The welfare impacts of buffer stock operations in agriculture in Ghana

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Chapter 6: Conclusions and discussions

This chapter presents a discussion of the various chapters' main findings based on the thesis's main theme: the impact of buffer stock operations on smallholder farmers’ welfare. The chapter starts with a recap of the leading research question, sub-questions, and the objectives in section 6.1. Section 6.2 presents the study's main findings and conclusions, as found in Chapters 2-5. Even though each of the preceding chapters concludes in its own right concerning its main findings, this final chapter integrates these conclusions to draw an overarching conclusion in line with the thesis's core arguments in section 6.3. Policy implications of the study are presented in section 6.4. Section 6.5 provides some lessons learned while the study's limitations, direction, and suggestions for consideration for future research conclude the chapter in section 6.6.

6.1 The research goal and the research questions

This doctoral research work sought to provide insights into how an agricultural policy of public buffer stockholding operations, targeted at smallholder farmers in a developing world setting, impacts its actors. Buffer stock operations, often implemented as a policy intervention in a failing market environment, involve buying and selling agricultural commodities from farmers, mostly grain, to guarantee that market prices only move within the desired price band by publicly announcing floor and ceiling prices to control price movement. This research attempted to conduct an impact evaluation of the public buffer stockholding operations policy on commodity prices, household welfare, and well-being of smallholder farmers in Ghana. Four research papers were developed in this regard.

The main research question for this study was: having implemented the buffer stock operations policy in Ghana over the past decade, what have been the policy's effects on the welfare of smallholder farmer’s households? To answer the main research question, the thesis poses four sub-research questions relating to different perspectives of the leading research question posed above.

Therefore, the analyses in this thesis were set out to first provide an empirical evaluation of the efficacy of buffer stock operations policy in Ghana; the primary question we posed was: has the volatility – the variation (amplitude and frequency) of commodity price changes around their mean value - of prices of maize and rice reduced following the implementation of buffer stocking and dual pricing? The sub-objective then was to analyze the impact of the buffer stock operation on the price volatility of maize and rice. Having shown that the public buffer stockholding can be applied to ensure price stabilization in the agricultural food systems in Ghana, the research examined the impacts of the policy on the welfare of smallholder farmers in the second step. The second sub-question posed considers whether the buffer stock operations being implemented in the country have improved small household farmers' dietary diversity. The sub-objective therefore was to measure the impact of the buffer stock initiative on food security. Given that Ghana's buffer stock operation is a form of support given to producers to improve their income, the question of how have the buffer stock operations, as output price support intervention, impacted the household
income of smallholder farmers is studied as the third sub-question. A follow-up question to the third sub-question was: which factors drive smallholder farmers’ participation in the buffer stock operations? Hence, the sub-objective was to investigate the impact of output price support on smallholder farmers’ income following their participation in the buffer stock market policy intervention. Finally, the thesis examined the well-being of farmers and posed the fourth sub-question: having implemented the buffer stock price stabilization policy for the past ten years, what has been the impact of the policy on the objective well-being and the subjective well-being of smallholder farmers. Follow-up questions to the fourth sub-question examined how far objective well-being is a good predictor for smallholder farmers’ subjective well-being and how differences could be explained. The sub-objective was to estimate the effects of buffer stock operations on smallholder farmers’ well-being.

6.2 The main empirical findings

This section, which provides recaps of the findings of the earlier Chapter 2 to Chapter 5, is organized by the sub-objectives/themes. The themes are policy analysis, food and nutrition security improvement, income effect, and buffer stock operations’ well-being effect. Each of the four preceding chapters discusses one specific (above mentioned) theme. The sub-objectives that present the main empirical findings are as follows.

i. Analysis of the impact of buffer stock operations on price volatility for maize and rice

The research question posed for this sub-objective was whether the buffer stock's operations had affected the volatility of maize and rice prices. Chapter 2 of the thesis addressed this sub-question. Price stabilizations are the desired outcome of the buffer stock operation mechanism. While the target for introducing a buffer stock scheme could vary between producers and consumers or both, the critical thing about the success or otherwise is the efficacy of a buffer stock scheme in stabilizing commodity price. Indeed, when prices are stabilized under a buffer stock scheme, there could be various benefits to the targeted group. Hence, the analysis of price volatility of maize and rice conceptually ties in to this thesis's key objective. Therefore, the analysis in Chapter 2 forms the basis for any further analysis regarding the impact(s) of buffer stock operations in the sense that the potential benefits of buffer stock operations are mainly subjected to stable prices. Furthermore, the analysis in Chapter 2 aims to expand the literature on the efficacy of buffer stock operations in Ghana which the thesis sought to address. The analysis is based on time-series data on the wholesale prices of maize and rice from the Ministry of Food and Agriculture Ghana.

Based on monthly price data spanning from January 2006 to April 2015, I employed the coefficient of variation as a measure of volatility. I performed econometric tests for the efficacy of public buffer stock operations, as reflected by reduced price volatility measured by variation coefficient. The results show that maize and rice price volatilities were stabilized in the markets where the output price stabilization policy was implemented. For the same crops, price volatility was persistent in a market where the policy was absent. The results mean that prices of the commodities
in the policy-on market are varying more slowly over time. This is making it less complicated for farmers to adjust their activities and investment/commercial decision-making. The reasons are that farmers could easily make decision to adjust their farm activities and investment due to relatively improved level of commodity (output) price certainty. Thus, the results provide foresight for farmers and policymakers as well.

**ii. Measuring food security of the rural farm households using the household dietary diversity index (HDDI) approach**

This sub-objective, addressed in Chapter 3, provides an assessment of the impact of buffer stock operations on households' food security. The analysis is based on food consumption among households benefitting from the buffer stock operations to reflect their living standards and welfare (Pradhan 2009). I examined the causal effect of buffer stock operations on nutrient-content household dietary diversity index (NHDDI), a proxy for measuring food security, and also the socio-economic factors affecting dietary diversity (Chegere and Stage 2020). The NHDDI is developed based on the household dietary diversity index (HDDI). To measure HDDI, a simplified 12-food group item list questionnaire was used to capture the number of household food groups consumed over the one-week reference period. The study then incorporated nutritional dimensions into the food security measure to provide information on the adequacy of nutrients consumption.

To overcome some of the drawbacks of HDDI, I recoded the HDDI and ordered it into low, basic, moderate, adequate, and high NHDDI to reflect nutrient adequacy. For added precision, I employed the novel matching method, the Coarsened Exact Matching in combination with the Weighted Least Squares and the advanced binary response model, the Weighted Ordered Probit for the analysis to enhance the rigor of the results with national survey data from smallholder farmers.

The findings indicate that participation in buffer stock operations (NAFCO) has a positive effect on NHDDI, providing evidence to support the hypothesis that participating in the buffer stock operations positively impacts farmers’ food security. The results further revealed that income, marital status, gender, and education had positive effects while the household size and the number of children less than five years negatively affected the NHDDI level. Though income and participating in NAFCO) both had significant positive impacts on NHDDI, the positive impacts of income are smaller than those of NAFCO. This finding indicates that income stability is more critical for smallholder farmers in maintaining their food security than income-level itself. NAFCO is a market intervention program which involves the use of buffer stock operations for commodity price stabilization. The NAFCO program purchases cereals from smallholder farmers during the harvesting period and resells during the peak seasons at a fixed remunerative price.

Based on the results, NAFCO is critical for the smallholder farmers in meeting their fundamental rights for adequate and nutritious food (as documented in Article 25 of the United Nations Universal Declaration of Human Rights), as many families struggle to achieve food adequacy with the required nutrients for the sustainability of life. Thus, for low-income families who spend a
substantial proportion of their income on food (for food security), buffer stock operations present a tool for insurance against vulnerability to food insecurity (see also Kalkuhl et al., 2016). The critical issue of consuming quality food is also assured as a result of the buffer stockholding. The results suggest that participation in the buffer stock scheme of NAFCO improves food security: a critical component of poverty.

Furthermore, in Chapter 3 we find evidence of income and education having mitigating effects on children's negative effect under-five on NHDDI levels. The results give credence to the view that removing failed markets conditions, facilitated by the buffer stock operations, is vital to improving food security (Ciaian et al. 2018; Jones et al. 2014). Thus, food security intervention/initiative that targets only the farmers' economic conditions such as income and income stability and ignores market dynamics such as road conditions, price volatility and bargaining power of farmers may not be very successful in improving dietary diversity and food security among smallholder farmers in Ghana. Therefore, all these factors need to be considered in an integrated manner during food security program design, planning, and implementation.

The results also have implications for post-harvest losses. With the improved access to marketing and storage provided by buffer stock operations, more grains are put into proper storage by the NAFCO as the activities of NAFCO mop up all available maize harvested. With purchases by NAFCO, more grains (maize and rice) are put under storage under better conditions and handling practices. These help to reduce post-harvest losses that would have occurred if the grains were to be under the care of farmers who do not have proper facilities and capacity to handle the grains. Under the NAFCO storage, post-harvest loss due to biological factors (such as pest, insect, pest, rodents) and environmental factors (such as rain, humidity, temperature) are reduced due to the high quality of the storage materials and the conditions under which the produce are stored. With this, national food security is likely to be enhanced. This can also smoothen the supply of grains in the food market and likely to have impacts on the stability dimension of food security of the nation. With this transitory food insecurity (i.e., sudden and temporary disruptions in the availability, access, or utilization of food) is reduced as there is smoothing in the supply of grains and reduced post-harvest losses.

*Figure 1: Maize in storage at one of NAFCO warehouses at Ejura*
iii. Analysis of the impact of output price support on smallholder farmers’ income

This sub-objective investigates the impacts of output price support on smallholder farmers’ income in Ghana that result from buffer stock operations. The analysis of this sub-research question was addressed in Chapter 4. Instability in smallholder farmers’ income in developing countries due to unstable farm prices has been a challenge for farmers and agricultural policymakers over the years. Sustained price stabilization mechanisms are mostly lacking. In some countries, output price support has been initiated to stabilize prices and improve incomes and as an incentive to enhance farmer investment and boost production. Buffer stock operations do stabilize income, eventually increasing income, and impacting the process of trading (Deuss 2015). However, the buffer stock operations' effect on the low and unstable incomes of smallholder farmers in Ghana is not known. We set out to distill the effect of the buffer stock operation on farmers' income and attribution to the buffer stock intervention policy.

In the research, beneficiaries and non-beneficiaries of buffer stock operations were matched using household- and farm-level data. I then estimated the effect of the buffer stock operation by combining the advanced matching technique, the Coarsened Exact Matching, and the Propensity Score Matching techniques in a regression framework. This helped to improve the balance in the data between farmers who participated and those who did not participate in the initiative and hence reduced selection bias. The matching results indicated that the matching controlled factors found to determine farmers' participation in buffer stock operations because the distances in covariate values (the multivariate imbalance measures $L_i$) between the treated and control before and after the matching reduced to acceptable level indicating success. The matching improved the balance between the treated and the control households in the means and in joint distributions of the data.

The empirical results affirm that output price support via buffer stock operations increases households’ farm incomes by at least 12%. The results demonstrate that with buffer stock operations, a price stabilization policy can be designed and implemented to have a positive income effect on smallholder farmers. However, market dynamics such as private storage and farmers' investment behavior could alter the results, thus limiting the generalization of our results. The level of private storage and the farmer's investment behavior could prolong which time of the lean period to sell their stocks. A more-delayed sale could influence farmer income positively. I also find that smallholder farmers' participation in buffer stock operations is driven by age, gender, access to the market, and use of extension services, and various costs such as transaction, transport, and packaging. Thus, other socio-economic factors influence farmer’s income in addition to commodity price.

The results of the analysis of this sub-objective suggest that promotion of output price support through buffer stock operations to smallholder farmers in rural areas of developing economies, such as Ghana, can improve smallholder farmers’ incomes. However, participation in a market-oriented initiative such as the buffer stock operations is contingent on how the initiative is designed to provide market information to the target beneficiaries. The level of awareness of the initiative
is critical for farmers’ decisions to participate. Past experiences show that public stockholdings can be very expensive and even affect other countries. For example, under the Common Agricultural Policy (CAP) of the European Union, bottom prices were implemented, stabilizing prices and supporting farmers’ incomes in the 1960-1980s. This resulted in overproduction and large surpluses. So, the produce was either stored or exported. However, the intervention price was set well above the world market price. As a result, exporters were given subsidies to compensate for the price between the internal and world market prices. Over time, international prices were depressed for those importing and exporting countries that could not compete for the low price of produce from the EU market, hence hurting those countries (Deuss 2015). By the 1980s, the policy had incurred huge cost due to storage and export subsidies and was withdrawn by the early 1990s (Deuss 2015). These observations about the EU’s price support under CAP, and subsequent overproduction has implications for Ghana in the event of overproduction of maize. Overproduction of maize in Ghana could mean NAFCO has to purchase more maize for storage to make an impact on stabilizing maize price volatility, with the likely high budgetary consequences that could affect NAFCO’s success negatively. Hence, the policy should be terminated at that time and farmers and other participants should be made aware of this long before, to prevent investments based on too high a price.

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

This sub-objective relates to the analysis of the subjective well-being of smallholder maize farmers. It provides an analysis of the effect of buffer stock operations on the well-being of smallholder farmers. Improved well-being is a reflection of improved quality of life or an improved standard of living. However, the nexus between buffer stock operations initiative, an agricultural marketing initiative, and smallholder farmers’ well-being and its implications are of much concern to policymakers. Policies are developed to help improve targeted beneficiaries’ well-being to improve the standard of living of the citizens. I examined the relationship between self-reported objective and subjective well-being of smallholder farmers due to their participation in public buffer stockholding activities. Studying the link between objective well-being and subjective well-being allows for analyzing the comprehensive sets of objective indicators on subjective well-being rather than focusing on one objective well-being indicator such as income. To measure objective well-being, I developed a framework for composite household objective well-being that integrates three broad life domains; economic, social, and environmental domains. Twelve life indicators were adopted, and a matching and the Two-Stage Least Square (2SLS) were employed to account for endogeneity in the analysis. This sub-objective analysis dwells on survey data from farmers participating in the buffer stock operations (BSO) and those not.

The results indicate that the BSO initiative impacted the objective well-being and the subjective well-being of smallholder farmers that participated. In particular, the results provide evidence that participation in the buffer operation initiative improves the objective well-being and subjective well-being of smallholder farmers by 20% and 13%, respectively. Overall, the results indicate that price stabilization buffer stock initiative improves subjective well-being indirectly through the
various aspects of objective well-being. This finding is corroborated by Tsai's (2009) findings, who found that price stabilization influences subjective well-being of farmers through stable income. Furthermore, the results of the analyses indicate a strong relationship between objective well-being and subjective well-being among smallholder farmers, indicating that improvement in the objective well-being of households is a critical condition for improvement in the subjective well-being among smallholder farmers.

An interesting finding of Chapter 5 is that in the absence of the buffer stock initiative, middlemen's activities hurt smallholder farmers’ objective and subjective well-being directly. This is caused by information asymmetry and the farmers’ inability to influence prices; making farmers to be exploited by the middlemen. The negative effect of middlemen can stimulate smallholder farmers to switch to the production of tree crops such as cashew and cocoa (mainly for exports), thereby affecting the level of food production and, ultimately, food security. Interestingly, the results show that smallholder farmers' engagement in multiple jobs increases their objective well-being but is negatively associated with subjective well-being. Kuykendall and Tay (2015) explain that engagement in multiple jobs increases the workload and the stress level, and this lowers the subjective well-being of farmers. Juggling between multiple careers/roles has been linked to stress-related health outcomes such as high blood pressure, among others (Sumra and Schillaci 2015).

The results in Chapter 5 further demonstrate that economic, social, and environmental aspects of life could constitute priorities for public policy to improve smallholder farmers' well-being. The index developed out of these factors to measure objective well-being index relates positively to subjective well-being and demonstrate that these aspects of life needs attention if well-being is to be improved.

Figure 2: Prof Strijker observing a maize field being converted to cashew farm
The finding in Chapter 5 also revealed that marriage had a significant positive effect on subjective well-being, suggesting that married smallholder farmers are happier than those unmarried. Reasons for this finding, as suggested on the broader literature, could be that marriage promotes better health by increasing the likelihood of couples’ early detection of symptoms of sickness, encouraging medical treatment, and helping each other with the recovery process (Stack and Eshleman 1998). Marriage also encourages partners to follow a healthy diet, provide emotional support to each other, and allows couples to pools resources together for use by the household.

6.3 Overarching findings

Having provided a recap and summary of the main findings of the study presented in Chapters 2-5, I now address the central question of the study: having implemented the buffer stock operations policy for the past decade, what have been the effects of the policy on welfare of smallholder farmer’s households.

Overarching finding on price volatility, welfare and poverty reduction

It is interesting to note that from Chapter 2 there was evidence that the policy has stabilized the prices of the two major targeted commodities, maize and rice, in Ghana. Beyond stabilizing the prices of the two commodities, beneficiary farmers’ income and food security are better than those of the non-beneficiaries, and the differences can be attributed to the farmers’ participation in the policy initiative (see Chapter 3 and Chapter 4). I argued that, for smallholder farmers, while buffer stock operations stabilize and eventually improve their income, income stability is of much more concern to smallholder farmers than income increases when dealing with their households' food security. For vulnerable people like smallholders, income stability improves the households’ food security and provide them assurance against food insecurity over time. Therefore, the current buffer stock policy (NAFCO) improves income and helps to insure farmers against hunger and malnutrition.

The results demonstrate that buffer stock operations improve smallholder farmers’ income in a developing world setting and contribute to the agricultural policy of income stabilization: public buffer stock operation is a price stabilization tool and a poverty reduction tool/instrument for rural communities in low-income countries. The results show that buffer stock operations are able to contribute to rural communities’ multiple objectives of food security, higher income level, income stability, and increased well-being. Food insecurity is a vital component of poverty, therefore any improvement in food security indicates poverty reduction. The results imply that providing marketing services to rural farmers are likely to facilitate an improvement in rural poverty and the overall rural development in low-income countries. However, Ghana's long-term perspective is that, gradually the non-agricultural sectors will become more important compared to agriculture. Hence, supporting agriculture tends to diminish or decrease structural transformation processes (Rostow 1991). This is maybe not an acute problem now in central Ghana, but once the Ghanaian economy starts to grow faster, it could eventually get there. Generally, supporting agriculture from
a well-being perspective versus not hampering structural transformation of the economy is a thin line, requiring periodic evaluation to enable the shift from agriculture to manufacturing and services that could result in increases in overall productivity, incomes and well-being of the people and the country.

Also, attention should be paid to the long-term effects of this policy and its viability. As long as the guaranteed prices are not above world market prices (taking account of costs of handling and transportation) and the policy does not structurally require government funding, the policy is viable in the long run. However, as soon as international trade is seriously impacted and the policy requires structural public funding, the viability is questionable. Stabilizing pricing potentially increases agricultural investments and, hence, productivity; price subsidies tend to increase (because more produce will be subsidized).

**Overarching on farmers’ investment and well-being**

Throughout this thesis, the critical role of buffer stockholding operations as a tool for eliminating market failures in a developing world context to improve smallholder farmers' welfare and well-being has emerged and been highlighted. The price stabilizing effects of the buffer stock operation policy initiative on maize and rice identified in this thesis show that the price risk posed to smallholder farmers is minimized. In the absence of an insurance mechanism for maize and rice farmers, the results mean that the policy will continue to provide farmers with a hedge against future market developments and stimulate their investment and efficient production decisions. Price stability and foresight are fundamental elements for investments. The improvements in food security, income, objective and subjective well-being suggest that smallholders have enjoyed improved livelihoods. Thus, the buffer stock operations have impacted positively on the welfare of the smallholder farmers’ households. The results further suggest that the buffer stock initiative enhances livelihood resilience and reduce poverty leading to improved well-being among farmers. Despite these achievements, smallholder farmers have production risks such as climate variability, insect invasions, and disease infestations to battle with, as price volatility is not an isolated phenomenon in Ghana’s Agriculture (Assouto et al. 2020).

**Overarching middlemen and market failures**

The study results show that the buffer stock operations initiative and improving the welfare of farmers provide some side effects for smallholder farmers. These include lowering transaction costs and serving as stimuli to increase farmer investments. The results demonstrate that transaction costs of packaging and transportation are reduced following the participation in the initiative. This indirectly makes cash available to the farmer for other uses by the household. The reduction in the marketing risks associated with buffer stocks operation provides the needed motivation for farmers to invest more in their farming as they are assured of the required returns on their investment. Also, a side effect for both participants and non-participants of the NAFCO is the improved bargaining power (i.e., farmers' relative capacity to obtain favorable terms from the transaction of their produce) to smallholders. The buffer stock operations initiative provides
smallholder farmers with improved access to an efficient marketing service with a better value for their produce, an alternative market source, and back-up. Hence, they can reject the unfavorable terms from middlemen, which they could not do hitherto.

Another overarching finding of the study is the countervailing factors of middlemen and their effect on smallholder farmers' well-being. The results reveal the maize market's complex market structure where middlemen form a wedge between smallholders and tradersprocessors. These middlemen generally hail from the areas that are proximate to the market centers; thus, they have a better knowledge of the market dynamics and information than the producers (smallholder farmers) do. Therefore, they take advantage of this privileged information and market dynamics that create asymmetric information, which is a dominant feature of the relation between the producer-middleman and the middleman-buyer. These middlemen usually act as arbitrage and intermediaries between the farmers and the other market actors. The middlemen do not allow farmers who bring their produce to the market center to sell directly to traders; but through the middlemen, i.e., the farmer must give his/her produce to an intermediary in the market sell for him/her. The middlemen are often accused of manipulating and expropriating the produce of farmers in rural areas. The middlemen are, therefore, exploitative instead of enhancing the efficiency of the markets.

![Figure 3: A typical maize market scene at Techiman with middlemen in the market](image)

**Methodological reflections**

A reflection on the methodological aspects and the research data brings to bear some noticeable issues. First, a wide variety of techniques and tools was employed throughout the thesis, ranging from Corrected Coefficient of Variation in Chapter 2, the Weighted Least Square and Weighted Ordered Probit model in Chapter 3, a combination of the Coarsened Exact Matching (CEM) and the Propensity Score Matching (PSM) in Chapter 4, and the OLS and Two-Stage Instrumental
Variable Least Square (2SLS) in Chapter 5. The corrected coefficient of variation allowed to compare price fluctuation across the price series with linear or non-linear time trends, or any other specification that underlined the price series data used for the analysis. The analysis in Chapter 2 was based on time-series data from the Ministry of Food Agriculture (MoFA), Ghana. The analysis in Chapters 3, 4, and 5 were on quasi-experimental data. Two separate surveys were conducted to collect cross-sectional data from smallholder maize farmers participating in the buffer stock initiative and those not in Ghana's rural areas. As a result, a common feature of Chapters 3, 4, and 5 is the CEM for processing the quasi-experimental data to improve balance, reduce selection bias and improve heterogeneity.

Second, matching technique for impact evaluation is more appropriate for a robust analysis that ensures attribution to a specific intervention or a policy is identified. The use of the Coarsened Exact Matching (CEM) technique in the framework of constructing a counterfactual (control) group for impact estimation, as applied here, is enjoying increased usage and popularity in recent times (King and Nielson 2019). The CEM technique has been found to yield estimates of the lowest variances and biases for any sample size (King et al. 2011). The growing preference for CEM over other matching techniques is also because CEM controls for model dependency (King and Nielson 2019: Iacus et al. 2012). The absence of model dependency means the estimates will remain almost the same irrespective of the model's functional form to estimate the impact (Ho et al. 2007). Thus, with the CEM, the models functional form for estimating the impact does not matter. Besides, the methodology demonstrates the combination of the Coarsened Exact Matching (CEM) and the Propensity Score Matching (PSM) in a single analysis for an improved balance of the data and rigor of the analysis. Nilsson et al. (2019) described the CEM technique to be a better technique compare to the PSM, due to the PSM’s ability to increase the imbalance in the two groups.

This thesis highlighted two key methodological innovations for research improvement. First, the combination of the two matchings in a single analysis yields more robust results. The combination CEM matching combined with PSM analysis brings a methodological innovation in that while the CEM reduces balance, heterogeneity, selection biased, and model dependency, the PSM also ensure that the common support assumptions are achieved. The PSM also helps identify cofounders and control for them. Combining the two matching techniques in a single analysis harnesses the strengths of the two matching techniques for more robust results. Thus, a high scientific rigor is achieved in estimating the treatment effect even though the subject were not assigned randomly, i.e. there was no randomization.

Secondly, the empirical improvements in the dietary diversity measure highlighted in Chapter 3 presents a tool for research in food and nutrition security and other related studies. The nutrient-content household dietary diversity index (NHDDI) ordered to reflect nutrient adequacy provides an improved method of measuring household dietary diversity and food security. The NHDDI, thus, captures the relevance of nutrition for the measurement of food security. If the relevance of nutrition is to be integrated into the food security measurement, then surely an indicator that captures both the macro and micro-nutrients and their densities such as the NHDDI is required. The
nutritional relevance capture by the NHDDI can be maximized for measuring food and nutritional security. The novel NHDDI is a promising metric for measuring food and nutrition security. This new metric provides a new approach for testing how agricultural and food security programs impact food nutrition security of households in rural areas of developing countries.

6.4 Policy implications

In this thesis, I have shown that buffer stock operations have substantial impacts on the price volatility of cereals and the welfare of smallholder farmers. The results have implications for agricultural commodity trade, food security and income, and the well-being of smallholder farmers in rural communities in Ghana. In addition, the results of the study have implications for some aspects of the smallholder farmers’ agricultural life: farm (agricultural) diversification, cost of program implementation, cooperative action by farmers.

Implications for price volatility and agricultural commodity trade

Overall, the insights provided by the thesis's results are relevant to local policymakers and development partners who develop tailored interventions to stabilize and increase household income for improved quality of life for smallholder farmers. The study results provide a guide and basis for the review of the current public buffer stockholding policy initiative. It further provides insights and understanding of how policymakers in other developing countries could design a tailor-made buffer stock program in their countries for improving the well-being of smallholder farmers.

With these findings, I conclude that the buffer stock operations have successfully controlled the price volatility of maize and rice. Comparing the results to the experiences of countries such as Kenya, Malawi, Zambia, and Zimbabwe where public buffer stockholdings used to control price volatility and showed mixed results (David et al. 2016), the results of this study imply that countries that have created an economic environment that allows for rapid supply responses to demand tend to be successful in reducing price volatility of staple food crops. Indeed, buffer stock operations are a viable tool to reduce the volatility of some staple food crops, especially cereals, in sub-Saharan Africa.

Even though the success is modest, it has empirical implications for the local maize and rice market and the economy. The results mean that food price inflation could be impacted. The results in Chapter 2 demonstrate a reduction in price volatility. Empirically, this result means that private sector investment in agricultural marketing infrastructure is likely to increase. A significant side effect of the buffer stock operations is that they provide traders, individual farmers, and their farmer organizations or groups with more secure and reliable storage, which is crucial for the quality and price of the produce sold when prices are high.
Moreover, reliable and safe storage could provide farmers with a credible title to their produce, enabling them to obtain credit for their activities from the Government and the private sector (Katunze et al. 2017). Reliable storage helps to create a warehouse receipt system that enables smallholder farmers to access credit due to improved security for loan recovery. In effect, the stable price for maize and rice can help farmers to access financial service that smallholder farmers often lack.

The findings in Chapter 2 further appeal to scaling up the policy to other parts of the country, mostly remote areas, where maize and rice production are intensive, yet access to these areas by buyers is challenging. This implies that attention to the spatial dimension is required when fixing the floor price. The policy has been able to stabilize the price volatility in the policy-on areas; hence, upscaling to the policy-off areas, and other cereals can impact price volatility in these areas and induce farmers to invest. The results in Chapter 2 further suggested that local private sector investment is encouraged by the cereals' stable market, maize and rice. Stabilizing output prices within a band has the potential to defuse interest groups. Private traders who usually have the incentive to import cereals during high prices are rendered less potent during periods of stable (lowering) domestic price. This stability of maize and rice prices also reduces the price risks faced by farmers, and influences their economic and decision making to become more manageable, and are forward-looking.

In Chapter 2, I highlighted the importance of buffer stocks operations as a tool for stabilizing prices volatility and implementing crop insurance programs (Varangis and Anderson 2002); especially with the private sector's involvement, to hedge farmers against the risks posed by adverse weather conditions, destruction by pests such as armyworms, and disease outbreaks. Weather index-based crop insurance programs may be facilitated with buffer stock providing storage systems. If farmers have access to market-based-insurance tools, variations in the production and prices may not require an immediate policy response by Government unless characterized by catastrophic events. Moreover, with the private sector's involvement, farmers will have different packages of insurance programs to choose from to minimize risk. However, in developing countries, we see that farmers tend to underestimate risks and are less willing to participate. Similar trends could be found in some developed countries as well. For instance, the Netherlands offers a subsidized crop insurance programme (executed by private insurance companies), and still, the majority of the farmers does not participate as they think it is too expensive: they also underestimate risks just like those in the developing world (Hudson et al. 2020; Zhao et al. 2020). However, the trends in developed countries seem better compared to developing countries due to relatively more stable prices for produce in the developed countries. So, it requires at least investment price stabilizing interventions, sound guidance and campaigning. It is expected that with stable output prices, the risk posed to farmers by high price volatility could be reduced and stimulate smallholder farmers to invest in securing their farm outputs (Erickson and Lensink 2015).

A necessary condition for the policy to be useful to impact price volatility is that the proportion of the production volume that enters into buffer stock system as noted in Chapter 2. Too small a
proportion renders the policy ineffective. Benin et al. (2013) argue that the proportion is critical for the policy to be effective and sustainable. As a rule of thumb, the authors recommended about 27% of the production volume for Ghana. They argued that, because it is only 60% of Ghana’s production volume that reaches the market for trade and the rest for household consumption, 27% of the production volume purchased by NAFCO could be significant enough to make the program effective sustainable.

**Implications for income and food security**

Chapter 3 provided insights and highlighted the dynamics of dietary diversity among rural farm households. This is critical as it can guide any policy initiative aimed at improving food and nutrition security in Ghana. Overall, the policy implication of the findings is that food security strategies that seek to generate nutritional outcomes require increased production and income stability and improvement, and education of households towards their food choices. Besides better knowledge, it is not only the price level that matters for household dietary diversity and diet quality but also the volatility of prices. As incomes increase, food security improves, but income alone may not improve diets’ diversity and quality. Hence, policies toward building households capacities in making food choices that are more likely to produce better health outcomes need to be integrated into the country’s food systems. Cultural values, i.e. the perception and opinions of households/people relating to food choices, preparation and consumption, has long influence food security and nutrition security (Varriet 2013). How these cultural values developed and evolve among rural and low-income people over time is important in the food and nutrition discourse as they shape what people eat and their diversity. Noack and Pouw (2015) put it as ‘a blind spot in food and nutrition security: where culture and social change shape the local food plate’ suggesting that among some rural poor people, the cultural and social dimension are capable of narrowing the food plate rapidly towards a high-calorie low nutrient diet which could lead to malnutrition.

Education is needed to shape this cultural values in relation to food choices for food and nutrition security. The study, therefore, suggests that an additional nutrition education component on dietary diversity should be added to the buffer stock operations program through extension agents for the households. Nutrition education and literacy are key to food choice and behavior of household members. Food nutrition education influences the food choice households make to improve health outcomes and influences farmers’ food productions, purchases and consumptions. Therefore, incorporating nutrition education into the current design of the buffer stock operations or establishing nutrition education programs in the food systems might proactively promote better food choices and eating among rural farmers who seem to be eating monotonous diets despite improvement in their incomes.

The findings of the negative effect of having children under five on dietary diversity, the mitigating effect of education on children under five, suggest that there are several factors that impact food security other than income stability and income improvement. While the challenges of caring for children under five impacts food security, Governments need to look across and beyond the food
system as the results call for a re-look at the birth control measures of spacing birth among low-income countries quest for improving food security. Integrating these farm output market access with birth control measures in rural areas could positively impact food security.

**Implications for farm diversification**

The results reveal that buffer stocks operations improve the nutrient-content household dietary diversity of the diets consumed among rural households. This has implications for farmers’ own food productions and health outcomes. It is important to emphasize that, from the results of this study, agricultural production in Ghana and other developing countries need broadening in terms of crop diversification for food consumption from economic and environmental perspectives. From economic perspective, crop diversification provides farmers with more options of food choices for consumption. This indirectly has the potential of improving farmers’ income and ability to access relatively expensive foods like vegetables. Without sustained income, farmers' only alternative to sustain their NHDDI is farmers to rely on their own productions for the consumption of diversified diets. Smallholder maize farmers need to diversify their crop production to include vegetables and livestock, if the gains in NHDDI following the participation in the buffer stock operations are to be sustained. The combination of various crops by smallholder farming therefore, provides diversity of human diets and improves household income, nutrition, and food security (Mango et al. 2018). The outcome of the empirical analysis applying the NHDDI is instrumental for the achievement of this purpose.

From environmental perspective, crop diversification has the ability to reduce outbreaks of pests and diseases. Further more, crop diversification help increase the biodiversity and help the well function of the ecosystem to reduce climate variability as well as helping to reduce the risk of losing crop production due to greater climate variability (Ponce 2020). Thus, crop diversification help households develop resilience against climate change variability (Berhen et al. 2017; Lin 2011). Also, diversifying agriculture to include livestock production by smallholder farmers reduces the pressure on limited land as farmers may require less land for animal production depending on the production system. Even when animal production requires more land for crop production, say vegetable production, animal production could be inefficient but enriches the the diet considerably and it produces manure. While animal products' consumption has good health outcomes for the development of children and reproductive nursing women, the effect of ‘overeating’ of animal products may have negative health outcome for older family members (Nemecek et al. 2016).

I drew three policy implications based on the findings in Chapter 4. First, empirically, the study results show that the buffer stock operation policy provides access to market for farmers and helps stabilize their income and improve their household income. These could incentivize the production of the two kinds of cereals that the NAFCO deals with, leading to the commercialization of smallholder farmers’ activities, increasing engagement with input and output markets as farmers move away from integrated or subsistence farming systems to specialized crop systems. During
these periods, farmers are more likely to increase the inputs, such as improved seeds and fertilizer, for the overall increase in food production in the country.

Second, the results imply that well-planned public buffer stockholding is still a viable option for governments in developing countries to stabilize and improve incomes of smallholder farmers. However, some African countries have not been quite successful, such as Malawi, Zambia, and Zimbabwe, where it was initially successful but later had challenges due to high fiscal cost (Brümmer et al. 2016). For instance, in the European Union (EU), the program incurred high cost and was reviewed and later scraped because of oversupply. As Deuss (2015) noted, one of the main reasons public stock systems often fail is that it is trying to achieve too many objectives with one instrument, at the same time targeting objectives such as stabilizing prices, providing grains in cases of emergencies, distributing food aid, providing food assistance, managing international trade and in the EU, targeting environmental goals as well. Despite the advice by Noble Price Winner, Tinbergen (1958) that: each policy objective needs one additional independent instrument in order to be successful, some governments try to achieve many policy objectives with one instrument. The effect would be different when the emphasis is on both producers and consumers. A reason for the different effect on producers and consumers could be the lack of policy concentration and resources could be dispersed among several issues with the view of achieving many benefits that could benefit producers and consumers alike. Indeed, multiplicity of objectives and lack of clarity of objectives of public buffer stock operations have led to failures (World Bank 2012). For example, the underlying objective of ensuring price stability at levels affordable for consumers and benefit producers has often been confused with the objectives of meeting urgent food needs arising from emergency situations, addressing the needs of poor households suffering from severe food insecurity and others. This has, in the past, led to complex management and implementation structures with overlapping, sometimes contradictory policy priorities resulting in high cost and in inefficient use of public resources. Also, the fixing of the optimal ceiling prices for the benefit of both producers and consumers is often complex and often turns to favor one group compared to the other.

There would be the likelihood that the price differential between the ceiling and the floor prices would not cater to the storage and administrative costs making the buffer stock operations expensive (World Bank 2012). The success of the NAFCO implies that while public buffer stock operations still can help both producers and consumers, only if the emphasis is placed on one group: for instance, producers only. The reason is that when the dual benefits are to be achieved at the same time, there is the tendency of setting unrealistic floor and ceiling prices, which would make the operations of the public stockholdings not to be budget neutral and hence unsustainable. Also, in some instances, price setting could be done in the mist, mostly when spatial dimensions are ignored in the price settings. In the European Union (EU), the case, for instance, there was in the 1970’s-80’s continuous pressure from farmers’ organisations to keep intervention prices (too) high.
I note that the operations of NAFCO have potentially spatially uneven impact, given that NAFCO-prices are space-neutral, but production and transport costs differ across locations, needs attention. The country's dynamics in terms of transportation and the routes of transportation are different, especially between the northern and southern parts of the country and could impact the fees charged by local transporters. Therefore, there is the potential for Licensed Buying Agents to travel to communities with relatively ‘better’ roads and neglect very remote communities with bad roads. Also, the open market prices are spatially different across different local markets with production volumes also deferring. Thus, the level of food surpluses (glut) that need to be purchased are spatially different and require different levels of attention. These spatial differences could impact on the activities of NAFCO on farmers’ income differently. Though all the above were catered for under CAP in the EU, the policy was eventually scrapped due to overproduction (Tracy 1989).

Thirdly, upscaling the NAFCO intervention has implications for incomes of both large-scale and smallholder farmers who engage in private storage, as public buffer stock schemes can disincentive the private sector to participate in stockholding and trading activities. This is especially the case when the purchase and release of grain for public stocks are unpredictable (see Deuss 2015; Jayne and Tschirley 2009). The private sector can also be discouraged from participating in domestic market activities when the public stockholding programme’s size is relatively large. When the private sector is crowded out, the Government is likely to face an even bigger role in stabilizing prices and improving farmers’ incomes, which add additional pressures to the budget. Therefore, the buffer stock operation intervention's upscaling needs to be done with caution so that the private sector is not crowded out. With smallholder farmers who do not sell their produce right after harvest likely to receive lower prices for their produce, transparency of information on public stockholdings is critical. Most often, public buffer stockholdings aim to create more transparency of information on grain stock than private stock levels, which are deliberately kept secret (Gilbert 2011). With this, enough stockholding will take small farmers to produce and release supply to consumers and hold the prices with an efficient band to benefit producers and consumers.

**Implications for implementation cost**

While the primary constraint to public buffer stockholdings is the high fiscal cost, which exceeds the budgetary capacities of many countries, a related constraint to public buffer stockholding implementation is when borders of the country are porous (HPLE 2011). If a country’s main target is to use buffer stocks to target localized/domestic food prices, as the current NAFCO is for Ghana, with potential porous borders, and when the neighboring countries are not following similar price policies, there is the likelihood that a country that implements a buffer stock policy may be forced to stabilize not only its domestic price but also that of its neighboring trading partners/countries. This situation makes buffer stock operations even less financially sustainable. Hence, Ghana needs to tighten its borders to ensure the sustainability of the policy's gains. In fact, this was why Europe in 1960 immediately created one single market with one single agricultural policy, the CAP. This was done in order to prevent artificial trade flows, which would put high pressure on the national budgets. The buffer stock programmes are financially only feasible in a net-import situation.
Therefore, Ghana could continuously evaluate the price level in the light of the trade-off between farmers’ reasonable incomes and structural transformation across time and space.

**The implication for farmers’ well-being**

The results in Chapter 5, from a policy perspective, have some critical implications for Ghana. The current buffer stock operations influence subjective well-being through all aspects of objective well-being of smallholder farmers. That outcome may be useful in conducting a review of the NAFCO initiative and identifying the indicators of quality of life that must be incorporated into the re-design of a (similar) initiative to facilitate improvement in the subjective well-being. Compared to earlier findings that the relationship between objective well-being and subjective well-being is weak and inconsistent (Diener et al. 2010), the results of the study suggest that the direction and magnitude of the effect could be different under different contexts.

The finding that agricultural market-intermediation-middlemen activities in developing economies could lead to economic outcomes that have undesirable consequences for smallholder farmers’ welfare, calls for policies to mitigate the adverse effects of middlemen’s activities on well-being. Because of the lack of public agricultural market information systems, the LBCs/middlemen may skim additional profit by reducing the NAFCO price as opposed to the price paid to the farmers because the farmers do not know the ‘real’ identity of the buyers (LBCs) operating on behalf of NAFCO. A case of moral hazard and adverse selection may arise due to the asymmetric information between LBCs/middlemen. The LBCs/middlemen could conceal information on the support price (NAFCO price) and their status and NAFCO agents from the farmers and purchase produce per the open market terms against the NAFCO terms. As a solution to the exploitation of farmers by LBCs/middlemen, NAFCO could design a system of collecting the selling farmer's signatures for their consent. This could be done by NAFCO developing a standardized duplicate receipt for the LBCs to be filled by the selling farmers. The LBCs must return a copy of this receipt before their produce is accepted into the warehouse to pay their commission. The contact information, e.g. telephone number, could be collected for verification of the price paid. Detail contact information about NAFCO should be on the receipt for farmers to contact him or her when needed. All these measures will enhance openness and reduce asymmetric information and potential buyers’ (LBCs/middlemen) not being transparent.

The results further demonstrate that economic, social, and environmental domains of life could constitute priority areas for public policy towards improving smallholder farmers’ well-being. Though they do not constitute all essential aspects of life, these aspects of life are enough for identifying indicators for building an index for measuring the objective well-being of smallholder farmers in rural and developing country settings. For smallholder farmers, these aspects of farmer’s life constitute the larger parts of the issues relating to their livelihood and their basic needs and survival.
Implications for cooperative action by farmers

The overall results have implications for cooperative/collective action for agricultural marketing as it presents an incentive and opportunity for smallholder farmer-based organizations (FBOs) in Ghana to link up with the buffer stock operations. The FBOs are the cooperative societies of farmers in Ghana. However, the viability of these FBOs has been very poor in the past, with most of them collapsing after a few years of existence. A reason for their collapse is that most of these farmer groups are developed top-down instead of bottom-up. In the top-down development, most FBOs are formed by donor projects to access project activities and they collapse after such projects end. Francesconi (2009) observed that farmer cooperatives that use collective action to collect and help their members to market their outputs are the only farmer cooperatives that remain viable, sustainable and relevant institutions over time. Farmer groups that have used collective action to market their produce in the past have improved their incomes, and it is an important way of ensuring the sustainability of their farming activities/enterprises as well as the well-being (Abdul-Rahaman and Abdulai 2020).

Therefore, with the ‘competitive price’ being offered by the current buffer stock operations initiative, the farmer-based organizations in Ghana have an incentive to adopt collective action to market their produce through the buffer stock operations to enhance their welfare and ensure the sustainability of their groups. The sustenance of the farmer-based organizations based on their participation in the buffer stock, in the long run, can contribute to better food security and strengthened agricultural performance for economic development and poverty reduction in Ghana. Furthermore, the current activities of the NAFCO present an opportunity for innovative small-producer organizations and institutional arrangements with NAFCO. These arrangements could provide an array of services ranging from enhancing access to marketing services and information, accessing input markets, credit facilities, and facilitating smallholder farmers’ participation in the policy-making process. These could further strengthen the sustenance of the farmer organizations and weaken the power of middlemen.

Figure 4: Emmanuel and Prof. Strijker with some smallholders in Ghana.
6.5 Lessons from the policy implementation strategy

Besides the policy implications of the buffer stock operations policy, two key lessons learned about the policy are noted. First, there are spatial differences in the production cost due to differences in the local production, distance to inputs markets, and market conditions and dynamics. However, there is no spatial differentiation in setting the floor price\textsuperscript{17}. As a result, the Government’s floor price does not indicate supply and demand trend in the year. However, the open market prices, which are spatially different, indicate supply and demand trends in the various markets spatially. Therefore, the uneven spatial open market prices movements have implications for when NAFCO should move to buy stocks and when to release its stocks to the markets. The uneven spatial prices in the open markets mean that LBCs could make better profit buying from specific geographic areas/markets than others. This could cut off farmers in other (‘expensive’) communities in the policy-on areas, because the LBCs may not visit those communities.

To overcome the implementation challenge of the undifferentiated spatial pricing, consideration could be given to a two-tier pricing system for fixing the NAFCO minimum prices. Following Tracy (1989), there could be a basic intervention price and the target price. The basic intervention price could follow the current pricing approach while the target price is a mark-up of some percentage of the basic intervention price. The target price is applied after zoning the production areas into NAFCO zones and analyzing the market conditions, and apply the mark-up to reflect the peculiar market conditions in the NAFCO zones. The different NAFCO (production) zones could have different percentages in determining target price based on their market dynamics and other factors. A thorough analysis could be done to determine the percentage for the mark up. Production zones that deserve the target prices will use and non-deserving zone will use the basic intervention price. Thus, while the basic intervention price is not space neutral, the target price is space sensitive.

Second, NAFCO, as an implementation method and as practice, does not sell its stocks directly to households but targets and sells directly to institutions (such as secondary schools, hospitals, army, prison services, etc.) and poultry farmers. These institutions usually purchase maize/rice in large volumes and are able to impact prices in the open market. Therefore, when NAFCO takes them out of the open market (temporally during the peak season when prices are highest), it frees open market maize/rice for households to purchase, reducing the demand created by these institutions' large-scale/volume purchases. These large-scale buyers (institutions) ' ability to influence the open market price and raise it during the lean season is also reduced. This, likely, keeps the open market

\textsuperscript{17} The guarantee/floor/bottom price fixed by Government for the purchase of produce from farmers is set annually. Typically, the fixing of the floor price is based on an analysis of the cost of production (crop budget) of different farms with no consideration in spatial cost and other spatial issues. The floor price is set at the cost of production, plus a 15% profit margin for farmers (Benin et al. 2013).
maize/rice price within the targeted band. Thus, even though NAFCO does not sell directly to household consumers, they (household consumers) directly benefit from the localized price stability created by NAFCO. The institutions that purchase grains from NAFCO are provided with better services, such as large quantities and improved quality of the grains, especially in drying to the required moisture level, low/free from debris or pests, and infestation. Hence purchases from NAFCO by these institutions give them better value for money. The current results show that this design of the Ghana’s buffer stock operations has contributed to the market intervention policy's success, which hitherto failed in some African countries. In addition, NAFCO is the only organisation that is able to supply these users with high volumes of produce during the lean seasons. The selling price is not the sole characteristic benefit these institutions derive from the buffer stock operations by NAFCO.

6.6 Discussions and suggestions for future research

The indicators for measuring objective well-being could not take all dimensions of life into account, such as leisure and religion, even though crucial aspects of life were considered. The inclusion of these two dimensions of life could have increased the ‘completeness’ of objective well-being index. The current study on objective well-being and subjective well-being could be extended in several ways as the current study focused on only three domains of life; economic, social, and environmental domains. Other domains such as leisure and religion are other essential domains that could be explored about smallholder farmers’ well-being. For instance, leisure is an important issue for the individual and household well-being in the developed world setting, but for the smallholder farmers in rural setting of a developing country, the role of leisure on their well-being could be explored. It would be exciting and essential to see how leisure and religion and other quality of life indicators could be used to further develop the objective well-being index from both theoretical and policy perspectives.

In addition, while the current study focuses on quantitative dimensions of the topic, welfare impacts of buffer stock operations, the qualitative dimensions of the program's impacts on beneficiaries are also relevant and could deserve future consideration for a thorough study. Qualitative dimensions such as perceived impact on the convenience of marketing process under the NAFCO initiative, the impacts on gender equality and equity deserve research attention.

However, the results of the study lend insight into the implications of smallholder farmers’ participation in buffer stock operations, particularly the extent to which the gains made through the stabilizations of prices of maize and rice affect the welfare of the smallholder farmers via their food consumption, income, and well-being. I note that deriving household food and nutrition security based on an NHDDI categorization alone may not be wholly satisfactory since it does not account for the quantities of the food groups consumed and cultural differences. Culture impacts the choices of food people make. Therefore, variations in culture, attitudes, and history are also critical in discussing household dietary diversity (Cavatorta et al. 2015). Thus, to add to the thesis
findings, a new dimension in future research that captures the quantities of the food groups and the cultural differences of farmers could be useful since it may lead to identifying new and relevant variables to understand better the effectiveness of food and nutrition security programs for smallholder farmers’ welfare and help to optimize these.

Furthermore, I suggest that future research could investigate how transparency of information about government buffer stockholdings could impact private buffer stockholdings and what this implies for smallholder farmers. This could be done through collaborations with donors, research institutions, and farmer-based organizations.
References


