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HOW CAN INCLUSIVE AGRICULTURAL HEALTH POLICY INTERVENTION PROMOTE SHARED AGRICULTURAL PRODUCTIVITY IN NIGERIA? EVIDENCE FROM RANDOMIZED CONTROL TRIAL

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ABSTRACT

We engaged randomized control trial to measure the effects of an agricultural health training intervention among 480 randomly assigned crop farmers from 24 farming communities in Nigeria. Structured questionnaire, interviews and random farm visit were used for data collection. The intervention component includes one-time village level agricultural health training and a three-month farm safety mobile text messaging follow up. We engaged a peer-developed module covering safe ergonomic practices and safe use of agrochemicals for the training. Findings from the study revealed that every one day increase in sickness absence decreases farmers' labour productivity by 3% ($p<0.01$); the agricultural health intervention reduced sickness absence in the season by 1.9 out of 6.5 days (29%) with significant improvement in farmers' agricultural health knowledge and attitude ($p<0.01$). However, we documented weak evidence on the intervention effect on farmers' labour productivity. The study concluded that cassava farmers were engaged in unsafe farm practices exposing them to some health risks which negatively affect their well-being. Although, evidences from the study supports that the intervention enhanced farm safety knowledge, attitude and reduced sickness absence in short term, additional research is needed to establish the long-term intervention effects and explore issues of cost effectiveness of the intervention.

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1. Introduction

The quality of labour productivity which refers to the quantity of labour input required to produce a unit of output is an important measure of a nations' well-being. Though, labour input is not the only input utilized in the production process. High labour productivity can be an important signal of the improvement in real incomes (wages of labour). It also has implications for the conduct of both monetary and fiscal policies of a nation. In many developing economies like Nigeria with large endowments of labour, enhancing the labour productivity is an important way boosts the nations' economy (National Bureau of Statistics [NBS], 2017).

Health is viewed as a tangible asset in production process (capital good). It is not just a pivot for labour supply but a critical factor for agricultural labour productivity and quality. Asenso-Okyere, et al (2011), posited Agriculture's role in human livelihood to mean that agricultural development has strong linkages with other fields of development practice and research, including health and nutrition. Therefore, the success of agricultural livelihoods depends on the health of its workforce. At the same time, different agricultural production systems have different impacts on health, nutrition, and well-being of the people. Households can use income from agricultural production for improved access to health products and services; agriculture provides food and nutrients for energy, as well as maintenance of good health. On the other hand, exposure to agricultural related health risks affect nutrient absorption and people's nutritional status. Poor health will result in a loss of days worked or in reduced worker capacity, and is likely to reduce output productivity. Limited access to food may occur in a household if individual are too ill or overburdened to produce or earn money to buy food (Keverenge-Ettyang et al., 2010).

Worldwide, agriculture-related health losses are massive, accounting for up to 25 percent of all disability-adjusted life years lost (DALYs) and 10 percent of deaths in low-income countries (Gilbert, Lapar, Unger, & Grace 2010). Furthermore, ILO reported the agricultural sector as one of the most hazardous to health worldwide (as cited in Loureiro, 2009). Occupational hazards in agriculture range from simple conditions like heat exhaustion to complex diseases like respiratory disease, zoonotic disease, and poisoning from agrochemicals (International Food Policy Research Institute [IFPRI], 2011). It is estimated that 2 to 5 million people suffer acute poisonings related to pesticides annually, of whom 40,000 die every year; and there are 170,000 recorded fatal injuries in agriculture annually (Cole, 2006). As reported by Nuwayhid cited in IFPRI, (2011), in spite of these numbers, occupational health in general, and in agriculture in particular, remains neglected in most developing countries (as cited in IFPRI, 2011).

World Bank estimated about 355,000 people yearly die from unintentional chemical poisoning from exposure to pesticides. Two-thirds of these victims are found in developing countries (World Bank, 2007). Further estimates by the WHO showed that globally, 30 million people suffer severe chemical poisoning cases annually and 25 million of these occur among agricultural workers in developing countries (Duffy, 2007; Kuye, et al., 2008). In addition, effects of unsafe agrochemicals use have been linked to some non-communicable diseases (NCDs) such as cancers and respiratory diseases. WHO (2013), indicated that NCDs cause over 36million deaths each year with 80% of this in low and medium income countries. The occurrence of NCDs and related deaths is expected to grow by 2020 with the largest projected increase in the African region (Lim et al., 2012). With this projection, without appropriate interventions, agriculture the largest employer of labour in Africa will suffer.

Access to agricultural health training is generally low among farmers and this has been linked to increase in pesticide-related diseases (Antle & Pingali 1994 as cited in Asenso-Okyere, Chiang, Thangata, & Andam, 2011). Lack of such training could lead to unsafe practices among farmers. This could lead to agricultural injuries and diseases affecting farmer's productivity and income. Asenso-Okyere et al. (2011) highlighted the effects of ill health on farm households to include production loss time due to ill health (and eventual death); loss of family time diverted to caring for the sick; and loss of savings and assets in dealing with disease and its consequences. The long-term impacts of ill health include loss of farming knowledge, reduction of land under cultivation, planting of less labour-intensive crops, reduction of variety of crops planted, and reduction of livestock. The ultimate impact of ill health is a decline in household income and possibly food insecurity leading to severe deterioration in household livelihood (McNamara, Ulimwengu & Leonard 2010; Asenso-Okyere et al., 2011).

Poor work-posture from poor ergonomic practices leads to musculoskeletal disorders (MSDs). These disorders have consequences including pain at the lower and upper back, shoulders, ankles, knees, elbows, neck, wrist and hand. Furthermore, chronic musculoskeletal disorders include back pain, neck pain, tenosynovitis (inflammation of the wrist tendon), bursitis (inflammation of the shoulder joint fluid sac (bursa) and osteoarthritis of the knee (degeneration of the knee joint cartilage), identified to be very common among agricultural workers (Erondu & Anyanwu, 2005; Moreau & Neis, 2009; Myers, 2010; Durborow et al., 2011). Fathalah (2010) submitted that MSDs are so common among experienced farmers that most of them perceived it is inevitable consequences of farm labour. These issues are yet to receive the needed attention in Nigerian Agriculture in terms of research, awareness programmes and agricultural health policy. The paucity of agricultural health data in Nigeria an agrarian nation is of concern. Unsafe agricultural practices from poor agricultural health literacy and poor safety management are still major challenges predisposing farmers to health risks in agricultural workplaces. However, a clear understanding of the extent of agricultural health risks, effect on farmers' productivity is necessary in the design of any policy intervention.

Currently, systematic studies on agricultural related risks that are work related are rare in Nigeria. Although, the problem is acknowledged, the extent of these problems and its effects among crop farmers in Nigeria remains largely unclear. The dearth of agricultural health data in Nigeria has provided no impetus for policy formulation in this regard. This research is an attempt to bridge this research gap by providing estimates on agricultural related health risks along the cassava production chain, their effect on farmers' productivity as well as the effectiveness of an intervention in combating the challenge; and gauging the short-term effects of the intervention among crop farmers in Nigeria. The inclusive agricultural health policy is expected to cater for the occupational health of the agricultural workforce. It is specifically expected to address the health and safety of farmers, farm workers and farm families which at the moment is not in place in Nigeria.

2. Materials and Method

2.1 Study Area

The Study was carried out in Kogi and Kwara States, Nigeria. Both states are found in the North-Central Geo-political zone of Nigeria.

Figure 1: Map of Nigeria showing the location of Kogi and Kwara State. Source: http://www.ngex.com/nigeria/images/maps/nigeriamap.gi

2.2 Study design and Intervention

This study is a longitudinal study of a randomized control trial approach focused on agricultural health intervention for cassava farmers in Nigeria. The general objective of the intervention project is to reduce negative health effects of agricultural health risks especially agrochemical and ergonomics health risks. The main elements of the intervention consist of educating farmers via training and reinforcement of the training with farm safety mobile text messaging, sent to farmers two-times a month for 3months. Farmers were provided a one-time agricultural health education using focus group discussion at village level with standardized module on safe chemical use and ergonomics. The training content was developed based on health risks issues of priority from data collected at baseline. This section was followed up with farm safety mobile text messaging for three month. This was meant to reinforce the physical training to help farmers' engagement of safe and healthy farm practices. The baseline data collection was carried out from February 2017 to April 2017 from Kogi and Kwara States, Nigeria. The post intervention data collection was between August and November, 2017. However, the endline labour productivity data collection was collected in May, 2019 to ensure farmers have harvested their cassava tubers. The two States are in the North central Zones of Nigeria which accounts for about 30% of the cassava produced in Nigeria. Kogi State is located in the North-Central geo-political zone of Nigeria. It extends from latitudes 6.33^{o} N to 8.44^{o} N and from longitudes 5.40^{o} E to 7.49^{o} E. The State covers a land area of about 75,000 square kilometers. The current population figure for Kogi State is 3,278,487 people based on the 2006 population census, which comprised 1,691,736 males and 1,586,750 females (NPC, 2006; KOSEED, 2006). While lies between latitudes 7^{0}45'N and $9^{0}30^{!}$N and longitudes 2^{0}30'E and 6035'E and has an estimated population of about 2.37 million people (Kogi ADP, 2003 and Ibitoye, 2006). Both States are summer rainfall area, with an annual rainfall range of 1000mm to 1500mm. The months of December and January coincide with the cold and dry harmattan period, while the annual rainfall pattern across the state extends between the months of April and October. Kwara State has minimum temperature ranging from 21.1^{0}C to 25^{0}C and average maximum temperatures varying between 30^{0}.C and 35^{0}.C (FOS, 1995). While Kogi has an annual season daily mean temperature of 28' C, while in the hot season, the average temperature is about 35'C. High humidity is also common (Ibitoye, 2006).

2.3 Study Participants

Agriculture is a major livelihood means in Nigeria. Cassava is a major crop grown in the study area. However, the study engaged cassava farmers that use agricultural chemicals, and the farmer applies the chemicals and he/she is actively engaged in the manual labour of the farm. The sample included 240 farmers from each state making a total of 480 participants. The sample size is estimated using optimal design (OD) software developed by Steve Raudebush was engaged for power calculation (Raudenbush, *et al.* 2011). Using lottery design 20 respondents each were randomly assigned to the study in 24 cassava cropping communities with a power of 80%. The sample however, is over 5% of the population of cassava farmers from the 24 farming communities engaged in the study. Agricultural health intervention was randomly assigned to 200 farmers. 172 of the treatment completed the treatment due to attrition. This sample size was deemed sufficient to give a realistic picture of the situation on agrochemical health risk exposure, knowledge, attitude and practices among pesticide using cassava farmers based on experience from similar studies in other parts of the world (Jensen *et al.,* 2011; Oesterlund, *et., al* 2014). The selection of farmers was done by random assignment into the study based on the entry criteria.

2.4 Standardized interviews

All participants were interviewed individually using a standardized structured questionnaire, augmented with focus group discussion and random farm visit at both baseline and post intervention data collection. The post intervention data collection was collected 6months after the completion of the treated. The questionnaire with simple questions was developed on the basis of a questionnaire tested and used in similar studies in Africa.

2.5 Statistical methods

Descriptive statistics, ordinary least square regression, difference-in-difference estimator were used for analysis. Ordinary Least Square Regression: In estimating determinants of sickness absence among farmers: ordinary least square regression was modeled. The implicit model is stated as

$$Y = ß_0 + ß_1 X_1 + ß_2 X_2 + \ldots\ldots\ldots\ldots + ß_5 X_5 + e_t \quad (1)$$

Y= sickness absence in days

X_1=Age of farmer

X_2=Education in years

X_3=Daily duration of chemical spray

X_4=Care time (days)

X_5=Number of ergonomic exposure

e =Error term

ß0, ß1… ß5=regression coefficients

Ordinary Least Square Regression: In estimating the effects of exposure to health risks on crop farmers' productivity: Ordinary least square regression was modeled. The implicit model is stated as

$$Y = ß_0 + ß_1 X_1 + ß_2 X_2 + \ldots\ldots\ldots\ldots + ß_6 X_6 + e_t \quad (2)$$

Where Y is the average labour productivity of farmer derived from the formula

Cassava Output (tons)/Labour (man days).

$X_{1=}$Age of farmers (years)

X_2=Farmers' Production loss time (days)/sickness absence

X_3= Estimated duration of self-reported chemical symptoms exposure (hours)

$X_{4=}$ Farming Experience (Years)

$X_{5=}$ Number of ergonomic exposure

$X_{6=}$Educational level (years of schooling)

e =Error term

ß0, ß1… ß6=regression coefficients

Difference in Difference estimator: In estimating the effects of the training intervention on farmers' production loss days/sickness absence, farm safety knowledge and attitude; and labour productivity. The Difference in Difference estimator (DID) was adopted with the form:

$$Yit = \alpha + \beta 1 \text{Treat}i + \beta 2 \text{Post}t + \beta 3 (\text{Treat} \cdot \text{Post})it + \epsilon it \qquad (3)$$

Yit is the outcome variable for an individual i at time t, *is the constant* ,$Treati$ is the dummy equals 1 if treated and 0 if not treated, and$Postt$ is the dummy equals 1 if data collected at post intervention, 0 if at baseline , the Treat · Post is the interactive effect, $\beta 1, \beta 2$ and $\beta 3$ are the coefficients. However, α measures the average treatment outcome before the program.

$\beta 1$ measures the difference between treatment and control before the program (selection effect)

$\beta 2$ measures changes accross time in the outcome varible common to both groups

$\beta 3$ measures the average treatment effect of the program on the outcome variable .

Attrition is the number of respondents lost from both group due to varying reasons. The study recorded attrition of 14% (28) for the treated group and 16% (45) for the control group. Attrition among the treated group was mainly due to inability of some of the respondents to receive the six (6) follow up text messages leading to uncompleted treatment and the control attritees were largely due to their unavailability during post treatment data collection.

3.0 Results and Discussion

Table 1: Baseline farmers' knowledge, attitude and practice in chemical use (N=480)

	Item	Frequency	%
1	Mostly used WHO chemical Class		
	WHO class II only	96	20
	WHO class III only	144	30
	WHO class II and III	240	50
2	Hand washing after spraying		
	Yes	256	53
	No	224	47
3	Cloth changing after spraying		
	Yes	336	70
	No	144	30
4	Other use of agrochemicals		
	Home surrounding spray	384	80
	Pest spray	48	10
5	Hand washing before eating in the field		
	Yes	64	13
	No	416	87
6a	Sprayer washing		
	Yes	304	63
	No	176	37
6b	Sprayer washing place		
	In the field	261	86
	Near the stream	21	07
	At home	21	07
7	Container management		
	Throw in the field	312	65
	Bury in the soil	48	10
	Burn in the field	48	10
	Washed and re-used as household container	72	15
8	Chemical measurement into sprayer		
	The use of chemical lid cap	288	60
	Measured by experience	192	40
9	Reading of chemical label		
	Yes (occasionally)	336	70
	Yes (always)	29	06
	No	114	24
10	Adherence to advice on chemical label		
	Yes (Sometimes)	254	53
	No	226	47
11	Information read on chemical label		
	Expiration date	480	100
	Safety instructions e.g Protective gear use	96	20
	Re-entry time	24	05
	General Instruction of use e.g mixing volumes	400	83
12	Understanding of safety instructions on label		
	Yes	144	30
	No	336	70

Source: Baseline Survey, 2017

The World Health Organization (2009), recommended classification of pesticides by hazard was used to classify pesticides used by farmers. This classification is used to distinguish the more and less hazardous forms of pesticides from each other based on the acute risk to human health, ranging from extremely hazardous (class Ia), highly hazardous (class Ib), moderately hazardous (class II), slightly hazardous (class III) to unlikely to present acute hazards (class U) (World Health Organization, 2009). This study found that most of the farmers used the WHO class II and III chemicals for their farms. See table 1. This was in consonance with other studies in Africa as Oesterlund et al., (2014) earlier reported WHO class II and III pesticides as mostly reported chemicals by small-scale farmers in Uganda. However, an observational study conducted concurrently in the same two districts among pesticide dealers and their stock of pesticides supports the finding that the pesticides used are mainly class II and pesticides of lower toxicity sold, as no class I pesticides were identified in the shops (Duus, 2011). Also, the study by Ngowi et al., (2006) in Northern Tanzania, close to the border of Uganda, has shown a low quantity of class I pesticides; while a study made in Ghana indicates that small-scale farmers mainly used class II and III pesticides (Ntow, 2001).

These studies suggest that African small holder farmers were not as exposed to class I pesticides as Asian and Latin American farmers. Marianela (2010) also reported that found that 95% of acute pesticide poisoning results from WHO class I and II. It should therefore be noted that class II and III pesticides are still classified as hazardous. They are known to have severe negative effect on human health and environment. Based on this, other less dangerous alternatives should still be promoted to farmers and application should be done with the appropriate safety measures.

This study also found that about 47% of the farmers do not wash their hands after handling chemicals either mixing/spraying. About 30% do not change cloths after spraying chemicals. 87% of the farmers reported non-washing of hands before eating on the farm and 70% use chemicals for home spraying apart from chemicals used on the farm. 63 % (304) reported they wash their sprayer after chemical use however 261 of this figure washed it on the field and 21 wash it near water stream and at home respectively. Washing near streams could and at home could pose the danger of unintentional chemical poisoning to farming households.

Further findings showed that after chemical use most farmers about 65% throw containers on the field, this could pose danger to farm kids who may pick container and re-use. 15 % reported they re-use containers after washing for drinking and other domestic ventures. These are bad safety habits as these may aid chemical ingestion. However, only a handful 20% buries or burn chemicals to discourage re-use of such containers. Ogunjimi and Farinde (2012), reported some other unsafe practices by farmers were associated with the use of pesticides by some sampled rural farmers in Nigeria to include non-use of protective gears like gloves, goggles and boot, the habit of drinking during the application of chemicals, not washing their contaminated cloths after use of chemicals, smoking during application, stored their chemicals in the living room together with foodstuff including bedrooms leading to health problems. These bad safety habits were in consonance with this present study.

Finding on chemical container management were in consonance with study by Bassi et al., (2016) who reported that about 78% of farming respondents disposed empty chemical containers on the field, 8% re-used the containers for domestic purposes while 2.63% used the containers as farm tools. It also agrees with the study carried out in Nepal which pointed out habits related to poor safety practices and re-usage of containers of agrochemicals among farmers. The study reported that 26.31% burnt the empty agrochemicals containers, 6.43% indicated that they used same for various household purposes (e.g., for food and water storage) while 14.61% indicated that they buried them and 29.23% indicated that they left the empty agrochemicals containers in their farms (Govinda, 2014).

Kuye et al. (2008) also found that 35% of the farmers disposed -off empty pesticide containers by burning, 55% by burying, and 55% also used other disposal methods. Of those who reported using other disposal methods, 90% reported dumping them in latrines, 5% dump in old wells, and 5% reported leaving them at the village seed store. A study carried out among cocoa farmers in Ondo State, Nigeria strongly agrees with the foregoing. The study reported 10.4% disposed pesticide container by burying it in the soil, 2.1% by burning, while 25.0%; sold them to buyers; however, the 35.4% majority washed their pesticide containers for other uses such as storing palm oil (Tijani, 2006).

Findings showed that about 70% reported occasional reading of chemical labels while 20% do not read labels at all. Further, probe shows that most farmers read expiration dates and mixing instructions on labels with neglect for safety precautions and re-entry time for chemicals. This non-reading habit of may have aided the non-usage of safety gears and non-compliance with the re-entry period. About 47% (226) do not follow the advice read on the labels while 53 reported they occasionally follow such advices. However, 70% reported they do not understand the information presented on the labels. This finding is corroborated by Oesterlund et al., (2014) who earlier reported that (26%) of farmers sampled said they were unable to read and understand these instructions.

Socio-economic characteristics of farmers

Table 2: Baseline Characteristics of randomly assigned treated farmers and control

	Treatment (N=200) Mean (Sd)	Control (N=280) Mean(Sd)	t-value for test of difference in means(p-value)
Socio economics			
Age	38.0(8.0)	39.0(8.4)	0.1(0.91)
Household Size	5.0(2.7)	5.3(2.3)	0.8(0.43)
Years of Schooling	13.6 (2.5)	13.3(3.6)	1.3(0.10)
Farming Experience	13.7(7.6)	14.4(7.4)	0.3(0.76)
Farm Size	2.1(2.9)	2.4(2.4)	0.4(0.68)
Monthly Health Expenditure	1193(1187)	1135(1028)	0.1(0.92)

Source: Baseline Survey, 2017

The primary purpose of this section is to provide information on the balancing of the two groups under study and to provide the socio-economic environment of the area where the RCT was implemented. Table 2 documents the socio-economic characteristics of respondents at baseline. All the farmers were male, with an average age of respondents was found to be 38 years with the oldest being 60years and the youngest being 24years old. On the average household members consists of 5members; household size varies in the range of 1-10 persons per household. The average schooling years and farming experience for the population was 13 years. The farm size was 2.2ha on the average. However, average monthly health expenditure was ₦1128.

Table 3: Baseline Characteristics of randomly assigned treated farmers and control

	Treatment (N=200) Mean (Sd)	Control (N=280) Mean(Sd)	t-value for test of difference in means(p-value)
Chemical and ergonomics			
Frequency of chemical spray/3months	12.5(3.5)	13.4(4.2)	0.4(0.7)
Daily duration of spray (hours)	5.9(2.4)	6.2(2.5)	0.04(0.9)
Years of chemical usage	9.0(2.6)	10.0(3.8)	0.5(0.6)
Re-entry time (hours)	15.0(7.4)	17.0(7.5)	0.2(0.8)
Spray times till harvest	3.0(2.5)	3.0(2.4)	0.6(0.4)
Number of symptoms	5.0(6.3)	4.0(5.2)	0.7(0.6)
Length of symptoms (hours)	13.0(2.5)	11.0(3.7)	0.8(1.2)
Ergonomic discomfort per week	2.0(3.3)	3.0(3.6)	0.4(0.6)
Production Lost time (days)/season	5.0(3.5)	6.0(4.4)	0.7(0.6)
Care time (days)/season	3.0(4.2)	2.0(3.6)	0.2(0.8)

Source: Baseline Data, 2017

Table 3 highlights the chemical and ergonomics characteristics of farmers in the two groups. It shows the two group shares similar characteristics, a basis for RCT use in the study. The average number of times a farmer sprays in 3 months period was found to be 12. This frequency of spray ranges from 3-30 times in 3months. Daily duration of spray was found to be 6hours with average years of chemical usage of 8years. The daily duration of spray varies from 3 hours to 9hours and years of chemical use varies from 3-10 years. Average re-entry time to spray field was found to be 15hours, this is below standard recommendation of at least 24hours re-entry time for liquid herbicides and 48hours for wettable powders. Farmers attributed this bad safety habit to the belief that sprayed field should be checked few hours later to find out the chemical effectiveness. The average number of self-reported pesticide poisoning symptoms per farmer was found to be 4; these symptoms vary from 1- 12 acute pesticide poisoning.

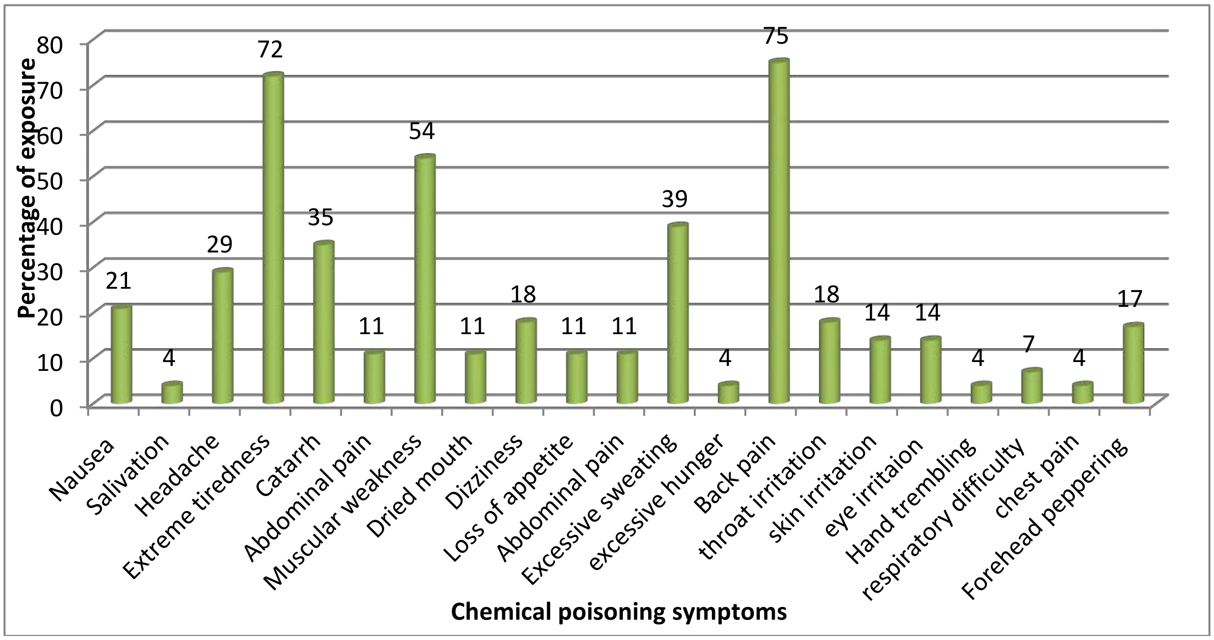

Figure 2: Baseline self-reported chemical symptoms experienced by farmers during chemical handling (N=480)

Source: Data Analysis 2018

A detailed medical examination of sampled farmers was beyond the scope of the study. Instead of medical examination, this study relied solely on farmers'' self-reported health effects/symptoms. Farmers were questioned if they experienced any health impairment after mixing and spraying pesticides recurrently. The study, however revealed that prominent among the acute pesticide poisoning symptoms self-reported by farmers include back pain 75%, extreme tiredness 72%, muscular weakness 54%, and excessive sweating 39% among others.

Farmers experienced multiple symptoms of 4 symptoms on the average. Similar findings on acute pesticide poisoning were made by Dasgupta, Meisner and Haq (2005), who reported that over 49% of farmers experienced at least one symptom, with the most commonly reported as neurological (headaches: 27%, dizziness: 8%), eye (irritation: 26%), dermal (skin 13%), and gastrointestinal (vomiting: 9%). The interviews further revealed that 26% of the respondents experienced multiple health effects, with an average of 3 and a maximum of 5. Upon asking sick farmers whether they believed that these symptoms were related to pesticide use, 82% believed this to be true.

Also it has been pointed out that main pesticide poisoning symptoms reported by farmers include skin irritation, headache, extreme tiredness, excessive sweating, blurred vision and dizziness which are consistent with other studies including (Oesterlund et al., 2014; Williamson, Ball and Pretty 2008; Jors, et al., 2006; Salameh, et al., 2004 and Ngowi et al., 2001). Results from studies conducted on human health and occupational exposure to pesticides among smallholder farmers in cotton zones of Cote d'Ivoire and Lesotho respectively showed that exposure to pesticides and occurrence of ill health symptoms is evident in agricultural households in cotton growing areas of Cote d'Ivoire and that a greater health risk is present when a lack of training and education on the use of pesticides (Mokhele, 2011).

Ogunjimi and Farinde (2012) in a study conducted in Nigeria reported tearing, redness of the eyes, cough, difficulty breathing, excessive sweating, headache and yellowing skin as chemical poisoning symptoms. Other complaints by farmers included lack of muscle coordination, 56% of the sample population have one ailment or the other which might be as a result of improper use of chemicals which include dermatosis, cancer, and allergies.

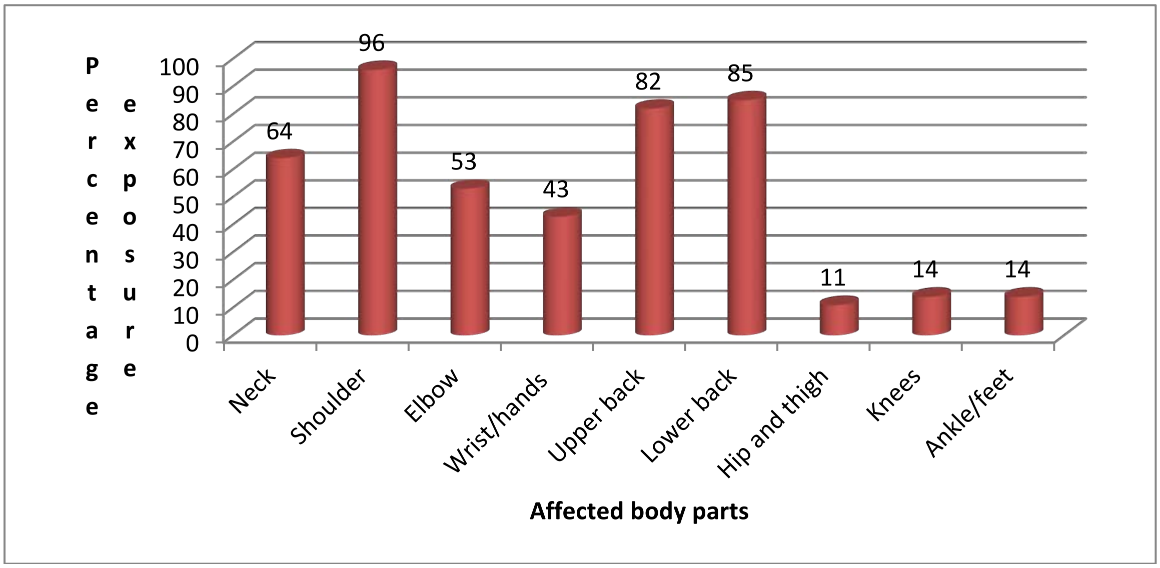

Figure 3: Baseline ergonomic exposure experienced by farmers (N=480)
Source: Data analysis, 2018

Work-related ergonomic disorders have been identified to be prominent among farmers. Figure 3, shows that 96% had shoulder pain, 85% reported lower back pain, 82% reported upper back pain, 64% reported neck pain and 53% reported elbow pain. Empirical evidence had also posited that work-related ergonomic disorders are manifested in form of pain at the lower and upper back, shoulders, ankles, knees, elbows, neck, wrist and hand. As further highlighted musculoskeletal disorders, including back pain, neck pain, tenosynovitis (inflammation of the wrist tendon), bursitis (inflammation of the shoulder joint fluid sac(bursa) and osteoarthritis of the knee (degeneration of the knee joint cartilage) are common among agricultural workers (Earle-Richardson, et al., 2005, Erondu & Anyanwu, 2005; Moreau & Neis, 2009; Myers, 2010; Durborow et al., 2011).

Fathalah (2010), submitted that MSDs are so common among experienced farmers that most of them perceived it is inevitable consequences of farm labour. Previous research by the New York Center for Agricultural Medicine and Health (NYCAMH) suggests that back, neck and shoulder strain is a common problem among farm workers (Earle-Richardson et al., 2003).

Costello, Mirka, and Gustke, (2003) had earlier opined that crop production is often labour intensive and requires extensive amounts of repetitive bending, stooping, lifting and carrying of loads weighing as much as fifty pounds across uneven and unstable surfaces which are considered high-risk job characteristics for work related musculoskeletal disorders (WMSD). In their study they found that farmers reported WMSD most often in conjunction with equipment (e.g., climbing up/down equipment; equipment coupling; and equipment operation). Farm workers reported experiencing increased WMSD with: tobacco topping (e.g., shoulder WMSD; forearm and wrist tendonitis); tobacco leaf harvesting and curing barn work (e.g., neck, shoulder, back, and lower extremity WMSD); sweet potato harvesting (e.g., neck, shoulder, back, and lower extremity WMSD; and fingernail tearing); cucumber harvesting (e.g., neck, shoulder, back, and lower extremity WMSD); and watermelon harvesting (e.g., neck, shoulder, and upper extremity WMSD).(Costello, Mirka, and Gustke, 2003).

Oranusi, Dahunsi and Idowu (2014) found in their study that disorders of muscles, bone, and joints as the most common occupational-health issues. This is similar to the findings of Morse and Schenck (2011) who observed about 64% of chronic musculoskeletal disorders among workers. Oduwaiye at al., (2015), who assessed crop farmers health related hazards found that about 83.8% of the respondents experienced general body pain which forced farmers to take days off from farm.

Table 4: Sickness absence determinants

OLS estimates		
Y Sickness absence (days)	Co-efficient	t-value
Age in (years)	0.837	3.68***
Educational qualification (years)	-0.352	-2.37**
Daily duration of chemical spray	0.146	2.45**
Care time	0.296	7.49***
Number of ergonomic exposure	-0.053	1.63
Constant	3.97	6.89
R-square	0.16	

Note:***, and ** represent significance at 1% , and 5% respectively
Source: Data analysis 2018

Sickness absence or production loss time/days are number of days a farmer is unable to attend to his farm work because he was sick. It is also referred to as absenteeism. The mean sickness loss among respondents was found to be 6.5days/season. Ordinary least regression was used to estimate the determinants of sickness absence among cassava farmers. The R^2 = 16% which means the variables in the fitted regression was able to explain the determinants of sickness absence by 16% while 84% was attributed to other variables not accounted for in this model. The is study revealed farmers' sickness absence is influenced by age, educational level, daily duration of chemical spray, care time and number of ergonomic exposure. Specifically, older farmers have higher sickness absence in their work. This may be due to accumulated exposure to health risks leading to more ill health in old age. Educational qualification has a negative relationship with sickness absence among farmers. This may be due to the fact that education could aid health care utilization leading to reduction in ill health frequency. Daily duration of chemical spray was found to increase sickness absence. This may be linked to unsafe practices by farmers exposing them to chemical and ergonomic health risks leading to high sickness absence. Care time which is the number of days a farmer was unable to attend to his farm work because a member of the family was sick and such farmer had to care for such family member was found to have positive relationship with sickness absence. See table 4.

Analyzing productivity and attendance of tea estates in western Kenya, Fox et al. (2004) found that HIV-positive workers plucked between 4.11 and 7.93 kilograms per day less in the last year and a half before termination. Compared with non-HIV-positive pluckers, HIV-positive workers used between 9.2 and 11.0 more sick leave days, between 6.4 and 8.3 more annual leave days, between 11.8 and 19.9 more casual leave days, and spent between 19.2 and 21.8 more days doing less strenuous tasks in the two years before termination. Tea pluckers who terminated because of AIDS-related causes earned 16.0 percent less in their second year before termination and 17.7 percent less in the year before termination.

For example, in Tanzania, a study of vegetable farmers reported that 68% of farmers who used pesticides reported having felt sick after routine pesticide application (Ngowi et al. 2007). In Zimbabwe, it was found that pesticide acute symptoms significantly increased the direct cost of illness in cotton growers (Maumbe & Swinton, 2003). The time spent recuperating from illnesses attributed to pesticides average 2 to 4 days during the growing season. In Oyo State, Nigeria, the estimated average number of workdays lost per year due to malaria was 64 days in agrarian households. In Leyte province in the Philippines, 45.4 days in a year were lost to schistosomiasis. In India, the average number of days lost to tuberculosis (TB) was 83 days per year. One study analyzed the effects of illness on agricultural households in 22 districts in rural Kenya, a country with one of the highest rates of HIV infection (Yamano &Jayne 2004).

Effect of health risks exposure on farmers' labour productivity

Farmers' productivity is often a major consideration for food security and poverty reduction. However, the average labour productivity of a farmer could be impeded by ill health. This section was analyzed using ordinary least regression (OLS) to find out effects of health risks exposure on farmers' productivity. See table 5

Table 5: Effect of health risks exposure on farmers' productivity

OLS estimates		
Y average labour productivity	Co-efficient	t-value
Age (years)	0.00	0.19
Estimated duration of self-reported chemical symptoms exposure (hours)	-0.00	-0.76
Farming experience (years)	0.00	0.46
number of ergonomic exposure	-0.00	-0.82
Educational qualification (years)	0.00	1.36
Production loss time/sickness absence	-0.03***	-4.06
Constant	1.37	8.95
R-square	0.14	

*** represent significance at 1% level

Source: Data analysis, 2018

The labour productivity of a farmer is the production rate per hour of a farmer's working time on the farm. Table 5 shows that ergonomic exposure; production loss time/sickness absence and duration of chemical symptoms exposure had a negative relationship with farmers' average labour productivity. However, only the production loss time/sickness absence had a significant statistical relationship with labour productivity of a farmer per season (t=4.06). This implies that the number of days a farmer was unable to go to the farm in a season due to health issues being referred to as production loss time/sickness absence affects farmer's labour productivity. It means every unit increase in production loss days leads to 3% reduction in farmers' labour productivity. This means risks factors such as chemical and ergonomic health risks exposure that leads to ill health and production loss should be addressed to aid significant increase in labour productivity.

The finding of this study agrees with similar study on impact of health on agricultural technical efficiency in Nigeria by Egbetokun et al., (2012) that reported that one percent improvement in the health condition of the farmers will increase efficiency by 21 percent. Similarly, Donald (2006), also reported that health capital is affected by a number of preventable diseases such as malaria fever, HIV/AIDS, farm injuries, cholera fever, schistosomiasis, diarrhoea, respiratory diseases and skin disorders.

Further findings from the study show that the estimated duration of self-reported chemical symptoms exposure in hours and average number of ergonomic exposure had a negative relationship with farmers' labour productivity. However, farmers' age, farming experience and educational level had a positive relationship.

Ajani and Ugwu (2008) examined the impact of health conditions on farmers' productivity in north-central Nigeria and found that a one percent improvement in a farmer's health condition led to a 31 percent increase in efficiency. Studies such as Loureiro (2009), Ulimwengu (2009), and Badiane and Ulimwengu (2009) employed stochastic frontier regression techniques to assess the impact of farmers' health status on agricultural productivity in Spain, Ethiopia, and Uganda respectively. In each case, the authors found a significant and positive relationship between measures of health and agricultural technical efficiency. As pointed out by Hawkes and Ruel (2006), in agricultural communities, poor health reduces income and productivity, further decreasing people's ability to address poor health and inhibiting economic development.

Poor health in turn affects agricultural production. Poor health and Illnesses impairs farmer's ability to innovate, experiment, and implement changes, and to acquire technical information available through extension activities (Hawkes & Ruel 2006b; Asenso-Okyere, at al., 2011). On the other hand, agricultural income influences households' ability to purchase health-related goods and services that determine their overall health status. Healthcare expenses may also consume resources that otherwise might be used to purchase improved seed, fertilizer, equipment, or other inputs. Households with sick members are less able to adopt labour-intensive techniques (Hawkes and Ruel 2006a; Asenso-Okyere, at al., 2011). Negative health and economic impacts of pesticides can be minimized through training and information campaigns on pesticide use. In Nicaragua, farmers trained in appropriate pesticide use suffered lower exposure after two years and had higher net returns than those who had not been trained (Asenso-Okyere, at al., 2011). This evidence has proved beyond reasonable doubt that balancing the agricultural occupation with health is crucial to agricultural productivity.

Estimating average program effect on farmers' production loss time/sickness absence

This section provides information on the effect of the intervention on the production loss time of farmers in the short-term. The Difference-in-Difference estimator was used in analyzing this effect since there is two point data. The baseline data and the post intervention survey data taken at 6months after the completion of the intervention trial.

Table 6: Average program effect on sickness absence/days

Difference in difference estimates		
Y production loss time/sickness absence	Co-efficient	t-value
Treatment	0.11	0.28
Time trend	-0.95	-2.39
DID(Interaction)	-1.88***	-3.34
Constant	6.50	23.16

*** represent significance at 1% level

Source: Data analysis, 2018

The study from the reduced DID regression model is shown in table 6. The average production loss days at the baseline was found to be 6.50. The difference in the outcome variable between the treatment and non- treatment before the treatment (selection effect) was found to be 0.11 while change across time common to both group was found to be -0.95. However, the difference overtime attributed to the intervention was found to be significant at 1% with a negative effect on the outcome variable (t=-3.34). The statistical significance implies there is an established causal effect on treatment/intervention on the outcome variable. The study shows the intervention is effective, reducing production loss by 1.9days/6.5days (29% production loss day's reduction) per treated farmer compared to the control group. With this finding, the treated group is also more likely to adopt safe farm practices an effect bolstered further by 3months follow up safety text messages. It implies the treatment model could be scaled up at reducing production loss time suffered by farmers due to health risks exposure.

The finding of this study shared some similarities with the study by Cole and Fernado (2016) engaging RCT and mobile phone in dissemination of information to farmers. The study reported the treated farmers were 5.3 percentage points more likely than the comparison group to purchase recommended seeds, an effect bolstered further by reminder text messages. The researchers also reported an increased the likelihood that farmers purchased recommended fertilizers. They also found that the group with follow up reminder text messages had about 60Kg/acre or 8.6% higher yield than the control mean at mid line.

The findings of this study was further corroborated by earlier studies (See Robert 2006; Liu, Dow, Fu, Akin and Lance 2008; Loureiro, 2009; Badiane and Ulimwengu 2009; Ulimwengu 2009; McNamara, Ulimwengu and Leonard 2010) who reported that that inexpensive health interventions can have a very large impact on agricultural labour productivity. Studies have further revealed that occupational safety initiatives could lead to an average increase of 71percent in cost-benefits, 66percent in productivity and 44percent in quality as well as six dollars return for one dollar investment on safety (Safety Compliance Letter 2004; Maudgalya, Genaidy & Shell 2008).

Estimating Average program effect on farmers' safety knowledge

This section provides information on the effect of the intervention on farmers' safety knowledge in the short-term. The Difference in Difference estimator was used in analyzing this effect since there is two point data. The baseline data and the post intervention survey data taken at 6months after the completion of the intervention trial. The farmers' safety knowledge was used as the outcome variable. The outcome variable was scored as follows: knowledge of chemical route of entry 4points (1point for each body parts), container management knowledge 1points for the correct way of management and 0 for incorrect answer, knowledge of label usage 1points for safety knowledge information on label, expiration date, and knowledge of protective gear is also scored 1point each and 0 for incorrect answer. A total of 8points is allocated for farm safety knowledge. The higher the number of points scored by a farmer, the better a farmers' knowledge of safe farm practices.

Table 7: Estimating Average program effect on farmers' safety knowledge

Difference in difference estimates		
Y Farmers' safety knowledge	Co-efficient	t-value
Treatment	0.43	1.60
Time trend	-0.23	-0.64
DID (Interaction)	2.45***	4.97
Constant	2.86	15.08

* **represent significance at 1% level

Source: Data analysis, 2018

As shown in table 7, on the scale of 8 points, at baseline the average knowledge points were 2.857, this is quite low. The difference in the outcome variable between the treatment and non- treatment before the treatment (selection effect) was found to be 0.42 while change across time common to both group was found to be -0.23.However, the intervention treatment effect was found positively statistically significant at 1% (t=4.974). This shows the intervention was able to increase farmers' safety knowledge points by 2.446. Though, knowledge increase may not directly translate to attitudinal change from a bad safety habits to a good safety culture, knowledge however, increases the chances of moving towards a safer farm practices.

Estimating average program effect on farmers' safety attitude

This section provides information on the effect of the intervention on farmers' safety attitude in the short-term. The Difference in Difference estimator was used in analyzing this effect since there is two point data. The baseline data and the post intervention survey data taken at 6months after the completion of the intervention trial. The farmers' safety attitude was used as the outcome variable. The outcome variable was scored as follows: attitudinal change in re-entry time under 24hours-1point, above 24hours-2points, the use of protective gear (1point for each body parts), totaling 4points, attitudinal change in container disposal, 1points for the correct way of management and 0 for incorrect answer. A total of 7points is allocated for farmers' safety attitudinal change. The higher the number of points scored by a farmer, the safer the attitude towards chemical related health risks.

Table 8: Estimating average program effect on farmers' safety attitude

Difference in difference estimates		
Y Farmers' safety attitude	Co-efficient	t-value
Treatment	0.48	1.50
Time trend	-0.29	-0.67
DID (Interaction)	2.65***	4.39
Constant	3.29	14.66

***represent significance at 1% level

As shown in table 8, on the scale of 7 points, at baseline the average safe attitude points was 3.286, this is quite low. The difference in the outcome variable between the treatment and non- treatment before the treatment (selection effect) was found to be 0.48 while change across time common to both group was found to be -0.29. However, the intervention treatment effect was found positively statistically significant at 1% (t=4.389). This shows the intervention was able to increase farmers' safety attitude points by 2.649. As farmers' move higher on the safety attitudinal scale leads to attitudinal change from a bad safety habits to a good safety culture, this enhances safe farm practices. This in-turn is expected to reduce health risks exposure and lead to better health status and enhanced productivity of farmers.

Table 9: **Estimating average program effect on labour productivity**

Difference in difference estimates Y Labour productivity (Tons/Mandays)	Co-efficient	t-value
Treatment	-0.008	-0.13
Time trend	0.10	1.42
DID(Interaction)	0.16*	1.77
Constant	1.10	21.83

*represent significance at 10% level
Source: Data analysis, 2019

Findings from table 9 showed that average labour productivity at baseline was 1.10 tons/ man-days among the farmers. The difference in the outcome variable between the treatment and non- treatment before the treatment (selection effect) was found to be 0.008 while change across time common to both groups was found to be 0.10. Although a positive relationship was established with the intervention and labour productivity significant at 10% level. We opined that it is a weak evidence to establish that the intervention significantly enhanced labour productivity across the two groups as (t=1.77) for the interaction effect. This suggests that the ability of the intervention to reduce sickness absence does not necessarily translate to a strong positive significant effect on the labour productivity of farmers. However, the positive relationship of the intervention effect on the labour productivity suggests the possibility of finding a positively strong significant effect of the intervention on labour productivity in the long term.

4.0 Conclusions

Studies have established a strong link between good health and improved farmers' welfare. This study assessed the agricultural health risks exposure among randomly assigned cassava farmers in Nigeria. The study developed a novel agricultural health training intervention delivered using blended training approach targeted at crop farmers. The study also evaluated the effects of the agricultural health training intervention on farmers' well-being. We engaged a unique RCT design, using farm level randomized control trial data from the study, and we concluded cassava farmers are engaged in unsafe farm practices at different stages of cassava production. We established farmers' exposures to health risks affect their labour productivity. Using difference-in-difference estimators, we also established that the intervention enhanced farm safety knowledge, attitude and reduced sickness absence in short term. We however documented weak evidence on that the intervention effect on labour productivity. This suggest, we do not have sufficient evidence to clearly state that the intervention significantly enhanced farmers' labour productivity. The highlighted results in the study showed the necessity of policy makers to design effective agricultural health interventions for Nigerian crop farmers to enhance safe and healthy agricultural practices in farm workplaces. Additional research is needed to establish the long-term effects and explore issues of cost effectiveness of the intervention. Also additional research is needed to isolate the mobile technology component of the intervention. With the short-term evidences, similar interventions engaging the a blended training approach could be engaged in the future to enhance farmers' adoption of safe farm practices and other relevant technology with focus on long term intervention effects.

References

Ajani, O.I.Y. & P.C. Ugwu. (2008). Impact of adverse health on agricultural productivity of farmers in Kainji Basin north-central Nigeria using a stochastic production frontier approach. *Trends in Agriculture Economics* 1:1–7.

Asenso-Okyere, K., Chiang C., Thangata, P., & Andam, K (2011) Interactions between health and farm-labor productivity. Food Policy Report of International Food Policy Research Institute Washington, DC

Badiane, O. & J. Ulimwengu (2009). *The growth–poverty convergence agenda: Optimizing social expenditures to maximize their impact on agricultural labor productivity, growth, and poverty reduction in Africa.* Discussion Paper 00906. Washington, D.C.: International Food Policy Research Institute.

Cole, D. W (2006). Occupational health hazards of agriculture. In C. Hawkes and M. T. Ruel, (eds.) *Understanding the links between agriculture and health for food, agriculture, and the environment.* 2020 Focus 13, International Food Policy Research Institute, Washington, DC.

Cole, S & Fernado A. (2016). Mobile'izing Agricultural Advice: Technology Adoption, Diffusion and Sustainability. Harvard Business School Working Paper, Cambridge, April 2016

Costello,T.M, Mirka, G & Gustke, S (2003) A Multi-Method Approach to Agricultural Injury and Illness Surveillance.A Written for presentation at the 2003 ASAE Annual International Meeting Sponsored by ASAE Riviera Hotel and Convention Center Las Vegas, Nevada, USA 27- 30 July 2003. Paper Number: 038023

Dasgupta S., Meisner C & Huq (2005).Health effects and pesticide perception as determinants of pesticide use: evidence from Bangladesh, World Bank Policy Research Working Paper 3776, November 2005, Washington, USA

Donald, S. & Lang, K., (2007).Inference with Difference in Differences and Other Panel Data,"forthcoming, *Review of Economics and Statistics,. 89(2)*: 221-233.

Duffy P.(2014). Environmental impact assessment training for sustainable agriculture and rural development: A case in Kenya. Available at: http://www.fao.org/sd/EPdirect/ *EPan0012.htm*. Accessed October 9, 2014.

Duflo, E., Kremer, M., & Robinson, J. (2008). How high are rates of return to fertilizer? *American Economic Review*, 98(2): 482–88.

Durborow, R.M., Myers, M.L., Cole, H.P., Ogunsanya, T.O., & Thompson, S.L. (2011).Presented at the National Symposium on Agriculture, Forestry, & Fishing Health and Safety in Boise, Idaho, June 28, 2011.

Earle-Richardson, G., Jenkins, P., Fulmerc, S., Mason, C., Burdick, P., & May, P., (2005).An ergonomic intervention to reduce back strain among apple harvest workers in New York State. *Applied Ergonomics 36*, 327–334

Earle-Richardson,G., Jenkins, P.L., Slingerland, D.T., Mason, C., Miles, M., &May, J.J., (2003). Occupational injury and illness among migrant and seasonal farmworkers in New York State and Pennsylvania, 1997–1999: pilot study of a new surveillance method. *Am. J. Ind. Med. 44* (1), 37–45.

Egbetokun, O.A., Ajijola, S., Omonona, B.T. & Omidele, M.A. (2012). Farmers' Health and Technical Efficiency in Osun State Nigeria. *International Journal of Food and Nutrition Science, 1*(1): 13-30\

Erik Jors, Aggrey Atuhaire, Katia Buch Harvig, Lene Kierkegaard, Majbrit MolgaardNielsen, Mercy Wanyana, Bernadette Mirembe, Charles Okorimong, & Deogratias Sekimpi (2012).Are SMS messages the way forward in spreading health information?Afr Newslett on Occup Health and Safety 2012; 22:18–9

Erondu, E.S.&Anyanwu, P.E. (2005). Potential hazards and risks associated with the aquaculture industry. *Afr J Biotechnol.* 4 1622-1627

Fathallah F.A (2010).Musculoskeletal disorder in labour intensive agriculture. Department of Biological and agricultural engineering, University of California Agricultural ergonomic research centre. Western centre for agricultural safety and health.One shields Ave, Davis, USA

Fox, M.P., S. Rosen, W.B. MacLeod, M. Wasunna, M. Bii, G. Foglia, & J.L. Simon. (2004). The impact of HIV/AIDS on labour productivity in Kenya. *Tropical Medicine and International Health* 9:318–324.

Gilbert, J.,. Lapar, M.L Unger, F& Grace, D (2010). The Most Important Zoonosis in the World.‖ Ecohealth Conference, August 18-20, London.

Hawkes, C,& Ruel, M.T. (2006). The links between agriculture and health: an inter-sectorial opportunity to improve the health and livelihoods of the poor. Bulletin of the World Health Organization, 84(12): 985-91.

Hawkes, C., & Ruel, MT (2006b).*Understanding the links between agriculture and health for food, agriculture, and the environment: Overview*. Focus 13. Brief 1 of 16. Washington, D.C.: International Food Policy Research Institute.

Ibitoye, S. J. (2006). The Impact of Cooperative Societies on Rural Development in Ankpa LGA of Kogi State, Nigeria.*National Association of Science, Humanities and Education Research Journal (NASHERJ). 4 (2)*: 193-198.

International Food Policy Research Institute (IFPRI) (2011). Agriculture for improved nutrition and health. A revised proposal submitted to the CGIAR Consortium Board. GIAR research program 4

Jensen HK, Konradsen F, Joers E, Petersen JH, Dalsgaard A.(2011) Pesticide Use and Self-Reported Symptoms of Acute Pesticide Poisoning among Aquatic Farmers in Phnom Penh, Cambodia. Journal of Toxicology. 2011 Article ID 639814.

Jors E, Morant RC, Aguilar GC, Huici O, Lander F, Baelum J, & Konradsen F. (2006). Occupational pesticide intoxications among farmers in Bolivia: a cross-sectional study. *Environ Health 5*:10

Keverenge-Ettyang G, Neumann C, & Ernst J (2010). “Food security among HIV-infected rural Kenyan women.” Research Brief 10-01-HNP, Global Livestock Collaborative Research Support Program, Davis: University of California.

KOSSED (2004). Towards Poverty Alleviation and Wealth Creation, Lokoja, Kogi State Ministry of Budget and Planning. P7.

Kuye R, Donham K, Marquez S, Sanderson W, Fuortes L, Rautiainen R, Jones M, & Culp K(2006). Agricultural health in the Gambia I: agricultural practices and developments. *Ann Agric Environ Med* 13, 1–12.

Kuye, R, Donham, K, Marquez .S, Sanderson, W Fuortes, L, Rautiainen, R . Jones, M & Culp, K (2008). Pesticide Handling and Exposures Among Cotton Farmers in The Gambia. *Journal of Agromedicine, 12*:3, 57-69, DOI: 10.1080/10599240801887876

KWADP (2006).Kwara State Agricultural Development Projects. Annual Reports

Lim A. A, Vos T, & Flaxmman A.D, et al. (2012).A comparative risk assessment of burden of disease and injuries attributable to 67 risk factors and risk factor clusters in 21 regions, 1990 to 2010. A systematic analysis for the Global Burden of Disease Study 2010. *Lancet,* 380(0859):2224–60.

Liu, G.G., Dow, W.H., Fu, A.Z., Akin, A &Lance, P. (2008). Income productivity in China: On the role of health. *Journal of Health Economics* 27 (1): 27–44.

Loureiro, M.L. (2009). Farmers' health and agricultural productivity. *Agricultural Economics* 40:381–388.
Maudgalya T, Genaidy A, & Shell R. (2008). Productivity-Quality-Costs-Safety: A sustained approach to competitive advantage – a systematic review of the national safety council's case studies in safety and productivity. Human Factors and Ergonomics in Manufacturing 18(2):152–179.
Maumbe BM,&Swinton SM (2003). Hidden health costs of pesticides use in Zimbabwe's smallholder cotton growers. *Soc. Sci. Med.*, *57*: 559-1571.
McNamara PE, Ulimwengu JM, Leonard, KM (2010). Do Health Investments Improve Agricultural Productivity?Lessons from Agricultural Household and Health Research. The International Food Policy Research Institute (IFPRI) Discussion Paper 01012, July, 2010
McNamara PE, Ulimwengu JM, & Leonard, KM (2010). Do Health Investments Improve Agricultural Productivity?Lessons from Agricultural Household and Health Research. The International Food Policy Research Institute (IFPRI) Discussion Paper 01012, July, 2010
Mokhele T. (2011).Potential health effects of pesticide use on farm workers in Lesotho. *S Afr J Sci*. 107(7/8), Art. #509, 7 pages.
Moreau, D.T.R. & Neis, B. (2009). Occupational health and safety hazards in Atlantic Canadian aquaculture: Laying the groundwork for prevention. *Marine Policy*. *3*3, 401-411.
Morse T, & Schenck P.(2011).Occupational disease in Connecticut. University of Connecticut Health Center Research; 2011.
Myers, M.L. (2010). Review of occupational hazards associated with aquaculture.*J Agromedicine*. 15, 412-426.
National Bureau of Statistics (NBS, 2017). Labour Productivity Report - Q4 2016: June, 2017
Ngowi AV, Maeda DN, Partanen TJ, Sanga MP, &Mbise G. (2001).Acute health effects of organophosphorus pesticides on Tanzanian small-scale coffee growers. *J Expo Anal Environ Epidemiol.11*:335–339
Ngowi AVF, Mbise TJ, Ijani ASM, London L, & Ajayi OC (2007). Smallholder vegetable farmers in Northern Tanzania: pesticides use practices, perceptions, and cost and health effect. *Crop Prot. 26*: 1617- 1624
Nigerian Population Census (NPC) (2007). National Population Commission, Sample Survey, Nigeria
Oduwaiye, M.O., Akangbe, J.A. Komolafe, S.E.& Ajibola, B.O., (2015). An assessment of knowledge of farming-related hazards and precautionary practices of farmers in Kwara State, Nigeria. *Journal of research in forestry, wildlife and environment 7*(2) 27-35
Oesterlund, A.H., Thomsen, J.F., Sekimpi,D.,K., Maziina, J., Apio Racheal & Erik Jørs (2014)Pesticide knowledge, practice and attitude and how it affects the health of small-scale farmers in Uganda: a cross-sectional study.Afr Health Sci. 2014 Jun; 14(2): 420–433. doi: 10.4314/ahs.v14i2.19
Ogunjimi SI. & Farinde AJ (2012).Farmers' Knowledge Level of Precautionary Measures in Agro - Chemicals Usage on Cocoa Production in Osun and Edo States, Nigeria *International Journal of Agriculture and Forestry*, *2(4)*: 186-194.
Raudenbush, S. W., et al. (2011). Optimal Design Software for Multi-level and Longitudinal Research (Version 3.01) [Software]. Available from www.wtgrantfoundation.org.
Safety Compliance Letter (2004).Safety creates jobs 6(1):13. Available: www. asse.org/ business of safety.html
Salameh PR, Baldi I, Brochard P & Abi SB.(2004).Pesticides in Lebanon: a knowledge, attitude, and practice study. *Environ Res. 94*:1–6

Ulimwengu, J. (2009). Farmers' health and agricultural productivity in rural Ethiopia. *African Journal of Agricultural and Resource Economics* 3 (2): 83–100.

Williamson S, Ball A, & Pretty J. (2008). Trends in pesticide use and drivers for safer pest management in four African countries. Crop Protection.27:1327.

World Bank (2007).World Development Report 2008: Agriculture for Development. Washington, D.C.: World Bank.

World Health Organization (2013). Media centre. Factsheet: Non-communicable diseases. Updated March 2013.http://www.who.int/mediacentre/ factsheets/fs355/en/workers available on line. 18:03-11.

Yamano, T., & T. S. Jayne.(2004). Measuring the impact of working-age adult mortality on small-scale farm households in Kenya. *World Development* 32 (1): 91–119.