



New green revolution in Ghana: perceived benefits, challenges, and implications for the environment

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Abstract

This paper reflects on Africa's new green revolution (NGR) movement by drawing data from Ghana as an illustrative case to assess the benefits and challenges of NGR and discuss the long-term environmental implications of NGR interventions. We draw insights from agrarian change theory to understand the complexity of local, national, and international factors that interact to produce changes in agricultural systems that affect smallholder farmers in poor settings. Data were collected using qualitative methods based on the lived experiences of farmers and analyzed to understand farmers' perspectives. We identified increased yield and income levels as crucial benefits of the NGR. Politicization and excessive bureaucracy resulting in perennial delays in the delivery of inputs emerged as critical challenges to the NGR. These findings have implications for the social environment (including the transformation of traditional gender roles and the erosion of traditional knowledge systems) and the physical environment (including forest degradation and the depletion of beneficial soil microbial organisms), which may erode short-term gains of the NGR and compromise broader scale environmental sustainability goals. Critical steps are needed toward consolidating actors and innovations for sustainable agriculture in Africa if global ecological management and poverty reduction objectives are to be achieved consistently with the principles of environmental sustainability.

Keywords Agrarian change · New green revolution · Food security · Smallholder agriculture · Ghana

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1 Introduction

The global food crisis in 2008 created severe impacts, especially among the world's poorest populations (Hossain, 2018). The food price hikes propelled the food crisis, necessitating an urgent increase in food production. Players in the agri-food industry were divided on how to sustainably improve food security amid worsening environmental degradation and global climate change. To address this dilemma, policy in the global food system advocated for a 'new green revolution' (NGR), which would propel increased yield and provide adequate food for the growing food-insecure, especially in sub-Saharan Africa (SSA), using a technocentric approach (Blaustein, 2008). The NGR is an agribusiness approach to farming that uses Genetically Modified (GM) crops, chemical inputs, and pesticides, focusing mainly on SSA (Gengenbach et al., 2018). The approach is purposed to generate large-scale crop production, and productivity increases in developing countries through artificial fertilizers, pesticides, high-yield crop varieties, and biotechnology (Bergius & Buseth, 2019). While different from the initial green revolution in Asia, the NGR purports to extend the benefits of the original approach to SSA based on the belief that the original initiative largely bypassed the continent. Another dichotomy between the original green revolution and the NGR is that the NGR has a new focus on public–private partnerships and a drive for integration into global markets via value chains—elements that are dominated by corporate interests and philanthrocapitalism (Bergius & Buseth, 2019; Moseley, 2016). As such, the NGR is heavily supported by diverse interests, including the G8 (New Alliance for Food Security and Nutrition), northern development agencies (e.g., United States Agency for International Development [USAID], Department for International Development [DFID], and Agence Française de Développement [AFD]) (Toenniessen et al., 2008). These organizations build an alliance in partnership with key institutional and international players in SSA, such as the United Nations, African Development Bank, New Partnership for Africa's Development (NEPAD), and the Africa Union. At the same time, various philanthrocapitalist foundations, such as the Bill and Melinda Gates Foundation, Alliance for Green Revolution in Africa (AGRA), Rockefeller, and Yara, leaders of the food industry (Unilever, McDonald's, Coca-Cola, Cargill, etc.) and agro-petrochemical industry, such as Monsanto, Bayer and Syngenta, have backed the NGR (Blaustein, 2008; Moseley, 2016). The argument is that the agricultural landscape can be transformed by creating new partnerships and alliances to increase crop yield for the increasing global population (Martin-Guay et al., 2018).

For over a decade, governments have championed the modernization of small-holder agriculture through the NGR model (Ignatova, 2017; Moseley, 2016). In SSA, the NGR focuses on eight interrelated areas: seeds, soils, water, markets, agricultural education, African farmer knowledge, supportive agricultural policies, and monitoring and evaluation (Conway, 2012). With its aim of transforming agricultural production into an input-intensive system to reduce drudgery and improve yields, the NGR movement encourages countries to adopt and adapt

NGR-related policies and integrate them into the existing farming systems to boost output (Mathis, 2019). Consequently, government ministries, regional institutions, think tanks, and prominent philanthropists have marshaled resources and stretched the discourse to ensure the adoption of the model proposed in the NGR (Vilain, 2016). Furthermore, under the banner of sustainable intensification, the NGR considers environmental challenges, such as climate change and variability, and seeks to act as an ecologically sound replay of the 1950s and 1960s green revolution (Bergius & Buseth, 2019; Patel, 2013).

While the NGR presents an opportunity for SSA countries to break the cycle of perennial food shortages, with food policies incorporating the agenda's tenets (Holt-Giménez & Altieri, 2013), there are arguments that the adoption of such an approach is unlikely to end hunger, and may have deleterious impacts on smallholder farmers and their physical and social environment (Holt-Giménez & Shattuck, 2011). For instance, recent increases in food insecurity and poverty in SSA (FAO et al., 2021) suggest that investments in agriculture have not yielded desirable productivity gains. Others (e.g., Dawson et al., 2016) argue that the NGR is a neo-liberal ploy to take production out of the control of the smallholder farmers in rural areas and has reduced food access among smallholder farmers (Moseley, 2016). Yet, some scholars, primarily supporters of the food sovereignty movement, contend that the NGR, which is version 2 of the 1950s and 60s agricultural revolution in Asia and Latin America, is more tailored towards the institutionalization of a productivist and extractive model meant to generate profits for multinational corporations and maintain Western powers' grip on the poor and vulnerable smallholder farmers and their production systems (Vilain, 2016).

Over the last decade in Ghana, several initiatives and interventions that adhere to the tenets of NGR have featured in agricultural policies and programs (Kansanga, 2017). These initiatives and interventions include the Agricultural Mechanisation Service Enterprise Centres (AMSECs), input subsidy programs, and rural enterprise development programs. Experiences with implementing programs such as the Sasakawa Global 2000 project, which was deemed a failure (GRAIN, 2007), have stimulated researchers' interest in scrutinizing the NGR movement's impacts on smallholder farmers and their environments. However, assertions about the success or otherwise of NGR can only be made based on the narratives of local farmers and implementing agencies. Such contextual information would better position stakeholders to examine the impact of NGR interventions on local agriculture, livelihoods, and the environment. In this study, therefore, we reflect on the more than a decade-long implementation of the NGR policies, interventions and schemes in Ghana through an in-depth qualitative analysis. We aim to identify the impacts of such policies and programs on rural farmers based on the experiences of farmers and other stakeholders involved in the implementation side. Previous studies on this topic have focused on interventions that are more readily accessible by farmers in relatively urbanized locations. Urbanized locations have greater access to the equipment being supplied, and the farmers there are relatively more financially sound, dynamics that may not readily favor farmers in more rural locations. The lived experiences of these rural farmers with the NGR might differ and could outline insights into better ways of implementation and the unintended impacts on rural landscapes.

Linking these perspectives to the environment in rural areas could provide insights into how to implement the programs more sustainably. We draw insights from the agrarian change theoretical framework to explore farmers' experiences to better situate these experiences within the broader trend of the ever-changing agrarian landscape in rural SSA.

2 The context of the new green revolution in Ghana

In Ghana, the NGR focuses on several subsectors which policymakers envisage would stimulate growth in agricultural productivity and contribute to reducing food insecurity. In the last decade, agricultural mechanization, inputs subsidy schemes, and rural enterprise development programs have served as intermediaries through which the NGR is practiced in Ghana. For this study, we focus on agricultural mechanization and input subsidy schemes, because changing family dynamics and climate change have significantly reshaped how farmers till the land and the kinds of inputs they use (Kpienbaareh et al., 2022). The changing family and environmental dynamics constraining rural smallholder agricultural expansion make NGR more appealing. For instance, in their study, Kpienbaareh et al. (2022) found that smallholder farmers adopt herbicides for land cultivation because it makes their work easier (reduces drudgery) and allows them to adjust their planting time to increasingly erratic rainfall patterns, despite the perceived serious health effects associated with their use. With such changes bound to continue and drive interest in such NGR-related policies, interventions and programs, the question often asked is whether farmers have access to these and inputs to meet the changing demand?

Agricultural mechanization schemes implemented in Ghana have followed two modules: (i) state-led mechanization programs and (ii) private sector-led service hiring market (Diao et al., 2012), reflecting the focus of the NGR on public–private partnerships. Under the private sector-led scheme, farmers access mechanized services for land preparation through a competitive market to hire private tractors (Kansanga, 2017). Since 2003, the government has directly influenced the supply side of mechanization by providing subsidized services to farmers (Houssou et al., 2013). For instance, the government introduced AMSECs in 2007 to offer affordable, subsidized, and timely mechanized services to farmers by providing credit facilities to qualified private-sector companies to provide mechanized services for farm activities in each district (Benin, 2015; Ministry of Food and Agriculture [MoFA], 2013a). The logical thinking is that ready and affordable tractor services can transform labor-intensive farming practices and increase productivity. About 89 AMSECs were established nationwide and sited strategically to ensure that at least 500 farmers are served by each center (Diao et al., 2014). Nine (9) of these AMSECs are in the Upper West region (MoFA, 2013a). Several studies have assessed the impacts and dynamics of agricultural mechanization services on productivity in other parts of the world. For instance, studying the adoption patterns and productivity impacts of agricultural mechanization services in China, Lu et al. (2022) outlined two key findings: the ratio of off-farm wage to agricultural mechanization services price, or the wage-rent ratio, has a significant positive effect on agricultural mechanization

services' adoption; and switching to agricultural mechanization services in plowing, transplanting, and harvesting increases rice yield. Their findings highlight the need to subsidize mechanized services in rural areas—there is a high incidence of poverty in rural Ghana. The findings underscore the productivity increases resulting from adopting mechanized services.

Aside from agricultural mechanization, the NGR is also operationalized in Ghana through subsidy schemes for farm inputs, such as fertilizers, hybrid seeds, and agrochemicals. The usefulness of input subsidy schemes in African agriculture was in doubt following the failures of the structural adjustment and market liberalization reforms in the 1980s and 1990s (Benin et al., 2013). However, after the 2008 global food crisis, many countries witnessed severe food shortages and civil unrest, which led to renewed attention to subsidizing inputs to increase yield. The Fertilizer Subsidy Program (FSP), which started in 2008 and extended to 2009, is one example of an input scheme meant to cushion farmers against high fertilizer prices in the global market (Baltzer & Hansen, 2012a). The FSP was executed using the waybill approach, with subsidies on four types of fertilizer (nitrogen, phosphorous, potassium [NPK] 15:15:15, NPK 23:10:05, urea, and sulfate of ammonium) which reduced the price to about 64% of the retail market price (Benin et al., 2013). The FSP aimed to increase the national average rate of fertilizer use from 8 kg per hectare (kg/ha) to 20 kg/ha to increase crop yield (MoFA, 2013b). However, Lu et al. (2022) observed in China that using inputs such as pesticides may decrease yield and contribute to adverse health impacts. Questions, therefore, emerge about how rural smallholder farmers reliant on agriculture benefit from policies that advocate for the use of mechanized services and agrochemicals. Further, in subsidizing the inputs and services for the sake of NGR, several actors, including governments and philanthropists, interact at different levels to ensure implementation, thus necessitating the need to assess the perspective of these stakeholders.

3 Materials and methods

3.1 Analytical approach

NGR interventions, such as intensified agriculture and mechanization, can be framed as critical drivers of agrarian changes (Bernstein, 2010). Agricultural changes that once spanned centuries now occur within decades because of the rapid implementation of schemes that environmentally, socially, politically, and economically change human relations with rural agricultural systems (Ahmed et al., 2018). This rapid change in agrarian systems results from multiple factors within the global political economy (Ahmed et al., 2019). As a result, our study frames NGR as a political process of change and interaction of actors and hence adopts the political economy questions of Bernstein (2010): “who owns what”, “who does what”, and “who gets what.” According to Bernstein (2010), every rural society’s agrarian structure comprises different labor classes and actors within the NGR value chain. Due to power and information asymmetries, NGR disproportionately affects other social groups (i.e., poor farmers, women, youth, etc.).

From the perspective of Bernstein, “who owns what” relates to issues of rights concerning land (von Maltitz et al., 2019). In the context of NGR, this includes land and rights to information. The second question, “who does what,” refers to the roles of different actors within the NGR policy framework. This consists of the roles of farmers, government, private sector (i.e., seed providers and mechanization service providers), and civil society organizations. The third question, “who gets what,” relates to the distributional impacts in terms of benefits and burden, which translates into winners and losers of NGR policies. As the issue of land rights is not the central matter for this study, we instead focus on the other two questions (“who does what” and “who gets what”) to understand the benefits and challenges of NGR in Ghana and environmental implications of the interventions. We, therefore, applied this analytical framework considering the human–environmental relations within NGR. The framework allows for teasing out the local effects of NGR by understanding its successes, failures and broader implications.

3.2 Study context

Agrarian change literature shows that the location of a place determines how much the forces of globalization influence it, the amount of technological change adopted over time, and the need for integration into the global economy (Ahmed & Gasparatos, 2021; Moseley, 2021; O’laughlin, 2016). Based on these considerations, we chose the Daffiama-Busie-Issa (DBI) district in the Upper West Region (UWR) of Ghana (Fig. 1) as a suitable context for our study. We focus on four major rural

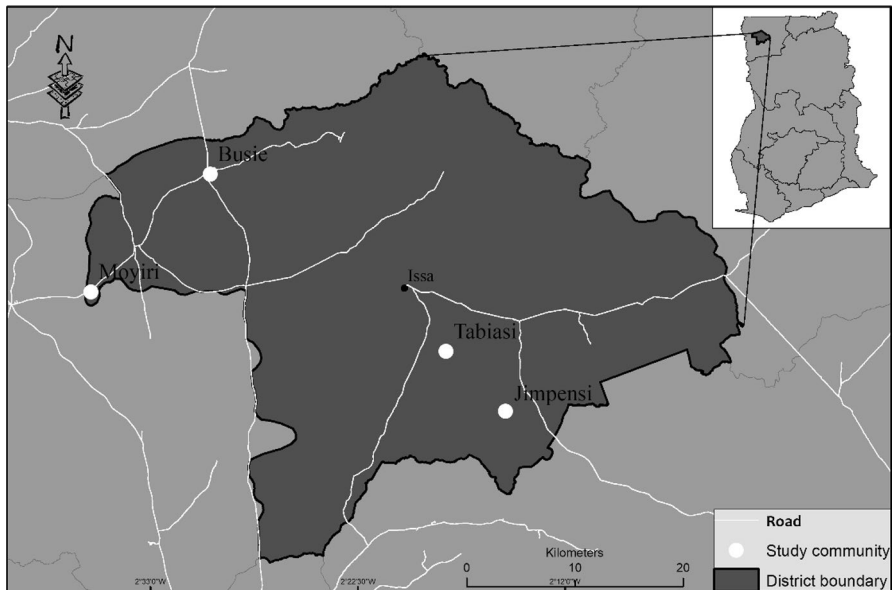


Fig. 1 Location of study sites

farming communities in the DBI: Busie, Jimpensi, Moyiri, and Tabiasi. Busie, one of the largest markets in the DBI, has a population of 2,666 (1,386 female). In contrast, Jimpensi, Moyiri, and Tabiasi have populations of 1,828 (895 female), 1,014 (578 female), and 2,311 (1,165 female), respectively (Ghana Statistical Service [GSS], 2014). The location of these communities to other larger markets and district capitals, such as Nadowli and Jirapa, further gives them a locational advantage in terms of access to the market for selling farm produce and procurement of agricultural inputs. They are also located near AMSEC service centers in Nadowli (2 centers), Jirapa (1 center), and Wa (3 centers), as well as the input outlets in those district capitals, allowing farmers the possibility to access these NGR-related interventions (MoFA, 2013a). Additionally, the district is connected to markets in the West African subregion through Burkina Faso, making it susceptible to changes in the international market dynamics. These attributes make the communities a proper context to assess the benefits, challenges, and prospects of the NGR.

The communities are located within the northern savannah agro-ecological zone, characterized by a unimodal rainfall pattern that begins in May and ends in September. The average annual rainfall is about 1100 mm, with maximum and minimum annual temperatures of 36 °C and 27 °C, respectively. The rainy season is followed by a long dry season during which wildfires are common (Kpienbaareh & Luginaah, 2019), and seasonal food insecurity sets in (Kansanga et al., 2022). The agricultural system and the cultivated crop types follow the patterns of the savannah climate as it pertains to the northern savannah agro-ecological zone. Rain-fed peasant farming, which traditionally involved the cultivation of millet, sorghum, and yam, but now primarily hybrid maize, groundnuts, and cowpea, is practiced in the area, usually on a smallholding basis. In addition, the MoFA has set up fertilizer distribution in the district at Issa, Fian, and Sombo where farmers can access farm inputs.

3.3 Data collection methods

To achieve our study objectives, we used a combination of purposive and random sampling to conduct in-depth interviews, $n = 176$ (male = 91, female = 85) with farmers in the study communities. The farmers were purposively sampled to reflect differences in socioeconomic characteristics, such as age, gender, and social status. Interviews were conducted with the informed consent of the farmers, and the questions were translated into the language each farmer is familiar with to ensure a better understanding of the issues (Marschan-Piekkari & Reis, 2004). Interviews were conducted until saturation was reached, which was at most, 45 min. The discussions focused on understanding farmers' perspectives on the benefits of subsidized tractor services, inputs, and agrochemicals and the challenges they face in accessing these services. We also conducted key informant interviews with government officials ($n = 2$) spearheading the implementation of NGR policies at the local level—an Agricultural Extension Agent and a district officer of MoFA using structured interview guides to seek the perspective of the supervising and implementing authorities of government agricultural policies.

Gender-specific focus group discussions (FGDs) ($n=3$) with six farmers in each group were conducted. The gendered FGDs were to reflect diverse perspectives and enable us to understand any gender dynamics in the implementation of NGR. All interviews and FGDs were tape-recorded, with consent from the farmers, and transcribed for thematic analysis using NVIVO (v12). We identified themes using line-by-line coding (Ryan & Bernard, 2003; Strauss & Corbin, 1990). The themes are presented according to two of the political economy questions of Bernstein (2010): *who does what* and *who gets what* to ensure simplicity in the presentation of the findings. All interviews and FGDs were conducted between February and April 2019.

4 Findings

4.1 Participant characteristics

Table 1 presents the characteristics of the participants. Most farmers (39.8%) had at least a primary education, 33.5% had secondary education or higher, and 26.7% had no education. Overall, we observed that location plays a vital role in accessing the benefits of NGR—most farmers with access to mechanized services and inputs are from relatively larger communities (e.g., Busie and Moyiri). Gender also plays a key role—participants with the most access to these benefits are the male farmers. Generally, there was better access to inputs such as fertilizers and hybrid seeds than tractor services. Details of the findings are presented in the following section.

4.2 Perceived benefits

Our interactions with farmers who have accessed hybrid seeds, fertilizers, and tractor services revealed that the inputs helped increase yield in the years they accessed them. The farmers attested that some of the subsidized seed varieties and agro-chemical they bought from the MoFA helped to increase farm output. We observed

Table 1 Description of sample characteristics

| Characteristics | Gender | | | Educational attainment | | |
|-----------------|--------|------|-----------|------------------------|---------|----------------------|
| | Female | Male | Total (%) | None | Primary | Secondary and higher |
| Busie | 27 | 29 | 56 (31.8) | 13 | 20 | 23 |
| Jimpensi | 19 | 20 | 39 (22.2) | 10 | 13 | 16 |
| Moyiri | 18 | 19 | 37 (21.0) | 11 | 14 | 12 |
| Tabiasi | 21 | 23 | 44 (25.0) | 13 | 23 | 8 |
| Total | 85 | 91 | 176 (100) | 47 | 70 | 59 |

that farmers who had access to these inputs were mostly from Busie, a comparatively much larger community by population with the largest market of all the study communities. One farmer who was able to access improved seeds in the past season said:

The groundnut seeds I acquired from an agriculture extension agent had a higher yield [...]. I know this because I was able to harvest more bags of groundnuts since I began using these seeds. I have been able to pay for the seeds and settle all my debts because my income level has improved [42-year-old male farmer, Busie].

Another farmer stated:

Three seasons ago, I only got one bag of beans. But ever since I started using agrochemicals to control the beetles and other pests on my bean farm, I have been able to harvest up to six bags of beans in each of the last two seasons [37-year-old male farmer, Moyiri].

As well as the use of agrochemicals for controlling pests and insects to boost yield, other farmers indicated that they use agrochemicals to kill (or control) weeds before planting, which is likely an indication of inaccessibility to tractor services. One of the farmers stated that:

I use herbicides/weedicides to 'kill' the weeds before planting and to control weeds on my farm during the growing season. The herbicides are easily accessible in the market these days, and we have a local agent who sells them. Using herbicides makes work easier and faster and enables me to time my planning to match the rains [48-year-old female farmer, Tabiasi].

In addition to the hybrid seeds and agrochemicals, a few farmers indicated they had access to subsidized tractor services from the AMSECs during some of the seasons in the past 3 years. Several farmers in some communities who benefited from the tractor services hailed the scheme as helpful in increasing their farm sizes. The farmers highlighted that introducing the tractors at subsidized prices helped them to reduce drudgery, save time, and expand cultivated land areas. A female farmer who hired one of such tractors in the past growing seasons explained that:

I could access a tractor to clear the land for my maize and groundnut farms in the last two seasons. Some farmers in this village have tractors, but the ones the government provides are cheaper than private tractors. So many of us, the farmers, want to use the subsidized tractors. In addition, the tractors have enabled me to expand my farm, [thus] increasing my output [53-year-old female farmer, Busie].

Overall, farmers with access to some of these services concluded that while their general well-being is not where it should be, they have experienced appreciable improvements in their overall well-being due to marginal improvements

in productivity. During one of the focus group discussions, most farmers agreed with the following assertion by one of the farmers:

Since I began getting some of these inputs, I can say there has been a slight improvement in the economic status of my household in the years that I get these inputs because I can provide for most of their needs thanks to money generated from the sale of farm produce. In addition, we don't quickly run out of food during the dry season [42-year-old female farmer, FGD, Jimpensi].

4.3 Challenges of implementation

Whereas the participating farmers derived some benefits from accessing inputs through the subsidy schemes, they also acknowledged myriads of challenges with the implementation. The lengthy bureaucratic processes involved in accessing the services and political interference in distributing inputs emerged as the significant implementation inhibitors. During the in-depth interviews, we noted some diversity in the nature and form of the challenges based on gender and socio-economic characteristics. The most cited challenge faced was the politicization or political influence on the flow of inputs and services to communities and individuals. Farmers bemoaned that the access to seeds, fertilizers, and tractors services is based on political party affiliation and 'connections' (social networks) and which political party the community generally votes for during general elections. Members and sympathizers of the ruling party often access the inputs before they become available to non-party community members. While some farmers persisted in seeking the inputs even if they were not politically active by traveling to other locations, other farmers gave up in trying to access them all together and rely on the traditional practices or purchase unsubsidized inputs at higher costs from different dealers. One farmer expressed his frustration about the mode of delivery of input subsidies:

Yes, I am aware of these programs [the fertilizer subsidy scheme], but I have not bothered to try accessing inputs recently because politics has been involved. If you are not a member or sympathizer of the ruling party, accessing the services and inputs is very difficult or even impossible. When my party comes to power, I will also have leverage because the party officials know my family and will prioritize my needs [47-year-old male farmer, Jimpensi].

Another farmer indicated the phenomenon of 'whom you know' as a significant barrier to accessing tractor services in particular:

There are only a few tractors in the district. Most of them are broken down and have not been operating over the last few years [...]. When the rains begin, it is extremely difficult to have timely access to the few operating tractors to plough my field. You need to have connections with the officials or politicians to access the tractors at the right time. Otherwise, you have to use manual labor through hoes and cutlasses [...] else the rains will leave you behind [47-year-old female farmer, Tabiasi].

Other farmers emphasized the uncertainties and delays in the arrival of a season's inputs to the agents from the Ministry of Agriculture as the main challenge. Given the nature of the rainfall pattern in the study communities, this complaint is legitimate, because the timing of planting is crucial to the successful growing season, given the unimodal rainfall pattern in the savannah agro-ecological region. One farmer expressed the following views:

When the program started, they said they would give each farmer fertilizer to start cultivation. So we cultivate our lands while awaiting the arrival of fertilizers. When you go to collect the fertilizer, they tell you it's not time to pick up the fertilizers yet. This means we will have to wait for their time of distribution but not our time of the fertilizer need. This is what is punishing us. We apply the fertilizers later, which are not useful at that time [51-year-old female farmer, Moyiri].

And another farmer added:

The agricultural extension officer asked if I would like to sign up for the tractor service. But by the time the government tractors get here, it is usually too late to cultivate the land for the season. If you plough around that time of the season, you can put a whole bag of fertilizer under a single maize crop, but it will not yield anything meaningful. Before those tractors and other services arrive, I would have already ploughed and gotten my unsubsidized fertilizer from Wa [the regional capital]. If you wait for the government people, you will run into debts [47-year-old female farmer, FGD, Busie].

Comments by female farmers during the group discussions highlight the gender differentiation in the access to some inputs:

Usually, when the information and tractors eventually arrive late in the season, the male farmers have access to them before the female farmers. This affects when and what to grow for the season if we get to grow anything at all [36-year-old female farmer, FGD, Busie]

An Agricultural Extension Agent (AEA) further highlighted politicization as a bane of government policies designed to support farmers. He blamed the failure of these schemes on the defaulting farmers who have the backing of politicians. He notes that:

Most farmers default on their payments at the end of the season. It is because some put politics in the distribution of the inputs and services. Sometimes, they will say my government is in power, so I will not pay. And you know, sometimes politicians make the farmers understand that their party brought the scheme and that they are entitled to free inputs and services. Unfortunately, as the AEA I cannot do much about it [Agricultural Extension Agent, Key Informant].

Apart from the politicization, connections, and delays in access to the inputs, the bureaucratic process of accessing the inputs poses a challenge. Given that the

rainfall pattern has become erratic and unreliable due to climate change/variability, bureaucracy unduly frustrates the farmers and further delays access to the needed inputs. Moreover, the processes involved in accessing the inputs are complex and sometimes expensive. For example, they may include traveling to one town or community to obtain a coupon and then traveling to another town with the coupon to claim the inputs. One farmer's complaint puts into perspective this challenge when he was asked about how and where he gets his input from:

Yes [...] with one of them [there are two kinds of coupons], the farmer can pick the coupon here in this village and go to any town there is fertilizer and pick up the fertilizers. The fertilizer outlets near here are in Kaleo, Bussie, and Sombo. So, it gets difficult for you to get government fertilizers, and we sometimes prefer to buy this other one [unsubsidized fertilizers]. With the other type of coupon, one must go to Wa and pay at the bank and return to the village with the coupon to access the fertilizer. This is too much stress and a waste of money [56-year-old male farmer, Tabiasi].

Meanwhile, the unavailability of a ready market for increased farm produce was mentioned as a threat to the sustenance of some schemes. Farmers who invest in large farmlands due to access to tractors and other inputs end up with gluts that they need help finding the demand (markets) to sell and to pay for the investments. The lower prices for such goods result in post-harvest losses. As indicated by one of the implementing officials:

Sometimes there is no market, or there are very low prices for the produce. Farmers who cultivate on large scale do not have designated bulk buyers for their produce. The poor roads in the villages make their location unattractive to the National Food Buffer Stock Company and other bulk buyers. So, they cannot pay for the inputs at the end of the season. This situation is a major threat to the long-term sustenance of such government schemes [District Agriculture Officer, Key Informant].

Finally, we asked the focus group discussants and key informants to discuss how the schemes can be made more sustainable for agricultural transformation in rural areas. Concerns raised included de-politicizing the schemes, transparency, increasing the number of tractors and inputs at the various centres, and establishing and increasing centers guaranteed markets for outputs. For instance, during one of the discussions, a female farmer made the following suggestion:

The officers should be able to ask some of the farmers to see if they have benefitted from some of these projects to be sure if the target farmers are being reached. Some farmers deny others from accessing these benefits [47-year-old female farmer, FGD. Tabiasi].

One of the key informants indicated that the government needs to have mechanisms in place to deliver the inputs earlier than currently being done and institute a guaranteed market for farm produce to reduce post-harvest losses:

Just as the government can regulate cocoa purchases and ensure guaranteed prices, it should be able to provide ready markets for improved yield to limit post-harvest losses. Such markets would also reduce the amount of these outputs that are exported to other markets in the sub-region at lower prices which are later sold back to the farmers at higher prices during the dry season [District Agriculture Officer, Key Informant].

5 Discussion

5.1 Benefits

The new green revolution has shaped agricultural policies and directed the flow of agricultural resources in Ghana for the last decade or more. With the backing of global players in the food system, national policies have been tailored toward introducing transformation in the agri-food sector through a technocentric approach. Purported to be pro-poor, these policies advocate for and favor the supply of subsidized inputs and implements to smallholder farmers to enable them to increase production, improve food security, and alleviate extreme poverty. Our study assessed the perceived benefits of these NGR policies to smallholder farmers in Ghana, focusing on four rural communities in the Upper West Region, investigated the challenges encountered in implementing/accessing these policies, and discussed the implications of the findings for the environment.

Farmers with adequate and timely access to farm inputs reported that the inputs contributed to relatively improved farm output. Beneficiaries of the schemes reported benefits, including relatively higher yield from fertilizers/agrochemicals and reduced drudgery in the execution of farm work due to the access to tractors. Previous studies report similar impacts of adopting technocentric agriculture. For instance, data from the FAOSTAT have shown that maize production in Ghana increased by 21% (2008) and 10% (2009), while rice output increased by 58% (2008) and 30% (2009) (Baltzer & Hansen, 2012a, 2012b). This period coincides with the implementation of the Block Farming Scheme in Ghana, one of the flagship NGR-related policies at the time. In a study in the Upper West region to explore the drivers of herbicide use, Kpienbaareh et al. (2022) observed that a critical motivation for adopting herbicides is the quickness with which they facilitate land preparation and weed control on farms, consistent with findings in this present study. Quantitative studies in other contexts have also revealed that the introduction of subsidized fertilizers, hybrid seeds, and farm implements spurs agrarian change and improved yield. For example, a quantitative study by Martey et al. (2019) in northern Ghana found that mineral fertilizer use among smallholders significantly increased land productivity and agricultural income by 55% and 30%, respectively. In Mozambique, Carter, Laajaj, and Yang (2019) reported that subsidies to smallholder farmers stimulated green revolution technologies' adoption, subsequently increasing yield. Furthermore, Benin (2015), who studied the AMSEC program in Ghana, found that adopting mechanized agriculture reduced drudgery and increased

yield. Our qualitative findings demonstrate farmers' lived experiences of the significance of adopting pro-poor policies for agricultural development.

This present study contributes to scholarship in agrarian change theory that seeks to address the question of *who gets what*. First, this rural-focused study reveals variation in access to the inputs by location. The relatively larger cities of the four communities had timely access than the more rural communities, suggesting that those in even larger towns, such as district and regional capitals, have better access due to proximity to service centers and agents who deal in agro-inputs. This observation explains why access to certain mechanized services is based on the 'connections' you have, as observed by earlier studies (e.g., Kansanga, 2017). Second, the finding that male farmers in relatively larger study communities have better access than female farmers further addresses the question of *who gets what* by highlighting equity issues in access to productive resources.

5.2 Governance challenges and the way forward

Despite the perceived benefits, most farmers outlined various challenges that mainly relate to the governance of the interventions. The politicization of various programs emerged as significant factor militating against the accessibility, inclusivity, and widespread adoption. In many respects, the governance issue of politicization ties in with the agrarian scholarship that addresses the question of *who does what*. For instance, when farmers need to pay for the farm inputs after harvest, some willfully refuse to pay, because they believe that it is their entitlement, since they voted for the government that is providing the inputs. Relatedly, some communities and individuals perceived to be opponents of incumbent governments often experience delays or complete inaccessibility to inputs and services, because managers intentionally refuse or delay the supply in favor of party supporters.

The politicization of government policies and economic reforms, more broadly, including agrarian policies, has been reported in previous studies. For instance, Kansanga (2017) documented that in the northern savannah zone of Ghana, access to mechanized services depends on the political/government official a farmer knows and the strength of the social capital (networks) of the farmer within a community. In Uganda, Kjær and Joughin (2019) documented that the implementation of agricultural advisory services is often politicized, and various governments have variants of the same policy, because they redesign them to suit their political base. In Malawi, Aberman et al. (2012) found that fertilizer subsidy policy formulation is influenced mainly by political belief systems, interests, and power relations that involve several key actors among donors and the government. These political dynamics transcend the national level to the local level, where managers of agricultural policies tend to favor farmers who share in their political beliefs, as highlighted by some of the farmers in the study communities in which our study was conducted. Therefore, the question of *who does what* regarding the implementation of NGR-related interventions has no straightforward answer in many SSA countries. Participants in our study strongly suggested that government should devolve itself from direct involvement in the distribution of agro-inputs to address the problem.

Participants noted the delay in the delivery of inputs as another key challenge, because delays affect the timeliness of applying the inputs to their crops. This observation is consistent with the other studies about implementing input schemes in Malawi and other SSA countries. As well as delayed delivery of inputs, inefficient coupon processing, and redemption systems, inadequate information on the availability and location of inputs; and shortages of fertilizers, and mismatch of coupons and fertilizer types emerged as governance challenges that militate against the realizing the objectives of initiatives designed to deliver on the goals of NGR (Asogwa et al., 2014; Denning et al., 2009; Dorward et al., 2008). These challenges are particularly daunting to agricultural productivity in recent times, because climate change-related weather uncertainties imply that delays in accessing inputs and services are a significant inhibitor for seasonal productivity. The low productivity impedes farmers' ability to repay for inputs at the end of the growing season. As already outlined, being unable to repay for these inputs has far-reaching implications for sustaining such subsidy schemes. Dorward et al. (2008) intimate that, apart from the poor distribution networks, the complexities with the timely receipt of donor funds from philanthropists and global market inefficiencies are also factors that occasion delays in the arrival of inputs. These diverse views that relate to the roles played by partners in these programs all contribute to the scholarship of agrarian change that address the question of *who does what*.

While the conceptual model of the NGR advocates a tighter integration of African smallholders into formal markets via the value chain, our findings suggest that this integration is non-existent or, at best, very poor. As a result, farmers complained that they need markets to sell the surplus from their farms, and the prices are so low due to poor value addition that they do not realize returns from their investments in their farming. Consequently, without value addition and ready markets, farmers tend to sell their produce at very low prices at harvest and then return to the market to buy similar products as food at higher prices during the long dry season in the area. This partly explains the findings in the other studies (e.g., Kansanga et al., 2022) that seasonal food insecurity exists in the study region. As posited by the agriculture extension agents, the key to addressing this challenge is establishing guaranteed prices for farm produce, similar to what has been done for cash crops such as cocoa. For instance, the National Buffer Stock Company can mandate boarding schools in Ghana to buy from smallholders at guaranteed prices.

5.3 Implications of NGR interventions for the environment

The findings of our studies reveal far-reaching implications for environmental sustainability, because the interventions/policies often have unintended consequences (Burney et al., 2010). First, using tractors in smallholder landscapes, where 'hoe and cutlass' have been used for centuries, has resulted in yield increases in some instances, as the highlighted by the farmers. However, research also shows that mechanization is associated with the felling of farm trees in preparation for ploughing, farmland expansion through the clearing of forested areas, thus, resulting rapid deforestation (Daum et al., 2020).

Deforestation is a known cause of global warming, because it is a major contributor of carbon dioxide to the atmosphere. Additionally, while farmers indicated that the interventions resulted in increased yield, these increases will likely be in the short term, because plough-based mechanization can harm soil fertility (e.g., through increased leaching) and increase soil erosion and ultimately lead to poor yields in the medium-to-long term (Daum et al., 2020). Recent studies (e.g., Kpienbaareh et al., 2022) have established that some agrochemicals, which are in increased usage in the study area, reduce biochemical reactions and activities of soil enzymes that are critical indicators of soil microbiological health (Mandal et al., 2020). With climate change intensifying, the continuous degradation of forests and soils could undo the reported short-term benefits of the NGR in the long term and present a significant challenge for environmental sustainability.

Agrochemicals, including pesticides and herbicides, have become more common because the NGR encourages or escalates their use, even among smallholder farmers, as the participants in this study highlighted. While they present a quick way to prepare the land for cultivation, improves farmers' adaptation to uncertain rainfall patterns, and remove weeds and insects on farmlands, Kpienbaareh et al. (2022) have found that, among smallholder farmers the perception is that the use of these synthetic agrochemicals impacts seed viability and dormancy—prevents seeds from germinating or delays their germination, and thus affect overall survival rate of crops. The increased usage of the chemical implies that the chemicals will have long-term implications on the sustainability of soils in local communities and their ability to support crop growth and yield. Further, due to poor regulatory and supervisory oversight on the use of the now prolific chemicals (Kpienbaareh et al., 2022), insects could develop resistance to them, thus compromising entire food systems and ecosystems in smallholder systems, exacerbating poverty and food insecurity, rather meeting the intended targets of the NGR.

Implementing the NGR has also resulted in changes in the social environment. Farmers indicated that the increased adoption of the so-called 'modern seeds and technologies' has resulted in the erosion of traditional knowledge systems, including knowledge of sustainable farming methods and traditional approaches to environmental conservation. The introduction of mechanized agriculture through mechanization services and the increased use of agrochemicals have altered gender roles in rural agricultural landscapes. Kansanga et al. (2019b) argued that farm mechanization is skewed towards easing traditionally ascribed male farm roles (e.g., weeding and ploughing). Yet, the women in such households still maintain the non-mechanized manual farm roles, such as sowing and harvesting, that have been culturally ascribed to them. Further, the emphasis of the NGR on markets, inputs and investment, which are critical to increasing agricultural productivity, runs the risk of limiting the revolution's impact on women (Negin et al., 2009), because traditionally women had poor access to credit for any form of economic activities in many parts of the Global South. Thus, these agrarian changes brought about by the NGR have altered the social environment to perpetuate existing gender inequities that already prevail in poor

rural settings in northern Ghana and many parts of SSA. With our finding that women farmers were more challenged in accessing the NGR interventions, we posit that the design of these interventions must have inbuilt equity measures that will ensure access for all.

6 Conclusions

Amid food insecurity and growing poverty, especially in sub-Saharan African countries, players in global agri-food systems have proposed and significantly promoted the new green revolution as a panacea to these problems. For more than a decade now, agricultural policies in Ghana have been designed to follow the guidelines of the new green revolution (NGR). In this study, we reflect on implementing the NGR policies and interventions in Ghana through an in-depth qualitative analysis of interviews with smallholder farmers and key informants (implementing agencies of NGR policies). We focused on assessing the impacts of the schemes and interventions on rural farmers by eliciting the perspectives and experiences of smallholder farmers and other actors facilitating their implementation. With the help of the agrarian change theoretical framework, we discussed these findings and highlighted the potential unintended implications of these policies and programs on the environment of smallholder landscapes.

We found that adopting subsidized inputs, such as hybrid seeds, synthetic fertilizers, and herbicides, and tractor services has mainly been beneficial largely to farmers when they have timely and adequate access to them. According to these, rather minority, farmers who get sufficient access to the inputs have been able to increase the yield of especially maize, improve household incomes, and reduce farm drudgery. However, most farmers identified politicization and political interference, delay in access to inputs when they are most needed, bureaucratic processes in obtaining inputs/schemes, uncertainty in the operation of the schemes, and lack of market for produce as key challenges inhibiting the NGR. The farmers recommended de-politicization and ensuring transparency/decentralization of the implementation to improve input subsidy schemes. At the same time, farmers believe that implementing measures to ensure ready markets and guaranteed prices to make the schemes profitable would significantly improve the program's success. We contextualized the implementation of these challenges of NGR to smallholder farmers but also highlights some gaps that require further research. First, NGR in Ghana and SSA is primarily led and steered by official donor assistance in collaboration with national governments and other international, and regional corporations. These diverse actors operating beyond the state and their interactions with the state require critical evaluation for effectiveness. Second, more studies are needed to provide a nuanced understanding of the gendered knowledge and intersectional inequalities among farmers and corporate stakeholders. This will require detailed qualitative studies on the intersection of identity, positionality, socioeconomic constructs (e.g., age, migratory status/ethnicity, etc.), and NGR in SSA. This will involve the application of more critical theories and frameworks and should be the focus of future studies.

Implementing the policies also have implications for the environment. Given the introduction of new methods of ploughing the land and addressing farm-level challenges such as insect infestation, the landscape is being depleted rapidly, and human health is being negatively impacted (Kansanga et al., 2019a, 2019b; Kpienbaareh et al., 2022). Indeed, some detailed studies were conducted on the program's impact on the environment (John & Babu, 2021). This degradation challenges environmental sustainability, especially in this era of rapid climate change. Long-term implementation of the NGR and the success of the schemes and programs will require a review of the interventions to make them more ecologically friendly. A close collaboration between national policymakers, implementing agencies, and global players in the agri-food system and environmental sustainability arena is needed to make the interventions more environmentally sustainable.

Data availability Data will be available upon request.

Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical statement The research got ethical clearance from the University for Development Studies.

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