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The effects of 2015 El Nino on smallholder maize production in the transitional ecological zone of Ghana

Kwadwo Owusu, Ayisi Kofi Emmanuel, Issah Justice Musah-Surugu, Paul William Kojo Yankson,

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Kwadwo Owusu
Department of Geography and Resource Development, University of Ghana, Legon, Greater Accra, Ghana

Ayisi Kofi Emmanuel
University of Ghana Business School, Accra, Ghana

Issah Justice Musah-Surugu
Department of Public Administration, University of Ghana, Legon, Greater Accra, Ghana, and

Paul William Kojo Yankson
Department of Geography and Resource Development, University of Ghana, Legon, Greater Accra, Ghana

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Abstract

Purpose – This paper aims to provide empirical evidence on the El Nino and its effects on maize production in three municipalities: Ejura, Techiman and Wenchi in the transitional zone of Ghana. Using a mixed approach, the study details the effects of the El Nino on rainy season characteristics, particularly, rainfall amounts and distribution, onset and cessation of rains, duration of the rainy season and total seasonal rainfall and how it impacted smallholder maize production.

Design/methodology/approach – The study used a mixed method approach in collecting and analyzing data. For stronger evidence building, (Creswell, 2013) the authors combined interviews and focus group discussions (FGD) to collect the qualitative data. Semi-structured questionnaires were administered to extension officers, management information system officers and other relevant personnel of the Ministry of Agriculture in the three municipalities. Six FGD's were held for maize farmers in six communities in all three municipalities.

Findings – The study shows that the 2015 El Nino had dire consequences on farm yields, subsequently affecting farmer's incomes and livelihoods. The study further finds that complex socio-cultural factors, some unrelated to the El Nino, aggravated the effects on maize farmers. These include the lack of adequate climatic information, predominance of rain-fed farming, a lack of capacity to adapt and existing levels of poverty.

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Originality/value – The study recommends inter alia, appropriate use of seasonal rainfall forecasting to enhance better farming decision-making and the development of elaborate climate variability interventions by national and local agencies.

Keywords Ghana, Adaptation, Rainfall, Climate variability, El Nino

Paper type Research paper

1. Introduction

One of the topical issues in the world today is climate variability and its effect on crop production. According to Rowhani *et al.* (2011), climate variability is expected to increase in some regions, with significant consequences on food production beyond climate change impacts. The issue attracts much attention because among other things, such changes have implications for food security globally (Godfray *et al.*, 2010; Frelat *et al.*, 2016). For Africa in particular, climate variability impact is pertinent because the continent receives the most food aid, with some 30 million of its people requiring emergency food aid in any one single year (Godfray *et al.*, 2010; FAO, 2016). As indicated by the 2015 global food security index, malnutrition, starvation and deaths still persist in Sub-Saharan Africa despite significant food security improvements over the past decade. Although this situation is attributed to a number of factors including distribution obstacles, (Godfray *et al.*, 2010; FAO, 2016), ineffective local agriculture (Antwi-Agyei *et al.*, 2013) and poor governance (Clover, 2003), it is the changes in climate and climate variability that seem to have a stronger explanatory weight in the whole food security discourse (Sasson, 2012; Mawunya and Adiku, 2013).

The El Nino-Southern Oscillation (ENSO), the largest known source of climate variability in the tropics, has severe impacts particularly on agricultural activities (Goddard *et al.*, 2001; Woli *et al.*, 2012). Although the phenomenon is pretty much predictable, sometimes a year or more ahead (Chen and Cane, 2007; Adiku *et al.*, 2007), its impacts are still devastating on sectors that are climate sensitive such as smallholder agricultural and hydropower production (Schaeffer *et al.*, 2012; Boadi and Owusu, 2017). In Ghana and other developing countries, vulnerability to El Nino event is exacerbated by the predominance of rain-fed agricultural systems and the absence of reliable climatic information (Rockström *et al.*, 2004; Mongi *et al.*, 2010). However, the risks associated with the El Nino cycles may be mitigated if effective plans are instituted. Adaptation to within season or terminal drought could be improved by irrigation efficiency and the timeous dissemination of information among farmers as well as the use of seasonal rainfall forecasting to help in decision-making (Adiku *et al.*, 2007). Thomas *et al.* (2007), highlight the success of such strategies in Southern Africa for example, where farmers cultivate lands closer to a water source during drought periods.

The effect of ENSO on rainfall in the Guinea Coast area of Ghana is evident in many studies (Opoku-Ankomah and Cordery, 1994; Adiku *et al.*, 2007 Owusu and Waylen,2009). The 1982/83 ENSO season for instance is known to be associated with a severe drought that caused general crop failure (Owusu and Waylen, 2009), resulting in Ghana receiving food aid. Given the severity of the 2015 El Nino, it becomes imperative to assess how the phenomenon impacted food production in Ghana. The main objective of the study is to investigate the effect of the 2015 El Nino on maize production in three municipalities in the transitional agro ecological zone of Ghana. We concentrate on maize in particular because of the important socio-economic consequences it has on smallholder farmers. Maize is widely produced by smallholder farmers and serves as the main staple food for most households and livestock in Ghana (Asantewah, 2003; Braimoh and Vlek, 2006). However, because it is mostly cultivated under rain-fed conditions, it becomes vulnerable to extreme climate events like the El Nino. Among its specific objectives, the study details the extent to which the

El Nino affected rainfall and its impacts on yields and livelihoods of smallholder maize farmers. In addition, the coping strategies used by these farmers are explored, with the aim of contributing to the formulation of appropriate policies to reduce food insecurity associated with ENSO events.

The study is relevant in understanding how ENSO impacts agriculture and maize production: an enterprise that could move the country closer to eliminating hunger and meeting goal one of the Sustainable Development Goals.

2. El Nino and Maize production

The ENSO commonly referred to as "El Nino" has been the subject of scholarly efforts in the last four decades (Babkina, 2003). Occurring every three to seven years and lasting between 9 to 24 months, it represents an irregular periodic variation in winds and sea surface temperatures (Wang *et al.*, 2004; Cane, 2005). El Nino is attributed to a weakening of the trade winds which result in atmospheric modifications (Trenberth, 1997). Selvaraju (2003) explains that heated surface water becomes concentrated near the equator of the eastern Pacific where it then spreads up and down the coasts of North and South America. The expanse of warm waters in the Pacific causes such a huge increase in evaporation from the ocean resulting in a natural mode of oscillation from unstable interactions between the tropical Pacific Ocean and the atmosphere leading to El Nino. The effects of El Nino have global tele-connections resulting in pressure, temperature and rainfall variability with the severest impacts in the tropics.

During El Nino years, the dry period separating the two rainy seasons gets longer through a reduced occurrence of the rainy seasons in Equatorial Africa (Camberlin *et al.*, 2001). The dry periods of the 1980s and the associated crop failures in West Africa is known to have been caused by droughts resulting from the El Nino (Mohino *et al.*, 2011). Drought over West Africa is mostly characterized by the growth of positive SST anomalies in the Eastern Pacific complimented by a negative SST anomaly in the Northern Atlantic (Fontaine and Janicot, 1996), which according to Owusu and Waylen (2009) has been accompanied by declining rainfall amounts and a decreasing agricultural productivity since the 1970s. The occurrence of this phenomenon implies that economies largely dependent on the agricultural sector which is climate sensitive become even more vulnerable. Different economic sectors in different locations across the globe are affected differently by the occurrence of an El Nino event (Davey *et al.*, 2011).

The literature on El Nino is replete with empirical evidence on how it impacts crop production generally across the globe (Hansen *et al.*, 2009; Subash *et al.*, 2014; Kellner and Niyogi, 2015). These and other studies discuss the impact of El Nino on food production, value and prices and highlight how ENSO's intensification of climatic variations and shifts in climatic conditions has major implications for crop production. With particular regards to its effects on maize production, there are useful descriptions of associations between ENSO and maize yields in different environments (Hall *et al.*, 1992; Carlson *et al.*, 1996; Iizumi *et al.*, 2014; Shuai *et al.*, 2016). Hall *et al.* (1992), for example, present a description of the climate, soils and crop production systems in the Pampas of Argentina and establish a clear relationship between maize yields and ENSO-related climate variability in one of the major maize producing areas of the world. They conclude that low yields are more likely during El Nino years than in normal ones. Similarly, Ferreyra *et al.* (2001) developed a risk assessment framework for the characterization of maize vulnerability to ENSO and found less precipitation, a common feature of the El Nino as the one variable that influences maize yields in rain-fed production systems. Amissah-Arthur *et al.* (2002) also explore the link between El Nino-related variability in rainfall at annual and seasonal scales and nationallevel maize yield in Kenya and report of a fall although spatial and regional differences were also recorded. Beyond these, ENSO has been found to have a negative socio-economic impact by decreasing farm income, employment and adversely affecting prices, trade, and market access (Iizumi *et al.*, 2014).

3. Methodology

3.1 Study area

The research was conducted in the transitional agro-ecological zone of Mid-Ghana which coincides with Ghana Meteorological Agency's (GMet) Zone C agro-climatological classification. The specific municipalities studied were Techiman, and Wenchi in the Brong Ahafo region and Ejura in the Ashanti region all of which are noted for maize production in Ghana.The zone has a mean annual rainfall totals ranging between 1,200 to a peak of 1,500 mm which decreases from south to north in accordance with the general rainfall pattern of Ghana. The migrating inter-tropical convergence zone and monsoons flows produce peak rains in May/June and September/October, with a long dry season (harmattan) lasting from November through March (Owusu and Waylen, 2013) which is associated with high inter-annual and multi decadal variability. The major rainy season begins in late March/early April and runs until mid-July. The bi-modal rainfall pattern allows for two crops per season under rain-fed agriculture. The regime however presents variability in the time of the onset of each rainy season and the beginning of the short dry spell (Adiku and Stone, 1995; Yorke and Omotosho, 2010). The study area is a major agricultural region of Ghana characterized by a highly diversified agricultural production of both tuber crops of the forest region of the South and the grains and cereals of the North (Cudjoe *et al.*, 2010). The study area has been described as the bread basket of Ghana (Egyir *et al.*, 2014; Owusu and Waylen, 2013), even though production here like all parts of the country is almost entirely rain-fed. According to Owusu and Waylen (2013), rainfall variability in the area has a significant impact on crop yields and general food security in Ghana.

3.2 Data and methods

The study used a mixed method approach in collecting and analyzing data. For stronger evidence building (Creswell, 2013), we combined interviews and focus group discussions (FGD) to collect the qualitative data. The purposive sampling technique was used to select key informants in the Municipal offices of the Ministry of Agriculture who were deemed to possess relevant information to answer the study's research questions. These included Directors of Agriculture, management information system officers and Extension officers who were purposively selected and interviewed (Table I). Interviews took a semi-structured format to make it possible for interviews to be steered along the research objectives while allowing respondents adequate room to explain issues in depth. The projected sample was 12, but saturation was reached after 11 interviews overall.

Six FGD's were held for maize farmers in six communities in all three municipalities. Whereas the interviews offered in-depth understanding of the climatic conditions that accompanied the El Nino and its impact on overall maize production, the FGD approach on the other hand generated rich insights on farmer's perceptions and experiences on rainfall patterns over the years, maize cultivation practices, community relations and relationships with extension officers as well as the overall impact of the El Nino on farmers livelihoods. The group interactions among farmers provided a better appreciation of common issues, the people's socio-cultural views and how these inform decision-making.

With the benefit of using multiple sources and methods of data collection, the qualitative data were effectively validated and triangulated. Interviews were recorded and then

Table I. Breakdown of interviews and FGDs

Target groups	Data collection tool	Location
Directors of the ministry of Agriculture in municipalities (3), Extension officers (3), Management Information system officers (3) and meteorological officers (2) the Ministry of Agriculture in the three municipalities. *N* = 11	Key informant interviews	Techiman Wenchi and Ejura Municipal offices
Smallholder farmers in the communities *N* = 6	FGDs, Composition – (Female only, male only) 8 participants on average	Techiman – Bonsu, Forikrom Wenchi – Nkonsia, Akrobi Ejura – Dromankuma and Ejura Sekyere Dumase

Source: Fieldwork data

transcribed verbatim. This transcribed data were not coded but systematically analyzed according to themes initially developed from the literature and those that emerged from fieldwork.

In addition, the study drew on quantitative rainfall data for Wenchi and Ejura from the GMet to contextualize the reduction in rainfall for the 2015 season associated with El Nino. Yield data for the three study areas obtained from the District Agricultural offices were compared between El Nino and normal years to corroborate the results obtained from the FGD's and key informant interviews.

4. Results

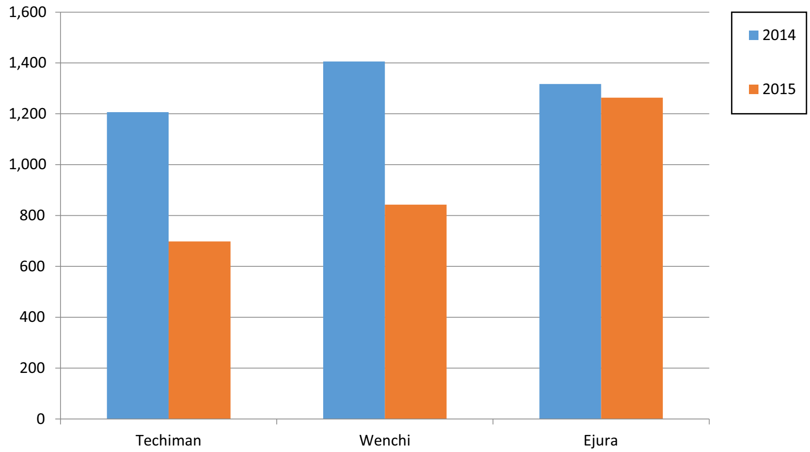
4.1 Effects of El Nino on rainfall

Given that El Nino is associated with a reduction in rainfall in the study area (Owusu and Waylen, 2013; Adiku and Stone, 1995), the study among other things sought to examine the severity of rainfall reduction in the transitional zone during the 2015 El Nino year. As shown in Figure 1, the 2014 normal and (2015) El Nino years rainfall recorded in the study area was approximately 1,200 (698) mm 1,400 (843) mm and 1,300 (1,264) mm for Techiman, Wenchi and Ejura respectively. Ejura had an appreciable amount of rainfall, but that goes to buttress the spatial component of El Nino effect and the strong variability associated with rainfall in West Africa in general (Owusu, 2017). Even though the farmers did not record the rainfall, they recounted that the amount received in 2015 was not near the previous years as revealed in the FGDs as follows:

> Although rainfall has been reducing by the years, the 2015 season was exceptional. The rains were just inadequate and it was clear something went wrong [Male FGD Akrobi].

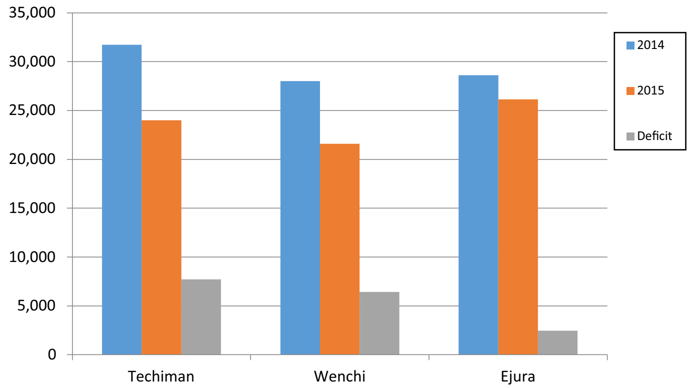
In addition to the reduction in the rainfall totals, it was also found that there was a reduction in the number of rainy days, thus, the average number of days when a measurable amount (defined as 1 mm) of rain falls. As shown in Figure 2, the number of rainfall days reduced considerably during the 2015 El Nino year as opposed to the previous year. While farmers report of a late onset of the rainy season, they also experienced dry spells over most parts of the zone around mid-May instead of the normal cessation at the end of June. The usual major farming season which begins in March-April, delayed during the 2015 farming season and started in May. A farmer intimated:

> I usually begin planting at the end of March through to April for the main season and August for the minor season. This year, I planted in anticipation of rains that took forever to come and I had



Source: Data provided by District Agricultural Office

Figure 1.
Rainfall amount for 2014/15 in the study districts



Source: Yield Data from Municipal Department of Agriculture (2016)

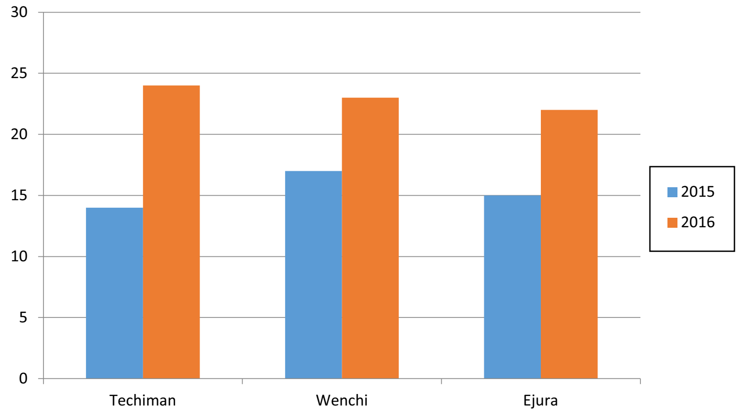
Figure 2.
Maize production in municipalities (in metric tons) normal year versus El Nino year

> to plant and re-plant several times. Because there was no rainfall, the seeds could not germinate [Male FGD, Wenchi].

Farmers generally decried their helplessness in terms of having no prior information on weather changes and for which reason they were caught off-guard. The few farmers who acknowledged getting some weather information from the meteorological agency, mainly through local media, pointed out that, it did not inform their farming decisions as the forecasts tended to be largely unreliable. They therefore depended on their own experience and indigenous knowledge acquired over time.

4.2 Effects of El Nino-Southern Oscillation on maize production

Data from our fieldwork shows a significant reduction in maize production in all the three municipalities in 2016 compared to the previous year (see Figure 3). According to the data



Source: Field data

Figure 3. Maize price per 100 kg bag for 2015 and 2016 in dollars

provided by the District Agricultural offices, all the three study districts recorded a deficit in production over the previous year. Techiman had a deficit of 7,708 tons, Wenchi 6,434 tons and Ejura 2,452 tons. The reduction in yield is consistent with the reduction in rainfall totals as shown in Figure 1. Farmers in the communities recounted the seriousness of low yields for the same pieces of land cultivated in previous years. They attributed their losses to the reduction in rainfall that characterized the El Nino year. One distraught farmer observed:

> I cultivated four (4) acres with a yield of 40 bags in 2015 [. . .]. but in 2016, I had only 15bags for the same piece of land because the rains failed me [Ejura FGD].

Although the data showed a general reduction in yield, a few farmers reported minimal reduction in yields that was attributed to sheer luck and not planning based on weather information. Such experiences could also be as a result of localized factors like soils and rainfall variability in addition to the variety of maize planted. Farmers attributed the general low yields to inadequate rains, indicating that fertilizer application delayed and in some cases was simply not possible because of the unavailability of adequate moisture in the soil. In addition to inadequate rainfall and lack of weather information, the farmers also lamented the fact that they did not get any technical or financial assistance. Weather index insurance that could have helped the farmers is nonexistent in the study area.

The respondents reported that the poor harvest resulting from the El Nino induced drought also resulted in price inflation across the zone. Checks from the markets for prices of maize revealed increases over the past year as depicted in Figure 3. In Techiman, a 100 kg bag of maize which sold for $14 in May 2015 was reported to be $24 around the same month in 2016. Similar increases were recorded for Wenchi and Ejura which went for $17 and $23 and $15 and $22 in 2015 and 2016 respectively. With production slashed by about 15 per cent, as shown in Figure 3, these increases were to be expected. However, while the increases were quite significant in all the study areas, it still remained unclear whether the maize price inflation experienced was as a result of the fall in maize production due to the El Nino droughts as price could be influenced by production and demand outside the study area. However, the study established that prices could have gone up further but for inflows from the Northern parts of the country particularly Hamile and Tumu as well as neighboring Burkina Faso as reported by maize traders in the Techiman market. These inflows augment the local supply and keep prices from soaring beyond normal. Therefore, the effects of the El Nino and its associated impacts on food availability also depend on external factors including trade policies such as open borders.

4.3 Effects of 2015 El Nino on farmer's livelihood

With about 60 per cent of people in the study area deriving their livelihood from maize cultivation and other related farming activities, the El Nino and its associated reduction in rainfall had a number of local effects. The implications were dire and ranged from less food for subsistence to loss of investments and increased household poverty. As has been indicated earlier, the reduction in rainfall had a serious toll on farming activities, delaying preparation of land, planting, fertilizer application and harvesting. Stalled farming activities resulted in crop failure and poor harvest at best. One director of agriculture in Wenchi noted that "more than 50 per cent of farmers lost everything because of inadequate rainfall last year".

The fall in maize production as a result of the El Nino negatively affected the farmers by way of unavailability of food and income for subsistence. Farmers struggled to make ends meet with some having virtually nothing to subsist on. One woman lamented:

> The cheapest foods in this area are those prepared from maize including, porridge (koko), 'kenkey' and 'banku'. But with poor harvests from our maize farms, we cannot even have these foods to eat and that makes life very difficult [Ejura FGD].

The expectations of these farmers, in terms of incomes from the sale of their produce were cut short. For most of the people in the study area, agriculture provides the main source of income from which household responsibilities are catered for. The lack of income due to poor harvest was reported to have brought untold hardship to households. The effects are captured by one farmer who lamented the impact on her children's education.

> My expectations regarding my maize farm were cut short. I am now struggling to pay my children's school fees and meeting other needs like books and transport [Akrobi FGD].

The El Nino adversely affected the poorest and most vulnerable people in the study area, further worsening their poverty situations. The interviews revealed that the impact varied, severely affecting some districts like Wenchi, but much less in Ejura. The study also found out that the outcomes and responses to the effects of the El Nino have been dependent on the safety-net structures available in a particular municipality, as well as the general food security policies in Ghana. One widespread effect of the El Nino on farmers is the loss of investments. Farmers, particularly those in the rural communities noted that low productivity in 2016 had negative consequences on their productivity and future investments. One farmer illustrated this point as follows:

> Maize cultivation has become capital intensive in modern times. From preparation of the land, through planting, application of fertilizers and spraying of farms, to harvesting, so much money and time is invested. Yet, for this year in particular, these investments proved not to be worth our while as the farms did not do well [Ejura FGD].

The farmers' losses were compounded by the absence of farm insurance in the study area. For those who invested their own capital but lost out, they had no money to reinvest in the new season. Farmers expressed a lot of apprehension for the post El Nino year, as the drought that caused so much damage to their farms in 2015 had protracted into the new 2016 farming season.

4.4 Famers' coping strategies

Confronted with the debilitating effects of the 2015 El Nino, smallholder farmers devised a number of strategies, mostly upon the advice of extension officers to manage the unexpected situation. Extension officers visited farms especially after sensing delays in the onset of rains and advised farmers to plant early maturing and drought resistant breeds like "opeburow" and "Omankwa". One municipal director of agriculture at Techiman noted that "it is the planting of early maturing varieties like Dodi and Omankwa which mature in 70 days that saved some farmers from recording total losses".

Even then, they note that some farmers planted old breeds because of the high costs of the new ones. Farmers were also directed to plant and replant deep in anticipation of rains. They were advised to use folia to conserve moisture and protect their seeds. However, most of the seeds could not even germinate, with those surviving neither tasseling nor reaching full maturity before the rains ceased. This affected production and yields. Farmers also managed the El Nino induced droughts by diversification where they mixed crops and varieties in the same field, staggered planting times and scattered crops in different soils and locations. Some farmers mixed their maize with other crops like beans and okra. This was found to be useful when the maize failed although the other crops did not do too well either.

Trading and other non-farm incomes such as remittances served as alternatives in assisting households meet their needs and to survive the post 2015 El Nino season. We found that while some of the male farmers had moved into other ventures like driving and working as laborers in poultry farms to earn a living, most of the women engaged in petty trading to help support their families. One woman noted":

> Because the rains disappointed us, there was not much to be done on our farm. I got a loan which I invested in selling used clothing at Techiman market. That is how I managed to support my family [Female FGD, Bonsu].

However, the low production of maize as a result of the El Nino had made local trading and non-farm activities less profitable because the local people had lost their purchasing power. The loss of incomes and investments from maize farms affected patronage of commodities like used clothing. With the decline in household incomes, the already alarming poverty situation had worsened especially amongst the lower income earners.

5. Discussion

This study found evidence on the El Nino and its linkage with reduced rainfall in the transitional zone of Ghana. The findings presented indicate that rainfall was significantly reduced in terms of amounts and distribution during the 2015 El Nino year with some spatial variability. The reduction in rainfall as a result of the El Nino is consistent with findings of other studies which report of such rainfall patterns associated with the phenomenon in other parts of the world and the study area as well (Adiku *et al.*, 2007; Owusu and Waylen, 2009; Collins *et al.*, 2010; Davey *et al.*, 2011). In other jurisdictions like the Philippines, Indonesia and Australia, El Nino events have been found to cause similar rainfall deficits (Davey *et al.*, 2011). There was a reduction in the number of rainy days which could have more severe impact on crop production. The reduction in rainfall had negative consequences for maize production by smallholder farmers. Given that maize is largely cultivated under rain-fed conditions, farmers suffered the worst of crop failure with low yields recorded across the towns and villages. These observations also resonate with other studies in Ghana and elsewhere (Akpalu *et al.*, 2008; Hansen *et al.*, 2009; Acquah and Kyei, 2012; Adamgbe and Ujoh, 2013; John and Olanrewaju, 2014; Huang *et al.*, 2015), which report of a significant relationship between maize yield and climate variability. A study by Araújo *et al.* (2015) for instance, found the occurrence of El Nino to cause about 50 per cent of productivity losses for corn and beans in northeast Brazil.

Low productivity of maize resulting from El Nino induced cuts in rainfall had implications for farmers' livelihoods and incomes. With maize serving as the main staple food and source of income for these farmers, low yields resulted in shortages of maize stock for food and income for other needs like health and education. This worsened the poverty situations of smallholder farmers most of whom live from "hand to mouth". As earlier observed by Akpalu *et al.* (2008), reduced rainfall as a result of climate variability has detrimental effects on crop yield, food security and livelihoods.

The severity of the rainfall reduction on maize yields was mainly because of the fact that smallholder farmers did not receive adequate information on the impending El Nino and therefore, were unable to adjust and adapt their initial farming decisions to the situation. The extension service intensified their contact with farmers after the rainfall had delayed and the early crops had been destroyed by late onset. The fact that the farmers who yielded to the information provided by the extension service and used drought resistant maize varieties sustained lower losses confirms observations of earlier works by Amegnaglo and Mensah-Bonsu (1999); Adesina and Elasha (2007); Fosu-Mensah *et al.* (2012) and Jiri *et al.* (2016), that the application and use of forecast information, science and technology is still limited among poor rural farmers, thereby affecting their productivity. This also implies that to build resilience against climate variability and climate change, smallholder farmers would have to embrace the use of climate information and technology as well as careful crop selection, as proposed by Owusu (2017). Like this study, we also found that farmers depended on their own indigenous knowledge and experience to cope with the El Nino and that affected their ability to make appropriate responses.

6. Conclusion and recommendation

It was established that like other severe El Nino's, there were significant reductions in rainfall and increased variability with the within season characteristics. The number of rainy days was found to be fewer than normal years. Productivity of smallholder farmers was found to be low and in the Techiman Municipality in particular, production was reduced by as much as 15 per cent. In the Ejura Municipality, however, the impact was not that severe indicating that there is a spatial component to the El Nino induced rainfall variability in mid-Ghana.

The major impacts of the El Nino induced rainfall failure and yield reduction were household food insecurity, loss of income, indebtedness and deepening poverty. These were exacerbated by the lack of institutional support; save for the agronomic services of extension officers. Households survived mainly through income and crop diversification, and off-farm practices like petty trading and remittances. Some of the adaptation strategies were found not to be effective due to households' total dependence on agriculture for employment and income generation and the general lack of application of climate information and technology in smallholder farming in Ghana.

Based on our findings, we make the following recommendations. First, although El Nino cycles are a natural occurrence, we note that they may have a less devastating impact on food production and livelihoods of communities if effective plans are put in place. Based on what we know about the effect of El Nino on rainfall and the fact that the IPCC (2017) has projected an increase in the frequency and intensity of El Nino due to global warming, we recommend that provision and conservation of water for agriculture in the study area should be improved. If El Nino becomes frequent and severe, the current smallholder practice which is almost entirely rain-fed will not be resilient enough to ensure food security. Therefore, local government units and the Ministry of Food and Agriculture should work together to develop community irrigation to help smallholders improve maize and other food crop production.

Against the backdrop that most farmers did not get sufficient information on the El Nino and were therefore left to their own devices, we recommend a close collaboration between the meteorological agency and the Ministries of Agriculture on the application of climatic information and relaying same to farmers in a timely manner. In peripheral communities, such information could be circulated through text messages, local radio and television networks to ensure effectiveness. In developing country contexts like Ghana where poverty is at biting levels especially among rural farmers, subsidies on drought-resistant breeds must be provided during unusual periods like the El Nino to make them affordable for farmers.

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Corresponding author

Issah Justice Musah-Surugu can be contacted at: musah123@gmail.com