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**AGRICULTURE, INCLUSIVE GROWTH AND NATIONAL STABILITY:
EXPLORING THE NEXUS BETWEEN FOOD SECURITY AND NATIONAL SECURITY**

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Abstract

Several studies have examined the causes and consequences of major national security threats, especially terrorism, which has become a key global challenge. Others have explored the place targeting behavior of terrorist groups. While food security is widely accepted as an important element of national security, few studies, if any, have explored the nexus between both. Using Nigeria's Boko Haram insurgency as a case study, this study explores three dimensions of the food-national security nexus: (1) food insecurity as a root cause of terrorism; (2) the socio-economic consequences/impacts of terrorism on agriculture and food security; and (3) why and how terrorists target agriculture and food security. To explain the vulnerability of food security to terrorism, the study further develops a theoretical model of terrorist motivation and place-targeting behavior, as well as several related hypotheses about their goals of causing food insecurity and enhancing their own food production and supply capacities. The application of this model to data from the Boko Haram insurgency yielded empirical evidence to support a number of hypotheses, including the greater vulnerability of specific agricultural and food production places to terrorist attacks and fatalities due to the commodities they produce. The paper concludes by recommending that the nexus between food security and national security should be more aptly investigated.

Key Words: *Agriculture, Attacks, Food Security, National Security, Terrorism, Insurgency, Inclusive Growth, Root Causes, Boko Haram, Nigeria.*

AGRICULTURE, INCLUSIVE GROWTH AND NATIONAL STABILITY: EXPLORING THE NEXUS BETWEEN FOOD SECURITY AND NATIONAL SECURITY

A. Introduction

Historically, the term, “national security”, described the “maintenance of national peace and stability”. Because most historical “threats” to national peace and stability were external, national security efforts focused mostly on using the military and security agencies to protect territorial integrity, the state and its instruments; and to contain subversive activities (US Department of Defense, 2005). The scope of national security threats has expanded in recent years to include those which have their roots in socioeconomic problems. This has led scholars and security experts to think more broadly about what constitutes national security. Furthermore, many conflicting definitions of national security have now emerged.

One key reason for the broadening thinking about national security is the growing evidence that poverty, inequality, lack of jobs opportunity, ethnic rivalry, religious extremism, disdain for corruption and other socio-economic factors affect the potential for disenfranchised groups to organize and engage in subversive activities. Other reasons include the growing tendency of disenfranchised groups to challenge existing or widely constituted state authority and the growing likelihood that domestic unrest will have cross-border or spillover effects through transnational terrorism. In an attempt to address these emerging dimensions, many nations are expanding the scopes of their goals, plans and strategies, despite the lack of clarity about the new boundaries of national security. An important element of this new environment is the growing acceptance of food insecurity as a national security threat.

For more clarity, based on existing definitions, the following contemporary definition of “national security” is hereby proposed: “*maintenance of the survival and prosperity of a nation through the prevention of and protection from human, economic, social, physical, resource, food, environmental, natural, external, and other threats to its national interests*”. The “*threats to national security*” is also hereby defined as: “*events, actions or the absence thereof that may threaten a nation’s existence by creating mass disturbance, hurting large numbers of people, causing significant loss in human life, causing major property damage, destabilizing the economy, disrupting government functions or undermining governance and national cohesion*” (see

Security Council Report, 2011). Obviously, an effective national security strategy is one that would effectively prevent, contain, manage and abate relevant threats in order to promote state stability, continuity and prosperity. In their attempt to develop food security-related tools for addressing national security problems, a key challenge facing policy makers is the lack of credible information about how food insecurity affects national security.

Unfortunately, the term, “food security”, also has many definitions, depending on the scale and context to which it is being applied. At the global level, a widely accepted definition is “physical, social and economic access of all people of the world at all times to safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (see UN, 2004; UN, 1975; UNFAO, 1983; World Bank, 1986). Given the interest in the nexus between food and national security at the national level, food security is hereby define as: “consistent access of people to adequate food for an active and healthy life”. This definition, which implies “no food want” or “no hunger”, aids in defining “*food insecurity*” as “*persistent lack of access to food by people in a place due to their socioeconomic conditions*”. This definition of “*food insecurity*” also suggests that when access to food is chronically limited and people have few alternatives to address their needs as their backs are against the wall, they may become militant and insurgent. From this perspective, the link between food insecurity and national security problems is triggered when people in a place are persistently in need of food.

Recent events in the Middle East and North Africa (MENA) suggest that food insecurity (high food prices, amidst eroding employment and income opportunities) contributed to demonstrations, unrest and the eventual overthrow of long-existing governments (Shrier, 2011). Therefore, to the extent to which it could affect many people; cause people to mobilize to engage in unrest; and result in significant loss in human life and property damage; food insecurity is a national security threat. The possibility that national insecurity problems could, in-turn, exacerbate the socio-economic root-causes of insecurity and create secondary adverse effects further supports the notion that food insecurity is a national security concern. In light of the above, it is important to better understand the nexus between food security and national security, especially the terrorism element. This could enable governments to more closely

monitor chronic food access problems and address them in order to avert the more expensive option of battling unrest, insurgency or terrorism.

It is important to understand the characteristics of the terrorism element of national security. “*Terrorism*” is hereby defined as “*the pre-meditated use or threat to use violence by individuals or subnational groups to obtain political, religious, ideological or social objective by intimidating a large audience beyond that of the immediate victims*” (see Enders and Sandler, 2012; Hoffman, 2006; and RAND, 2012). While, in many cases, it is closely linked to “insurgency” because it is a prominent course of action that insurgents chose to achieve their objectives, terrorism does not always involve insurgency.¹ Terrorists act outside of normative legal and political mechanisms as they cannot access or trust such mechanisms, which they see as not serving their goals. Motivated by a sense of higher morality, freedom seeking, alienation and economic suppression, terrorists desire change so desperately that its achievement is more highly valued than human lives. The desire to destroy is paramount to their causes and actions (Elu and Price, 2015).² This explains the bombings of innocent victims, government targets and critical infrastructure. To instill fear, their violence and damages may involve a larger spectrum of society than the immediate target victims (e.g., civilians, government facilities, military, security agents, international agencies, etc.).³ Depending on their motivations, structures, sophistication and resources, their destructions can be ghastly and heinous and can involve a large number of innocent victims (communities, infrastructure and industries).

Many studies have investigated the relationships between terrorism, on one hand, and its causes and consequences. For example, Piazza (2006) studied the role of poverty in terrorism; Enders, Sandler and Parise (1992) and Drakos and Kutan (2003) studied the economic impacts of terrorism on the tourism industry; while Enders and Sandler (2012) studied more aggregate economic impacts. However, few studies, if any, have directly examined the nexus between food security and national security. There are three key dimensions of this nexus. First is the extent

¹ The Term insurgency can be defined as “an organized rebellion against a widely constituted and recognized state authority when the perpetrators are not widely considered to be legitimate representatives of their claimed constituency and/or their actions are not considered legitimate or appropriate under international rules of sovereign conduct or war” (see Morris, M.F, 2005). Terrorism begins to approach insurgency when a grand vision and plan to achieve the goals of the terrorists are present.

² In the New Globalized Economy, these conditions are intensifying. Often, these motivations are most acute in rural isolated areas, with populations that have low levels of education and high rates of poverty.

³ http://www.sagepub.com/upm-data/51172_ch_1.pdf, 4.

to which food insecurity contributes to insurgency and terrorism (CAUSE). Second is the extent to which terrorists target agriculture, the food value chain and/or food insecurity to advance their cause (TARGET). Third is the destructive and disruptive impacts of terrorism on the agricultural and food system, especially in rural areas where farming is the mainstay (CONSEQUENCES).

The primary objective of this paper is to explore all three dimensions by drawing on observations from the on-going Boko Haram insurgency in Northern Nigeria. In recent years, Boko Haram has emerged as the key challenge to Nigeria's national security. With Boko Haram, there were early warning signs and symptoms of the emergence of a major crisis, but these were largely ignored for decades. A common explanation for the emergence of Boko Haram is the difficulty in achieving adequate security in the backdrop of acute food shortage, population explosion, low level of productivity and per capita income, low technological development, inadequate and insufficient public utilities and chronic problems of unemployment, not to mention religious intolerance and criminal politicking. Boko Haram (Jama'at Ahl al-Sunnah li Da'wah wa-I-Jihad), a group founded by Mohammed Yusuf as Yusufiya Islamiya Group in Maiduguri, Borno State between 2001 and 2002, first became known globally following sectarian violence when the police arrested several sect members including the leader, Mohammed Yusuf, who subsequently died in police custody. Since then, the group has waged a violent campaign against the government to impose its authority under Sharia law.

In Section B, observations from the Boko Haram insurgency were used in developing preliminary conceptual frameworks for exploring each of the three dimensions (CAUSE, TARGET and CONSEQUENCES). In Section C, a theoretical model to explain why and how terrorists attack agricultural areas is presented. In Section D, an empirical analysis designed to test various hypothesis that emerged from the conceptual and theoretical frameworks is presented. This analysis is based on data from Nigeria's Boko Haram insurgency. In Section E, empirical results are presented. Finally, in Section F, the paper draws some conclusions and discusses possible areas of future inquiry with respect to the nexus between food security and national security.

B. Conceptual Relationships Between Food Security and National Security (Terrorism)

Terrorism is on the rise globally, due, in part, to the rapid expansion of the new global economy.⁴ Indeed, it has emerged as one of the most significant threats to national security and stability globally. In the Middle East, with the influence of the Islamic State of Iraq and Syria (ISIS or ISIL) and Al Qaeda, terrorist activities are strong in Syria, Iraq, Israel and Yemen while occasional targets have been reported in countries such as Jordan, Lebanon, Oman, Saudi Arabia, and the United Arab Emirates. In North Africa, states like Libya, Egypt, Tunisia, Algeria, Mauritania and Morocco have recently experienced terrorism. In Asia, places in Afghanistan and Pakistan have been under attack. Even in Europe, within the past ten years, attacks have occurred in the United Kingdom (London), Netherlands (Apeldoorn), Sweden (Stockholm), Greece (Athens), Denmark (Copenhagen), France (Paris), Germany (Frankfort), Italy (Brindisi), Belgium (Brussels), Spain (Madrid), Turkey (Istanbul) and Portugal (Lisbon).

In sub-Saharan, East and West Africa, Algeria, Angola, Burkina Faso, Cameroon, Chad, Cote D'Ivoire, Djibouti, Ethiopia, Kenya, Libya, Mali, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zimbabwe and Nigeria witnessed terrorist activities. In fact, perhaps the most deadly terrorist attacks in the world today are in Nigeria 's (CNN, 2015) where Boko Haram (BH) insurgents over 2 million people have been displaced from their homes, jobs and communities. To understand place target behavior, one needs to better understand terrorism causes, motivations, and therefore strategy. Since the products of terrorists include damage, devastation, despair and global visibility of such outcomes, the knowledge of consequences (impacts) is also critical to the understanding of place target behavior. Because of its broad root causes and devastating impacts, Nigeria's Boko Haram incidence provides a rich context in the conceptualization of the target behavior of terrorists and their motivations and impacts with respect to food security.

⁴ Three (3) aspects of the new global economy help explain the growing incidence of terrorism: (a) as terrorism thrives on isolated conditions and the globalized economy is expanding rapidly, those left behind without knowledge, skills or access become more isolated and disaffected; (b) the clash of cultures for those who simply do not believe in the tenets of the global economy will intensify; and (c) high growth sectors are those that these isolated populations cannot participate in. In the context of a developing country or fragile state, other threats to national security include such things as ethno-communal clashes, frequent armed robbery, major acts of sabotage, mass acts of arson, subversive activities, large scale looting, wanton vandalism, labor unrest, students unrest, demonstrations, violent riots, strikes, extra-government violence, intra-government violence, pro-government violence, acts of espionage, drug trafficking, cyber-attacks, regional challenges to democratic governance and piracy (see Security Council Report, 2011, amongst others).

B.1. Food Insecurity Pathway to National Insecurity (CAUSE)

There is currently no compelling empirical evidence of direct causality from food insecurity to terrorism. However, food insecurity is often mentioned as a factor that exacerbates other socio-economic and political drivers of insurgency, as well as a consequence of insurgency. Food insecurity is believed to heighten the risk of democratic breakdown, civil conflict, protest, rioting and communal conflict, and is seen to be intertwined with economic security, national security and global security (Speckhard, 2015). For example, a number of popular articles have argued that the 2008 spike in world food prices led to the Arab Spring and that the multi-year drought in Syria, which turned over half of the nation into desert, caused the loss livelihood for over 800,000 people and created major dislocations, laid the ground for the uprising against an oppressive dictatorship and led Syria into a full scale civil war (Speckhard, 2015).

The root causes of terrorism are an appropriate starting point for conceptualizing the food insecurity - national security causality. Root causes previously identified in the literature include (a) economic deprivation (b) discrimination, (c) marginalization of people or perceptions thereof, (d) religious persecution, (e) nationalist/separatist motives, (f) religious fundamentalism and (g) clashes in political ideology (see, for example, Wilkinson, 1986; Kavanagh, 2011; and Enders, Hoover and Sandler, 2014). Other include low income (Enders and Hoover, 2012; Gassebner and Luechinger, 2011), poverty (Krueger and Maleckova, 2003; Piazza, 2006) and the lack of liberties (Krueger and Maleckova, 2003). Gassebner and Luechinger (2011) further identified high population, existence of wars, religious and ethnic tensions, human rights abuses, absence of law and order, military spending, foreign portfolio investment and lack of economic freedoms as causes of terrorism. Despite these studies, there is little consensus on the totality of relevant root causes, how they are related to each other, and how each affects the incidence of terrorism.

The characteristics of terrorism also provide insights into the causality between food security and terrorism (see Section A and UN, 2004)⁵. Core characteristics identified in the literature include: (a) a fundamental motive to make political/societal changes; (b) political, economic, or religious aims by the perpetrator(s); (c) the goal of affecting society, (d) use of

⁵ Unfortunately, a simple definition of terrorism is difficult to arrive at, as evidenced by the ongoing struggle of the United Nations General Assembly to create a common definition (see paragraph 164 of the Report of the High Level Panel on Threats, Challenges and Change "A more secure world: Our shared responsibility").

violence or illegal force; (e) threats of violence; (f) attacks on civilian targets by non-state and/or sub-national actors; (g) the communication of fear to an audience beyond the immediate victim; and (h) attacks on government agents and facilities (see Blee, 2005; Hoffman, 2006; Vallis et. al, 2006; Schmid, 2004; Sandler, 2014). Findings from such the literature on root causes and characteristics are explored next to highlight food insecurity's role in spurring terrorism.

As insurgency does not develop spontaneously, root causes are the necessary condition for its development. Figure 1 below, which is based on existing literature, provides a simple conceptual framework for examining how root causes create an environment of dis-satisfaction, which can lead to insurgency after two sufficient conditions are met. The first sufficient condition is the need for a significant segment of the population to be dis-satisfied. Disenfranchised people with little to lose are key recruitment targets of terrorist groups. The second is the need for a group(s) to emerge with agenda for change in the status quo and their willingness to use terror as a means to achieve such change. Ideology is therefore an important element of the veracity of terrorist groups. When the group begins to mobilize resources, recruit sympathizers and occupy territory, full blown insurgency has emerged. The consequences can become dire, intractable and destabilizing for the nation or region affected by terrorism.

Due to its complexity, the Boko Haram crisis provides a lens through which these relationships can be explored more comprehensively. The fact that Boko Haram emerged from the Borno, Adamawa and Yobe, the poorest and most-insecure region of the world, buttresses the causality argument.⁶ The tendency of Boko Haram to recruit from within the ranks of the disenfranchised who have very little to lose also buttresses the causality argument.⁷ The nature of Boko Haram attacks also buttresses the causality argument. The fact that many Boko Haram attacks took place in rural areas and many seemed to involve direct targeting of agriculture and the goal of creating food insecurity also buttresses the causality argument.⁸ Figure 2 maps the

⁶ This region is the poorest in the world and certainly Nigeria (Adelaja, et. al., 2015). For decades, the region did not embrace modern education and many young people participated in Almajiri education (Quran schools). A large number of people that are now disconnected from the emerging economic opportunities in Nigeria (Adelaja, et. al., 2015). Such limited economic opportunities translated into major food insecurity, especially in the absence of strong social intervention programs.

⁷ Boko Haram has been known to lure poor and underserved recruits with money and food.

⁸ Boko Haram has been known to plant mines and other explosive devices on farms; to attack, kill and steal farm animals; and to kill ranchers, perhaps to create food insecurity and encourage potential recruits to seek food access through their terrorist group (Kindzeka, 2016). Boko Haram has also been known to blow up tractors, irrigation systems, food markets and agricultural feeder roads, and chase away farmers.

Boko Haram attacks and fatalities from 2010 to 2016. It shows that attacks occurred not only in urban areas with high population and infrastructure density, but also in rural areas.

Despite the absence of empirical evidence showing the food insecurity-terrorism causality, many major public policies have been based on the assumption of such causality. For example, a US State Department Official Blogsite posted an article by Jonathan Shrier (2008) which attributes the following statement to Vice President Biden: "Investments made to ward off food insecurity and prevent its recurrence can prevent the vicious cycles of rising extremism, armed conflict, and state failure that can require far larger commitments of resources down the road." The recognition of this connection has spurred renewed investment in food security (e.g., Feed the Future Initiative (FTF)) as a centerpiece of the Obama Administration's foreign policy (Shrier, 2008). FTF invests in small farmers, but also along the entire agricultural value chain in programs to improve access to credit, technology and markets in order to boost productivity.

The evidence above strongly suggests food insecurity-terrorism causality. One reason why such causality is not well investigated is the latency of most root causes, including food insecurity. Governments hardly see a crisis coming because the root causes tend to be unobservable until some event then triggers unrest, terrorist group formation and/or heightened terrorist activity.⁹ From a methodological standpoint, the relationships between causal factors and insecurity (or terrorism) also seem murky. The problem is akin to challenges associated with modeling latent variables in econometric analysis. Because many of the causes seem related (e.g., poverty, lack of opportunities, low income and food insecurity), researchers face the added problem of multicollinearity and specification error. These methodological challenges, coupled with significant data challenges, especially in developing countries, may well explain the limited activity in research to explain the nexus between food security and national security.

B.2. Motivations for Terrorist Attacks on Agricultural Areas (TARGET)

Previous studies on the motivations (e.g., Ozdamar, 2008), location decisions (e.g., Gaibulloev, 2015), targets (e.g., Brandt and Sandler, 2010) and lethality (Berman and Laitin, 2008)

⁹ In the MENA region, for example, the demonstrations and riots that preceded the current spike in terrorism activities seem to have had their roots in many of the causes identified in Figure 1. Many of the leaders were ill-informed about the dynamics of the early stages of terrorism. More importantly, the demonstrations themselves were triggered by simple things such as self-emollition due to concerns about inadequate housing.

of terrorist groups provide a good foundation for a conceptual framework for why and how terrorists target agriculture and food security. Again, terrorists seek to inflict damage and raise fear amongst the populace through their place targeting behavior. As shown in Table 1, the damage and fear from terrorism can be measured in various terms.

The *human damage effects*, which typically attract significant attention, are associated with: (a) where terrorists choose to attack, (b) how frequently they attack the area, (c) the number of fatalities, (d) the number of injured people, (e) the number of people displaced (i.e. Internally Displaced Persons (IDPs)), (f) the number of captured/kidnapped people, and (g) the national and international visibility of the fatalities, injuries, kidnapped and captured. The *infrastructure damage effects* are associated with: (h) the critical nature of the facilities damaged or destroyed, (i) number of facilities damaged or destroyed, (j) value (cost) of damaged/destroyed facilities, (k) disruptive effects of the damage and destruction to facilities on the economy, and (l) national and international visibility of the facilities damaged and destroyed.

The *capacity building effects* relate to the desire of terrorist groups to enhance their capacity through their attacks. These include: (m) extent to which destructions & damages deter counter-attacks, (n) number of recruits, (o) volume of acquired weapons, (p) volume of stolen combat equipment, (q) number of captured farmers, (r) volume of stolen foods, (s) volume/value of stolen farm equipment, and (t) volume/value of stolen seeds & other inputs. The food insecurity effects or motivations are those that squarely affect food security. These include: (u) the number of killed farmers, (v) the number of injured farmers, (w) the number of kidnapped farmers, (x) the number of displaced farmers, (y) the extent of destroyed markets, and (z) the disruptions to the food supply chain.

Now examine the place implications of terrorist attacks, especially their rural-urban choices. Naturally, based on Table 1, terrorist groups would be attracted to urban areas primarily because of their human and infrastructure damage potential: (a) high concentration of people, schools, health facilities, critical government offices and assets, public infrastructure and market facilities, (b) much greater national and global regional and economic connectivity, and (c) greater national and global visible. However, urban areas are much more difficult to penetrate because of (a) their higher concentration of security forces, (b) the strong desire by government

to protect such areas and their residents, and (c) the logistical coherence of and familiarity with those places for security forces. Furthermore, urban areas tend to be characterized by higher levels of education and better prosperity, thereby making them less attractive for recruitment purposes. Because terrorists must also maintain a decent level of financial, food and resource endowments, they often stage raids in order to accumulate assets and resources to enhance their future operations. The first four of the capacity building effects or motives in Figure 2 (m, n, o and p) make urban areas attractive to terrorists.

Table 1, however, suggests that terrorists would be attracted to rural areas because of their capacity building and food security implication. With respect to capacity building, Boko Haram has deliberately targeted agricultural places and carted away such things as fertilizer, non-perishable food items, tractors and mobile farm equipment and experienced farmers. These directly enhance the capacity of Boko Haram, including the capacity to feed itself. These attacks also enhance the capacity of Boko Haram to recruit new terrorists by creating an environment where people lose their livelihoods, have almost nothing further to lose and may have to depend on Boko Haram to feed them. The last four of the capacity building effects or motives in Figure 2 (q, r, s and t) make agricultural areas attractive.

With respect to food security, Boko Haram has been known to deliberately kill farmers, destroy their homes, destroy and poison existing wells, destroy immovable farm equipment, burn markets, attack local and religious leaders, and mine farm fields. While achieving their human and infrastructure damage goals, these attacks have debilitated agriculture, ground the agricultural economy to a halt and created one of the most poignant food security problems in the world today. The human and infrastructure destruction, coupled with the collapse in the viability of agriculture, farm input and product markets, rural job markets, the food supply chain, and communities, has essentially killed the rural economy. By destroying the rural agricultural economic base, these attacks directly create food insecurity.

One of the largest impacts that the rural attacks have had stems from human translocation or rural-urban migration. Many people have had to flee to safer places due to fear (often to urban areas such as Maiduguri, Yola, Damaturu, Bauchi and Gombe). With homes and villages in rural areas destroyed, the economies of vast areas have collapsed as both employers

and workers have run for their lives. For example, in the case of North-East Nigeria, Boko Haram activities have generated over 2 million Internally Displaced Persons (IDPs) who have migrated to urban centers and other more rural places. In addition, over 300,000 refugees have sought refuge in places in Niger, Cameroon and Chad. The large displacement of people has created a huge humanitarian challenge, whereby federal and state government, domestic and international humanitarian organizations (United Nations, the Red Cross Society, etc.) and global and local development partners have had to mount an enormous humanitarian response as they sought to reduce the suffering of people.

Now, examine further the rural attacks and their food security implications. The ultimate effects of agricultural and food security attacks include higher prices, reduced supply, unmet demand, limited access to markets, and therefore, greater food insecurity. Based on their survey of the general public in Maiduguri, Awodola and Oboshi (2015) confirmed the food insecurity effect. They reported that amongst the list of security challenges faced in Maiduguri, agriculture was perceived by respondents to be the most adversely impacted (56.3%). This compares with 8.6% for the security sector, 12.6% for the educational sector, 4% for the government sector, 9.9% for the religious sector and 8.6% for the economic sector. When asked how Boko Haram affected food security, 34.7% of respondents indicated higher food prices, 31.1% cited adverse impacts on farming, 19.3 percent cited reduced food supply, and 14.9% cited reduced food access. Finally, respondents reported that the largest price increases were in pepper (160%), cattle (122.22%), tomato (81.82%), millet (80%), maize (50%), goat (54.16%), water melon (43.75%), fish (35.71%), wheat (33.33%), sweet potato (32.25%) and orange (31.25%). Price increases were reported for all food prices.

Another aspect of attacks in rural areas with food security implications is the impact on land use. To create a large disruptive impact, terrorists have been known to plant mines and other improvised explosive devices to ensure that farmers do not return to their fields. The mainstay being agriculture in rural areas, rural terror attacks often lead to a major roll-back in efforts and advances in rural economic development. Much of the poverty alleviation and economic development strategies of federal and state governments, as well as development organizations, in rural areas has been in the development of local agriculture. Attacks on

agricultural areas therefore translate into a major setback in rural economic development as past investments can be destroyed almost overnight.¹⁰

Based on the above, it is hypothesized that terrorists are attracted to rural areas and especially agricultural production areas for five primary reasons: (a) specific agricultural areas near the bases of terrorist groups and which produce non-perishable and easily transported foods offer a source of food for terrorists and will therefore be attacked and food items carted away (capacity building); (b) specific agricultural areas near the bases of terrorist groups and which produce more perishable and difficult to transport food products also offer a source of food for terrorists and will be attacked with fewer fatality in order to preserve their production capacity (capacity building); (c) rural places will generally be more subject to attacks because rural residents are less educated, face fewer opportunities, earn less and are less exposed, and are be more readily brainwashed and recruited for suicide bombing and other atrocities (capacity building); (d) rural places are more vulnerable to attacks aimed at creating food insecurity because they have much more limited infrastructure and government safety and security apparatus (low risk – food insecurity); and (e) gaps exist in governance in rural areas and terrorist groups seeking to capture territory see such areas as ungoverned places (capacity building). Of course, the fact that global warming has contributed to food insecurity by causing draughts and reduced farm viability in rural areas is acknowledge as a reason why terrorists target some areas.

B.3. Effects of Terrorism on Agriculture and Food Security (CONSEQUENCES)

The root causes of terrorism (see Section B1) and the motivations and targeting behavior of terrorists (see Section B2) are helpful in understanding the costs and consequences of terrorism with respect to food security. The diversity of the activities and tactics that the Boko Haram, coupled with existing literature on costs and consequences further provides a rich context for exploring a wide range of damages and losses possible from terrorist activities. In this section, the implications of the findings from the literature for food security are discusses first, followed by more precise evaluation of the direct impacts of terrorism on food security.

¹⁰ The fear element is important to highlight. Essentially, it amplifies the adverse direct effects of terrorism. Fear helps to explain why many flee from affected areas. Such fear includes concerns about loss of life, injury, dismemberment, loss of family, loss of livelihood, subjugation to terrorists control, rape and torture.

Studies on the economic consequences of terrorism tend to support the argument that terrorism generates adverse economic impacts and hinders economic development (e.g., see Neumayer, 2004; Frey et al, 2009; Abadi and Gardeazabal, 2008; Gassebner et al., 2008; Barth et al, 2006; Gaibulloev and Sandler, 2008; and Sandler and Enders, 2008). Specifically, terrorism has been linked to damages to homes, businesses and infrastructure; reduced investments, adverse impacts on tourism; reductions in the flow of goods and capital; reduced quality of life; government instability; increased government spending on defense and national security; slowdown in financial markets; negative impacts on supply chains; and human productivity losses. These general impacts are expected to also affect agriculture and food security, especially when terrorist activities occur in agricultural and food production areas.

With respect to financial systems, the areas that Boko Haram took hold of were rural and somewhat isolated to begin with. Terrorist activities further disconnect the people of these regions from the financial system. The results include limited formal support for commerce, few operational banks, limited access to cash and few safe money storage facilities. A barter economy can emerge, making the reestablishment of a financial system even more difficult.

The information and communication (ICT) impacts are complex. On the one hand, terrorists destroy cellular towers, making telecom and data connectivity impossible. On the other hand, they make access to cellular tower management extremely difficult. Even when telecoms are functional, governments often intentionally disrupt or cut them off in efforts to deny strategic communication between terrorists. By extension, everything that relies on ICT (information movement, communication and financial action) is impaired, including electronic banking and information tools for farmers and food companies.

With respect to industry and manufacturing, companies rely on connectivity to suppliers and distributors and access to logistics to function. Therefore, businesses are ground to a halt when they are disconnected while supply and distribution chains, as well as logistics, are disrupted or completely halted. The labor market can dry up, and so can talent be displaced to find other opportunities. This creates a long term recovery problem. For those that try to weather the storm, a massive security overhead exists. Private armies and secured stockpiles are often needed to support logistics. This means that only extremely profitable ventures can operate. One

can expect the industrial support base of the agricultural and food system to be seriously compromised in areas facing insurgency.

With respect to education, the damage has been devastating in the case of Northeast Nigeria. Because Boko Haram views the education system as an expression of interests opposed to its own, it has deliberately targeted school infrastructure for destruction and students and teachers have been frequently captured. Indirect impacts include the migration of talent, isolation from national assistance programs and mass migration of the student body. In Nigeria for example, arrangements were made to transfer hundreds of students to “Unity Schools” in other parts of the country, but this only affected less than 1% of students displaced from school. In the longer term, this is expected to create high unemployment. One can again expect an indirect effect on agricultural and food system.

The health system is expected to face challenges similar to the educational system. When health infrastructure is destroyed, medical talent migrates to more prosperous areas. For talented medical professionals that stay, security is compromised and there is a lack of access to national assistance programs. Patients are dispersed and economies of scale are reduced or become non-existent. The health system is also subject to other impacts, including disrupted supply chains, and cold chains for medicinal storage and limitations to patient movement. Problems that are typically manageable can become acute, as health care is deferred due to risk of movement and lack of affordability. Farmers’ health is critical to their ability to contribute to food security. Hence, damage to the healthcare system has implications for food security.

Utilities are also subjected to a series of impacts, which in turn may lead to disruptions in other sectors that depend on electricity, water, sanitary services, etc. Specifically, utilities are vulnerable to disruptions in supply, maintenance, logistics, revenue collection and new installations. Huge security investments are often needed to regenerate utility-related services. In the longer term, infrastructure development is halted, slowing down re-development for years. The fact that transmission and distribution companies can lose their profit base in insurgent areas leads to industry decline. Isolation of the insurgent area from national and regional infrastructure prevents synergies and effective management.

As a luxury good, the threat of terrorism stops the tourism cold turkey. Given the difficulty in restoring national and global perception, the time lag to recovery can be very long. International trade faces similar challenges in that the revenue generating capacity is lost, leading to a long recovery period. One of the few international trade activities that can flourish is illicit trade in such areas as narcotics, weapons, endangered species and precious gems and metals. Once these activities take hold, they can aid the financing of insurgency. They are also very hard to eradicate after the insurgency. This is also expected to affect agriculture and the food system by eliminating the demand on agricultural products by the tourism and hospitality sector.

Bad governance is often seen as a root cause of terrorism and insurgency. Therefore, the governance structure is often specifically targeted by terrorists. Resulting impacts include financial strain on political leadership, fleeing of leadership and disconnection of public services. As government cannot reach its people, communication and feedback loops are broken with the people. Often, a bunker mentality emerges that can give rise to summary judgement, human rights abuses and the choice of security over democracy and civil rights. Accountability of officials is also hampered as participatory processes stop. The rule of law subsequently suffers and government legitimacy can be further called into question. Obviously, agriculture and food security are impacted by this as the political representation of farmers becomes compromised. The Matrix in Table 2 summarizes the impacts of terrorism by sector. It shows that most sectors are expected to be adversely affected, depending on the seriousness of the insurgency at hand.

Agricultural and Food System Impacts

Now, let's examine the more direct effects of terrorism on the agricultural and food system. First, many terrorist groups locate their bases in rural areas where people can easily be radicalized and indoctrinated. Terrorist groups that have the desire to capture territories often select their base locations based on the capacity to capture, defend, hold and expand such territory. Urban areas are more difficult to capture and hold, compared with rural areas. In the case of Boko Haram in Nigeria, they launched numerous attacks in and around the city of Maiduguri. While they made some areas of the city unsafe, and, in some cases, had major influence, Maiduguri was never fully captured. However, at the height of the insurgency, twenty-

four of the twenty-seven local government areas of Borno State were either fully or partially occupied by Boko Haram. These were mostly in rural areas where agriculture was the mainstay.

Generally, agricultural areas tend to feature food availability, unemployed and less educated youth, less governed spaces, less resistance from security agencies and the military, and other factors critical to terrorist recruitment success. This puts agriculture and food security in the path of terrorism. With respect to food, non-perishable agricultural plant products such as cassava, millet, rice, groundnuts and soybeans may be particularly attractive to terrorist groups as they can be easily stored or transported to their home bases without spoilage. Small animal livestock such as chickens and turkeys will probably also be more desirable than cows, sheep and goats if the plan is to transport these back to their bases. Anecdotal information and observations from the Boko Haram situation suggests that terrorists target rural communities, not just urban areas, but for different reasons. It is hypothesized that they target more urban and built places when their objective is to do damage (killing, maiming, visibility, etc.), but target rural areas more when the objective is to support their capacity building and survival motives.

Figure 3 below, which shows the distribution of IDPs from the Northeast from the Boko Haram insurgency, shows a movement away from rural areas to more urban areas where government security and support facilities are more prominent. This supports the hypotheses that terrorists target and have impacts on agricultural areas. This pattern of population shift also puts pressures on host communities and on IDP camps while leaving many rural areas largely abandoned. Among the impacts on host communities are stressed infrastructure, law and order challenges, security problems, greater poverty, stresses on the police, stresses on the food supply system, stresses on schools and conflicts between new entrants and long-term residents. One of the prominent food security impacts of this pattern of migration is high food prices, which have been documented by Awodola and Oboshi (2015) in the case of Maiduguri.

Another expected impact results from the disconnection of people from their home communities, lands, existence, homes, market infrastructure, schools, livelihoods and jobs. With the large number of IDPs and international refugees resulting from insurgencies, the humanitarian challenges tends to be amplified when terrorists attack agricultural area. The costs to governments at all levels are significantly high as the food bills of many people must now be

picked up via public funds from governments, humanitarian agencies and donor agencies. While these food security challenges have been highly visible, they have not been an important part of investigations into the costs and effects of terrorism. Clearly, based on the above, it is important to gain better understanding of the vulnerability of agriculture and the food system to terrorist attacks and the impacts of such attacks on agriculture.

The talent related effects of terrorism are specifically highlighted due to their importance in the post-crisis peace-building process. Protracted terrorism represents a loss of agricultural production and market talent, making the recovery very difficult. This is because migrants take with them their talent, connection to the land, agronomic knowledge and know-how. This creates a “ground zero” effect whereby rebuilding the system would require simultaneously addressing a complex set of problems, starting almost from scratch. Water, seed, knowledge and markets systems all need to be addressed simultaneously. This requires a large infusion of budgetary and talent resources. Even with adequate resources, coordination becomes a central problem as the entire system loses communication, feedback and signaling capacity. In short the breakdown of the Agri-food system is confounded by a deluge of catch 22’s and comprehensive efforts are needed to recover. In the past, significant development investments were made in agricultural areas in order to reduce poverty, improve productivity and boost rural economic growth. Therefore, attacks on agricultural areas have the tendency to compromise or obliterate past investment activities thereby offering significant disruptive value to terrorists.

In conclusion, when terrorists attack rural areas, one should expect a series of negative impacts, ranging from direct disruption, decimation of input markets, dismantling of product markets, disruptions to the flow of goods, human dislocations (including talent), loss of political representation, and the loss of land. Hypothesized effects of terrorism on agriculture, the food system, and therefore, food security, are summarized below in Table 3.

C. Theoretical Framework for Agricultural Attacks

An appropriate starting point is the objective function of a terrorist group. As shown in Table 1, the group seeks to inflict damage and raise fear amongst the populace (e.g., human,

infrastructure and agriculture/food insecurity impacts).¹¹ Therefore, it is assumed that it maximizes its utility by optimally choosing between specific locations to attack, each of which provides impact possibilities such as death, injury, destruction of property, disruption of economic activity, secession of agriculture and the displacement of people. The human, infrastructure and agriculture/food security features of alternative places make them attractive (e.g. people concentration, key destination points, concentration of critical assets and access to crops and livestock). However, a terrorist group also has the objective of building its own capacity when it attacks or raids places. Such capacity building comes through kidnapping or collateral recruitments; acquisition of stolen weapons and other combat equipment, foods, farm equipment, seeds and other inputs; and the targeting of attacks in such ways as they deter retaliatory action from security agencies. However, the group must also consider costs associated with each target (distance, accessibility, penetration possibility, military presence, etc.)

It is assumed that a terrorist group located in place J chooses places to attack (targets) based on the human/people (Z_1), infrastructure (Z_2), Agro-Food (Z_3), and capacity building endowments of such places ($E\mu$). The target choice is constrained by its capacity, which invariably is related to its income (Y). Utility from Z_1 , Z_2 and Z_3 depend on the accessibility of the terrorist group to the endowments of the places it wishes to attack (i.e., the accessibility factor for human-related endowments (γ), for infrastructure (α), for agro-food-related endowments (ϕ), and for capacity building (e.g. recruitment) opportunities (w). ϕ itself is influenced by Z_1 , Z_2 and Z_3 because place attributes, which vary with the type of place attacked, also affect the types of people in the place. For example, it seems plausible that quality urban places will attract more informed and knowledgeable people who are difficult to recruit by terrorists while less endowed places offer better recruitment opportunities. In essence, the accessibility parameter for capacity building, (w), reflects varying people recruitment, weapon capture and food capture and other resource building capacities of places.

A terrorist group chooses either to stay at its base location (J) and not attack any place, or attack other potential locations (i), depending on the relative benefits of attacking these other places (i), vis a vis staying within its domain (J). Let Q be all the general goods and services

¹¹ The author is currently developing models for all three dimensions of the food/national security nexus.

consumed by the terrorist group (a numeraire). Let $Z_{1i} - Z_{1J}$ be the difference in people related endowment between location J and all other potential locations, $i = 1, \dots, J-1$). Let $Z_{2i} - Z_{2J}$ be the difference in infrastructure related endowments between location J and all other potential locations. Let $Z_{3i} - Z_{3J}$ be the difference in agri-food related endowments between location J and all other potential locations. Let P_{Z1} be the potential cost of attacking place endowments Z_1 and $P_{Z_{2i}} - P_{Z_{2J}}$ be the difference in accessibility price of attacking people-related assets in location i rather than continue its operations at the home base J. Let P_{Z2} be the potential cost of attacking place infrastructure endowments Z_2 and $P_{Z_{2i}} - P_{Z_{2J}}$ be the difference in accessibility price of attacking infrastructure-related assets in location i rather than continue its operations at the home base J. Let P_{Z3} be the potential cost of attacking place agri-food endowments Z_3 and $P_{Z_{3i}} - P_{Z_{3J}}$ be the difference in accessibility price of attacking agro-food-related assets in location i rather than continue its operations at the home base J. Let the difference in the potential capacity building benefits of an attack between locations i and J be $(E_i(\mu) - E_J(\mu))$ while the differential cost of capacity building (attracting resources, weapons and people) between locations i and J be $w_i(Z_1, Z_2, Z_3, E_{\mu_i}) - w_J(Z_1, Z_2, Z_3, E_{\mu_J})$. Let Y_J be terrorist group's disposable income (including current earnings). Recall that γ , α , ϕ , and w are accessibility parameters (0 = no access, 1 = open access).

Let $\tilde{Z}_1 = \gamma_i Z_{1i} - \gamma_J Z_{1J}$; $\tilde{Z}_2 = \alpha_i Z_{2i} - \alpha_J Z_{2J}$; $\tilde{Z}_3 = \alpha_i Z_{3i} - \alpha_J Z_{3J}$; $\tilde{P}_{Z_1} = P_{Z_{2i}} - P_{Z_{2J}}$; $\tilde{P}_{Z_2} = P_{Z_{2i}} - P_{Z_{2J}}$; $\tilde{P}_{Z_3} = P_{Z_{3i}} - P_{Z_{3J}}$; $\tilde{E} = (E_{\mu_i}(\gamma, \alpha) - E_{\mu_J}(\gamma, \alpha))$; and $\tilde{w} = w_i - w_J$. Then, the objective function of the terrorist group can be specified as:

$$\text{Max } U[Q, Y_J - \tilde{w} - \tilde{P}_{Z_1} \cdot \tilde{Z}_{1i} - \tilde{P}_{Z_2} \cdot \tilde{Z}_{2i} - \tilde{P}_{Z_3} \cdot \tilde{Z}_{3i}, \tilde{Z}_{3i}, \tilde{Z}_{3i}, \tilde{Z}_{1i}, \tilde{Z}_{2i}, \tilde{Z}_{3i}, \tilde{E}_{\mu}] \quad (1)$$

A terrorist group maximizes its utility by optimally considering \tilde{Z}_{1i} , \tilde{Z}_{2i} , \tilde{Z}_{3i} and \tilde{E}_{μ} across locations. The conditions for optimization are:

$$U_{\tilde{Z}_1} + U_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_1 = \tilde{P}_{Z_1} + [U_{\tilde{w}} \cdot \tilde{w}_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_1 + U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_1}] \quad (2)$$

$$U_{\tilde{Z}_2} + U_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_2 = \tilde{P}_{Z_2} + [U_{\tilde{w}} \cdot \tilde{w}_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_2 + U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_2}] \quad (3)$$

$$U_{\tilde{Z}_3} + U_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_3 = \tilde{P}_{Z_3} + [U_{\tilde{w}} \cdot \tilde{w}_{\tilde{E}_{\mu}} \cdot \tilde{E}_{\mu} \tilde{Z}_3 + U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_3}] \quad (4)$$

$$U_{\tilde{w}} \cdot \tilde{w}_{\tilde{E}_\mu} = U_{\tilde{E}_\mu} \quad (5)$$

The relationships in Equations (2), (3), (4) and (5) characterize a spatial equilibrium. That is, optimal target choice occurs when the marginal change in utility from killing, maiming and hurting people and building capacity through raids between its base location and other potential locations equal the marginal cost share differentials and net resource development cost of terrorist raids (from Equation (2)). The same applies to infrastructure damage and agricultural damage (from Equations (3 and 4)). Furthermore, the marginal utility from differential capacity building activities must equal the recruitment cost differential (from Equation (5)). These conditions define the decision to attack or not, and to which location(s) to attack.

The choice of target by the terrorist group, given \tilde{Z}_{1i} , \tilde{Z}_{2i} , \tilde{Z}_{3i} and \tilde{E}_μ are, however, controlled by accessibility. With respect to access to endowments, the optimal target choice for human attacks, given degree of accessibility is:

$$(1 - \tilde{P}_{Z_1}) [U_{\tilde{Z}_1} \cdot \tilde{Z}_{1\gamma}] = U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_1} \cdot \tilde{Z}_{1\gamma} \quad (6)$$

The optimality condition in Equation (6) suggests that ease of attacking people can enhance utility if $\partial U / \partial \tilde{Z}_1 > 0$, and that at equilibrium, the utility enhancing effect of such ease is equal to the downward resource access cost effects.

It is important to note that the marginal utility of access to human endowments of places is weighted by $(1 - \tilde{P}_{Z_1})$. As \tilde{P}_{Z_1} increases (i.e., the attack cost differential), the utility associated with attacking people assets declines. When \tilde{P}_{Z_1} equals 0, there is no human capital cost advantage and the community attacked provides the same resource acquisition cost on \tilde{Z}_1 as the terrorist base community. In this case, the utility associated with enhanced access to human damage increases. Furthermore, as \tilde{P}_{Z_1} becomes negative (i.e., the community target choice provides lower capacity building cost share on \tilde{Z}_1 than the base community), the utility associated with access to human damage substantially increases.

The weighting factor $(1 - \tilde{P}_{Z_1})$ can play a crucial role, given access to location endowments.

From Equation (6), let $U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_1} \cdot \tilde{Z}_{1\gamma} = A$, and $U_{\tilde{Z}_1} \cdot \tilde{Z}_{1\gamma} = B$. Then, given access to place endowments, it follows that:

$$\left. \begin{array}{l} A = (1 - \tilde{P}_{Z_1})B \quad \Rightarrow \quad \text{Optimal target choice given } \gamma \\ \text{If } \tilde{P}_{Z_1} \in (0,1) \text{ and } \tilde{P}_{Z_1} \uparrow \Rightarrow A > (1 - \tilde{P}_{Z_1})B \Rightarrow \text{Target J becomes attractive given } \gamma \\ \text{If } \tilde{P}_{Z_1} = 0 \quad \Rightarrow A = B \quad \Rightarrow \text{Target choice...indifference} \\ \text{If } \tilde{P}_{Z_1} < 0 \quad \Rightarrow A \ll (1 - \tilde{P}_{Z_1})B \Rightarrow \text{Target J becomes much less attractive given } \gamma \end{array} \right\} \quad (7)$$

The effect of access to infrastructure assets can similarly be shown by differentiating the terrorist group's utility function with respect to this access. It then follows that:

$$(1 - \tilde{P}_{Z_2})[U_{\tilde{Z}_2} \cdot \tilde{Z}_{2\alpha}] = U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_2} \cdot \tilde{Z}_{2\alpha}. \quad (8)$$

Let $U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_2} \cdot \tilde{Z}_{2\alpha} = A$, and $U_{\tilde{Z}_2} \cdot \tilde{Z}_{2\alpha} = B$. Then, it follows that:

$$\left. \begin{array}{l} A = (1 - \tilde{P}_{Z_2})B \quad \Rightarrow \quad \text{Optimal target choice given } \alpha \\ \text{If } \tilde{P}_{Z_2} \in (0,1) \text{ and } \tilde{P}_{Z_2} \uparrow \Rightarrow A > (1 - \tilde{P}_{Z_2})B \Rightarrow \text{Target J becomes attractive given } \alpha \\ \text{If } \tilde{P}_{Z_2} = 0 \quad \Rightarrow A = B \quad \Rightarrow \text{Target indifference.} \\ \text{If } \tilde{P}_{Z_2} < 0 \quad \Rightarrow A \ll (1 - \tilde{P}_{Z_2})B \Rightarrow \text{Target J becomes much less attractive given } \alpha \end{array} \right\} \quad (9)$$

Finally, let $U_{\tilde{w}} \cdot \tilde{w}_{\tilde{Z}_3} \cdot \tilde{Z}_{3\alpha} = A$, and $U_{\tilde{Z}_3} \cdot \tilde{Z}_{3\alpha} = B$. Then, it follows that:

$$\left. \begin{array}{l} A = (1 - \tilde{P}_{Z_3})B \quad \Rightarrow \quad \text{Optimal target choice given } \phi \\ \text{If } \tilde{P}_{Z_3} \in (0,1) \text{ and } \tilde{P}_{Z_3} \uparrow \Rightarrow A > (1 - \tilde{P}_{Z_3})B \Rightarrow \text{Target J becomes attractive given } \phi \\ \text{If } \tilde{P}_{Z_3} = 0 \quad \Rightarrow A = B \quad \Rightarrow \text{Target indifference.} \\ \text{If } \tilde{P}_{Z_3} < 0 \quad \Rightarrow A \ll (1 - \tilde{P}_{Z_3})B \Rightarrow \text{Target J becomes much less attractive given } \phi \end{array} \right\} \quad (10)$$

Attacks of different types would be different in lethality. However, this basic framework only allows for the evaluation of the roles of place desirability and damage opportunities in attack probability. More specifics on attacks are discussed elaborately in the empirical section.

D. Empirical Framework for Agricultural Attacks

The empirical framework for the evaluation of target richness and accessibility derives from the theoretical framework above. The dependent variables of interest to the author are (a) a binary choice variable (ATTACK) measuring whether a location has ever been attacked by Boko

Haram (Model 1), (b) a count variable (ATTACKS) indicating the number of times the area has been attacked, and (c) a count variable (FATALITES) indicating the number of fatalities. The conceptual and empirical framework sections (B and C) suggest that attack-related measures (e.g. probability of attacking a place, frequency of attacking a place and the lethality of an attack) are functions of place-related attributes (people, infrastructure, food security and capacity building (HIFC) attributes). The more endowed a place is, the more motivated the terrorist group is to attack the place, *ceteris paribus*. Independent variables should therefore include these measures of place HIFC attributes. For example, terrorists should prefer highly crowded and globally visible places if their motivation is to do huge and visible damage. Therefore, variables capturing such things as population density, road density, infrastructure density, scope of the built environment, destination points, gross domestic product and income are expected to be positively related to attack-type variables. Terrorists are also known to target those things they are opposed to. For example, Boko Haram is fascinated with blowing up schools and churches and targeting areas where the highly educated reside because of their disdain for modern education.

One would expect a positive relationship between variables capturing the things they abhor and their attacks. But a terrorist group also has to survive. To do so, Boko Haram has attacked rural areas to gain access to food to replenish their stock and attacked the agricultural capacity of places to render them non-productive. It is proposed that when Boko Haram seeks to replenish its food supply, it attacks a rural area outside its domain and cart away as much food as it could. But when its objective is to increase the volume of hungry unemployed people that can easily be radicalized, it attacks a place outside its domain to destroy its agricultural capacity by mining the fields, destroying tractors, killing farmers and destroying markets. When it seeks to expand the base of productive places under its governance, it captures a place near its home base, not destroy the capacity to produce, and puts locals to work producing for itself.

The key constraint on the activities of terrorists, which forces them to choose between locations, essentially boils down to their income. But income is analogous to travel distance, travel cost, logistics cost and the degree of difficulty in combat operations. The distance to the base of Boko Haram is clearly a key constraint. Not only does it translate into travel and logistics costs, it captures the potential for casualty through clashes with the Army and other security

agencies.¹² To test the hypothesis that terrorists target specific agricultural commodities, it would be appropriate to include the agricultural production levels of places in the regression specification. The estimated coefficients will show whether terrorists directly target some areas producing specific crop and animal products.

Potential proxies for the first category of proposed independent variables (human damage potential) include measures of population, income, economic activity, employment, education and literacy. Potential proxies for the second category (infrastructure damage potential) include measure such as road density, road miles, urbanization, electricity access and sanitation access, including water. Potential proxies for the third category (agricultural/food damage and capture potential) include measure such as inventory of animal production, volume of crop production, agricultural human capital and the dominant landscape (agriculture, built environment, water and pasture). Finally, potential proxies for the fourth category (resource capacity development through attacks) include distance from each attack location to the centroid of the Sambisa Forest (Boko Haram heartland) and distances from Yola and the Sambisa Forest.¹³

Some of the variables in a given category may also apply to another category. For example, a terrorist group might target a place for the ability to do major damage in the form of fatalities, but may also eye it for the recruitment of poor youth and the kidnapping of doctors, young girls and highly skilled professionals. Based on the patterns of Boko Haram attacks, which has been to attack both cities and rural areas, it would be useful to test this hypothesis. If the motivations differ by attacked places, then it would make sense to separate the data for urban and rural places and model the relationships separately, but test for structural differences. Details about the data sources and treatment are provided below.

D.1. Management of Data

Recall that the objective of this analysis is to evaluate the relationship between attacks and other factors that describe the characteristics of where such attacks took place. Of particularly interested are the HIFC location characteristics that explain target choice. The

¹² Distance is a key variable in this analysis. The farther Boko Haram travels, the greater the likelihood of military interception.

¹³ Based largely in the Sambisa Forest in later years, the direction of Boko Haram attacks was Northwest toward Maiduguri and Damaturu, and Southward toward Yola. Distance to Maiduguri and Yola were therefore added as explanatory variables.

fundamental question to be answered is: “Do the agricultural characteristics of a place affect the choice of the place as a target for a terrorist attack?”

The Armed Conflict Location and Event Data (ACLED) Project (Raleigh, 2016), provides data on armed conflict events in Africa for 1997 to 2015 by location (Version 6). ACLED includes terrorist events, including Boko Haram attacks. Variables in ACLED include an event code, country code, year code, time code, perpetrator code, a code identifying those attacked, interaction type, the number of fatalities, latitude, longitude, and measures of confidence about location and time precision. Because the database is geo-coded, it is easily integrated with contextual data available at scales ranging from a point or line upwards through the local government area (LGA) and the State. Therefore, a rich context could be constructed for event and the definition of place is dynamic and can be chosen to fit other data. In this analysis, only Boko Haram related elements of the database were utilized. Given the objective, there was a need to relate the ACLED database to other existing contextual data that provide information on place characteristics.

The Agricultural Census of the Nigeria, published by the Federal Ministry of Agriculture and Rural Development (FMARD), provides data on agricultural production variables at the regional, state and LGA levels, depending on the variable in question. This includes data on farm products and inputs. However, the Food and Agriculture Organization of the United Nations (FAO) provides agricultural production data at the 25 square kilometer (km²) grid level. With respect to socio-economic data, FMARD provides information on income, farm employment and farm income at the LGA level, and on unemployment, farm ownership and poverty at the state level. With respect to health data, information on the incidence of HIV, typhoid and malaria, on malaria deaths and survivors, on male and female deaths, and on births are provided by the Nigeria Federal Ministry of Health (NFMH), but only at the state level. With respect to education, data on schools by type and the number of students is available as point data. However, information on primary, secondary and university enrollment exists at the LGA level while information on graduation rates, literacy and type of training exists at the state level. Information on the locations of schools (primary, secondary and universities) are available at the point level. With respect to infrastructure, data exists as polylines. This includes roads by type, electricity infrastructure and gas and oil pipelines. As additional proxies for infrastructure presence, access

to improved water supplies, improved sanitation, phones, computers and Internet are available at the state level (see Table 4 for a general description of the nature and sources of data).

An innovative framework was developed to connect and overlay all available data of interest. Specifically, the data on terrorism attacks, agricultural production, infrastructure and socioeconomic/demographic factors was integrated into the same data file. The entire nation was divided into 25 km² grids (5 km x 5 km), matching the FAO grid structure. There were 1197 grid cells for the nation, 910 of which were in the North and 598 of which were in the Northeast. There was a total of 1047 Boko Haram events and 145 cells within which such events occurred (in some cells, multiple events occurred). This database therefore allowed significant degrees of freedom in econometric analysis. Most of the attacks outside of the Northeast were in urban areas (areas where land in more than 50 percent of the grid cells were considered built environment). Most of the attacks in the Northeast were in areas where more than 50 percent of land in the grid cell was not in the built environment. Of the total number of 598 grid cells in the Northeast, 587 were in areas where the grid cells had less than 50 percent of the land base not in the built environment. The relationships between the events within a grid and the place characteristics of the grid were modeled in this study, focusing on the 910 observations (80% from the North (all grids) and only the 587 from the Northeast (grid cells that are not dominated by the built environment)).¹⁴

For this pilot analysis, data occurring at larger spatial units than the sampling unit were spatially joined to the sampling grid without adjustment in magnitude or variation. Thus, for each variable, the values for a state are repeated for each cell that is within or intersects that state. The same applies to data available at the LGA levels. Conversely, all data available as continuous or count variables such as grids, lines and points, were intersected with the analysis grid and up sampled to the grid geography. Hence, some data is devolved from larger geographies and some data is amplified from smaller geographies.

¹⁴ It is important to note that while Boko Haram attacks were concentrated in the three states of Borno, Adamawa and Yobe (Bay States), they also attacked other Northeast states (Bauchi, Gombe and Taraba), other areas of the North beyond the Northeast (e.g., Kaduna, Kano and Jos), and other parts of the country such as Abuja.

There are obviously limitations associated with this approach, whether the analysis is at the grid or event level. The primary one is while several of the variables are available at the grid level, many of our variables only exist at the LGA or state levels. Some degree of heteroschedasticity can be expected with this analysis, but these can be tested and corrected for. The author is currently working on further treatment of the data to allow for more precision in order to reduce measurement errors.

D.2. Model Estimation

The data on all dependent variables were available at the grid level. In Model 1, ATTACK (=1 if a place is attacked, and 0 otherwise) was regressed against hypothesized causal factors via a logit model. King (2008) showed that the use of Ordinary Least Squares (OLS) or similar methods to estimate models with count data as the dependent variable leads to misspecification, inefficiency, bias, inconsistency and insufficiency. Because the dependent variables in Models 2 and 3 (ATTACKS and FATALITIES) are count data, the Exponential Poisson Regression (EPR) technique recommended by King (2008) is the appropriate estimation technique.

The decision to focus the estimation of Models 1, 2 and 3 on data from all Northern States (910 observations), not just the Northeast, is based primarily on knowledge of the history and nature of Boko Haram attacks. Figure 2 suggests that most attacks took place in Borno State, the epicenter of the Boko Haram influence; and the attacks in the BAY states far exceeded those in other non-BAY Northeast States of Bauchi, Gombe and Taraba, combined. Further, beyond the Northeast, going toward the North West and North Central region of Nigeria, one observes far less attacks. Kano and Kaduna (North West) and Jos (North Central) are examples of places beyond the Northeast that Boko Haram also attack. Even Abuja (Federal Capital Territory (FCT)). Most of these attacks were in urban areas. For this reason, rather than restrict the analysis to only the Northeast, it was applied to the entire North, including the Northeast, North West, North Central and the FCT. All in all, the analysis involved 19 out Nigeria's 36 States, as well as the FCT. In addition, to allow more robust test of hypotheses related to food security and capacity building, the analysis was performed based on data from only the Northeast: specifically, the 587 observations where most of the land in the grid were not in the built environment. These attacks are considered "rural attacks in the Northeast".

The independent variable used included direct indicators or proxies for the human damage, infrastructure damage, food insecurity and the capacity building motives of terrorists. The actual list of independent variables considered is provided in Table 4. To capture the human damage effect, the following variables were included: (a) population (popula), which was measured at the State level; (b) average incomes of Heads of Households and their spouses (income), which was measured at the LGA level; (c) total number of unemployed (unemployed), which was measured at the State level; (d) an optimism variable measuring the percentage of people in 2010 who felt that things were worse off for them over the past 10 years (worse off); and (e) the level of basic education, which was proxied by the percentage of people that have completed primary education (edat_prima), measured at the State level.

To capture the infrastructure damage motivation of terrorists, the following were included: (a) growth density within the grid (road-density); (b) road length in the grid (road-length); (c) the percentage of people with adequate modern sanitation, which was measured at the Local Government level (sanitation); and (d) the percentage of households with electricity in their homes (electric), which was measured at the Local Government Area (LGA) level. To capture the capacity building and food security objectives of Boko Haram, the variable (ag) was included. This variable was generated based on the dominant land use in a given grid cell. If an area is more than 50% agricultural land, the variable ag=1, otherwise ag=0. Similarly, three other variables were generated: built=1 if a grid had more than 50% of it in a built (urban) environment, otherwise built=0; water=1 if a grid had more than 50% water, otherwise water=0; pasture=1 if a grid had more than 50% pasture, otherwise pasture=0.

Two distance measures available at the grid cell level as proxies for the cost of attacking far locations: (a) distance from centroid of the Sambisa Forest where Boko Haram is headquartered to the centroid of the grid cell in question (sambisa_disc) and (b) distance from the center of Yola to the centroid of the grid cell in question (yola_dist). These were chosen based on knowledge of Boko Haram networks. Boko Haram's heartland is somewhat nestled between Yola and Maiduguri, but the road connectivity to the bulk of the region is through Maiduguri. Maiduguri is on the western portion of northern Borno while Yola is in the northern parts of

Adamawa State. So, if both yola_dist and distance from Maiduguri are both used as proxies, the results would be hard to interpret since many attacks happened beyond Maiduguri, going west.

Models 1, 2 and 3 were repeated but, this time, expanding further on the ag variable and restricting the database to only the non-urban areas of the Northeast. In Models 4, 5, and 6, as substitutes for ag, twelve (12) measures of agricultural crop production and six (6) measures of animal production were included as independent variables. The crop variables included hectares planted in 2009 of the following: soy beans (soybeans), cassava (cassava), maize (maize), yam (yam), rice (rice), cotton (cotton), ground nuts (groundnuts), millet (millet), water melon (melon), and kola nuts (kolanuts). The livestock inventory variables included were 2009 animal count information for cattle (cattle), goat (goat), sheep (sheep), chicken (chicken), turkey (turkey), and pigeons (pigeons). The standing hypothesis are as follows:

- a. Boko Haram is generally attracted to places producing high volumes of crop and animal products that are easy to gather, easy to transport and non-perishable, and that provide high calories and/or good nutrition.
- b. When places referred to in (a) above are close to its base of operations, fatalities will be low because the motivation of Boko Haram is to capture those places and maintain production for its own use (Capacity Building).
- c. When places referred to in (a) above far from its base of operations, fatalities will be high because the motivation of Boko Haram is to destroy agriculture in such places and create food insecurity (Food Security).

For the products that fall within the referenced product list in (a) above, one would expect the coefficients of ATTACK and ATTACKS to be positive, and of FATALITIES to be either positive or negative, depending on the motivation depicted in a, b and c above. Empirical result (preliminary, pending more aggressive database clean up and construction) are presented in the next section.

E. Empirical Results

The results of Models 1, 2 and 3 presented in Table 5 are discussed first. The pseudo R-Square for the ATTACK, ATTACKS and fatalities variables were, respectively 0.1632, 0.4649, and 0.3576. Please note that these estimates are general in nature and reflect urban and rural attacks.

E.1 All Northern Attacks

Starting with the ATTACH model (Model 1), the coefficient of roadlength is negative and statistically significant while the coefficient of roaddensity is positive and statistically significant, both at the 5% levels. These suggest that Boko Haram is attracted to the built environment, more specifically to places with greater road density, but not attracted to places with more road length. This is consistent with the author's expectation that places with concentrated road infrastructure provide greater human and physical damage potential from bombings than places with more linear road infrastructure. It may also suggest that attacks on places with dense road networks (not necessarily length) provides good opportunity to disrupt connectivity, transportation and market networks, as well as military logistics. Places with connectivity are also attractive because of the ease of access and getaways. The coefficients from the ATTACKS model (Model 2) are consistent in signs, magnitudes and significance with Model 1 results, suggesting that places with high concentration of road networks are not only more likely to be attacked, but are also more likely to be frequently attacked.

The coefficient of sanitation is statistically significant and negative for the ATTACK model, which is surprising given that the variable is an infrastructure proxy. This implies that access to modern sanitation deters Boko Haram. One possible explanation is that sanitation infrastructure in Nigeria reflects government presence and the coherence of local government and other authorities. Boko Haram would be expected to be attracted to ungoverned spaces, which are places with little modern sanitation infrastructure. The coefficient of sanitation in for the ATTACKS model is not statistically significant, suggesting that the frequency of attacking places with sanitation is not greater than places without. The coefficients electricity access in both the ATTACK and ATTACKS models were also found not to be statistically significant, suggesting that electricity is not a relevant factor. Most areas of the Northeast had been subjected to massive blackout due to attacks on the electricity grid, transformers and major electricity dependent places. Besides, with Boko Haram, many communities that previously depended on electricity from the grid just could not afford to pay their electricity rates. The Transmission Company of Nigeria (TCN) and the local distribution companies (gencos) also could not afford to continue services under such heavy security challenges.

The coefficient of *edat_prima* is also positive, supporting the widely held belief that Boko Haram is more likely to target places where residents are better educated than places where less educated people live. Disdain for modern education is one of Boko Haram's key mantras. Indeed, the name of the terrorist group translates directly into "modern education is bad". This finding connects Boko Haram's motivation directly with their modus operandi, implying that not only does the terrorist group disdain modern education, but that their attack patterns reflect such disdain. Further analysis is being planned to investigate the effects of specific educational assets such as elementary schools, secondary schools and universities. Again, the coefficients from the ATTACKS model (Model 2) are consistent in signs, magnitudes and significance with Model 1 results, suggesting that places with where more of the people are educated are not only more likely to be attacked, but are also more likely to be frequently attacked.

Surprisingly, the coefficients of total population is not statistically significant in both the ATTACK and ATTACKS models, suggesting that the population of a place is not a factor in the planning of attacks. This is inconsistent with the author's expectation because one of the key interests of Boko haram is believed to be doing maximum damage in terms of fatalities. The results may suggest that it is not necessarily be the population of a place, but the logistics and densities of such population in critical places that enhances the likelihood of the place being attacked. Similarly, the coefficient of income is not significant in both the ATTACK and ATTACKS models, suggesting that places where higher income residents live are not necessarily more vulnerable. The explanations for this are as follows: (a) the job bases and income generating potentials of most places had been destroyed already by the attacks of Boko Haram, (b) the road infrastructure variables may already reflect population and income effects, and (c) many of the people with high incomes had already fled the region in the earlier days of Boko Haram and relocated to host communities in Gombe, Bauchi, Taraba, Kano and Kaduna States and the FCT.

The coefficient of much worse off is statistically positive and significant at the 5% level for both the ATTACK and ATTACKS models, suggesting that Boko Haram targets places where residents perceived themselves to be suffering and economically handicapped. This is consistent with the hypothesis that Boko Haram attacks places where residents already feel disenfranchised because they are treasure troughs of terrorist member recruits. However, surprisingly the

coefficient of unemployed is not statistically significant at the 5% level in both the ATTACK and ATTACKS models. There are several possible explanations for this finding. First, it may well be that despair, not unemployment, is a more relevant factor to Boko Haram since unemployment is very high across the region and specifically in the Bay States. Second, while unemployment rate and numbers may have been relevant earlier on, jobs in most places in the Northeast, especially in the BAY States, had been shed early because of the security problems in the area. In subsequent analysis, the author plans to segment the data and modeling to account for the differences between earlier and later attacks. This will reveal whether unemployment is really not a relevant variable, or became irrelevant after the job base had been destroyed.

The coefficient of Sambisa_dist is negative, as expected, suggesting that the distance to the base of Boko Haram operations is a primary constraint for Boko Haram. This is the case with both the ATTACK and ATTACKS models. Greater distance from the Sambisa Forest base translates into greater direct monetary cost of logistics, more difficulty in getting back to base, greater likelihood of military counter attack and greater casualty amongst Boko Haram operatives, and therefore less likelihood of attack and less frequency of attacks. The Sambisa Forest is somewhat nestled between Maiduguri and Yola, with most attacks within the Maiduguri Sambisa axis. The coefficients of distance from Yola for both the ATTACK and ATTACKS models are positive and statistically significant, suggesting that within the Yola-Maiduguri axis, attacks are more likely and frequent closer to Maiduguri than closer to Yola. This is consistent with the author's expectations. It is important to highlight the fact that the signs and coefficients of the variables in the ATTACKS model were very similar to those of for the ATTACK model, except for the insignificance of the sanitation variable in the ATTACKS model. This essentially suggests that whether or not a place is attacked and the frequency of attacks are similarly influenced. Bois directly related to road length in the area, the frequency of attacks is negatively related.

The coefficients of the FATALITES equation are statistically significant only for the road density variable (positive) and the Sambisa distance variable (negative). The former suggests that Boko Haram targets areas with heavy road density for attack because of the high number of fatalities. This is consistent with the infrastructure argument and buttresses the finding on the greater likelihood of attacking such places. In other words, place with heavy road infrastructure

are not only attractive for attacks, but attacks on those places involve higher fatalities. The latter suggests that fatalities, like likelihood of attack, dwindles with distance from the Sambisa Forest. This, again, supports the hypothesis that higher costs are associated with attacking places far away from the Sambisa Forest.

The coefficients of the agriculture variable in the ATTACK, ATTACKS and FATALITIES models are statistically insignificant, suggesting that agricultural areas are not particularly targeted for attacks. While this is surprising, it was anticipated that trying to capture the motivation of Boko Haram via a model that utilized data from both urban and rural areas from the entire area of Northern Nigeria could lead to aggregation bias. The sphere of influence of Boko Haram is the Northeast. More importantly, to test the hypothesis related to agricultural attacks, it makes sense to focus only on the Northeast and specifically on areas that are not primarily built environment since it is within that space that most hypothesis regarding food security and capacity building would be relevant. Therefore, models 4, 5 and 6 were estimated for the Northeast. In these models, the agricultural dummy variable was replaced with measures reflecting the nature of agriculture in places, including specific production data, by commodity. The number of observations for this analysis is 587. The pseudo R^2 for the ATTACK, ATTACKS and FATALITIES models jumped to .4512 (almost tripled), .7633 (almost doubled) and .7678 (more than doubled). Considering the nature of the data, these reflect decent goodness of fit.

E.1 Rural Northeast Attacks

Now, examine the parameter estimates of Models 4, 5 and 6 in Table 6. In these models, the coefficients of both roadlength and roaddensity are not statistically significant, suggesting that in the rural Northeast, Boko Haram does not target nor is it attracted to areas with better road infrastructure. Indeed, the roads in rural areas are needed for Boko Haram to carry out its operations. The results also indicate that Boko Haram is not particularly attracted to rural places in the Northeast with better sanitation or better access to electricity. In fact, it stays away from those areas perhaps because they represent areas where local and other government authorities are not weak. However, the coefficients of educ_prima were all positive for ATTACK, ATTACKS and FATALITIES, suggesting that Boko Haram is much more attracted to places where people are better educated, more frequently attack such places, and these attacks result in greater fatalities.

The finding that knowledge communities are more vulnerable is consistent with the notion that Boko Haram has a particular disdain for modern education.

The coefficient of total population in the ATTACK model is not statistically significant, perhaps indicating that whether or not a place is attacked is not related to the population of the place. However, the coefficient of total population in the ATTACKS and FATALITIES equations were both statistically significant and positive, suggesting that while Boko Haram is not more likely to target such places, when it does, these would tend to be multiple and more deadly attacks. This may reflect the greater effort needed to subdue people in such areas and the possibility of organized vigilantes which are usually referred to as Civilian Joint Task Force (JTF).¹⁵

Consistent with the signs of the coefficients in Models 1-3, the coefficients of income is not statistically significant in Models 4-6, suggesting that the income of rural residents is not a factor in the target choices of terrorists in the rural Northeast. One explanation for this above was the fact that much of the income and job opportunities for residents were already destroyed in the early phases of Boko Haram. However, the while the coefficient of distance to the Sambisa forest is positive in the choice of where Boko Haram attacks and how frequently they choose to attack those places, the fatality rate decreases with distance from the Boko Haram base in the Sambisa Forest. This is consistent with the capacity building hypothesis and suggests Boko Haram prefers to travel further to gather food, but their lethality when they do that reduces with distance. However, the farther they are from Yola, the less the likelihood and likelihood and frequency of attacks.

The coefficient of unemployment is negative only for ATTACK, suggesting that Boko Haram considers rural places with higher employment to be more attractive to attack, but the frequency of attack and the fatalities from those attacks are not influenced. This is again consistent with the capacity building hypothesis. The coefficients of worse-off is positive for the probability of ATTACK, suggesting that they consider rural places where the residents are

¹⁵ The Nigerian military-led operation in the Northeast is called the Joint Task Force (JTF). The JTF involves all the armed forces, including the Army, Navy and Airforce, the Nigeria Police Force (NPF), the Department of State Security (DSS or SSS), the Nigeria Security and Civil Defense Corps (NSCDC), Nigeria Customs Service (NCS), Nigeria Immigration Service (NIS) and other armed forces. The organized vigilante groups that have evolved in various communities in the Northeast are referred to as the Civilian JTF (C-JTF).

impoverished to be more attractive. This implies that these areas are targeted because of their poor outlook.

Now, examine the more detailed food insecurity motives of Boko Haram by examining the crops and livestock products that it is attracted to. From models 4, 5, and 6, the signs of the coefficients suggest that Boko Haram's probability of attacking a place is enhanced when it produces rice and melons. The positive sign for the rice coefficient in the ATTACK model can be explained on the basis of its caloric content, the ease of gathering rice, its storability and ease of transport it while the positive sign for the melon coefficient can be explained on the basis of its nutrient content, the ease of gathering the product, storability and ease of transport. The statistically significant and negative sign for the coefficient for yams in the ATTACK model can be explained. Despite the ease of transport, relative non-perishability and the high calorific content, it is difficult to gather (much digging is involved). The statistically significant and negative signs for the coefficients for ground nuts and cashew nuts in the ATTACK model is intriguing. It suggests that despite the ease of transport and relative non-perishability, it is not highly attractive to Boko Haram. This may reflect the difficulty involved in gathering these products and the low calorific contents. Finally, the statistically significant and negative signs for the coefficient of sugarcane in ATTACK and ATTACKS may reflect the fact that it serves essentially as a sweetener. The insignificance of the coefficients for ATTACK in the soybeans, cassava, maize, cotton, millet and cola nut suggests no interest in these products by Boko Haram. These can be explained on the basis of difficulty in gathering, despite their easy non-perishability and ease of transport.

The frequency of attacks and fatalities coefficients are positive for rice and soybeans, suggesting more repeated activity and more struggle when Boko Haram attacks rice and soybean producing places. These are high value crops and producers of these products are expected to more likely mount defensive strategies to protect their crops. The FATALITIES coefficients for cassava and millet are negative while the ATTACKS coefficient for millet is negative, suggesting the lack of interest in these product by Boko Haram. The coefficients for yam and cashew nuts were positive for the FATALITIES model, but negative for the ATTACKS model, suggesting that while Boko Haram does not prefer to attack places producing these products, when they do, the

fatalities are more pronounced. These can be explained based on the high values of these products. It appears that farmers in these areas do fight back in an attempt to protect their products or Boko Haram has disdain for them because of their revenue potentials. In the case of groundnuts, the coefficient for ATTACKS is negative and significant, suggesting low frequency and incidence of attack. Surprisingly, despite its calorific and nutritional value and the ease of transport, maize is of no interest to Boko Haram. The explanation for this is that it can be grown easily anywhere and Boko Haram does not need to attack places to get maize. Kola nuts and sugarcane are of no interest and fewer fatalities are associated with places that produce them. Melons are of interest, but fewer fatalities are associated with places that produce them. Cotton is of no interest to Boko Haram, for obvious reasons.

Finally, examine the livestock products that attract Boko Haram. From models 4, 5, and 6, the signs of the coefficients suggest that Boko Haram's probability of attacking a place is enhanced when they produce chicken and turkey, but not pigeons, cattle, goats and sheep. The coefficients for chickens and turkeys are expected, considering the hypothesis that Boko Haram will prefer animals that are easy to cart away. The coefficients for cattle, goats and sheep can be explained on the same basis because they are bulky and more difficult to manage. However, it is difficult to explain why they are not attracted to pigeons as these are also birds like turkey and chickens. The coefficients for chickens is positive for the ATTACKS model, suggesting that chicken producing areas are also more subject to repeated attacks. The positive fatalities model coefficients for chicken and the insignificant fatalities model coefficients for turkey suggest greater struggles when Boko Haram raids chicken producing areas, but almost no struggle when it raids turkey producing areas. The fatalities model coefficients for cattle, goats and pigeons suggest no suggest no interest in these animal products on the part of Boko Haram.

The coefficients of the constant term suggest that on the average, a given rural place is not likely to be attacked if it has no asset at all. But adding specific agricultural capacity and place assets to its attributes, the likelihood of attack can increase. In general, the assets that attract Boko Haram attacks include better access to western education, greater feeling of despair, place productivity (employment opportunities), lack of electricity, melon and rice production, and chicken and turkey production.

E. Summary and Conclusions

A significant amount of literature has focused on the root causes of terrorism and the economic consequences of terrorism. While it is generally accepted by scholars, policy makers and security agencies that a causal relationship exists between food insecurity and national security and several policy instruments have been adopted and implemented to enhance national security through food security, there is little or no empirical evidence of such causality. The purpose of this research was to explore the nexus between food insecurity and national security by focusing on the terrorism element of the latter. More specifically, to explore this nexus, the study develops conceptual frameworks for exploring the causality between food insecurity and terrorism, the socio-economic impacts of terrorism on the agricultural and food sector, and the reasons for terrorists to particularly target agricultural producing. In the latter case, a theoretical model was developed to explain how and why specific places producing specific agricultural crop and livestock products might be targeted.

Boko Haram is probably the most lethal and deadliest terrorist organization in the world today. The broad scope and the diversity of its attacks provides a rich context for exploring the causes, consequences and attack location choices of terrorist organizations, enabling one to explore deeper the tactics and modalities of terrorists. The Boko Haram experience is used as a case study because of the rich context it provides. Specifically, the food insecurity motive of Boko Haram is focused on since, despite strong anecdotal evidence of the connection between food security and terrorism, no empirical evidence previously exists.

With respect to root causes, by combining evidence from the literature with evidence from the Boko Haram insurgency, a typology is developed that proposed four different motives of terrorists: (a) human damage, (b) infrastructure damage, (c) capacity building, and (d) food security. This typology is applied in developing the conceptual framework for understanding the pathways between causes of insurgency and insurgency itself. The CAUSE framework suggests the notion of a tipping point where general unhappiness in society can rapidly transform into the beginnings of insurgency if it is triggered by aggravating factors. The significant attention paid by

international aid and development agencies to programs that promote food security suggests the need to better understand this tipping point.

With respect to the targeting behavior of terrorists, the theoretical model advanced to link the motivations to the nature of their attacks suggest that terrorists attack more urban places because of their visibility, the concentration of infrastructure, the concentration of population and the strong likelihood of severe infrastructure and human toll. However, it also suggests that terrorists strategically chose agricultural places to attack in order to fulfill their own organizational food security and capacity building needs, as well as their objective to create food insecurity. Places producing products that can be easily carted away are hypothesized to be more vulnerable to attacks. The application of this model to Boko Haram data suggests that places producing chicken, turkey, rice and melon are more exposed to attacks and more likely to be attacked to meet the food security needs of Boko Haram and its food security capacity building objectives. However, places producing yam, groundnuts, sugarcane and cashew nuts are less exposed to attacks perhaps due to the difficulty of getting access to harvested products or the ability of producers to protect themselves due to the high value of the products. Places producing cassava, maize, cotton, kola nuts, cattle, sheep and pigeons seem to be largely irrelevant from an attraction standpoint. Places producing soybeans, yam, rice, kola nuts, cashew nuts and chicken seem to involve more fatalities, suggesting either that Boko Haram's objective in such places is to destroy capacity or that farmers resist their attacks, leading to greater fatalities. These results provide empirical evidence of a relationship between food insecurity, terrorism and national security.

One implication of these findings is that based on the nature of agriculture in a place, security agencies can better plan for the protection of lives, infrastructure and agricultural assets. In other words, if security agencies know what terrorists target for destruction, they can beef up security in such places to mitigate the losses and focus less on other places. Another implication is that if we know where terrorists want to go in order to cart away food to support their food needs, security agencies can also better fortify those areas as part of a strategy to choke off the food supply of terrorists.

A better understanding of the consequences of terrorism can help accentuate progressive abatement and prevention programs. However, such programs and strategies need to be tested for effectiveness. Deeply understanding the economic consequences is foundational to developing a cost benefit analysis for recovery and abatement and the strategies of optimal response scaling can be developed. It also paves the way for developing a “cocktail of responses” that comprehensively address the issues, rather than piecemeal strategies that cannot address the problem holistically.

The relationship between food insecurity and national security deserves significantly more research attention. First, depending on how strong the relationship is and the relative costs of attaining food security versus managing the resulting crisis, the potential to stave off conflict by targeting policies to promote food security can be proactively pursued. Second, insurgency and terrorism, when they start, often become intractable and take on lives of their own. Costs that are well understood are better dealt with than unknown costs. Deeper understanding of the food security-related mechanisms that give rise to terrorism increases the willingness to pay for early warning systems and abatement decision support systems. Third, knowledge about this relationship could help support the advancement of food security programs as much higher priorities in developing countries.

This study is just an early stage attempt to investigate the vulnerability of food security to terrorism. More work is needed in this area of inquiry to strengthen preparedness, early warning systems and community protection strategies. Specifically, more work is needed in predicting and forecasting terrorist events. With efficacious predictive models, the efforts of security agencies can be better planned, people can be better protected and critical assets can be better defended. The documentation of the costs and consequences of terrorism with respect to food security also deserves more research attention. A priori knowledge of such costs can help motivate more proactive action on the part of government to prevent unrest. Similarly, humanitarian response agencies and development partners can benefit from such information by using it to predict post-crisis intervention needs.

Table 1: Objectives of Terrorists and Conceptualized Effects of Terrorism.

Human Impacts	Infrastructure Impacts	Capacity Impacts	Food Security Impacts
a. Where they attack	h. Critical nature of facilities damaged	m. Extent to which destructions & damages deter counter-attacks.	u. No. of farmers killed
b. How frequently the area is attacked	i. No. of facilities damaged	n. No. of recruits	v. No. of injured farmers
c. No. of fatalities	j. Value of damaged facilities	o. Acquired weapons	w. No. of farmers kidnapped
d. No. of injured	k. Disruptive economic effects of damage & destroyed facilities	p. Stolen combat equipment	x. No. of displaced farmers
e. No. of IDPs	l. National/global visibility of damaged & destroyed facilities	q. No. of captured farmers.	y. Destroyed markets
f. No. of captured or kidnapped persons		r. Stolen foods	z. Destroyed food supply chain
g. National/global visibility of injuries, fatalities, captured & kidnapped		s. Stolen farm equipment	
		t. Stolen seeds & other inputs	

Table 2: Matrix of Hypothesized influence of Terrorism on Various Sectors

<i>Impacts</i>	<i>Sector</i>								
	Agri-food	Telecom	Industry	Education	Health	Utilities	Tourism	International Trade	Governance
Infrastructure Destruction		X		X	X	X			X
Supply Chain Disruption	X	X	X		X	X			X
Labor Migration	X		X	X	X				X
Talent Migration	X		X	X	X			X	X
Maintenance and Loss of know how	X								X
Logistics Interruption		X	X			X			X
Market Disruption	X		X	X		X	X	X	
Operational Shutdown		X			X	X	X	X	X
Added Security Cost		X	X	X	X	X			X
Co-option	X	X		X					X
Isolation	X	X	X	X	X	X	X	X	X

Table 3: Hypothesized Effects of Terrorism on Agriculture and Food Systems

Type of Effect	Effect Name	Sign
1. Agriculture ground to a halt	Stoppage	(-)
2. Destruction of backward linkages to agricultural input supply chain	Input	(-)
3. Reduction of connectivity to value added market opportunities	Market	(-)
4. Lost farm income	Lost Income	(-)
5. Disruption of local food economy	Food Economy	(-)
6. Disruption to land tenure arrangements	Land	(-)
7. Mining of farm fields	Land Mining	(-)
8. Destruction or capture of machinery and equipment	Mechanization	(-)
9. Destruction of irrigation and water storage systems	Water Infrastructure	(-)
10. Carting away fertilizer and other farm inputs	Input	(-)
11. Capture of competent farmers	Farmer Capture	(-)
12. Recruit people to indoctrinate	Recruitment	(-)
13. Capture the territory	Territory Capture	(-)
14. Farmers run away to become IDPs refugees	Farmer IDP	(-)
15. Political representation disrupted: politicians are killed or run away	Political Agency	(-)
16. Agricultural extension personnel also leave	Extension	(-)
17. Terrorists plant Improvised Explosive Devices (IEDs) to prevent farming	IED	(-)
18. Higher transportation cost	Transportation	(-)
19. Higher risk levels	Risk	(-)
20. Disconnection of farmers from their livelihoods	Poverty	(-)
21. Use of existing infrastructure to grow food for their own needs	Cooption	(-)
22. Capture, maim and kill people farm workers	Reduced Labor	(-)
23. Farmers/managers who take-off are those with better skills	Entrepreneurial	(-)
24. Agricultural extension personnel also leave	Extension	(-)
25. Difficulty in jumpstarting the economy	Jumpstart	(-)
26. Terrorized areas face greater incidence fears	Fear	(-)
27. Higher food prices due to greater risk and shortage	Product Price	(-)
28. Higher agricultural prices due to greater risk and shortage	Input Price	(-)

Table 4: Variables Considered in Alternative Models of Terrorist Attack Choices.

Variable Name	Description	Source	Original Scale
objectid	Geo Identifier for grid cell	Software generated	grid
ATTACKS	Number of terrorist attacks in grid cell	Calculated	Point
ATTACK (DUM)	Whether or not a grid cell was attacked	ACLED	grid
FATALITIES	Total fatalities in grid cell	ACLED	grid
statename	State that cell belongs to	Calculated	grid
bay	Dummy for Borno, Adamawa and Yobe (Bay) States (1= yes, null=no)	Calculated	grid
northeast	Dummy for Northeast (1= yes, null=no)	Calculated	grid
built	50% of the grid cell is considered built environment	Calculated using GIS and aerial imagery	grid
sambisa_dist	Distance from Grid Centroid to Sambisa Centroid	Calculated	grid
yola_dist	Distance from Grid Centroid to Yola	Calculated	grid
sanitation	Access to improved sanitation (% of population)	Strauss Center SNAID	State
roadlength	Road Length in grid (meters)	NIAF Roads, Calculated	Grid
roaddensity	Road Density In grid (meters of road/sqm of area)	NIAF Roads, Calculated	Grid
electric	Electricity in household (% of households)	Nigeria National Bureau of Statistics	LGA
population	Total Population in 2010	FMARD AG Population	State
income	Household Income_Head & spouse 2010	NIAF, Third Dimension Technologies	LGA
unemployed	Percentage unemployed 2010	Nigeria National Bureau of Statistics	State
edat_primar	No. of People that Attended Primary	Nigeria National Bureau of Statistics	State
worseoff	2010 % people who Perceived Economic Situation as Much Worse in 10 Years	NIAF, Third Dimension Technologies	LGA
ag	Agriculture is 50% or more of land in grid	Calculated using GIS	grid
cattle	Cattle Production 2009 Inventory	FMARD and FAO	State
goat	Goat Production 2009 Inventory	FMARD and FAO	State
sheep	Sheep Production 2009 Inventory	FMARD and FAO	State
chicken	Chicken Production 2009 Inventory	FMARD and FAO	State
turkey	Turkey Production 2009 Inventory	FMARD and FAO	State
pidgeon	Pidgeon Production 2009 Inventory	FMARD and FAO	State
cassava	Area Planted of cassava, Ha	FMARD and FAO	State
maize	Area Planted of maize, Ha	FMARD and FAO	State
cotton	Area Planted of cotton, Ha	FMARD and FAO	State
groundnut	Area Planted of Groundnut, Ha	FMARD and FAO	State
millet	Area Planted of Millet, Ha	FMARD and FAO	State
rice	Area Planted of Rice, Ha	FMARD and FAO	State
yam	Area Planted of YamHa	FMARD and FAO	State
mellon	Area Planted of Melon, Ha	FMARD and FAO	State
soybeans	Area Planted of Soybean, Ha	FMARD and FAO	State
sugar cane	Area Planted of Cane, Ha	FMARD and FAO	State
cashew	Area Planted of Cashew, Ha	FMARD and FAO	State
kola	Area Planted of Kola, Ha	FMARD and FAO	State

Table 5: Empirical Results for Boko Haram Insurgency Attacks: All Northern Nigeria Data

Data	TOTAL NORTH					
	ATTACK Dummy		ATTACKS Count		FATALITIES Count	
Pseudo R ² or R ²	.1632		.4649		.3576	
No. of Observat.	910		910		910	
Indep. Variables	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
ag	-0.3198358	0.2374415	-0.7906711	0.4895825	-0.2306223	.423903
length_m	-0.000031*	0.0000128	-0.0000299*	7.09e-06	-0.0000386	7.70e-06
density	24361.97*	9751.076	23468.45*	5378.16	30009.65*	5804.061
edat_primar	22.09021*	5.27962	27.92521*	7.994318	19.89819	8.421897
total-popula	-1.49e-06	1.79e-06	-6.17e-07	3.65e-06	5.82e-06	3.88e-06
income_headspouse	-0.0317573	0.0138771	-0.0121621	0.0177952	0.0175771	.0253238
sambisa_dist	-2.77e-06*	1.05e-06	-3.01e-06*	1.24e-06	-5.06e-06*	1.86e-06
yola_distance	3.24e-06*	1.30e-06	3.22e-06*	1.66e-06	5.42e-06	2.37e-06
unemployed	0.011814	0.1116898	-0.0019149	0.1788422	-0.1103787	.2559959
muchworseco	0.034489*	0.0155879	0.0580103*	0.022039	0.0373716	.028632
isanitatn	-0.348504*	0.1007708	-0.1481179	0.195156	-0.0216542	.2377168
elechh	-0.005229	0.0104833	-0.0260228	0.0147275	-0.0282885	.0139859
Constant	-2.264745	.9422555*	-2.64935	1.847546	-.1707678	2.205666

Table 6: Empirical Results for Boko Haram Insurgency Attacks: Northeast Nigeria Data Only

Data	RURAL NORTHEAST					
	ATTACK Dummy		ATTACKS Count		FATALITIES Count	
Pseudo R ² or R ²	.4512		.7633		.7678	
No. of Observat.	587		587		587	
Indep. Variables	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
length_m	0.0000152	0.000072	3.73e-06	0.0000679	-7.11e-06	0.0000729
density	-10385.97	54463.62	-1556.094	51295.67	6637.692	55139.44
edat_primar	44.60441*	13.01189	21.04998*	7.935177	26.98764*	13.76729
total-popula	5.84e-06	7.93e-06	0.000014*	7.49e-06	0.000025*	7.55e-06
income_headspouse	0.0434139	0.0281419	-0.026105	0.0214688	0.0144252	0.0381899
sambisa_dist	4.33e-06*	2.48e-06	4.23e-06*	2.23e-06	-6.85e-06*	3.38e-06
yola_distance	-5.51e-06*	2.97e-06	-5.12e-06*	2.51e-06	7.26e-06	4.61e-06
unemployed	-0.7008036*	.2767813	0.1790328	0.1683241	-0.0636993	0.2797626
muchworseco	0.1547324*	0.0520459	0.0404129	0.0367133	0.0351743	0.0548219
isanitatn	-0.1855846	0.2600977	-0.4635286*	0.201182	-0.475665*	0.2626077
elechh	-0.0587384*	0.0250292	-0.0539309*	0.0233577	-0.051065*	0.0270129
soybean	0.0183977	0.0234324	0.0466969*	0.0213957	0.104644*	0.0515059
cassava	0.0161542	0.0119783	-0.0428063	0.0325833	-0.094476*	0.0149929
maize	-0.0102988	0.0084557	-0.0017291	0.0074101	-0.0104517	0.0065196
yam	-0.0612498*	0.0164557	-0.014005	0.0470029	0.034633*	0.0162516
rice	0.0446156*	0.0176919	0.0328489*	0.0125322	0.056930*	0.0150894
cotton	0.0095556	0.0106664	-0.0136401	0.0273149	0.0092951	0.0137204
ground nut	-0.0108231*	0.0037514	-0.0089822*	0.00495	-0.0059054	0.0062764
millet	0.0011618	0.0017009	-0.0071252*	0.003429	-0.018549*	0.0058074
melon	0.0570075*	0.0197091	-0.0247362	0.0910925	-0.179453*	0.0397464
sugar-cane	-0.2922307*	0.1014085	-0.039931*	0.176301	-0.543235*	0.217866
cashew	-0.2901215*	0.1315945	-0.0195765*	0.1826701	0.619604*	0.2416951
Kola nut	-0.3644299	0.2602376	-0.1313528	0.0895242	-0.874991*	1.200379
cattle	-6.81e-07	9.95e-07	-1.11e-06	9.78e-07	-2.04e-06*	1.07e-06
goat	-3.76e-07	5.39e-07	-2.81e-07	3.46e-07	-2.69e-07	4.20e-07
sheep	3.19e-07	6.71e-07	3.08e-07	5.97e-07	5.48e-07*	6.68e-07
chicken	6.56e-07*	3.14e-07	6.02e-07*	2.64e-07	7.90e-07*	2.77e-07
turkey	0.000066*	0.0000272	2.85e-07	0.0000185	0.0000284	0.0000353
pidgeon	-6.09e-06	5.17e-06	-3.91e-06	3.09e-06	-7.34e-06	5.52e-06
constant	-7.445156*	2.847017	-0.4918589	2.126709	-1.347773	3.16618

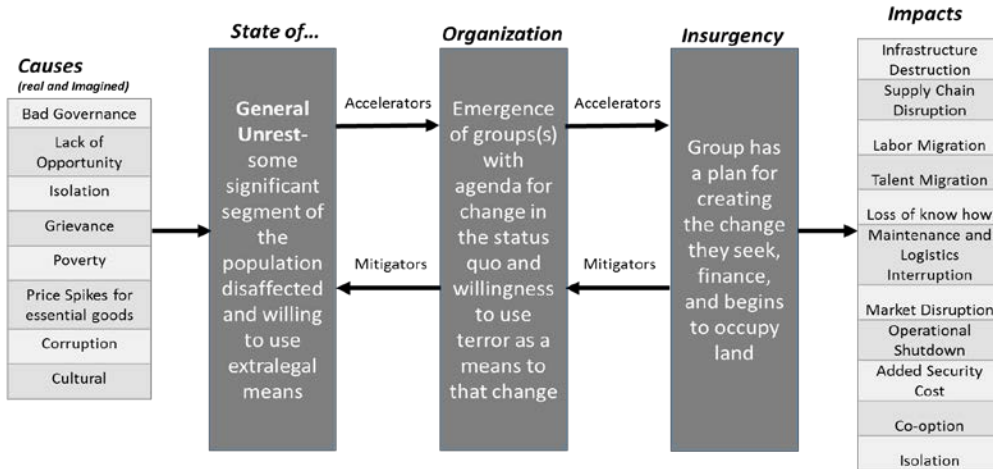


Figure 1: Pathway to Insurgency: Causes, Effects, Group Emergence and Impacts

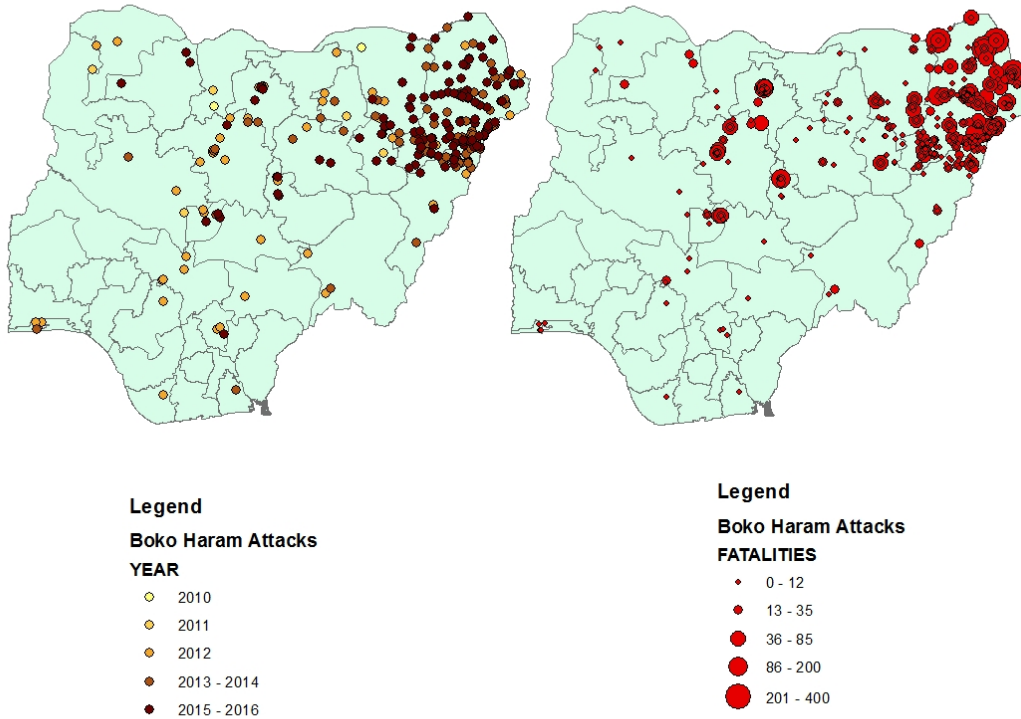


Figure 2: Boko Haram Attacks and Fatalities, 2010 – 2016.

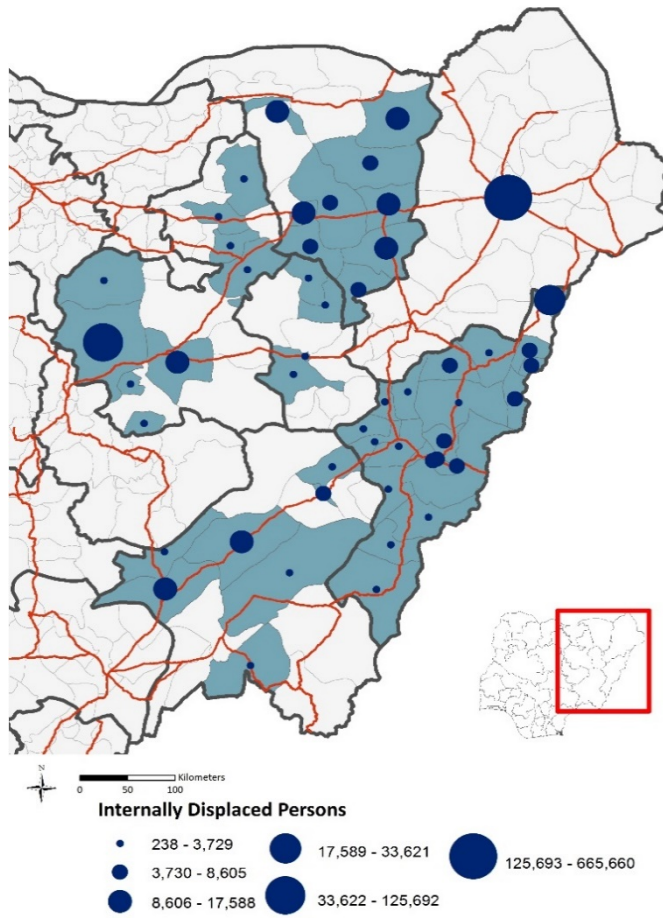


Figure 3: Internally Displaced Persons (IDPs) from Boko Haram

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