [6,14].

There are conflicting findings as to the extent to which participating in certified markets by smallholder farmers impacts on food security. For instance, Mintel *et al* and Hendrinski and Msaki (as cited in [6]) found that for smallholder farmers in Madagascan French beans contract farming and in certified organic crops in South Africa respectively, there were significant improvements in food diversity and sufficiency of household food, indicating positive impacts on food security. Another strand of knowledge suggests that participating in certified markets may have negative implications on food security. Non-compliance with quality and safety standards has been linked to food losses of cereals, fish, fruits and milk at each node of the value chain: from production due to poor harvesting equipment; during handling and storage

due to lack of proper storage equipment and facilities; during processing; and during distribution and marketing [34]. This negatively impacts food security. A study by Mendez *et al.* (as cited in [6]) found that for coffee producers in Central America, higher crop incomes were earned through Fair trade certification but this had negative implications on food security. This has led to questions about the long-term sustainability of current agriculture and food production [5] systems such as certification. These findings seem to suggest that certification and compliance with standards may have different implications on incomes generated, food security among smallholder farmers depending on the kind of agricultural production activity (crop, livestock or fishing), geographical region in which the agricultural activity is being undertaken, as well as the value chain activity undertaken.

The context specific integrated innovations should be supported by relevant innovation policy interventions in terms of best practices. The Innovative policy series from the Regoverning Markets Programme, that addresses specific policy innovations in the public or private sector to improve the livelihoods of small-scale farmers in accessing dynamic markets at the national, regional and global levels, serves as a good example of such an innovation policy [52]. To complement the innovation policy, the programme has also designed an innovative practice which constitutes country case studies of specific innovations in connecting small-scale producers with dynamic markets at local or regional levels [52]. The studies focus on four drivers of innovation: public policy principles, private business models, collective action strategies by small-scale farmers and intervention strategies and methods of development agencies [52]. Seville *et al.* [6] also point out the need for development of partnerships with the private sector to address policy issues that can bring more public investment and policy support for poor smallholder producers. The importance of such innovation policies is that they can be shared among various stakeholders, across regions and modified based on local unique needs and then replicated for similar projects and in similar geographical areas within SSA, while taking into account smallholder participation.

4. Conclusion

Questions have been raised about the long-term sustainability of current agriculture and food production [5] systems in response to the food security crisis in SSA. Further questions have been raised on how smallholder farmers can gain greater access to markets, enhance their value chain position and increase their value added in the face of increasing global concern on food security especially in Africa [14]. According to this review, the ability of smallholder farmers in SSA to benefit from upgrading strategies in the value chain differs depending on the type of agricultural activity pursued, the geographical region, local conditions, governance structures and even across the gender divide, with respect to poverty reduction, increased incomes, increased food security and nutrition. As a result, there is no one solution that fits all smallholder farmers in Africa in addressing food security and poverty reduction initiatives.

The first conclusion drawn from the review with regard to process upgrading is that, there are different perspectives that have emerged on the role played by process innovation and its importance in the value chain as an intervention with regard to its effect on improved food security and reduction in poverty levels. As a result, if various context specific interventions are put in place based on different geographical areas, different agricultural activities and participatory approaches, while addressing the social/gender dimensions to increase and enhance technological innovation adoption, there may be positive effects on sustainable food security in SSA. The second conclusion in relation to product upgrading is that different agricultural sectors and even geographical regions may present different results based on a decision to pursue individualized farming activities based on contract innovations or diversified farming in an effort to achieve increased productivity, reduced poverty and enhanced food security among smallholder farmers. A conducive institutional environment that is supportive to smallholder producers, based on a collaborative framework in the governance of the entire value chain, is therefore required to ensure production of more product innovations that have value. This will in turn lead to increased benefits to the producer end of the chain in terms of food security and improved incomes, as well as to all other participants in the entire value chain.

The third conclusion drawn from this paper is that smallholder farmers in developing countries are likely to benefit from being members of a value chain in terms of product and process upgrading, but their potential to reap the benefits of increased market opportunities, increased incomes and food security is curtailed by various factors, suggesting immiserizing growth. This suggests the need to come up with sustainable solutions to the food security situation in SSA in terms of market innovations that empower smallholder farmers. This should be integrated with sustainable innovative models to curb the negative effects of climate change through climate-smart agriculture models. The fourth conclusion is that targeted agricultural based interventions based on tacit knowledge are necessary for upgrading and innovation initiatives to result in the achievement of sustainable objectives, including food security aims in different regions within SSA. This is based on the unique needs of smallholder farmers in different regions, local conditions, gender responsiveness and different country contexts. Lastly, this paper proposes an intervention using context specific integrated strategic innovations based on tacit knowledge that aims at empowering smallholder farmers to add value to their farm produce using innovative models they participated in developing, while incorporating climate smart agricultural practices. The model should be designed with participation from the smallholder farmers in a certain locality, supported by stakeholders, to encourage creativity and an innovative culture, value addition, enhance ownership, acceptability and diffusion of the innovation, as well as scaling up once the farmers are left on their own. It will also enable smallholder farmers to design innovative ways to solve their own agri-business related problems with the goal of achieving increased incomes, reduction in poverty as well as sustainable food security and nutrition in SSA. This paper has explored various examples based on surplus

production that has been reported in Kenya in recent times. This research opens numerous opportunities for future research by considering quantitative analysis of the impact of upgrading initiatives on increased incomes and food security in SSA from local, regional and even global perspectives for different agricultural activities undertaken by smallholder farmers.

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