The welfare impacts of buffer stock operations in agriculture in Ghana

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Chapter 1: Introduction

1.1 Smallholder farmers and commodity markets in sub-Saharan Africa

The majority of the sub-Saharan Africa population lives in rural areas where poverty, deprivation, and food insecurity are predominant (Masipa 2017). These rural people mostly depend directly or indirectly on agriculture for their livelihoods. At the macro-level, given the significant contribution of the agricultural sector to the overall rural African economies, agricultural growth remains an effective means of addressing poverty in the region (Tomich et al., 2019). The challenge for many African countries is how to increase and sustain an agricultural income to meet the food security needs of the growing population and reduce malnutrition and poverty. This current situation of poverty and food insecurity is, among other things, due to failed or weak agricultural commodity (output) marketing systems as a result of low investments in physical infrastructure, institutions, human capital, as well as information asymmetry, and probably conflicts (Okello et al. 2020; Dillon and Barrett 2017). In a failed or weak agricultural commodity market, agricultural output exchange occurs at non-competitive prices (Dillon and Barrett 2017). The non-competitive pricing in failed markets means that prices do not equate to marginal benefit and marginal cost. For some failed or weak markets, prices may be competitive, yet the welfare outcomes for many farm households may be so low that market interventions need to be introduced to improve people's welfare (Dillon and Barrett 2017). In some instances, the markets do not even ‘exist’ because the ‘nearest’ market center is relatively far (De Janvry and Sadoulet 2006). Smallholder farmers are therefore sometimes unable to access these far-distant markets.

In rural Africa, there are fewer roads. In addition, these fewer roads are often in bad conditions and there are long distances to market places, leading to poor transport network (Okello 2020). Poor transport networks lead to high transaction costs, limiting opportunities for smallholder farmers to access various local output markets (Prices 2010). In this case farmers have access to a few markets. The agricultural output markets are further characterized by food stocks being available in some parts of a country, while there is a widespread famine observed in other parts of the same country due to market failure (Eba and Struthers 2019). As a result of failed output markets, most smallholder farmers sell their produce during periods of bumper harvest, often to middlemen, at prices that cannot help them meet their production costs, not to talk of making profits. There are instances of total spoilage of produce of some poor farm households in some rural areas due to the lack of buyers when there were high demands for food in urban areas (Struthers 2019). Impaired functioning output markets have also been linked to distress sales and the high storage cost (Ngenoh et al., 2019). These conditions place smallholders in a situation that deters them from investing in more productive technologies to produce surpluses for the markets. Smallholder agriculture in the region is therefore characterized by small production volumes (of variable quality) that reflect low levels of investment, resulting in the lack of supply response on the part of smallholder farmers (Poole 2017; Arias et al. 2013).

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1 Mostly, failed markets are characterized by information asymmetry and high transaction costs to access the markets (Okello et al. 2020).
Failed or weak agricultural commodity markets have implications for smallholder farmers as it impacts their welfare negatively. First, smallholders often make decisions in an economic environment in which markets do not function well, if at all, and they are subjected to many risks such as production and price risks (Assouto et al. 2020). Under these failed market conditions, smallholder farmers continue to work so hard and make progress in their productions, yet they do not see the desired progress in their incomes. Because smallholders can only very limited influence the terms upon which they participate in the failed markets, they are prone to low incomes. The failed markets also hinder economic opportunities that could arise if trade was available to smallholder farmers. For instance, due to poor link between rural areas and urban areas, higher food prices in the urban centers do not filter effectively down to the rural areas (farm-gates) where smallholder farmers often sell their produce reluctantly (Fafchamps and Hill 2005).

Second, the price risk relates to price surges. Agricultural output markets failures increase food prices or producer price volatility and have negative consequences for food insecurity and unstable incomes (Cuevas 2014). High food price volatility, for instance, affects household incomes, reduces purchasing power, and transforms vulnerable people, that is, it renders people susceptible to food insecurity, poorer, malnourished, and hungry (HLPE 2010). Vulnerable people typically include people whose food consumption falls below acceptable levels and households whose food consumption falls below accepted levels with any increase in food prices. Smallholder farmers for whom market uncertainties can either amplify or decrease their income and livelihood risks are among the most critical vulnerable people. Typically, in sub-Saharan Africa, smallholder farmers are farmers who produce on a small-scale for self-consumption and market with landholdings often less than two hectares and have low or limited resource endowment, making them vulnerable to food insecurity (Hazell 2020). In most cases they are both suppliers and buyers of food, be it at different times of the year. Therefore, the instability of the producer price of staple food crops is an essential risk for smallholder farmers in developing countries. This is true particularly of poor farm households in sub-Saharan Africa based on two reasons: staple food price variations tend to be higher in Africa than in other regions (Minot 2014), poor households allocate a large share, about two-thirds, of their household income to the food budget. Hence, any variation in food prices has large effect on the household’s purchasing power and food consumption (Kalkuhl et al. 2016). Ultimately, higher price volatility has negative health outcomes/implications for the overall well-being of farmers.

Because smallholders’ life is characterized by high price volatility, low and unstable incomes, they are unable to obtain nutritious food for their households all year round (Soosai-Nathan and Fave 2016). It is suggested that low-income households in developing countries tend to consume diets of poor quality characterized by inadequate amounts of fruit and vegetables because low-income households are unable to afford healthy foods (Dimitri et al. 2015). Their diets are often poor and monotonous with cereals and starchy staples leading to malnutrition. Hence, smallholder farmers account for large share of malnourished and hungry people in sub-Saharan Africa (Fan and Rue 2020). Malnutrition due to poor diets resulting from low income contributes to high mortality and morbidity among smallholders and consequently affect their health and life expectancy, especially children. (Phiri et al. 2010).
A more efficient functioning of agricultural output markets could impact on poverty-levels and the broader economies of sub-Saharan countries in three main ways. Firstly, it helps create conditions for increased income and welfare of the poor farmers who are often located in rural settings (World Bank 2008). Secondly, it could boost food production and raw materials for processing and service industries and create jobs, thereby reducing urban poverty. Thirdly, it stabilizes food prices which govern inflation and real incomes (Arezki et al. 2016). Indeed, well-functioning commodity markets are crucial to help stabilize output prices, improve food and nutrition security, facilitate income improvement for smallholders and ultimately improve their quality of life (Boffa and Varela 2019; Poole 2017). In summary, increasing farmers’ access to an efficient market could increase smallholder farmers’ ability to feed their families and other people.

1.2 Buffet stock operations as agricultural commodity market intervention policy

The stability of staple food supply, demand, and the price are of constant concern to many governments in developing countries. Many agricultural policies are employed in developing countries to intervene in the market to control and manage price fluctuations from both theoretical and policy-making perspectives. For instance, during the 2008 food crisis and beyond, different interventions were adopted by developing countries, including Ghana, to mitigate the high food prices (see details in Appendix 1). Most of the interventions’ policy objective is to help stabilize food prices and mitigate the economic hardships resulting from rising food prices. Among the key interventions adopted to manage the food crisis was the release of public buffer stocks at subsidized prices (Demeke et al. 2008).

A buffer stock operation is an intervention in a market system using a government's dual pricing policy to stabilize prices by procuring and storing farm produce during bumper harvest and selling them during lean periods at fixed prices (Pu and Zheng 2018; Demeke et al. 2008). Buffer stockholdings is one of the most widely discussed and debated policy options and used to mitigate price instability. Usually, buffer stocks are used to stabilize domestic output or food prices within a price band to benefit farmers, poor and non-poor households (consumers) by adopting minimum procurement and maximum sale prices (HPLE 2011). The strategic trust of public buffer stock operations is that government procures excess productions into public warehouses till prices increase above the floor prices. If market prices are too high, usually above a ceiling price, the government releases public storage into the domestic economy to depress prices by increasing market supply (Pu and Zheng 2018).

To address the challenge of high price volatility, low income, food insecurity, and improve smallholder farmers' overall wellbeing, several countries introduced buffer stock operation policies. This thesis focuses on the case of Ghana, where the government introduced a buffer stock operations policy in 2010. To implement the policy, the National Buffer Stock Company (NAFCO) was established. NAFCO as a policy instrument aimed to ensure the income security of farmers and insulate them against losses resulting from gluts, as well as ensuring national food security. The mandate of NAFCO is to guarantee farmers an assured income by providing a minimum guaranteed price, a ready market, and stabilized food prices by using the dual pricing mechanism (Benin et al. 2013). The dual pricing mechanism involves the setting up of floor (minimum) and ceiling (maximum) prices by government for the purchase of produce from farmers and keep price
within a band (Abokyi et al. 2018; Benin et al 2013). More African countries have tried in the past to influence agricultural markets and trade, for various purposes including stabilizing prices, using tools such as buffer stock operations (Bergguist and Dinerstein 2020; Pernechele et al 2018). However, empirical evidence suggest that agricultural markets in the region remain poorly integrated with prices varying widely across the region and seasons (Olipra 2020; Burke et al 2019).

The Ghana’s buffer stock operation is quite unique and interesting in its design, as produce are purchased from farmers at the floor price and stocks sold to institutions (such as secondary schools, hospitals, prison services, etc.) and poultry farmers but not households (Benin et al 2013). These institutions usually purchase produce in large volumes and are able to influence prices in the open market. Therefore, the buffer stock operations take them out of the open market (temporally during the peak seasons when prices are highest), it frees open market produce for households to purchase, reducing the demand created by such large-scale/volume purchases by these institutions. This, likely, keeps the open market produce price within the targeted band. Thus, creates price stability for household to benefit. Even though in most cases, small markets are more likely to be volatile, the price are able to remain in the band because the selling of produce to these ‘large’ buyers is temporal and takes place at the onset of the harvesting season.

1.3 Research aim and research questions

1.3.1 Main objective
This thesis presents an impact evaluation of the Ghana’s buffer stock operations policy initiative. Theoretically, public buffer stock operations stabilize commodity prices, influence income levels, assure food security, and improve smallholder farmers’ well-being (Pu and Zheng 2018). In practice, in Ghana, buffer operations to control for price volatility is expected to affect producers as well as consumers (Demeke et al. 2008). However, as observed earlier, the current buffer stock operations, which seeks to minimize excessive price volatility in food markets, is designed to focus on producers: smallholder farmers. Even though public buffer stockholding operations may be costly due to high procurement and storage costs, given the potential impacts of buffer stock operations on poor rural farmers and the economy, buffer stock operations are likely to have positive net gains. It is, therefore essential to estimate these gains by assessing the impacts on producers. Hence the focus of this study is on smallholder producer rather than consumers.

The market intervention policy has been in existence for almost a decade. Exploiting this, the overall objective of this dissertation, is to conduct an impact evaluation of the buffer stock operations policy initiative in Ghana and measure the welfare improvements among producers (smallholder farmers) who are participating in the buffer stock operations initiative. Thus, the main research question is: Ghana having implemented the buffer stock operations policy for the past decade, what have been the policy’s effects on smallholder farmer households’ welfare?

Welfare, in a narrow sense, is the satisfaction with income or material (assets) satisfaction (Ferrer-i-Carbonell 2005). The notion of welfare at the household level, is often measured by objective and subjective means (Kullenberg and Nelhans 2017). The concept of objective welfare mostly
signifies physical conditions of living or aspects of well-being that, in principle, can be verified by an external observer, ignoring the subjective perspective of the individual’s judgment about his or her life (White 2015). In contrast, subjective welfare is the subjective dimensions of welfare such as those factors that take into account the perception and interpretation by the person himself or herself, that is, the thoughts and feelings of the individual where in principle the individual is the authority in the assessment of welfare (Chindarkar et al. 2019). The objective measures of welfare include income-based measures such as income, consumption (food and non-food), and expenditure as well as wealth and assets (Aroca et al. 2017). However, several empirical works measuring the impact of welfare policies on households often measure welfare as income and or consumption (Danso-Abbeam et al. 2019; Lekobane and Seleka 2019). Food consumption has been identified as a means of measuring food security. Pinstrup-Anderson (2009) observed that the definition of food security to include household food access and consumption is a good measure of household welfare. Indeed, food security has been used as a measure of household welfare in low-income countries in several studies (see Lim et al. 2020; Katungi et al. 2018). The subjective measure of welfare includes subjective well-being, happiness, and satisfaction with life among others (Kullenberg and Nelhans 2017). These objective and subjective measures of welfare overlap with well-being measures.

In broad sense, well-being is what we have when our lives are going well for us; when we live lives that are good for us but are not necessarily morally good (Tiberius 2006). Therefore, well-being is composed of what is of prudential value to a person, i.e., goods for a person for the flourishing of a good life. While welfare basically refers to satisfaction with income, it is expected that better welfare improves well-being, i.e., welfare supports the apriorism “from welfare to well-being.” The notion of well-being incorporates a lot more variables compared to welfare. Hence, a multidisciplinary approach is required to study well-being. This means that well-being is more extensive in some aspects compared to welfare. Even though the concepts of welfare and well-being are technically distinct, they could be used interchangeably in normative economics, and justifiably so, as both notions of welfare and well-being reflect good quality of life (Diener and Tay 2015). Therefore, an overall measure of welfare could be a proxy measure of the overall well-being or vice versa. Therefore, this study attempts to measure welfare impacts of the buffer stock operations initiative by estimating the impacts of the initiative on income and food consumption (security), which are objective welfare indicators. Besides, the impact of the initiative on well-being of smallholder farmers is estimated in this study. The two aspects of well-being, objective well-being and subjective well-being are focused on how to reflect improvement or otherwise in the quality of life of smallholder farmers. The estimations of the welfare or well-being impacts are preceded by evaluating the efficacy of the buffer stock operations policy to stabilize commodity prices in the Ghanaian food system.

1.3.2 Sub-objectives
Based on the main objective, four other sub-objectives are derived. The first sub-objective relates to the price volatility of maize and rice. The other three sub-objectives relate to household food consumption, income, and well-being. The first sub-objective analysis is based on secondary time series data and the analyses of the other sub-objectives are based on survey data. The choice of
primary data for the first sub-objective is because it provides basis to test the efficacy of the policy over time. In addition, the choice of primary data from a survey provides an opportunity to access cross-sectional data to help distill the effects of the policy on households.

\[ \text{i. Analysis of the impact of buffer stock operations on price volatility of maize and rice} \]

This sub-objective focuses on the analysis of public buffer stock operations as a price stabilization policy option for Ghana. The basic question that guides the analysis which addresses the sub-objective: in Ghana's case, has the buffer stock operation stabilized maize and rice prices? If it has, what is the magnitude of the volatility of maize and rice prices, which are the two primary commodities being traded under the buffer stock operations in the country?

The analysis tries to estimate the impact of the buffer stock operation on maize and rice prices volatility in the intervention areas. Prices of agricultural outputs tend to fluctuate more than that of manufactured products. This is because of the instability in the supply of agricultural output and the fact that demand and supply are price inelastic. The effect of price volatility depends on the country's specific market conditions in question (Van Campenhout et al. 2018). Price stability here is the absence of price fluctuations or volatility around a mean price level. As an indicative measure of price uncertainty, price volatility is an essential factor that influences income and food security, two key welfare measures explored in this study. In addition, price volatility shows degree of variation in prices, resulting in the underlying characteristics of food crop production and its market (Pincinato et al. 2020). Therefore, to study the impact of buffer stock operations on farmers’ welfare, a critical analysis of the price volatility is undertaken.

Though there is anecdotal evidence to suggest not all farmers are participating in the buffer stock operations, it is expected that the policy will be able to stabilize prices of maize and rice due to reported cases of significant purchases under the buffer stock operations (Benin et al. 2013). This thesis seeks to provide an empirical evaluation of this policy and shows that the public buffer stockholding can be applied to ensure price stabilization in the agricultural food systems in Ghana or otherwise.

\[ \text{ii. Measuring food security of the rural farm household using the household dietary diversity index (HDDI) approach} \]

Sub-objective (ii) focuses on measuring the food security status of rural households. The research question derived from the sub-objective is: how has the buffer stock operations influenced the rural households’ food security?

Food security and malnutrition are strongly linked to poverty. For smallholder farmers, obtaining the food they require to lead healthy and productive lives is a critical component of their income levels, food production, and distribution systems in the local and national environment (Roetter and Van Keulen 2007). Therefore, strategies to reduce, improve, and measure food security at the household level must consider the local, biophysical, economic, and socio-cultural factors. These considerations are also crucial in measuring the performance and impacts of food security programs or interventions. The analysis is based on food consumption among households benefitting from the buffer stock operations and those not. Food consumption is considered one of
the most preferred indicators of welfare analysis as it can be used to track and compare the living standards of households and hence, an effective way to evaluate the effect of programs and policies on the households and related policy analysis (Pradhan 2009). Smallholder farmers are forced to sell their products when supplies are high and commodity prices are low, and purchase food when supplies are low and prices are high, and this has negative implications for their food consumption, with malnutrition being critical.

Malnutrition exists in different forms; macro and micronutrient deficiencies, undernutrition, overweight, and obesity. The focus here is on macro and micronutrient deficiencies, often more prevalent among women and children (Frimpong and Annim 2017). The analysis regarding this sub-objective dwell on the household dietary diversity index (HDDI) as a proxy for measuring and analyzing food security for low-income rural families in Ghana. This measure at the household level indicates the food security situation of women and children. Because of the complex and multidimensional nature of the concept of food security, it is difficult to capture all dimensions of food security: availability, access, utilization and stability using a single indicator (Leroy et al. 2015). The HDDI measures two dimensions of food security, utilization and access (Ogundari 2017). Improved HDDI indicates better nutrition and health outcomes for children and women (Frimpong and Annim 2017). The study incorporates nutritional dimensions into the food security measure to provide information on specific nutrients consumption adequacy. Hence, a nutrient content household dietary diversity index (NHDDI) is developed in this study, and this serves as a new and improved metric for measuring food security. The analysis examines the causal effects of buffer stock operations on nutrient content household dietary diversity index (NHDDI). It also explores the socio-economic factors that affect NHDDI.

### iii. Analysis of the impact of output price support on smallholder farmers’ income

This sub-objective focuses on assessing the impact of the buffer stock operations on farmer’s income. In light of the background information, the research question is: how has the buffer stock operation as an output price support intervention impacted smallholder farmers’ household income?

Instability in farmers’ income has been the bane of farmers and agricultural policymakers over the years due to unstable farm prices. Farmers in developing countries face significant uncertainty about their future incomes due to crop price volatility and the lack of a sustained price stabilization mechanism. Smallholder farmers are both producers and consumers of farm produce. After harvest, many households consume a substantial part of the food they produce, selling off the unconsumed produce. They also purchase food items (such as meat, fish, vegetables etc.) to supplement consumption from their own productions. Therefore, the impact of price volatility matters to them both as consumers and as producers. To understand the impact of higher food prices on welfare, one must focus on households’ food sales, purchases, and consumption (Vu and Glewwe 2011). This is because food purchases and food sales reflect food prices, incomes, and the utility of the households’ consumption of food. It is critical to note that smallholder farmers generally receive low prices for their produce and are more sensitive to price volatility. Market price supports are given to cushion their incomes. Market price support encompasses any market intervention that creates a price differential between domestic market prices and producer prices
so that farmers can get better incomes. The rationale is to raise unduly low returns to farm investments of low-income farmers by raising the low prices of farm output (produce) and to reduce risks by stabilizing commodity prices in the market over time (Allen 2016).

Considering the vital impact of price volatility on the welfare of poor farmers and the food-insecure households, there is reason to investigate whether intervention in the output markets helps to hedge farmers from income losses. Understanding how buffer stocks and price support impact smallholder farmers’ income as producers and consumers is a significant knowledge gap. Moreover, in the developing world, smallholders are more concerned with the price and cost of production rather than with their net incomes. Hence, output price supports are policy options that help farmers attain positive net incomes.

Output price support, implemented through buffer stock operations (BSO), has been initiated in Ghana to provide farmers access to efficient output market, act as price subsidy to help improve their incomes and welfare. The current BSO is a form of support to producers to deal with price risk (Benin et al. 2013). Given the above, this sub-objective analysis is to assess the impact of the output price support implemented via public buffer stock operations on farmers’ households by isolating the policy’s casual effects producers, rather than on consumers. The sub-objective seeks to provide empirical evidence of the factors that drive smallholder farmer’s participation in the buffer stock operations initiative. An attempt is made in this study to estimate how farmers have been affected by the support against changes in the relative low incomes and how the BSO policy interventions have altered these.

### iv. Estimation of the effects of buffer stock operations on the well-being of smallholder farmers

This sub-objective focuses on the objective and subjective aspects of well-being and their measurement. It provides an analysis of the effect of buffer stock operations on the well-being of smallholder farmers. The research question derived from this sub-objective is: so, after a decade of implementing the buffer stock price stabilization policy, what has been the impact of the policy on objective well-being (OWB) and subjective well-being (SWB) of smallholder farmers? Follow up questions are: how far is objective well-being a good predictor for SWB of smallholder farmers, and how can eventual differences be explained?

Improved well-being is a reflection of improved quality of life. Hence, policy makers are concerned with creating conditions that facilitate poor smallholder farmers' well-being, causing them to flourish. Empirical evidence suggests that the lives of smallholder farmers in the region are characterized by low and unstable incomes, inadequate and poor state of housing, and poor health facilities (Soosai-Nathan and Fave 2016). The low incomes of smallholder farmers, for instance, makes most of them experience severe malnutrition as there is the inability of the households to obtain enough nutritious food. They are vulnerable to food insecurity threats. They work hard, yet their incomes and efforts do not commensurate. Under these circumstances, the farmers’ well-being is likely to be negatively affected. As a dual pricing mechanism, the buffer stock operations of the NAFCO work to offset price movements to stabilize income and eventually improve income, influence trade for smallholder farmers and engender well-being of farmers (Benin et al., 2013).
Smallholder farmers having participated in the buffer stock operations for the past years, this objective seeks to analyze the effects of the initiative on farmers’ well-being. The analysis is grounded in the economic theory of procedural utility, which stipulates that people value actual outcomes of economic activities and the conditions and processes that lead to the achievement of these outcomes (Frey et al. 2004). People are not only concerned about the final monetary payoffs of their economic activities but are also strongly affected by the processes and the conditions which lead to the outcomes (Lee 2013). Participation in the buffer stock operations is expected to generate procedural utility for farmers.

1.4 Experience with buffer stock operation outside of Ghana

The development of buffer stock operations system results from inherent price risks associated with bumper harvest in most developing economies. As an output price support, buffer stock operations have been adopted by some African and Asian countries to stabilize prices in the past. Indeed, output price support used to be an integral part of the Common Agricultural Policy (CAP) objectives in the European Union (EU) in the 1980s to the 1990s, and successfully helped improve the incomes of farmers, increased agricultural production of the EU considerably and turned the EU\(^2\) into a major net exporter (Oskam et al. 2011; Tracy 1989). Today, with different modifications, buffer stock operation is a significant policy of the Chinese agricultural marketing system (Lyu and Li 2019; Pu and Zheng 2018). Buffer stock operations in Africa, such as Kenya, Malawi and Zambia, usually target grains due to their ‘non-perishability’ and their importance to the food budgets of rural poor household’s food consumption (Minot 2014). Cereals constitute a large share of the food requirements of most rural households in Africa. Hence, interventions towards maize and rice are likely to imply the food security and welfare of poorer rural households. Buffer stock operations can be implemented to achieve multiple objectives: price stability, subsidies for consumers and farmers, emergency food reserve, and stimulate investments by producers, among others. However, as a rule, Tinbergen (1958) observed that: each policy objective needs one additional independent instrument to be successful, some governments try to achieve many policy objectives with one instrument. However, the multiple objectives ultimately result in significant gaps between the stated objectives, the policy measures undertaken, and the actual achievements (Dorosh 2008). The design of current buffer stock operation policy seems to have ignored this policy advice by Tinbergen in design of the policy.

However, some economists are opposed to buffer stock operations and have described it as output price support given to farmers as it is a subsidy on farm produce that does not benefit the poor (Sumner et al. 2010; Wright 2009; Alston and James 2002). Alston and James (2002) argued that farm subsidies transfer income from consumers and taxpayers to relatively wealthy farmers and eventually impose net losses on society. Subsidies tied to outputs tend to favor wealthy farmers, who are often not the targets of such intervention, more than poor farmers (who are the target) because wealthy farmers can produce more and hence, get large fractions of the subsidy (Ashra and Chakravarty 2007). Farm subsidies also impede farm produce from movements towards more open international trade in commodities and thus impose net costs on the global economy. This is because farmers will not look for opportunities to send their produce to other efficient markets that

\[^2\]I use the term EU also for EEC (European Economic Community (EEC) and EC (European Communities).
do not support it. Wright (2009) also argued that the benefits of buffer stock operations are only short-lived, costly, and in the long run, ineffective and could crow out private stockholdings. In the case of Ghana, these observations are less correct in that majority of the farmers, especially cereal producers, are poor smallholders and constitute about 90% of farmers (MoFA, 2019). Hence a pro-poor policy that target maize farmers in Ghana is well targeted as any support by buffer stock operation is likely to benefit smallholders and not wealthy farmers. The observation by Alton and James (2009) for instance are in western world and developed countries where poverty is relatively low. However, output price support to farmers, especially low-income farmers, if well targeted, is capable of removing price distortions in the local market for the benefit of farmers. Therefore, the design of buffer stock operations that fit the developing country-specific context is likely to overcome the critics’ observations of buffer stock operations and could reduce poverty.

1.5 Overview of Ghana’s agriculture and its buffer stock operations
Ghana is a lower-middle-income country with a population estimate of 30 million, located on Africa's west coast. With a total land area of about 23.85 million hectares, of which 13 million hectares are agricultural land, agriculture contributes significantly (about 21%) to Ghana’s GDP and employs 45% of all households (MoFA 2019) and produce maize, rice, cassava, yam, and plantain as the staple food crops. Ghana’s agricultural development has recorded remarkable achievements in the past. For instance, the per capita food production has increased by 55% between 1990 and 2010, producing about 51% of its cereal requirement (Darfour and Rosentrater 2016). However, the country still faces many challenges such as malnutrition, micronutrient deficiency and rural poverty among others. It has been estimated that about 3.5 million people, mostly rural dwellers and smallholder farmers, representing about 15% of Ghanaian population, are either food insecure or are vulnerable to becoming food insecure (Darfour and Rosentrater 2016). However, how to improve smallholder farmers’ food security and ensure higher growth of their low incomes to reduce poverty is still a challenge (Atuoye 2019).

Agriculture in Ghana is predominantly on smallholder basis and accounts for about 90% of food production in the country, even though there are few large-scale farms, with the majority of these smallholders being among the poorest households (MoFA 2019). The farming system is mainly traditional, which involves the slash-stump and burn with hoe and cutlass as the main tools, with little mechanized farming (MoFA 2019). Crop production is mainly rain-fed and constrained by the lack of access to efficient produce market. The food system is further characterized by seasonal and year to year output price variations leading to persistent price volatility (Gilbert et al. 2017). The farmers are under pressure to sell their produce right after the harvest at cheap prices due to the lack of storage capacity and due to household demands to meet household needs, and this makes their supply inelastic. Generally, during the harvesting season, prices are depressed to their lowest and are at their peak during lean periods. Similarly, during times of crop failures, prices are high, and in bumper harvests, the price of produce, especially maize, can collapse completely. Farmers are unable to get commensurate returns for their produce because of the low prices they receive (Bellmann and Hepburn 2017). Soon prices increase, resulting in volatility. This volatility in price decreases and causes instability of smallholder farmers’ incomes, indicating failed or weak markets and weak marketing systems, posing price risks to farmers that could justify intervention.
The introduction of the policy saw the establishment of NAFCO. The primary mandate of the NAFCO is to implement a buffer stock operations policy with the view of purchasing cereals from smallholder farmers during the harvesting period and resell during the peak seasons. In doing so, NAFCO reduces post-harvest losses emanating from poor storage. The aim is to increase investment in agricultural production investment to improve farm households' food security and welfare. To avoid crowding out of private firms in the marketing system, NAFCO uses the services of Licensed Buying Companies (LBCs) to purchase produce from farmers on behalf of NAFCO. As of 2017, NAFCO registered and issued licenses to approximately 1,300 companies as LBCs (MoFA 2017). The LBCs reach out to farmers and purchase maize and other cereals at the farm gate at a price solely determined by NAFCO. The arrangement served as a guaranteed market for farmers at a minimum price. The NAFCO also undertakes internal marketing of grains with other government and non-governmental institutions (such as secondary schools, hospitals, prison services, poultry farmers, etc.) during the peak seasons using the ceiling prices.

1.6 The research approach

Grounded in the philosophy of positivism, the study draws on the broader issue of buffer stock operations and their impacts. The positivists’ philosophy dwells on conducting experiments or quasi-experiments, gathering quantifiable data to make deductions by testing theory through measuring economic and social realities, and allows for generalization (Tweheyo 2018). Based on the positivists’ philosophy, the study is phased in two stages. In the first phase, we use time-series data to test and evaluate public buffer stockholdings as a policy option that can stabilize prices of agricultural commodities such as cereals. This helps to gain a preliminary understanding of the effect of the policy at the market level. In the second phase, the study descends from the market level to the household level to analyze the buffer stock operations’ impact on smallholder farmers.

The fundamental challenge of any impact evaluation is determining the counterfactual, i.e. what would have happened to the farmers without the intervention, in this case the buffer stock operations? This problem is often overcome in impact evaluation studies by comparing individuals with and those without the intervention or policy. However, because it is not feasible to observe beneficiary farmers in and out of the buffer stock operations initiative simultaneously, it is important to create a control group (counterfactual) who are similar to the treatment group (beneficiary farmers) except that they do not participate in the buffer stock operations. In this case, any difference in an indicator between the treatment and control farmers is attributed to the buffer stock operations.

The main evaluation approach in the second phase is quasi-experimental. In the quasi-experimental approach, the researcher examines the differences in the outcomes between treatment and control groups, just like in the experiment approach, but with non-random assignment, i.e., without randomization (Greenstone and Gayer 2009). The treatment status is beyond the researcher’s control and is often determined by policies and or some other interventions, i.e. the process of assigning the exposure is outside the control of the researcher (Rocker et al .2015). Quasi-experiments are those studies designed to estimate causal effects using exogenous variation in interest exposure without random allocation. Thus, quasi-experiments are observational studies and are similar to randomized controlled trials in many respects, except that the subjects self-select
into different treatments instead of being randomized (Maciejewski 2020). A valid treatment group and control group. Using the quasi experimental approach, our goal is to identify a valid treatment group and control group and account for potential unobserved correlation between outcome and treatment assignment (Butsic et al. 2017). Econometric techniques are used to construct a valid control group for analysis of casual inference. Different quasi-experimental and econometric methods such as coarsened exact matching (CEM) and propensity score matching (PSM) are used to construct valid control group (counterfactual) and remove selection biases to mimic experimental approach or data. These matching methods, especially the CEM, reduce the imbalance in the data between the control and the treatment groups (Maciejewski 2020). Other statistical or regression methods such as weighted least squares (WLS), ordered probit model, and two-stage least square instrumental variable (2SLS) techniques are adopted to estimate the impact and to enhance internal validity.

For data collection purposes, two sets of structured questionnaires are designed for household-level data collection in two different surveys. In the first survey, a national survey across the policy-off and policy-on areas is conducted to analyze the second research question. The first survey covers all the four agricultural ecological (agro-ecological) Ghana zones: the Guinea Savanna, the Coastal Savanna, and two Transition and Forest zones. The agricultural zones were divided into NAFCO (policy-on) and non-NAFCO (policy-off) areas. The division yielded six clusters from which a total of 34 maize growing communities were randomly selected. The total sample consisted of 305 farming households: 126 in the policy-on areas and 179 in the policy-off areas. In the second survey, data is collected from farmers who do and those who do not participate in the buffers stock operations to analyze the third and fourth research questions. The second survey involves data collected from smallholder farmers’ households in five maize growing districts within the Transition Agro-ecological Zone of Ghana. The transition zone was selected for the survey as it constitutes the most predominant Zone for maize growing in the country. Above, the implementation of the buffer stock operation started in the Zone. The second survey collected data from 520 households in 40 communities. Both surveys are a face-to-face interview, with the first survey being pen-to-paper, and the second is through computed assisted data collection. The survey is a collaborative effort between different stakeholders; the Ministry of Food and Agriculture (MoFA), the Researchers and the Consultancy and Innovation Directorate of the Ghana Institute of Management and Public Administration (GIMPA).

1.7 Outline of thesis

This thesis consists of a collection of articles divided into six chapters, with the current first chapter introducing the topic of this thesis and describing the content of the entire thesis. The first chapter formulates the research problem and the research questions. The main objective and the sub-objectives of the thesis are elaborated in Chapter 1. In addition, Chapter 1 presents an overview of Ghana’s agriculture and its buffer stock operations system, and the research approach. Chapters 2 to 5 comprise the thesis's core sections, with each chapter separately answering one of the four different research questions. Generally, the thesis's core theme is examining the impacts of buffer stock operations on price volatility, food security, household incomes, and well-being of smallholder farmers. The organization of the rest of the thesis is as follows:
Chapter 2, entitled ‘Public buffer stocks as agricultural output price stabilization policy in Ghana’, addresses sub-objective one. The chapter provides an overview of the causes and the effects of price volatility and discusses the approaches to price stabilization policy options that are available to governments for intervening when there is a market failure. It also provides various conceptual models of measuring price volatility. An estimation of maize and rice's price volatility is provided by the chapter using price series data from the three major maize markets: Techiman, Tamale, and Ho maize markets. The analysis presents econometric tests for the efficacy of public buffer stock operations as reflected by reduced price volatility measured by the (corrected) coefficient of variation. The intervention involves government purchasing maize and rice from farmers through agents during periods of glut at a fixed price and re-selling when prices are high.

Chapter 3, entitled ‘Household dietary diversity index as a food security measure: the case of maize farmers participating in buffer stock operations in Ghana’, focuses on the second sub-objective. The chapter presents an analysis of the impacts of buffer stock operations on Ghana’s food and nutrition security. The chapter discusses an objective welfare measure from a food consumption perspective. A measure of how smallholder farmers’ consumption of different varieties of food has changed, following a participation in the buffer stock initiative is an indication of food security. Based on a cross-sectional data set, I estimate the nutrient content Household Dietary Diversity Index (NHDDI) to reflect nutrient adequacy. Here, I have to emphasize that the data was collected across the entire country. The coarsened exact matching (CEM), weighted least squares (WLS), and weighted ordered probit (WOP) estimations are applied to analyze the variables that affect NHDDI and estimate the treatment effect of buffer stock operations on the NHDDI.

Chapter 4 entitled ‘Impacts of output price support on smallholder maize farmers’ income: evidence from Ghana’, focuses on the objective welfare impact of the buffer stock operations on farmers as enumerated by third sub-objective. The chapter extends the analysis from the previous chapter, discussing objective measurement of welfare and household income changes. The chapter presents an empirical investigation of Output Price Support's impacts on smallholder farmers’ incomes resulting from farmer’s participation in the buffer stock operations. Beneficiary and non-beneficiary farmers of buffer stock operations are matched using coarsened exact matching (CEM). With household and farm-level data from 507 farmers, I estimate the buffer stock operations’ income effect using the weighted least square (WLS) and the propensity score matching (PSM) combined with the CEM techniques.

Chapter 5, which discusses the last sub-objective, is entitled ‘Buffer stock operations and well-being: the case of smallholder farmers in Ghana’. To gain more insights into smallholder farmers' well-being, the chapter analyzes the objective and subjective well-being effects of buffer stock operations on farmers. It presents an empirical analysis of objective well-being (OWB) of control and treated farmers in a rural setting. I demonstrate how farmers’ participation in buffer stock operations has implications for their objective well-being and subjective well-being. I used twelve-item metric indicators of quality of life that is distributed among three aspects of life: economic, social, and environmental well-being, to build a composite index for objective well-being. With the coarsen exact matching and instrumental variable based two-stage least square, I
model the effects of buffer stock operation on the objective well-being directly and indirectly on subjective well-being via OWB.

Finally, Chapter 6 combines the findings and the insights derived from the study presented in the preceding chapters (2-5) to formulate the study's general conclusions. First it recaps the research questions and the objectives of the study. It also discusses the main findings based on each chapter. The chapter integrates these conclusions to draw an overarching conclusion in line with the thesis's core arguments relating to price stability, food security, household income, and well-being. Also, the chapter provides recommendations for policy options for improving the buffer stock operations initiative to ensure enhanced food security, stable and better income, and a better life for farmers in Ghana. The chapter provides some directions for future research.

Appendix 1

Table A1. Interventions adopted by developing countries during the 2007-2008 food crisis

<table>
<thead>
<tr>
<th>Policy Areas</th>
<th>Number of countries surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Africa</td>
</tr>
<tr>
<td>Interventions</td>
<td>33</td>
</tr>
<tr>
<td>1. Trade policy</td>
<td></td>
</tr>
<tr>
<td>Reduction of tariffs and customs fees on imports</td>
<td>18</td>
</tr>
<tr>
<td>Restricted or banned export</td>
<td>8</td>
</tr>
<tr>
<td>2. Domestic market measures</td>
<td></td>
</tr>
<tr>
<td>Suspension/reduction of VAT or other taxes</td>
<td>14</td>
</tr>
<tr>
<td>Released stocks at subsidized prices</td>
<td>13</td>
</tr>
<tr>
<td>Administered prices</td>
<td>10</td>
</tr>
<tr>
<td>3. Production/Output support</td>
<td></td>
</tr>
<tr>
<td>Production support</td>
<td>12</td>
</tr>
<tr>
<td>Production safety nets</td>
<td>6</td>
</tr>
<tr>
<td>Fertilizers and seed programs</td>
<td>4</td>
</tr>
<tr>
<td>Output market interventions (e.g. buffer stock)</td>
<td>4</td>
</tr>
<tr>
<td>4. Consumer Safety Nets</td>
<td></td>
</tr>
<tr>
<td>Cash transfers</td>
<td>6</td>
</tr>
<tr>
<td>Increase disposable income</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Demeke et al. (2008)
References

56. Prices, F. (2010). Smallholder Farmers can be Part of the Solution. *International Fund for Agricultural Development (IFAD)*.