Nationally Representative Farm/Household Level Dataset on Crop Production in Ghana from 1987-2017

Francis Tsiboe. E-mail: ftsiboe@hotmail.com ORCID: 0000-0001-5984-1072

Acknowledgments

The author gratefully acknowledges the Ghana Statistical Service for making the Ghana Living Standards Survey dataset publicly available. The author also acknowledges useful comments from Mr. Isaac Gershon Kodwo Ansah of the University for Development Studies, Ghana. All errors are the responsibility of the author.

Abstract

Reliable and comprehensive national agricultural statistics is crucial not only for agricultural development but general economic transformation. While data collected via the Living Standards Measurement Study (LSMS) provides Ghana with this avenue, the reports from this data generated by the Ghana Statistical Service neither consider the trends nor in-depth analysis of agricultural statistics. This paper sets the premise to fill this knowledge gap by harmonizing and generating a nationally representative micro-level dataset from all previous LSMSs. The harmonized data has the widest geographic and seasonal coverage of farmers in Ghana. As such it presents a unique opportunity to empirically analyze key agricultural phenomena at the household if not at the farmer level.

Keywords – crop production; farmer characteristics; Ghana; trends

To cite this document use:

Tsiboe, F. (2020). Nationally Representative Farm/Household Level Dataset on Crop Production in Ghana from 1987-2017. [*provide url to document here*]

Introduction

The agricultural sector is the backbone of Ghana's economy contributing an annual average of 25% to the country's Gross Domestic Product (GDP) between 2006 and 2017 [1]. The sector also employs and provides a source of livelihood for about 50% of Ghana's economically active population (15 to 49 years), and a major export revenue earner, estimated at $1.55 billion annually for the period 2005-2012 [2,3]. Ghana's agricultural sector is divided into the crops, forestry and logging, fishing, and livestock subsectors; with the crops, subsector contributing about 72% towards Agricultural GDP between 2006 and 2017 [1]. Notwithstanding its contribution towards Agricultural GDP, crop production in Ghana is predominantly a smallholder business. About 90% of crop farms are less than 2 hectares (ha), with low mechanization, poor agronomic practices, inappropriate use of agrochemicals, and lack of quality planting materials. Furthermore, climate variability and declining soil fertility have contributed to a gap in crop yields.

Data collected via the Ghana Living Standards Surveys (GLSS) provides the avenue to study the trends in farmer demographics and the production characteristics in Ghana. However, historically, the generated reports from the GLSS data have generally been snapshots for the periods of the surveys without a comprehensive analysis of nationwide trends in farmer and production characteristics. The motivation of this paper is to fill this knowledge gap by utilizing sound harmonization methods to generate a nationally representative dataset from all previous GLSSs.

This study is not the first of its kind to harmonize data from multiple rounds of the GLSS. At the time of this study, there existed two similar initiatives that have done so. These are (1) Rural Income Generating Activities (RIGA) Project by the FAO (http://www.fao.org/economic/riga/riga-database/en/) and (2) Africa Region Poverty Program for Harmonized Household Surveys (SHIP) by the World Bank. RIGA constructs and harmonizes income and employment variables at the household level for the LSMS's, and SHIP generates a set of harmonized variables on household-level basic characteristics, income, and expenditure. To the best of this studies knowledge, the dataset generated from this study is novel and different from RIGA and SHIP in that it creates and harmonizes farmer level data from multiple rounds of the GLSS, thus making it possible to analyze nationwide trends on key agricultural phenomena at the household and farmer levels.

2. The Raw Data

The GLSS is Ghana's customized version of the Living Standards Measurement Study (LSMS) initiated by the Policy Research Division of the World Bank in 1980. Focusing on the household as the key socio-economic unit, the GLSS provides nationally representative data for policy and decision-makers to measure socio-economic indicators and gives valuable insights into living conditions in Ghana. Since the first GLSS in 1987/88 (GLSS1), six more were fielded in 1988/89 (GLSS2), 1991/92 (GLSS3), 1998/99 (GLSS4), 2005/06 (GLSS5), 2012/13 (GLSS6), and 2016/17 (GLSS7). The raw data span across all regions and twelve annual growing seasons from 1987/88 to 2016/17, and are publicly available at the Ghana Statistical Service(GSS) National Data Archive (NADA) found at http://www2.statsghana.gov.gh/nada/index.php/home .

All seven GLSS datasets were designed to provide nationally and regionally representative indicators. Hence, a two-stage stratified sampling design was used. First, enumeration areas (EA) were selected to form the primary sampling units (PSU) allocated to Ghana's ten regions using probability proportional to population size. A list of households in the PSUs was then collated to form the secondary sampling units (SSUs). In the second sampling stage, 15 households were selected systematically from each PSU. A total of 3,147 [15,492], 3,194 [14,924], 4,523 [20,403], 5,998 [26,411], 8,687 [37,128], 16,772 [72,372], and 14,009 [59,864] households [household members] nationwide were included in GLSS1 to GLSS7, respectively. Details on the sampling and data collection of the surveys are provided in the documentation published alongside the data which is also available at NADA.

The harmonized data for this study is limited to crop farmers. Additionally, to eliminate the influence of outliers, the sample was further restricted to those farmers with yield measured in kg/ha above the 5th and below the 95th percentiles by survey, region, and crop. The breakdown of the final generated data by survey is shown in Table 1. The specific sample size for each crop category is presented with each table of descriptive results.

The recent GLSS survey instruments (i.e. GLSS7) were composed of household, non-farm enterprise, governance, peace and security, community, and prices of food and non-food items questionnaires. The data generated by the study used information collected via the household, community, and price questionnaires. The household questionnaire was subsequently divided into parts A (SEC1 to SEC7) and B (SEC8 to SEC12). Part A covered information on household members' demographics, education and skill training, health and fertility, employment, time use, migration and tourism, and agriculture production holdings. Also included in part A is a section

on housing. Part B included information on household agriculture; income and expenditure; income transfers; migration and remittances; and use of financial services. The community questionnaire covered several sections on facilities and services available in communities. However, given the objective of this study only information on agriculture (SEC5) was used. Finally, the price questionnaire solicited information on the commodity prices at major markets in selected communities.

Table 1. Farmer Level Data Sources for Farmers in Ghana (1987-2017)

Survey	Season	Sample size	
		Farmers	Households
Ghana Living Standard Survey 1	1987/88	1,645	1,645
Ghana Living Standard Survey 2	1988/89	1,881	1,881
Ghana Living Standard Survey 3	1990/91	794	774
Ghana Living Standard Survey 3	1991/92	2,012	1,917
Ghana Living Standard Survey 4	1997/98	3,067	2,641
Ghana Living Standard Survey 4	1998/99	683	642
Ghana Living Standard Survey 5	2004/05	2,076	1,865
Ghana Living Standard Survey 5	2005/06	3,200	2,897
Ghana Living Standard Survey 6	2011/12	1,850	1,592
Ghana Living Standard Survey 6	2012/13	7,552	6,781
Ghana Living Standard Survey 7	2015/16	1,123	1,123
Ghana Living Standard Survey 7	2016/17	5,336	5,336

3. Constructed Variables

3.1 Farmer and Household demographic

Generally, the demographics of all household members were taken as recorded in the household roster (SEC1). However, to make harmonization across all the GLSS sensible, educational level, marital status, relationship to household head, ethnicity, and religion were recoded into fewer groups. Given the demographics of its members, household size in adult male equivalence (AME) was computed by dividing the total energy requirements of the household by 2,250 kcal. The value of 2,250 kcal is the energy requirement of an adult male between the ages of 19 to 50 years. The calorie-based scale of AME [4] has been commonly applied in studies in Ghana to quantify household size [5]. The scale recognizes energy requirement differences across age and gender lines. The AMEs were further used to establish the proportion of the household members classified as infants (less than one year), toddlers (1 to 3 years), children (4 to 11 years), teenagers (12 to 17 years), young adults (18 to 34 years), mid-age adults (36 to 55 years), old adults (56 to 70 years), and very old adults (older than 70 years). Given these categories, the dependency ratio of the household was then calculated as the total AME attributable to members aged 18 and 70 years divided by that for those aged below 18 years or above 70 years.

Household farmers were identified via; (1) the household responsibility registry in SEC6; (2) cropland ownership in SEC8b; and (3) crop harvest ownership in SEC8C. Once identified, farmer demographics were formulated as outlined below:

- Gender is coded 1 for female and 0 for male.
- Age in years was taken as recorded in the household roster (SEC1).
- Recent educational level completed was converted into years of education using appropriate factors published in the seventh edition of world data on education for Ghana.

- The headship of the farmer within the household was coded 1 if the farmer was listed as the head in the household roster (SEC1).
- Marital status is coded 1 if the farmer cohabits with a partner.

In addition to the above variables, household poverty and welfare were ascertained using existing living standard measures already calculated for each GLSS by GSS. The details of their constructions are presented in published reports [6]. Given these measures, households are classified as very poor, poor, or non-poor based on an appropriate poverty line calculated for each GLSS by GSS.

3.2 Farm size and land ownership

Information on farm size in the GLSS was usually collected via the farmland (SEC8A1), and harvest and disposal of crops (SEC8C) sections. While SEC8A1 records data on plot level farming characteristics (e.g. holder id, plot size, ownership, crops grown, etc.), SEC8C records the amount of total cultivated land on the harvest for each farmer. Furthermore, the land unit measurements were stated in hectares, acres, poles, ropes, and others. Given this information, farm size for each farmer in the sample was calculated via a three-step procedure involving the allocation of farm plots to crops grown by a given farmer.

First, the units for plot size and harvested area were converted to hectares (ha) by multiplying those recorded in acres, poles, ropes, and other, by 0.404686, 0.404686, 0.044965, and 0.01, respectively following published recommendations [7]. Secondly, if only one crop was cultivated for a plot operated by a farmer in SEC8A1, and the observed harvested area by that farmer in SEC8C was at least equal to the observed plot size, the proportion of the plot planted to that crop by the farmer was taken as the ratio of the observed harvested land to the plot size. Where harvested area was zero or missing, and only one crop was cultivated for a plot, the proportion of the plot planted to that crop was taken as one. For cases where there were multiple crops on the same plot and the total harvested area of such crops were greater than the observed plot size, the proportion of the plot planted to each crop was taken as their respective shares in the total crop harvest value by the farmer of that plot. In the final step, the proportions generated for each crop by plot were multiplied by the standardized plot size in ha and summed over each farmer by crop. Furthermore, the variable for land ownership was constructed as a dummy, coded 1 if the farmer-owned portions of the land under cultivation, 0 otherwise. Mode of land acquisition (i.e. kinship, bought, rented, free) and type of ownership (i.e. with documentation and/or selling/use as security rights) were taken as recorded.

Land fragmentation is defined as the extent to which farmer croplands consists of several spatially separated plots [8]. The Shannon-Weiner Index is used in computing each farmer's cropland fragmentation index, by utilizing the size and number of plots operated by the farmer. The index is calculated as; $-1 \times \sum[a_i \ln(a_i)]$, where a_i represents the size (in ha) of the i^{th} plot. A relatively higher index indicates a higher level of land fragmentation. Furthermore, a crop diversification index was also constructed like the land fragmentation index where *i* is the types of crop and a_i the land allocated to its cultivation, with a relatively higher index indicating higher diversity.

3.3 Crop output, yield, and commercialization

Unlike farm size, information on crop-specific production in the GLSS datasets was usually collected at the farmer level in SEC8C1. The recorded farmer outputs were in varying units of

measurement ranging from known (e.g. pounds, kilogram [kg], ton, bag [mini and maxi], and tins [American and margarine]), to unknown scales (e.g. sheet, basket, bowl, tree, stick, bundle, barrel, bunch, nut, fruits, log, box, tubers, fingers, and all). Thus, a five-step procedure was used in converting all production output quantities to kg.

First, the output for all units in kg was taken as recorded by the GLSS when the stated unit of measurement was kg. Kilograms in other metric prefixes were converted to kg using the appropriate conversion factor. Secondly, vegetables, fruits, roots/tubers, and plantains were converted to kg using average fruit weights retrieved from United States Department of Agriculture National Nutrient Database for Standard Reference Release 27, when their units were recorded as "tubers", "fruit", "singles", "fingers", "all", or "piece". Thirdly, for legumes and cereals, "Olonka" conversion factors [9] were used when the stated unit of measurement was either American or margarine tins. "Olonka" is the standard unit of measure for many agricultural commodities sold in local markets in Ghana. It consists of empty margarine tin cans or plastic containers and varies by size depending on price and the product being sold. In the fourth step, MOFA conversion factors were used to approximate weights in kg for crops with units stated in mini or maxi bags. Finally, the output in kg for crops in non-standardized local units were imputed as the quotient of their respective stated monetary values – in GHC – divided by the weighted (by quantity) average unit price – in GHC/kg – by crop, region, and survey.

Based on the calculated output and farm size, the yield (kg/ha) for each farmer by crop was calculated as the total output divided by total farmland cultivated for that crop. Commercialization was measured as the proportion of agricultural production that is sold. The Commercialization proportion is also available by the channel of sale, i.e. direct sale to consumers, farm gate, market trader, cooperative, state trading organization, or pre-harvest contract. The selling price was calculated at the regional level using weighted (by quantity) average unit prices as stated by the households.

3.4 Agricultural inputs

Information on inputs in all GLSS's were collected in monetary terms as household total farming expenditures on those inputs. Consequently, for each farmer and crop, the expenditures for each input were calculated as their respective shares in total household crop harvest value. Subsequently, these were divided by their prevailing national market prices by year to calculate their respective approximated quantities used. The only exception is hired labor where some households also indicated the quantity of harvest given to hired labor. Thus, the total value of hired labor was taken as the sum of expenditure made towards hired labor, and the value of harvest given to hired labor. The prevailing national market price used is made available in the dataset. Since no data were available on family labor, the study calculated this as the total AME attributable to members aged 15 years and older.

3.6 Other variables

- Access to Credit: Across all surveys, this dummy variable is coded 1 if at least one household member applied for a loan or received inputs on credit, 0 if not, and two if no credit information was collected in the survey. A value of two was assigned to data drawn from the GLSS1, GLSS2, GLSS3, and GLSS4 surveys since they were never collected. In this case, the coefficient on category one is taken as the credit effect in any econometric estimation.

- Access to Mechanization: Across all surveys, this dummy variable is coded 1 if the household owned a tractor or a tractor-drawn implement, 0 if not.
- Access to Irrigation: Across all surveys, this dummy variable is coded 1 if the household made expenditure on irrigation or owned irrigation equipment, and 0 if not.
- Access to Extension: Across all surveys, this dummy variable is coded 1 if the farmer is in an enumeration area (as defined by the survey) where at least one farmer reported having received extension services from MOFA or NGOs. Also, where community information was collected, this variable is coded 1 if there was an extension agent or office in that community, and 0 if not.
- Access to Phone: Across all surveys, this dummy variable is coded 1 if at least one household member-owned a phone, 0 if not, and 2 if no information on phone ownership was collected in the survey. A value of 2 was assigned to data from GLSS1 and GLSS2.
- Access to Radio: Across all surveys, this dummy variable is coded 1 if the household owned a radio, 0 if not, and 2 if no information on radio ownership was collected in the survey.
- Access to Bicycle/Motorbike: Across all surveys, this dummy variable is coded 1 if the household owned at least one bicycle or motorbike, 0 if not, and 2 if no information on bicycle or motorbike ownership was collected.
- Access to Information and communications technology (ICT): Across all surveys, this dummy variable is coded 1 if the household owned a personal computer, possessed computing skills, or had access to the internet via broadband, café, or phone, and 0 if not. A value of 2 was used where no such information was collected.

4. Descriptive and Trend Analysis

Arithmetic means were used to describe the data obtained from GLSS's over the 30 years for different crop categories (i.e. cereals, root/tubers, legumes, vegetables, and cash crops). Subsequently, linear and probit regressions were used to analyze the trend in continuous and dummy variables, respectively. In addition to the trend analysis, the spatial distribution of selected crop production statistics at the district level, using the GLSS fielded in 2016/17 and 2012/13 were also estimated. The statistics for each district were estimated as a weighted sum, using household weights provided by GSS.

4.1 Farmer and household characteristics

The distribution of the farmer population at the district level is shown in Figure 1a. Tables 2 presents the summaries for the farmer and household characteristics and how they change over the 30 years. Districts in the fifth quintile were classified as those with the largest population of crop farmers in Ghana. Based on this classification, the most important – top 5% – districts for crop farmer population (1000s), in descending order, were Kwahu South (39,956), Adansi South (34,040), Tolon (31,506), Bawku Municipal (31,451), Ejura-Sekyedumase (29,519), Nkoranza South (28,656), Nkwanta North (27,844), Garu-Tempane (26,918), Twifo Ati-Morkwa (26,786), Atwima Mponua (26,744), Kwaebibirem (26,692), and Sefwi-Wiawso (26,209). One caveat for Figure 1a is that the absolute population size values do not match those estimated by the 2010 population survey. However, the relative population size difference between districts are comparable.

Figure 1: District-level spatial distribution of selected crop production statistics in Ghana for 2012/13 and 2016/17

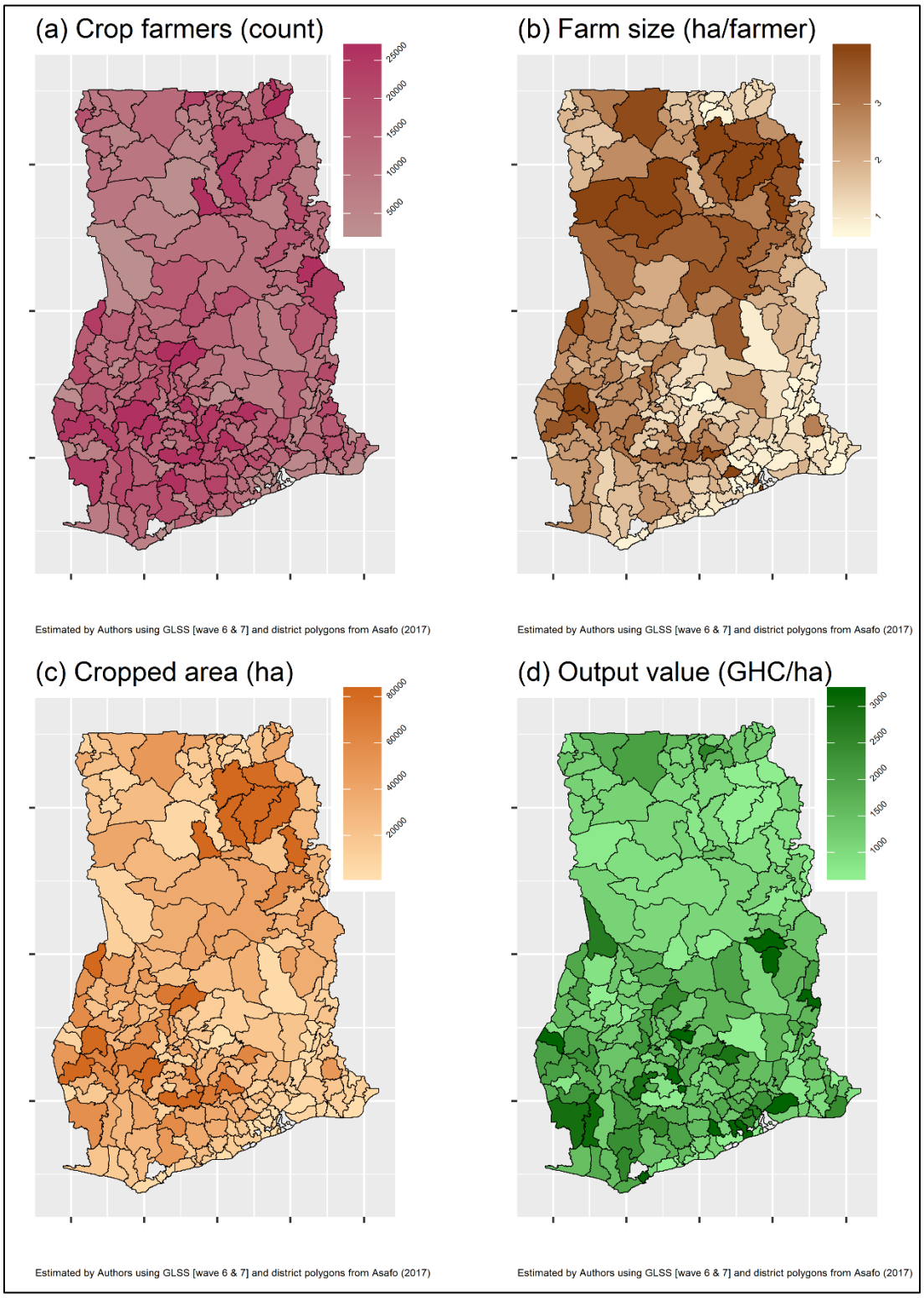

Table 2: Characteristics of crop farmers/households in Ghana from 1987-2017

Characteristics of crop farmers in Ghana from

Crop category	Female (yes=1)		Age (years)		Education (years)		Head (yes=1)		Married (yes=1)	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Cereals	0.25	0.05	45.80	0.35***	3.98	1.99***	0.90	0.04	0.78	-0.01
(n=22896)	(0.43)	[0.04]	(15.19)	[0.03]	(4.95)	[0.11]	(0.30)	[0.03]	(0.41)	[0.03]
Root/tubers	0.30	-0.08*	46.43	0.45***	5.08	1.81***	0.92	0.04	0.75	-0.02
(n=14176)	(0.46)	[0.05]	(14.91)	[0.03]	(4.91)	[0.10]	(0.27)	[0.03]	(0.43)	[0.04]
Legumes	0.23	0.39***	45.52	0.21***	2.35	2.44***	0.88	-0.10*	0.82	-0.16***
(n=9377)	(0.42)	[0.07]	(15.47)	[0.05]	(4.35)	[0.26]	(0.33)	[0.06]	(0.38)	[0.06]
Vegetables	0.30	0.13*	44.83	0.43***	4.17	1.89***	0.90	0.01	0.76	-0.11*
(n=4869)	(0.46)	[0.07]	(14.98)	[0.05]	(4.86)	[0.17]	(0.30)	[0.04]	(0.43)	[0.06]
Fruits	0.22	0.07	46.91	0.31***	4.74	3.60***	0.92	-0.03	0.77	0.04
(n=1138)	(0.41)	[0.12]	(15.23)	[0.09]	(4.89)	[0.31]	(0.27)	[0.08]	(0.42)	[0.11]
Cash crops	0.23	0.09	49.03	0.18***	5.54	2.46***	0.93	-0.08**	0.77	0.00
(n=6973)	(0.42)	[0.06]	(15.07)	[0.04]	(4.90)	[0.12]	(0.25)	[0.03]	(0.42)	[0.05]
Pooled	0.29	0.09**	46.08	0.34***	4.22	2.10***	0.89	-0.02	0.76	-0.08**
(n=31216)	(0.45)	[0.04]	(15.30)	[0.02]	(4.98)	[0.09]	(0.32)	[0.03]	(0.42)	[0.03]

Characteristics of crop-producing households in Ghana

Crop category	Size (AME)		Dependency ratio		Farmers (AME)		Standard of living (GHC/AME/day)		Poor (yes=1)	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Cereals	5.23	0.12**	1.41	-0.08	1.27	-0.06**	3.67	9.42***	0.40	0.17**
(n=21880)	(3.05)	[0.06]	(1.70)	[0.10]	(0.31)	[0.03]	(5.38)	[0.20]	(0.49)	[0.08]
Root/tubers	4.88	0.06	1.30	0.06	1.22	-0.03*	4.24	9.34***	0.27	0.14**
(n=13903)	(2.91)	[0.06]	(1.59)	[0.10]	(0.22)	[0.02]	(6.94)	[0.22]	(0.45)	[0.07]
Legumes	5.88	0.19**	1.54	-0.22	1.28	-0.04	3.29	8.24***	0.55	0.70***
(n=8917)	(3.29)	[0.09]	(1.83)	[0.16]	(0.34)	[0.04]	(5.27)	[0.30]	(0.50)	[0.13]
Vegetables	5.09	0.05	1.33	-0.24	1.22	-0.05***	4.18	9.32***	0.26	0.77***
(n=4826)	(3.05)	[0.09]	(1.59)	[0.17]	(0.17)	[0.02]	(6.57)	[0.38]	(0.44)	[0.09]
Fruits	5.06	-0.49***	1.26	0.24	1.22	0.03	4.58	12.27***	0.12	0.62***
(n=1132)	(3.22)	[0.19]	(1.60)	[0.36]	(0.16)	[0.04]	(8.63)	[1.10]	(0.33)	[0.11]
Cash crops	4.97	-0.36***	1.28	0.15	1.23	0.06***	5.14	9.69***	0.21	0.20**
(n=6809)	(2.94)	[0.08]	(1.60)	[0.15]	(0.23)	[0.02]	(10.68)	[0.45]	(0.40)	[0.08]
Pooled	5.08	0.02	1.37	-0.05	1.29	-0.01	4.08	9.26***	0.36	0.26***
(n=29094)	(3.01)	[0.05]	(1.68)	[0.08]	(0.38)	[0.03]	(7.16)	[0.21]	(0.48)	[0.07]

Significance levels: * p<0.10, ** p<0.05, ***p<0.01

Values without brackets denote the means of the variables and those in brackets denote their respective annual trend from 1987 to 2017.

Over the 30 years, 25% of Ghanaian farmers were females, with the age and education of all farmers estimated at 46 and 4 years, respectively. About 90% of the farmers were household heads with 78% indicating that they were married. Over the forgoing period, farmers originated from households with about five members and a dependency ratio of 1.4. Farmers in households with

the highest daily standard of living per AME were those producing cash crops, estimated at GHC 5.1. Cash cropping households were followed by fruits (GHC 4.6), root/tubers (GHC 4.2), vegetables (GHC 4.2), cereals (GHC 3.7), and then legumes (GHC 3.3). The percentage of poor households was highest for legume producers estimated at 55%, followed by cereals (40%), root/tubers (27%), vegetables (26%), cash crops (20%), and then fruits (12%).

Across all crops, Table 2 shows that over the 30 years farmer age and education, and the probability of observing a female farmer significantly increased by 0.34%, 2.1%, and 0.09% annually. Whereas an increase in female participation in crop farming and level of farmer education could impact Ghana's total crop output positively, the aging farmer population threatens the sustainability of crop production given that life-expectancy in Ghana average between 55-60 years. The estimates also show that the standard of living across all crop-producing households significantly increased by 9.26% annually, with cash crop households recording the highest, followed by those producing fruits, roots/tubers, vegetables, cereals, and then legume. Notwithstanding the improvements in the standard of living made over the period, the probability of observing poor crop-producing households significantly increased by 0.26% annually.

4.2 Land: cultivated area, acquisition, ownership, and fragmentation

The distribution of mean farm size per farmer and total crop area at the district level are shown in Figures 1b and 1c. Table 3 presents the summaries for key characteristics of cropland under cultivation and how they change from 1987 to 2017. The average land under crop cultivation over the forgoing period was estimated at 4.12 ha. By the same token as farmer population, the largest crop farms were estimated to be those greater than 3.94 ha. Calculating the weighted (by the number of farmers) mean farm size per farmer by districts showed that, overall, the most important districts for crop farm size per farmer in Ghana for the periods 2012/2013 and 2016/17 in descending order were Jaman North (6.6 ha), North Gonja (6.1 ha), Karaga (5.3 ha), Gushiegu (4.5 ha), and Upper West Akim (4.5 ha). In terms of total land under crop cultivation, the most important districts were Jaman North (128,720 ha), Tolon (127,096 ha), Yendi Municipal (113,928 ha), Adansi South (98,261 ha), and Juabeso (95,470 ha).

The estimates also show that over the review period, on average 56% of the land cultivated by farmers were acquired through kinship ties, resonating similar findings for cocoa farmers [10]; this was followed by free occupancy (23%), renting (18%), and then outright purchase (2%). In terms of land ownership, whilst the estimates show that 59% of croplands were directly owned by the farmers, this percentage reduced to 12% when land ownership with a land title deed was considered. For the remaining 41% of land not directly owned by farmers, they fall in the two predominant sharecropping contracts in Ghana; i.e. *abunu* (a division of output where the farmer receives 1/2) and *abusa* (a division of output where the farmer receives 2/3 or 1/3 depending on whether the landowner provides support for inputs). Furthermore, only 28% and 24% of the cropland was available for sales or as security to obtain credit, respectively.

Over the 30 years, whilst farm size significantly declined by about 7% annually, the model of ownership across all land ownership category did not significantly change. Furthermore, even though low, land ownership with a land title deed, land sales right, and the right to use the land as security have all increased by 5.6, 1.8, and 3.4% annually. These improvements in land ownership and rights are partly a reflection of the formalization of land rights through land registration in Ghana.

Table 3: Land under cultivation, ownership, and rights for crop producing households in Ghana from 1987-2017

Crop category	Area (ha)		Acquisition mode (ratio)				Ownership (ratio)			
							Status		Rights	
	House	Farmer	Kinship	Bought	Rented	Free	Owned	Deeded	Sell	Security
					Mean					
Cereals (n=21880)	1.90 (5.16)	1.17 (3.08)	0.56 (0.49)	0.02 (0.12)	0.18 (0.38)	0.24 (0.43)	0.57 (0.48)	0.10 (0.30)	0.27 (0.43)	0.23 (0.40)
Root/tubers (n=13903)	1.79 (5.22)	0.99 (2.71)	0.49 (0.49)	0.03 (0.16)	0.23 (0.42)	0.24 (0.42)	0.61 (0.48)	0.14 (0.34)	0.31 (0.44)	0.26 (0.42)
Legumes (n=8917)	1.41 (3.53)	0.87 (2.22)	0.66 (0.47)	0.01 (0.08)	0.07 (0.25)	0.26 (0.44)	0.60 (0.48)	0.08 (0.27)	0.25 (0.42)	0.22 (0.40)
Vegetables (n=4826)	1.63 (5.93)	0.79 (2.56)	0.55 (0.50)	0.02 (0.14)	0.21 (0.40)	0.23 (0.42)	0.69 (0.46)	0.12 (0.33)	0.31 (0.44)	0.24 (0.42)
Fruits (n=1132)	3.06 (8.21)	2.17 (5.96)	0.51 (0.50)	0.05 (0.20)	0.26 (0.44)	0.18 (0.38)	0.75 (0.43)	0.08 (0.27)	0.34 (0.43)	0.18 (0.38)
Cash crops (n=6809)	4.28 (11.83)	2.93 (8.09)	0.54 (0.49)	0.06 (0.23)	0.29 (0.44)	0.11 (0.30)	0.66 (0.47)	0.18 (0.38)	0.36 (0.44)	0.30 (0.43)
Pooled (n=29094)	4.12 (12.22)	1.22 (3.68)	0.56 (0.49)	0.02 (0.15)	0.18 (0.38)	0.23 (0.41)	0.59 (0.47)	0.12 (0.31)	0.28 (0.42)	0.24 (0.40)
					Trend (%)					
Cereals (n=21880)	-6.73*** [0.90]	-7.54*** [0.76]	1.36 [0.20]	6.53 [0.74]	-0.18 [0.41]	-3.41 [0.43]	0.04 [0.17]	5.92*** [0.39]	1.14 [0.25]	2.83*** [0.26]
Root/tubers (n=13903)	-8.20*** [0.81]	-8.06*** [0.74]	2.33 [0.22]	5.08 [0.65]	-1.23 [0.41]	-4.14 [0.42]	-0.17 [0.13]	4.54*** [0.33]	2.00 [0.20]	3.20*** [0.24]
Legumes (n=8917)	-8.63*** [1.62]	-8.71*** [1.59]	1.05 [0.29]	5.25 [1.48]	2.99 [1.18]	-3.51 [0.73]	0.27 [0.27]	7.61*** [0.78]	1.68 [0.43]	3.33*** [0.44]
Vegetables (n=4826)	-8.07*** [1.17]	-7.37*** [1.02]	1.32 [0.35]	2.24 [1.43]	0.49 [0.69]	-3.81 [0.81]	-0.36** [0.16]	5.99*** [0.60]	2.56 [0.31]	5.20*** [0.36]
Fruits (n=1132)	-6.21*** [0.86]	-6.02*** [0.83]	1.69 [0.83]	5.99 [2.61]	-0.01 [1.43]	-6.27 [1.90]	-1.12*** [0.20]	10.13*** [1.43]	2.00 [0.42]	8.50*** [0.77]
Cash crops (n=6809)	-6.90*** [1.04]	-6.42*** [1.00]	1.66 [0.32]	4.22 [0.69]	-1.40 [0.60]	-6.96 [1.05]	-0.98*** [0.14]	3.96*** [0.36]	0.97 [0.22]	3.02 [0.26]
Pooled (n=29094)	-7.81*** [0.76]	-6.98*** [0.65]	1.61 [0.18]	5.69 [0.52]	-0.54 [0.37]	-4.00 [0.40]	-0.07 [0.13]	5.57*** [0.30]	1.77 [0.19]	3.37*** [0.21]

Significance levels: * p<0.10, ** p<0.05, ***p<0.01
Values without brackets denote the means of the variables and those in brackets denote their respective annual trend from 1987-2017

4.3 Crop yield, commercialization, price, and revenue

The spatial distribution of district-level land productivity in kg/ha is shown in Figure 1d. Table 4 presents crop-specific productivity, price, revenue, and commercialization and their changes thereof from 1987 to 2017. Across all the crops, the estimated land productivities were far below their attainable yields reported by MOFA (2016). Over the review period, the productivity across

all the crops did not show any statistically significant changes, albeit the majority seemed to be trending up.

Table 4: Crop yields, price, revenue, and commercialization for crop producing households in Ghana from 1987-2017

Crop	Yield (kg/ha)		Price (GHC/kg)		Revenue (GHC/ha)		Commercialization (ratio)			
							All		Only sellers	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Maize	3495.31	2.50	1.33	2.81	1665.49	4.42	0.29	-1.78***	0.53	-0.01
(n=19441)	(18521.07)	[1.08]	(2.36)	[0.15]	(17011.14)	[0.60]	(0.34)	[0.19]	(0.28)	[0.11]
Rice	1643.55	4.96	1.91	2.83***	2722.12	4.22	0.24	-2.62***	0.50	0.10
(n=4039)	(10438.58)	[2.30]	(1.61)	[0.25]	(8343.65)	[0.63]	(0.30)	[0.57]	(0.25)	[0.26]
Sorghum	1116.16	3.80	1.56	1.64***	2074.24	4.84	0.12	-2.24**	0.47	0.05
(n=4265)	(2544.90)	[0.59]	(1.79)	[0.23]	(6841.38)	[0.86]	(0.25)	[0.88]	(0.27)	[0.30]
Millet	1348.94	2.14	2.24	0.25	3457.45	1.86	0.09	3.10*	0.49	3.84***
(n=3760)	(2785.72)	[1.34]	(2.07)	[0.53]	(11138.66)	[1.34]	(0.23)	[1.72]	(0.30)	[0.77]
Cassava	1704.61	2.42	0.58	4.37	918.74	5.92	0.20	-3.84***	0.59	-0.38***
(n=10646)	(6762.15)	[0.67]	(0.86)	[0.23]	(4518.58)	[0.79]	(0.33)	[0.34]	(0.28)	[0.12]
Yam	1341.64	4.14	1.23	3.14***	1445.81	6.50	0.18	-3.10***	0.50	-0.09
(n=3055)	(3965.88)	[0.57]	(1.43)	[0.36]	(6067.95)	[0.99]	(0.30)	[0.62]	(0.30)	[0.24]
Cocoyam	1088.91	4.99	16.06	6.37	21524.05	9.06	0.21	-6.57***	0.65	-0.20
(n=2415)	(3464.32)	[1.07]	(58.56)	[1.61]	(191013.88)	[2.35]	(0.35)	[0.50]	(0.30)	[0.22]
Plantain	1158.80	3.93	0.93	4.57***	1000.26	7.70	0.29	-2.34***	0.63	-0.05
(n=5670)	(3981.75)	[0.73]	(1.19)	[0.24]	(4209.50)	[0.86]	(0.37)	[0.33]	(0.29)	[0.14]
Beans	1197.13	7.22	2.15	2.56	1796.87	5.39	0.22	-2.90***	0.51	-0.41*
(n=5022)	(7430.08)	[3.36]	(1.92)	[0.21]	(4780.07)	[0.51]	(0.31)	[0.49]	(0.28)	[0.21]
Peanut	1327.50	4.34	2.26	3.48***	2602.63	5.10	0.34	-0.38	0.52	0.87***
(n=6716)	(3752.58)	[1.06]	(2.49)	[0.25]	(9205.85)	[0.64]	(0.32)	[0.25]	(0.26)	[0.15]
Tomatoes	1184.52	2.94	4.76	9.62***	6614.40	9.03	0.38	-1.99***	0.54	1.06***
(n=1517)	(3749.25)	[1.20]	(11.73)	[1.20]	(39898.12)	[1.91]	(0.35)	[0.33]	(0.29)	[0.23]
Pepper	1102.25	7.74	5.41	3.01***	5904.29	8.63	0.26	-4.15***	0.60	-0.01
(n=3005)	(5227.59)	[1.39]	(7.21)	[0.35]	(79073.52)	[2.92]	(0.35)	[0.36]	(0.29)	[0.20]
Okra	1102.57	6.83	6.77	7.02	8891.08	10.75	0.28	-5.08***	0.51	-1.66***
(n=1723)	(9544.00)	[2.51]	(16.79)	[0.82]	(100700.78)	[3.29]	(0.34)	[0.37]	(0.30)	[0.22]
Citrus	1851.55	-6.55	10.15	12.62	615.74	11.96	0.52	-2.55***	0.71	0.23
(n=449)	(8333.22)	[2.61]	(202.23)	[12.17]	(7176.55)	[7.06]	(0.41)	[0.48]	(0.31)	[0.29]
Bananas	983.07	1.17	0.31	9.11	110.16	10.74	0.55	-2.19***	0.64	-0.08
(n=577)	(3084.85)	[0.90]	(1.06)	[2.60]	(431.50)	[2.85]	(0.39)	[0.41]	(0.35)	[0.36]
Cocoa	551.02	3.12	5.97	3.64	2631.21	4.88	0.77	-0.09	0.80	0.12
(n=5010)	(1511.63)	[0.71]	(10.01)	[0.52]	(6949.27)	[0.55]	(0.30)	[0.14]	(0.27)	[0.13]
Oil palm	1173.14	3.80	0.91	6.57	1860.23	12.04	0.30	-2.34***	0.57	0.09
(n=2464)	(5633.56)	[1.30]	(2.21)	[0.82]	(24569.60)	[4.05]	(0.38)	[0.37]	(0.35)	[0.24]
Pooled	2175.70	2.44	1.96	5.00***	1616.47	4.73	0.34	-0.98***	0.48	-0.25***
(n=29094)	(11528.44)	[0.69]	(25.31)	[1.04]	(6716.38)	[0.29]	(0.33)	[0.13]	(0.29)	[0.09]

Significance levels: * p<0.10, ** p<0.05, ***p<0.01
Values without brackets denote the means of the variables and those in brackets denote their respective annual trend from 1987-2017

Generally, Table 4 shows that the output price measured in 2016/17 real terms has been significantly trending up. Regardless of crop price differences, annual revenue from production in real terms was highest for vegetables, estimated at GHC 7,136/ha. Vegetable was followed by roots/tubers (GHC 6,222/ha), cereal (GHC 2,479/ha), cash crops (GHC 2,245/ha), legumes (GHC 2,199/ha), and fruits (GHC 362/ha). Furthermore, like productivity, all the crops showed stagnation in revenue over the 30 years. Overall, the most important districts for crop revenue in Ghana (above the 95th percentile), in descending order, were Ga South (GHC 19,639 /ha), Krachi West (GHC 7,633 /ha), Sekyere Afram Plains (GHC 6,488 /ha), Awutu Senya West (GHC 6,274 /ha), and Asokore Mampong (GHC 6,148 /ha).

At first glance, the crop commercialization rates shown in Table 3 are low. The reason for these low values is due to the large number of farmers producing for household consumption only (53%). Farmers producing for the market only and both household consumption and market were estimated at 3% and 44%, respectively. When only farmers who grew crops for both household consumption and market were considered, aggregate crop commercialization was estimated at 48%. Note that farmers do not consume cash crops such as cocoa, hence all output is sold. Thus, this may inflate the calculated commercialization index. Disaggregating commercialization by crop groups shows that the non-cash crop category with the highest commercialization rate over the 30 years was fruits (68%), followed by roots/tubers (59%), vegetables (55%), legumes (52%), and cereals (50%). The overall trend shows that the commercialization of cereals, legumes, and fruits increased annually by 0.99, 0.23, and 0.08%, respectively. On the contrary, the commercialization of roots/tubers and vegetables declined by 0.18 and 0.20%, respectively.

4.4 Variable input usage

The input utilization rate over the review period and across all crops was estimated at 59, 39, and 43% for hired labor, fertilizer, and pesticide, respectively. The probability of observing farmers using these inputs has significantly increased annually by 0.66, 0.17, and 0.07, respectively. For fertilizer, the highest adoption rate was amongst cereal farmers, followed by cash crops and then vegetable farmers. In terms of usage rates, Table 5 shows the mean level of hired labor usage is estimated at 20.8 man-days/ha, the highest [lowest] estimated for vegetables [fruits], and an overall trend estimated at 2.7% annually. For fertilizer, the overall mean and trend values were estimated at 132 kg/ha and 7.15% annually, with the highest [lowest] rates estimated for vegetables [fruits]. The increase in fertilizer usage rates could be linked to Ghana's ongoing Fertilizer Subsidy Policy (FSP) initiated in 2008 in partnership with private fertilizer importers. FSP aims to ease the effect of the increased price of inorganic fertilizer and food, promote access and use of fertilizers, and reduce food insecurity [12]. From 2008 to 2013, FSP subsidized 71,022 MT of fertilizer.

For pesticide, the overall mean and trend were estimated at 11.8 liters/ha and 9.9% annually, with the highest [lowest] rates also estimated for vegetables [fruits]. As for the use of quality planting materials, the limited literature indicates that for most farmers about 70% of planting materials are farmer-saved and the remaining obtained from the grain market or neighboring farmers [13,14]. Only 26% of Ghana's maize seeds planted in 1997 were purchased from input dealers [15]. Other studies also show that most farmers first acquired seed of new maize varieties either from extension agents or other farmers [13,16]. Unfortunately, for leguminous crops, there are almost no studies on seed utilization [14]. In this study, the value of expenditure made towards planting materials was used as an indicator for the use of quality planting materials. Table 4 shows that the rate of

quality planting material usage over the review period significantly increased by 7.05. Furthermore, planting materials purchases were highest amongst cereal farmers, followed by root/tubers, legume, vegetables, cash crops, and then fruits.

Table 5: Level of variable input usage for crop farmers in Ghana from 1987-2017

Crop category	Hired labor (man-days/ha)		Fertilizer (kg/ha)		Pesticide (Liter/ha)		Planting material (kg/ha)	
	Mean	Trend	Mean	Trend	Mean	Trend	Mean	Trend
Cereals (n=21880)	21.71 (133.16)	2.55*** [0.50]	236.61 (4419.42)	7.07*** [0.99]	12.66 (207.90)	10.95*** [1.92]	293.80 (3772.93)	7.63*** [1.69]
Root/tubers (n=13903)	22.19 (301.17)	0.36 [1.34]	-	-	24.74 (1006.57)	10.58** [4.20]	156.39 (1244.54)	8.31*** [1.21]
Legumes (n=8917)	19.62 (100.84)	3.46*** [0.54]	-	-	8.73 (60.31)	9.87*** [1.39]	145.44 (1067.84)	6.88*** [1.36]
Vegetables (n=4826)	210.06 (5391.50)	6.86* [3.81]	6096.25 (234574.23)	9.91* [5.64]	94.18 (1806.65)	10.39*** [2.94]	80.06 (1869.48)	8.87** [3.64]
Fruits (n=1132)	10.01 (55.30)	5.83*** [1.44]	69.11 (765.29)	11.53*** [3.95]	4.12 (37.49)	12.37*** [4.16]	9.88 (76.69)	7.84*** [2.90]
Cash crops (n=6809)	20.72 (144.43)	1.25 [0.82]	110.51 (830.38)	7.68*** [1.09]	13.03 (70.58)	8.71*** [0.81]	67.24 (816.05)	5.40** [2.26]
Pooled (n=29094)	20.83 (173.66)	2.70*** [0.54]	132.05 (1440.61)	7.15*** [0.74]	11.83 (188.80)	9.93*** [1.35]	226.84 (2855.00)	7.05*** [1.13]

Significance levels: * p<0.10, ** p<0.05, ***p<0.01
Values without brackets denote the means of the variables and those in brackets denote their respective annual trend from 1987-2017

4.5 Agricultural services

In terms of farmers who had access or used credit, Table 6 shows that these were estimated at only 15 and 3%, respectively. Furthermore, the level of agricultural credit assessed by crop farmers was estimated at only GHC32.2/ ha, and albeit not significant, this has increased by 2.7% annually from 1987 to 2017. For agricultural extension, access was only 24%, and the probability of observing farmers with extension access significantly declined by 0.34 annually.

Droughts pose risks for farmers; however, irrigation development and adoption offer the potential for reduced weather risk and higher crop output by ensuring all-year-round production. In terms of access, less than 1% of farmers had access to irrigation. This low access to irrigation could be linked to Ghana's under-tapped irrigation potential. Ghana's water resource endowment puts its irrigation potential between 0.36-1.9 million hectares under irrigated cultivation [17,18]. However, less than 2% of Ghana's crop production is irrigated. Furthermore, there is a lack of understanding of Ghana's irrigation infrastructure. To demonstrate, less than 35% of irrigated lands lie within Ghana's public irrigation schemes, and not enough is known of the location, development, and management of the remainder [18]. Furthermore, the productivity and performance of existing publicly developed irrigation schemes are low [19].

The adoption of animal-drawn and mechanized implements amongst farmers was estimated at only 4 and 7%, respectively. The initial enhancement in Ghana's agricultural mechanization was in the form of government-subsidized mechanized services to farmers following independence in 1957 [20]. However, this was halted in the early 1980s partly due to low efficiency and high cost, and low sustainability [21]. Since 2003, the Government of Ghana's (GOG) established Agricultural Mechanization Services Enterprise Centers (AMSECs) provide affordable and timely mechanized services to small-scale farmers across the country.

Table 6: Agricultural services accessed by crop farmers in Ghana from 1987-2017

Crop category	Agricultural credit			Extension (yes=1)	Irrigation (yes=1)	Implement /equipment (yes=1)	
	Access (yes=1)	Used (yes=1)	Amount (GHC/ha)			Animal drawn	Mechanized
				Mean			
Cereals (n=22898)	0.15 (0.36)	0.03 (0.18)	25.57 (579.03)	0.23 (0.42)	0.01 (0.12)	0.05 (0.23)	0.08 (0.28)
Root/tubers (n=14176)	0.18 (0.39)	0.04 (0.19)	20.06 (284.80)	0.27 (0.44)	0.01 (0.09)	0.00 (0.07)	0.04 (0.21)
Legumes (n=9379)	0.11 (0.31)	0.03 (0.16)	12.47 (252.01)	0.20 (0.40)	0.02 (0.12)	0.10 (0.30)	0.09 (0.29)
Vegetables (n=4869)	0.13 (0.33)	0.03 (0.16)	73.60 (3743.27)	0.29 (0.45)	0.02 (0.14)	0.03 (0.17)	0.06 (0.24)
Fruits (n=1138)	0.12 (0.33)	0.02 (0.15)	13.90 (161.52)	0.38 (0.49)	0.01 (0.09)	0.01 (0.08)	0.04 (0.19)
Cash crops (n=6974)	0.20 (0.40)	0.04 (0.20)	23.69 (386.31)	0.27 (0.45)	0.01 (0.11)	0.02 (0.13)	0.05 (0.23)
Pooled (n=31219)	0.15 (0.36)	0.03 (0.17)	32.17 (1563.52)	0.24 (0.43)	0.01 (0.11)	0.04 (0.20)	0.07 (0.26)
				Trend (%)			
Cereals (n=22898)	-0.20*** [0.05]	-0.06*** [0.02]	3.78 [2.11]	-0.35*** [0.10]	0.06** [0.03]	-0.10*** [0.04]	-0.29*** [0.04]
Root/tubers (n=14176)	-0.25*** [0.05]	-0.09*** [0.02]	0.56 [0.68]	-0.31*** [0.11]	0.04*** [0.01]	0.00 [0.01]	-0.27*** [0.04]
Legumes (n=9379)	-0.11* [0.06]	-0.05** [0.02]	3.48 [2.76]	-0.28** [0.14]	0.06* [0.04]	-0.15** [0.07]	-0.04 [0.06]
Vegetables (n=4869)	0.17*** [0.06]	0.01 [0.02]	2.02 [1.36]	-0.54*** [0.15]	0.08** [0.03]	-0.05 [0.06]	-0.15*** [0.04]
Fruits (n=1138)	0.68*** [0.10]	0.14*** [0.04]	8.56 [3.69]	-1.83*** [0.19]	0.02 [0.03]	0.39** [0.18]	-0.01 [0.03]
Cash crops (n=6974)	-0.04 [0.08]	-0.07*** [0.02]	2.52 [1.37]	-0.72*** [0.14]	0.04 [0.02]	0.02 [0.02]	-0.29 [0.05]

Pooled	-0.19***	-0.06***	2.69	-0.34***	0.06***	-0.06**	-0.25***
(n=31219)	[0.04]	[0.01]	[1.32]	[0.09]	[0.02]	[0.03]	[0.03]

Significance levels: * p<0.10, ** p<0.05, ***p<0.01. Values without brackets denote the means of the variables and those in brackets denote their respective annual trend from 1987-2017

Each AMSEC is allocated a package of five tractors with basic implements (plows, harrows), and a trailer, with which they can serve about 500 small-scale farmers with an average landholding of 2.0 ha [22].

5. Concluding Remarks

Agriculture is considered one of the pillars of Ghana's development agenda. This is because of the links between key development indicators such as food and nutrition security and agricultural development. Comprehensive and up-to-date agricultural statistics give useful insights that aids the formulation of evidence-based policies that foster agricultural development. Whilst GLSS provides Ghana with such an avenue, historically, its reports generated by the Ghana Statistical Service have generally been snapshots for the periods of the surveys without a comprehensive analysis of the trends in farmer and production characteristics. Thus, the objective of this study was to fill this knowledge gap by utilizing sound harmonization methods to generate a nationally representative dataset from all previous GLSSs. Subsequently, descriptive statistics, and linear and probit regression were used to ascertain not just the characteristics of crop farmers and production in Ghana but also their trends from 1987 to 2017.

The results showed that, though with low mean values, key characteristics such as farmer education, female participation in farming, and fertilizer and pesticide use have increased between 1987 and 2017. However, the results also indicated red flags for some key variables. For example, Ghana's farmer population is aging and fast by about a quarter of a year annually. Younger farmers are physically able to handle the arduous nature of crop farming and tend to adapt easily to new ideas and technologies [23]. Thus, there is a need for a successful transition of crop farmland ownership from older farmers to a younger generation. Furthermore, providing support and training to younger farmers must be a top priority for Ghana's agricultural development agenda. The evidence of Ghana's aging farmer population has partly compelled the Government of Ghana (GOG) to initiate the Youth in Agriculture Programme (YIAP) to incentivize the youth to take up farming as a lifetime vocation, through the provision of tractor services and agro-inputs.

Notwithstanding the objectives of the YIAP, agriculture in Ghana is mostly carried out on household farms. This study showed that only 60% of crop farmlands are owned directly by the household. Moreover, only 12% of all crop farmlands have proper land ownership documentation, with no significant improvements from 1987 to 2017. For farming households to successfully transition crop farmland ownership to the younger generation, the process of cropland acquisition and ownership must be well formalized. Based on the results of this study, over 75% of cropped lands in Ghana were either acquired through kinship ties - which comes with its own set of problems [24] - or by free occupancy (which does not foster any transition to the younger generation). There is therefore the need to expand the incentive package of the YIAP to include assisted formalization of land rights through land registration for new and already existing farmers.

In terms of poverty and food security, Ghana achieved its Millennium Development Goal's (MDG) target of halving the proportion of hungry people in 2002 and met its poverty target in 2015.

However, these aggregate achievements are not uniform across different sub-populations in the country. Per the results of this study, the probability of observing poverty amongst crop farmers increased by 0.26 annually from 1987 to 2017. Furthermore, whilst non-agricultural households experienced a 63% poverty reduction for the period, agricultural households experienced a decline that was 47%. Two main prescribed solutions to alleviate poverty amongst agricultural households that dominate the literature and could be adopted by GOG are: (1) creating off-farm employment opportunities [25] and/or (2) improving agricultural productivity [26].

The study also showed that only about 50% of crop production is sold as surplus. Martey et al. (2012), observed that, among other things, distance to market and market information determined the level of commercialization amongst a sample of maize and cassava farmers in Ghana. However, research in Tanzania, Vietnam, and Guatemala suggests that investments in farm structure feature such as irrigation and use of improved seed rather than market access infrastructure could potentially increase both productivity and market participation [28].

In this study, less than 2% of farmers cultivating crops had access to irrigation. Moreover, over 70% of crop farmers planted from their own harvested seed. There is therefore the need for GOG to enhance the productivity and performance of existing publicly developed irrigation schemes and improve how farmers acquire improved seeds.

The number of farmers who have access to agricultural credit is also low. The volume of credit used by farmers is estimated at GHC 30 /ha only. In identifying the determinants of farmer credit participation and rationing, farmer education, and strengthening of Farmer Based Organizations (FBOs) have been suggested to serve as entry points for financial service providers [29]. Pursuing this policy objective by GOG could help improve farmers' access to financial services and consequently their flexibility in buying agro-inputs.

The analysis and discussions presented in this study come with some caveats. Particularly, the analysis did not rigorously account for the effect of other variables that may confound the averages and trends. A multivariate approach that accounts for the effect of other variables is essential in providing sound estimates. While this goes beyond the scope of this paper, subsequent studies could take up this challenge. Some interesting country-wide multiliterate analysis that could be examined based on the dataset generated by this study, inter alia, include; (1) identifying the prime age for crop-specific production and how it could be used to improve targeting of YIAP; (2) the link between land acquisition and ownership; (3) explaining the gap between credit access and use; (4) determining the factors of crop commercialization; and (5) identifying the crop production technical inefficiency and risk effects of the farmer, production, and institutional factors. In this regard, Tsiboe et al. [34] utilized the data generated by this study to show that technology gaps are severe for okra, modest for tomato, and non-existent for pepper cultivation, which implied that there is substantial potential for productivity gains from redistributing okra technology throughout Ghana. The microdata product from this study is an ever-evolving one as latest information is used to update the data generating process. In the interim, the author of the current study can be contacted directly for access to the current version dataset for further research.

References

[1] Ghana Statistical Service [GSS], Quarterly Gross Domestic Product (2009-2016) April 2017 Edition, (2017). http://www.statsghana.gov.gh/docfiles/GDP/GDP2017/April/GDP

quarterly bullettin_26_april 2017 edition.pdf (accessed June 27, 2017).

[2] Ghana Statistical Service [GSS], Food and Agriculture Organization [FAO], Export Value of Crops and livestock products by year, commodity (1000 US$)-By Ghana Statistical Service (GSS), Http://Countrystat.Org/Home.Aspx?C=GHA. (2015). http://countrystat.org/home.aspx?c=GHA&ta=081CTR015&tr=8 (accessed June 24, 2015).

[3] Ministry of Food and Agriculture [MOFA], Agriculture in Ghana: Facts and figures (2016), Doc. Provid. by Minist. Agric. Accra, Ghana. (2017).

[4] National Academy of Sciences-National Research Council [NRC], Recommended Dietary Allowances, 10th Edition, 1989, 1989. https://doi.org/10.1097/00017285-199001000-00008.

[5] F. Tsiboe, Y.A. Zereyesus, J.S. Popp, E. Osei, The Effect of Women's Empowerment in Agriculture on Household Nutrition and Food Poverty in Northern Ghana, Soc. Indic. Res. 138 (2018) 89–108. https://doi.org/10.1007/s11205-017-1659-4.

[6] Ghana Statistical Service [GSS], Poverty trends in Ghaa - 2005-2017, (2018). https://www.statsghana.gov.gh/gssmain/fileUpload/pressrelease/Poverty Profile Report_2005 - 2017.pdf (accessed February 10, 2020).

[7] Ghana Statistical Service [GSS], Ghana Living Standards Survey Round Four (GLSS 4) 1998/99: Data User's Guide, (1998). http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1181743055198/3877319-1190217341170/G4USERSG.pdf (accessed February 10, 2020).

[8] R. King, S. Burton, Land Fragmentation: Notes on a Fundamental Rural Spatial Problem, Prog. Hum. Geogr. 6 (1982) 475–494. https://doi.org/10.1177/030913258200600401.

[9] T. Nagai, Competitiveness of Cowpea-based Processed Products: A Case Study in Ghana, ProQuest, 2008. https://books.google.com/books?id=CzbOIesq-PgC&pgis=1 (accessed January 30, 2015).

[10] M. Vigneri, Drivers of change in Ghana's cocoa sector, IFPRI-GSSP Backgr. Pap. n. 13. (2007). http://www.ifpri.org/sites/default/files/pubs/themes/gssp/pubs/gsspwp13.pdf (accessed December 9, 2015).

[11] Ministry of Food and Agriculture [MOFA], Agriculture in Ghana: Facts and figures (2015), Doc. Provid. by Minist. Agric. Accra, Ghana. (2016).

[12] A.B. Banful, Operational Details of the 2008 Fertilizer Subsidy in Ghana—Preliminary Report, Accra,Ghana, 2009. http://www.ifpri.org/cdmref/p15738coll2/id/26336/filename/26337.pdf.

[13] R. Tripp, D.J. Walker, A. Okopu-Apau, A.A. Dankyi, L.L. Delimini, Seed management by small-scale farmers in Ghana : a study of maize and cowpea seed in the Brong-Ahafo and Volta regions, (1998) 28. http://gala.gre.ac.uk/11094/1/Doc-0158.pdf (accessed March 25, 2017).

[14] R. Tripp, A. Mensah-Bonsu, Ghana's commercial seed sector: New incentives or

continued complacency?, Int. Food Policy Res. Inst. Publ. (2013). http://www.ifpri.org/publication/ghanas-commercial-seed-sector-new-incentives-or-continued-complacency (accessed March 25, 2017).

[15] M.L. Morris, R. Tripp, A.A. Dankyi, Adoption and impacts of improved maize production technology: a case study of the Ghana Grains Development Project., Consult. Gr. Int. Agric. Res. (1999). http://impact.cgiar.org/sites/default/files/pdf/276.pdf (accessed March 25, 2017).

[16] Ghana Grains Development Project, A Study of Maize Technology Adoption in Ghana, (1991). http://libcatalog.cimmyt.org/download/cim/52414.pdf (accessed March 25, 2017).

[17] S.K. Agodzo, E.Y.H. Bobobee, Policy issues of irrigation in Ghana: 1960-1990, Proc. XIIth World Congr. Agric. Eng. Milano, 28 August-1 Sept. 1994. CIGR Vol. 1 Pp 335-343. (1994).

[18] R.E. Namara, L. Horowitz, B. Nyamadi, B. Barry, R.E. Namara, L. Horowitz, B. Nyamadi, B. Barry, Irrigation development in Ghana: Past experiences, emerging opportunities, and future directions, Int. Food Policy Res. Inst. Publ. (2011). http://econpapers.repec.org/paper/fprgsspwp/27.htm (accessed March 26, 2017).

[19] Ghana Irrgation Development Authority (GIDA), Japan International Development Agency (JICA), Strategies for effective utilization of existing irrigation projects. Small Scale Irrigated Agriculture Promotion Project-Follow UP (SSIAPP-FU), GIDA/JICA, Pp.328. Des. Print. by Delaram Limited.22359, Accra, Ghana. (2004).

[20] X. Diao, F. Cossar, N. Houssou, S. Kolavalli, Mechanization in Ghana: Emerging demand, and the search for alternative supply models, Food Policy. 48 (2014) 168–181. https://doi.org/10.1016/j.foodpol.2014.05.013.

[21] Prabhu Pingali, Y. Bigot, H.P. Binswanger, Agricultural mechanization and the evolution of farming systems in sub-Saharan Africa, World Bank Doc. Rep. (1988). http://documents.worldbank.org/curated/en/487111468202161680/pdf/multi-page.pdf (accessed March 25, 2017).

[22] Agricultural Engineering Services Directorate, Establishment of Agricultural Mechanization Service Enterprise Centers (AMSEC Proposal 2003), Minist. Food Agric. Accra, Ghana. (2003).

[23] J.G. Djokoto, V. Afari-Sefa, Alternative functional forms for technology choice: Application to cocoa production technologies, Technol. Soc. 50 (2017) 110–120. https://doi.org/10.1016/j.techsoc.2017.06.001.

[24] I. Lambrecht, S. Asare, The complexity of local tenure systems: A smallholders' perspective on tenure in Ghana, Land Use Policy. 58 (2016) 251–263. https://doi.org/10.1016/j.landusepol.2016.07.029.

[25] F. Tsiboe, Y.A.Y.A. Zereyesus, E. Osei, Non-farm work, food poverty, and nutrient availability in northern Ghana, J. Rural Stud. 47 (2016) 97–107. https://doi.org/10.1016/j.jrurstud.2016.07.027.

[26] X. Diao, P. Hazell, J. Thurlow, The Role of Agriculture in African Development, World

Dev. 38 (2010) 1375–1383. https://doi.org/10.1016/j.worlddev.2009.06.011.

[27] E. Martey, R.M. Al-Hassan, J.K.M. Kuwornu, Commercialization of smallholder agriculture in Ghana: A Tobit regression analysis, African J. Agric. Res. 7 (2012) 2131–2141. https://doi.org/10.5897/AJAR11.1743.

[28] A.R. Rios, W.A. Masters, G.E. Shively, A.R. Rios, W. Masters, G. Shively, Linkages between Market Participation and Productivity: Results from a Multi-Country Farm Household Sample, (2008). https://econpapers.repec.org/paper/agsaaea08/6145.htm (accessed November 23, 2017).

[29] C. Asante-Addo, J. Mockshell, M. Zeller, K. Siddig, I.S. Egyir, Agricultural credit provision: what really determines farmers' participation and credit rationing?, Agric. Financ. Rev. 77 (2017) 239–256. https://doi.org/10.1108/AFR-02-2016-0010.

[30] F. Tsiboe, J. Asravor, E. Osei, Vegetable Production Technical Efficiency and Technology Gaps in Ghana, African J. Agric. Resour. Econ. 14 (2019). http://afjare.org/wp-content/uploads/2020/01/3.-Tsiboe-et-al.pdf.