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Examining the Relationship Among Socio-Demographic, Institutional Factors and Adoption of Best Tomato Production Practices in Southern Ghana

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Abstract
Tomato, an important staple in many Ghanaian homes, provides livelihood for many farming households. Despite its importance, farmers within major growing tomato districts are either unaware or have not adopted productivity enhancing tomato production practices. This paper examined the relationship between socioeconomic and institutional factors and the adoption of pre-emergence, post-emergence and filed management practices in the Ada West and Central Tongu districts. The study employed descriptive and inferential statistics such as frequencies, percentages, means, and chi-square test to describe the respondents and test of independence between farmer characteristics and adoption. The results revealed that the adoption rates of pre-emergence, post-emergence and field management practices were 48%, 50% and 64%, respectively. Factors such as farm size, education, farming experience, land tenure arrangements, access to extension services, access to credit and point of sale were found to be significantly associated with adoption of these practices. The main constraints to double season production were reported as unavailability of water and fluctuations in market demand. It is recommended that extension officers and researchers focus their dissemination messages on improved tomato production practices through appropriate channels and build farmers' capacity on the improved practices for enhanced food security and incomes of smallholder tomato farmers in Ghana.

Keywords: Adoption, credit, chi-square, Ghana, land tenure, tomato

Examen de la relation entre les facteurs sociodémographiques et institutionnels et l'adoption des meilleures pratiques de production de tomates dans le sud du Ghana

Résumé
La tomate, un aliment de base important dans de nombreux foyers ghanéens, fournit des moyens de subsistance à de nombreux ménages agricoles. Malgré son importance, les agriculteurs des principaux districts de culture de tomates ne sont pas au courant ou n'ont pas adopté de pratiques de production de tomates améliorant la productivité. Cet article a examiné la relation entre les facteurs socio-économiques et institutionnels et l'adoption de pratiques de gestion pré-émergence, post-émergence et déposées dans les districts d'Ada West et Central Tongu. L'étude a utilisé des statistiques descriptives et inférentielles telles que les fréquences, les pourcentages, les moyennes et le test du chi carré pour décrire les répondants et tester l'indépendance entre les caractéristiques de l'agriculteur et l'adoption. Les résultats ont révélé que les taux d'adoption des

pratiques de pré-émergence, de post-émergence et de gestion sur le terrain étaient de 48 %, 50 % et 64 %, respectivement. Des facteurs tels que la taille de l'exploitation, l'éducation, l'expérience agricole, les arrangements fonciers, l'accès aux services de vulgarisation, l'accès au crédit et au point de vente se sont avérés être associés de manière significative à l'adoption de ces pratiques. Les principales contraintes à la production en double saison ont été signalées comme l'indisponibilité de l'eau et les fluctuations de la demande du marché. Il est recommandé que les agents de vulgarisation et les chercheurs concentrent leurs messages de diffusion sur l'amélioration des pratiques de production de tomates par des canaux appropriés et renforcent les capacités des agriculteurs sur les pratiques améliorées pour améliorer la sécurité alimentaire et les revenus des petits producteurs de tomates au Ghana.

Mots-clés: Adoption; le crédit; chi-carré; Ghana; le régime foncier; tomate

Introduction

Agriculture is an important sector in the Ghanaian economy, employing 44.7% of the work force (MoFA, 2017). Tomato (*Solanum lycopersicum),* is an important vegetable under the crop sub-sector cultivated by smallholders and few commercial farmers in Ghana (Osei *et al.,* 2010; FAO, 2005). The crop contributes greatly to the financial and nutritional well-being of smallholder farmers, hence very essential for inclusive growth in terms of food security. Tomato production covered a total area of 48,920 Ha representing 69.45% of the total vegetable area cropped in the Ghana in 2016 (MoFA, 2017; MoFA, 2011). As the most important vegetable crop, it improves the standard of living as an income-generating crop especially for the male youth who engages in its production and also serves as a requisite constituent of most local dishes due to the high concentrations of lycopene, vitamins A and C (Aidoo-Mensah, 2018 and Osei *et al.,* 2010), with about 90% of the domestically produced tomatoes consumed locally (Aidoo-Mensah, 2018; Agyekum, 2015 and Asante *et al.*, 2013).

In spite of its potential and importance in Ghana's agricultural sector and the economy, production has not kept pace with the growing demand due to low productivity and weak marketing systems compared with countries within the sub-region (Melomey *et al.,* 2019). The average on-farm yield of about 10 Mt compared to the potential yields of 20-40 Mt (MoFA, 2017; MoFA, 2011; Robinson and Kolavalli, 2010; http://www.mofa.gov.gh) is grossly inadequate to sustain the capacities of processing factories and enhance the commodity value chain. The low productivity can be attributed to poor and inefficient use of improved production practices (MoFA, 2011; Robinson and Kolavalli, 2010). Low rate of adoption of best production practices results in low yields which lead to low economic returns and worsened living standards for the pro-poor farmers (Monney *et al.,* 2009). Another factor accounting for the low productivity is the continuous dependence on local varieties and inadequate irrigation facilities. These factors have made Ghana a net importer of fresh tomatoes and tomato products from Burkina Faso and Europe (Horna *et al.* 2006; Bortey, 2010). For instance, Ghana is considered the second largest importer of tomato paste (Aryeetey, 2006). In addition, in 2013, Ghana imported about 78,000 tons of processed tomatoes from the European market and the total value of imports for tomato products stood at $112.1 million dollars (www.graphic.com.gh; Agyekum, 2015).

In the two study districts, according to their Medium Term Development Plan (2014-2017), the major challenge militating against sustainable agriculture was identified to be low productivity resulting from the continuous use of traditional farm implements, adoption of indigenous farming practices, erratic rainfall, high post-harvest losses and lack of irrigation inputs especially in vegetable and cereal production (Ada West District Assembly, 2014 and Central Tongu District, 2014). These trends could be reversed by application of best production practices and use of inputs applied at the recommended rates even under the average current farm sizes (MoFA, 2011). The process of technology acceptance and use is based on the Utility maximization theory and Rogers' Diffusion of Innovation Theory. The adoption of improved production technologies is demonstrated as farmer's decision process which is based on the utility maximization theory as postulated by Rahm and Huffman (1984). A farmer adopts a technology if the satisfaction derived is higher than not adopting (10>*iiUU*). Technology diffusion denotes the spread of theoretical ideas and concepts, technical information and actual practices within a social system, in which the spread refers to movement from a source to an adopter, usually through communication and influence (Roger, 1995 and Roger, 1983). The diffusion of innovation theory demonstrates that the perceived traits of a new technology significantly affect the adoption and diffusion of that technology (Roger, 1983 cited in Al-Shadiadeh *et al.*, 2012). The perceived traits as categorized by Roger are relative advantage of technology, compatibility, complexity, trialability and observability (Al-Shadiadeh *et al.,* 2012). The diffusion of innovations theory developed decades have offered a structure of how innovations and technologies are diffused and accepted in the society. Several authors (Magugu *et al.*, 2018; Sanou *et al.,* 2017; Obeng and Weber, 2014 and Al-Shadiadeh et al., 2012) have employed different estimation methods to evaluate factors that influence the adoption of improved agricultural technologies. Magugu et al. (2018) and Al-Shadiadeh *et al.* (2012) reported farm size, years of residence, percentage income from crop, educational level, access to information, household size and years of farming to positively and significantly influence adoption of agro-forestry technology and protected tomato farming practices respectively. Sanou *et al*. (2017) assessed institutional, biophysical and socio-economic factors influencing farmers' decision to adopt agro-forestry in Burkina Faso and found that farmers' knowledge, age, ethnic group, wealth status, participation in farmer association and perceived economic benefits to significantly influence adoption. Scott *et al*. (2008) also found relative advantage, intention of use and years of experience to be significantly associated with physicians' intention to use Healthy Heart Kit (HHK). Similarly, some of these factors are expected to be significantly related to the adoption of improved tomato production packages investigated.

The CSIR-Crops Research Institute in 2014 received funding from the Skills Development Fund (SDF) managed by Council for Technical and Vocational Educational Training (COTVET) under the Technology Development and Transfer Center (TDTC) Project, to facilitate the development and transfer of proven technologies aimed at addressing problems in the tomato industry and local communities. This paper hence collected benchmark information on current practices and adoption rates of best tomato production practices prior to project implementation, examined the association between the socio-demographic and institutional factors and adoption of these practices and finally identified constraints to all year round tomato production. The results

in this paper are thus based on information obtained from the baseline study conducted prior to the implementation of the project and this was imperative prior to project implementation in order to gauge the potential impact of the project. The analysis is therefore structured around three main questions; i) which best tomato production practices are adopted by farmers? ii) what socio-demographic factors are associated with the adoption of these improved production practices? and iii) What factors limit all year round tomato production in the study districts? Previous studies have focused on investigating socio-economic factors that influence the adoption of a variety or an agronomic practice however, this paper examined the adoption of sets of good agronomic practices at three levels of production – pre-emergence nursery, post-emergence and field management and further identify institutional factors associated with adoption. Such information is critical for researchers, policy makers and other stakeholders in identifying gaps and barriers to the adoption of best production practices.

Methodology

Description of study districts

Tomato is cultivated in 12 out of the 16 regions of Ghana which includes; Ashanti, Northern, Volta, Eastern, Upper East, Greater Accra, Savannah, North East, Bono East, Ahafo, Oti and Bono (Melomey *et al.,* 2019; Robinson and Kolavalli, 2010). These regions fall within the Forest Savannah Transitional and Savannah agro-ecological zones of Ghana (Adu-Dapaah and Oppong-Konadu, 2004). The study was conducted in two districts; Central Tongu and Ada west in Volta and Greater Accra regions of Ghana. The Central Tongu; formerly North Tongu lies within latitudes $5^0$47'N to 6^0N and longitude $0^0$25' E to $0^0$45'E with a total land area of 1460 Km^2 which represents about 7.1% of the Region's total area. Vegetable farming is the main source of livelihoods for many living in the district. The district has a population of 59, 411 representing 2.8 % of the region's population. The strategic position of the district and its closeness to the Volta regional capital; Ho and the country's capital, Accra enhances marketing of agricultural produce. The suitable soils, rivers, dams and dugouts present an opportunity for cultivation of vegetables such as tomatoes, pepper, okro, onions and garden eggs.

The Ada West district lies between Latitudes 5°45'S and 6°00'N and Longitude 0°20'W and 0°35'E and covers a total land mass of 323.72 sq.km representing about 10% of the total land size in Greater Accra Region. Agriculture is the main economic activity and employs 42.1% of the population with the crop production sub sector dominating and representing 48.1% (Ghana Statistical Service, 2014). The district is prominent in the cultivation of crops such as cassava, maize, legumes, fruits and vegetables. Apart from cassava and maize, the district is responsible for more than 50% of the region's output of the remaining crops (Ada West District Assembly, 2014). Table 1 shows the area under cultivation and production trends of the major crops for four years (2010-2013) in the district. From Table 1, it could be noticed that tomato cultivation in the district dominates in both area and production and therefore could be described as the major vegetable in the district. The district maps of the study areas are presented in Figures 1 and 2.

Design, sample size and sampling technique

The study employed descriptive survey design involving quantitative approach. The descriptive survey design tries to establish the range and distribution of demographic characteristics and determine the relationship between these characteristics and certain

Table 1: Area under cultivation and production trends of major crops in Ada West District

Major Crops	Production trends of major crops in the district							
	2010		2011		2012		2013	
	Area under cultivation (Ha)	Production level (MT)	Area under cultivation (Ha)	Production level (MT)	Area under cultivation (Ha)	Production level (MT)	Area under cultivation (Ha)	Production level (MT)
Cassava	1,603	10,150	1,715	10,860	1,647	10,426	1,730	10,947
Maize	252	221	275	239	262	228	278	242
Water melon	384	10,362	422	11,380	410	398	427	414
Tomato	**5,625**	**29,103**	**6,018**	**3,140**	**5,717**	**29,583**	**6,003**	**31,063**
Okro	650	2,867	702	3,096	681	3,004	709	3,125
Pepper	840	825	924	908	897	881-	951	934

Source: DADU, 2013, Sege; Ada West District Assembly

behavior patterns or attitudes (https://ir.uiowa.edu/cgi/viewcontent.cgi?article=1025&context=mzwp). This could be undertaken from diverse aspects involving case studies, observation and surveys. This design was chosen as it gives the investigator the chance to get accurate view of response to issues as well as test theories on social relationship at both the individual and group level (Kothari, 2003).

The study used both probability and non-probability sampling techniques; it employed a multi-stage sampling process to draw the sample. Based on the volumes of tomato produced, level of utilization and marketing, level of interaction with past projects and objectives of the TDTC project, the Greater Accra and Volta regions were purposively selected. Two districts (Central Tongu and Ada West) were also purposively selected from the regions based on similar criteria stated above. Six communities (Koluedor, Addokope, Matsekope, Mafi Kpedzeglo, Adidome and New Bakpa) were randomly selected from the list of tomato communities within the two districts obtained from the District Department of Agriculture. From a sampling frame developed by the Districts Department of Agriculture of MoFA, 42 tomato farmers were randomly selected to provide baseline information on improved tomato production practices utilized prior to project implementation.

Data collection and analysis

Cross sectional data was collected through formal survey using semi-structured questionnaires. Primary data was collected through individual interviews, which provide reliable data, accurate information and valuable insights into the issues being investigated. The first section included locational, socio-demographic characteristics of the farmers, next section discussed the adoption of the best practices in tomato production and the last section focused on the constraints to tomato production. In this study, an adopter referred to a farmer who uses at least three of the best practices under each category of pre-emergence and post emergence nursery and at least one of the field

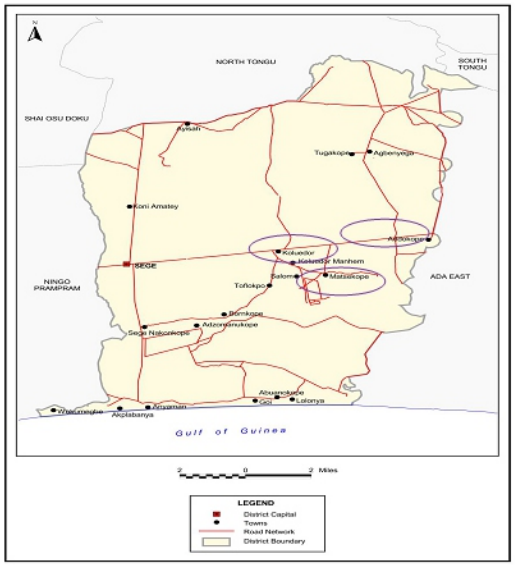

Figure 1: Map of Central Tongu district showing communities sampled
Source: Ghana Statistical Service, 2014

Figure 2: Map of Ada West district showing communities sampled
Source: Ghana Statistical Service, 2014

management practices of the production continuum. The pre-emergence practices included land preparation, nursery bed preparation, soil sterilization, planting method used in nursery and watering of seeds before emergence. Raising shed over seedlings, hand-picking weeds, covering with net to protect from pests, thinning out, irrigation type and fertilizer application were categorized under post emergence whiles integrated pests and diseases management practices (weed control, pest control, disease control) were classified under field management practices. It must be noted that the adoption of the practices is not mutually exclusive as a farmer is expected to employ all the best practices in production.

Descriptive statistics such as means, frequency tables, percentages and charts were used to describe the attributes of the households sampled. The Chi-square test of independence was used to evaluate the relationship between the socio-demographic and institutional factors and adoption of best tomato practices using STATA 15. The chi-square was used because of its ability to tests the association between sets of categorical variables. The Chi-square computation was based on the expression specified as:

$$\chi^2 = \sum \frac{(f_0 - f_e)^2}{f_e}$$

Where; 2*c*= Chi-Square0*f*= the observed frequency (i.e. the observed counts in the cell)*ef*= the expected frequency if the variables are independent.

The results are evaluated by comparing the actual value with a critical value read in the

Chi-square distribution table after considering the degrees of freedom which is calculated as the number of rows minus 1 (R-1) by the number of columns minus 1 (C-1).

Results and Discussions

Demographic characteristics of respondents by adoption

Tables 2 and 3 present the descriptive statistics involving socio-demographic characteristics of respondents in the study locations. The results revealed that about 67% of the farmers were males with 33% being females. Females represents one-third of the total sample indicating an appreciable representation and active involvement of women in tomato farming which is also evidenced in the ownership of their tomato farms. Majority of the farmers (73.8%) were married with an average of six (6) members per household (Table 2). This is a proxy for labour availability for the household to support farm operations, all things being equal. The average age of the respondents was 42.61 years and it ranged from 23 to 70 years (Table 2). This indicates that majority are within the economically active group and hence could supplement hired labour with own labour for farm operations. The results also showed that tomato production provided an avenue for the independent and responsible youth as more married young adults were involved. This may be due to its labour intensive nature and the short cycle of the crop (3 months), hence providing quick cash for the youth. Tampoare et al. (2012) found that more youth were attracted to tomato production when they examined the economic benefit of fresh tomato production at the Tono irrigation scheme in Upper East region of Ghana.

Majority of the respondents were educated; about 43% have completed JHS/Middle level, 17% were at the primary level category and secondary and tertiary accounted for 7% each, respectively (Table 3). Educated farmers are expected to have better understanding of the technical aspects and able to assimilate the good agricultural practices of tomato cultivation (Islam et al., 2010). The high level of education is therefore likely to be associated with adoption of the practices, as tomato growers could easily grasp new ideas and quickly try and adopt new practices. However, Tampoare *et al.* (2012) found the reverse in the Upper East region of Ghana. This difference may be attributed to geographical differences as the two studies were conducted in different locations and

Table 2: Summary statistics of quantitative variables

Variable	Minimum	Maximum	Mean	Standard deviation
Age (years)	23	70	42.61	12.10
Household size (number)	1	18	5.55	3.44
Years of schooling	0	16	6.86	4.78
Age of seedlings before transplanting (weeks)	3	6	3.74	0.86
Length of tomato in the field (Months)	3	5	3.40	0.57
Number of times tomato is cultivated annually	1	3	1.55	0.71

Source: Author's own construction

Table 3: Characteristics of respondents

Variables	Frequency	Percent
Sex		
Male	28	66.7
Female	14	33.3
Marital status		
Single	8	19
Married	31	73.8
Divorced	3	7.1
Educational level		
None	11	26.2
Primary	7	16.7
JHS/Middle	18	42.9
Secondary	3	7.1
Tertiary	3	7.1
Tomato farming experience (years)		
<5 years	12	28.6
5-10 years	13	31.0
>10 years	17	40.5
Farm sizes (acres)		
≤ 2 acres	26	61.9
>2acres	16	38.1
Preference to cultivate in both seasons (major and minor)	30	71.4
Preference to cultivate in only one seasons	12	28.6
Heard of soil sterilization	27	64.3
Practice soil sterilization	22	81.5
Farmers able to describe soil sterilization process	8	36.4
Apply fertilizer (Yes)	34	81.0
Encountered disease (Yes)	37	88.1
Encountered pest (Yes)	42	100

environments; Islam *et al.* (2010) in Malaysia and Tampoare *et al.* (2012) in Upper East region of Ghana.

The level of experience in any business is important as it affects people's behavior towards trying new technologies relevant for the enterprise. More than half of the farmers (71.5%) had been cultivating tomato for more than five years and could be classified as experienced in the tomato production business. Hence, are abreast with the risks and uncertainties associated and the best practices to employ. About 62% cultivated fields less than two acres (about 0.8ha). This conforms to findings by Adu-Dapaah and Oppong-Konadu (2004) which demonstrates that tomato production in Ghana is still subsistence (Melomey *et al.*, 2019). With the small farm sizes, adopting improved production practices and intensifying on production could enhance productivity compared to the continual use of conventional methods on these small plots. The mean maturity for tomatoes grown in the area is three months per season and farmers cultivated the crops about twice in a year (Table 2). The results of farmers' preference to cultivate in both the major and minor seasons and as high as 71.4% responded in the affirmative while 28.6% preferred one season cultivation (Table 3) due to erratic rainfall, lack of irrigation systems and market variability.

Adoption of best tomato production practices

Table 4 reveals that some of the farmers adhered to the best practices across the study districts. This corresponds with the findings by Adu-Dapaah and Oppong-Konadu (2004) in the forest transition zones of Ghana. However, there is still room for improvement as practices such as land preparation, soil sterilization, spacing and right amounts of fertilizer to apply were least followed. Moreover, the acceptance and use of the pre-emergence and post-emergence practices were minimal.

The relationship among socio-demographic, institutional factors and adoption of best production practices

Socio-demographic factors and adoption of best practices

To test the hypothesis of "no association between the socio-demographic variables and adoption of the best practices", the chi-square test was used. The categorical socio-demographic factors considered were farm size, form of education, farmers experience in tomato production and type of variety cultivated. Cross tabulations were done for each of the variables by the production practices, with the raw percentages reported in parentheses and the chi-square and the *p-values* computed. The summary results are as presented in Tables 5, 6, 7 and 8. From Table 5, the *p-value* for farm size by adoption of pre-emergence practice is less than 0.05 signifying that farm size and adoption of pre-emergence practice are related. The *p-value* for form of education by adoption of pre-emergence practice in Table 6 is less than 0.05. This implies that there is an association between education and adoption of pre-emergence practices. With the kind of practices considered under pre-emergence such as land preparation, nursery bed preparation, soil sterilization, etc; though labour-intensive, it may also require some technical knowledge and exposure; so formal education places a farmer in better position to grasp and apply these practices much easier.

The *p-values* of farmers' experience and variety type by adoption of all the production practices as presented in Tables 7 and 8 were greater than 0.05, which implies that, these variables are indeed independent of the adoption of the production practices.

Table 4: Adoption rates of best tomato production practices

Stages in tomato production	Recommended tomato practices	Percentage adoption
Pre-emergence		
Land preparation	Slash and burn and ridge/ mound (raised bed manual)	19.0
Nursery bed preparation	Slash weeds, prepare bed and plant	57.1
Soil sterilization	• Dig up soil and leaves exposed to the sun	0.0
	• Dig up soil, water to make moist, lay thick layer of mulch and burn	36.0
Planting on nursery beds	Drilling	31.0
Watering of seedlings	As and when its necessary	16.7
Post-emergence		
	• Raised shed over seedlings	42.9
	• Handpick weeds	52.4
	• Cover with net to protect from pests	16.7
	• Thin out	2.4
	• All the above	11.9
Spacing	• Plant spacing: 100 cm x 30 cm	
Fertiliser application	Inorganic fertilizer	0.0
	Applied three times	38.1
Field management		0.0
Weed Control	Hand tools;	
	Performed more than four times before harvesting	95.2
Pest Control	Apply pesticides [at threshold of the pest] with Golan, rim-on	85.7
Disease Control	• Rouging [especially for viruses]	25.6
	• Application of pesticides to manage disease. e.g. Victory, shavit F for fungal diseases;	60.5
	• Applied more than four times	7.1

Experience and variety type were not related with adoption of the practices because experience in terms of number of years of farming and having access to a type of variety are not enough but requires adequate knowledge and the skills and combine with the human and physical resources available to be productive.

Institutional factors and adoption of best practices

The association between institutional variables and adoption of the three level production practices were determined. The institutional factors studied were land tenure arrangements, extension services, credit and market. Table 9 shows that the *p-value* for the relationship between tenure arrangement and adoption of pre-emergence practice is less than 0.01. This indicates that there is an association between tenure arrangement and adoption of pre-emergence practice. This is important because access to land precedes production, therefore anything that affect access to land may even preclude the subsequent practices from occurring. Tenure

Table 5: Distribution of farm sizes by adoption of best tomato production practices

Farm Size	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
≤2 acre	9 (34.6)	17 (65.4)	26 (100)	11 (42.3)	15 (57.7)	26 (100)	16 (61.5)	10 (38.5)	26 (100)
> 2 acres	11 (68.8)	5 (31.2)	16 (100)	10 (63.5)	6 (37.5)	16 (100)	11 (68.8)	5 (31.2)	16 (100)
	Pr = 0.031			Pr = 0.204			Pr = 0.636		
	Pearson chi2(1) = 4.627			Pearson chi2(1) = 1.615			Pearson chi2(3) = 0.224		

NB: Values in parenthesis are in percentages

Table 6: Distribution of form of education by adoption of best tomato production practices

Education type	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
No formal Education	5 (27.8)	13 (72.2)	18 (100)	10 (55.6)	8 (44.4)	18 (100)	12 (66.7)	6 (33.3)	18 (100)
Formal Education	15 (62.5)	9 (37.5)	24 (100)	11 (45.8)	13 (54.2)	24 (100)	15 (62.5)	9 (37.5)	24 (100)
	Pr = 0.026			Pr = 0.533			Pr = 0.780		
	Pearson chi2(1) = 4.972			Pearson chi2(1) = 0.389			Pearson chi2(3) = 0.078		

NB: Values in parenthesis are in percentages

system affects the investments made in improving the productivity of the land in terms of input application and use of improved technologies, therefore with about 57% of the respondents owning the land on which they cultivate, it is anticipated that farmers will invest more in the land to achieve the needed benefits due to the freedom of use of the land. Different authors (Chand and Yala, 2009; Ayamga and Dzanku, 2013 and Alufah, 2015) have evaluated effects of land tenure system/ security on crop and farm level productivity. Chand and Yala (2009) analyzed the effect of land tenure on oil palm productivity in Papua New Guinea and found out that systematic differences existed between productivity and three land tenure types; "farms under customary purchase agreements, those under the land settlement scheme, and those under village-owned land schemes". Ayamga and Dzanku (2013) examined "how different methods of quantifying and measuring tenure security influence farm investment in eleven districts within four agro-ecological zones of Ghana". Their study found that only one-third of the farmers made investment into land improvement and irrigation. The study hence

Table 7: Distribution of farmers' experience by adoption of best tomato production practices

Farmers' experience	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
<5 years	6 (50.0)	6 (50.2)	12 (100.0)	5 (41.7)	7 (58.3)	12 (100.0)	7 (58.3)	5 (41.7)	12 (100.0)
5 - 10 years	6 (46.2)	7 (53.8)	13 (100.0)	5 (38.5)	8 (61.5)	13 (100.0)	8 (61.5)	5 (38.5)	13 (100.0)
>10 years	8 (47.1)	9 (52.9)	17 (100.0)	11 (64.7)	6 (35.5)	17 (100.0)	12 (70.6)	5 (29.4)	17 (100.0)
	Pr = 0.980			Pr = 0.287			Pr = 0.770		
	Pearson chi2(2) = 0.041			Pearson chi2(2) = 2.496			Pearson chi2(2) = 0.522		

NB: Values in parenthesis are in percentages

Table 8: Distribution of variety type by adoption of best tomato production practices

Variety type	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
Local	6 (46.2)	7 (53.8)	13 (100.0)	7 (53.8)	6 (46.2)	13 (100.0)	8 (61.5)	5 (38.5)	13 (100.0)
Hybrid	6 (37.5)	10 (62.5)	16 (100.0)	8 (50.0)	8 (50.0)	16 (100.0)	11 (68.8)	5 (31.2)	16 (100.0)
Both	8 (61.5)	5 (38.5)	13 (100.0)	6 (46.2)	7 (53.8)	13 (100.0)	8 (61.5)	5 (38.5)	13 (100.0)
	Pr = 1.678			Pr = 0.926			Pr = 0.894		
	Pearson chi2(2) = 0.432			Pearson chi2(2) = 0.154			Pearson chi2(2) = 0.224		

NB: Values in parenthesis are in percentages

anticipated a strong relationship between land tenure security and farm investment.

The *p-value* for access to extension by adoption of pre-emergence practices as indicated on Table 10 is less than 0.05, hence implies that access to extension is related with adoption of pre-emergence practice. The *p-value* for access to extension and adoption of post-emergence practices is less than 0.10, hence implying that, access to extension is related with adoption of post-emergence practices. Since access to extension was not related with field management practices, it could be suggested that, tomato farmers are more assisted during the pre- and nursery

Table 9: Distribution of tenure system by adoption of best tomato production practices

Tenure system	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
Onership	7	17	24	11	13	24	16	8	24
	(29.2)	(70.8)	(100.0)	(45.8)	(54.2)	(100.0)	(66.7)	(33.3)	(100.0)
Hiring	13	5	18	10	8	18	11	7	18
	(72.2)	(27.8)	(100.0)	(55.6)	(44.4)	(100.0)	(61.1)	(38.9)	(100.0)
	Pr = 0.006			Pr = 0.533			Pr = 0.710		
	Pearson chi2(1) = 7.644			Pearson chi2(1) = 0.389			Pearson chi2(1) = 0.138		

NB: Values in parenthesis are in percentages

Table 10: Distribution of extension access by adoption of best tomato production practices

Extension access	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
Access to extension	7	15	22	8	14	22	15	7	22
	(31.8)	(68.2)	(100.0)	(36.4)	(63.6)	(100.0)	(68.2)	(31.8)	(100.0)
No access	13	7	20	13	7	20	12	8	20
	(65.0)	(35.0)	(100.0)	(65.0)	(35.0)	(100.0)	(60.0)	(40.0)	(100.0)
	Pr = 0.032			Pr = 0.064			Pr = 0.580		
	Pearson chi2(1) = 4.624			Pearson chi2(1) = 3.436			Pearson chi2(1) = 0.305		

NB: Values in parenthesis are in percentages

Table 11: Distribution of credit access by adoption of best tomato production practices

Credit access	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
Access to extension	6	14	20	7	13	20	12	8	20
	(30.0)	(70.0)	(100.0)	(35.0)	(65.0)	(100.0)	(60.0)	(40.0)	(100.0)
No access	14	8	22	14	8	22	15	7	22
	(63.6)	(36.4)	(100.0)	(63.6)	(36.4)	(100.0)	(68.2)	(31.8)	(100.0)
	Pr = 0.029			Pr = 0.061			Pr = 0.580		
	Pearson chi2(1) = 4.752			Pearson chi2(1) = 3.436			Pearson chi2(1) = 0.305		

NB: Values in parenthesis are in percentages

Table 12: Distribution of point of sale by adoption of best tomato production practices

Point of sale	Pre-Emergence			Post-Emergence			Field-Management		
	Yes (*N*=20)	No (*N*=22)	Total (*N*=42)	Yes (*N*=21)	No (*N*=21)	Total (*N*=42)	Yes (*N*=27)	No (*N*=15)	Total (*N*=42)
Farm gate	9 (50.0)	9 (50.0)	18 (100.0)	5 (27.8)	13 (72.2)	18 (100.0)	11 (61.1)	7 (38.9)	18 (100.0)
Other markets	11 (45.8)	13 (54.2)	24 (100.0)	16 (66.7)	8 (33.3)	24 (100.0)	16 (66.7)	8 (33.3)	24 (100.0)
	Pr = 0.789			Pr = 013			Pr = 0.710		
	Pearson chi2(1) = 0.072			Pearson chi2(1) = 6.222			Pearson chi2(1) = 0.138		

NB: Values in parenthesis are in percentages

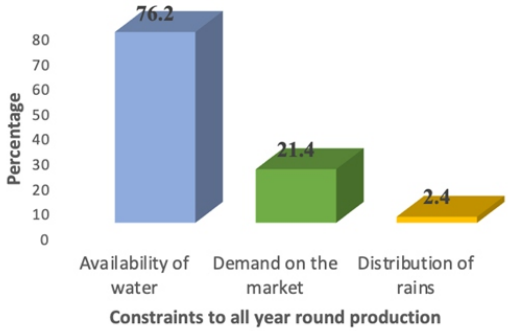

Figure 3: Factors leading to one season production

stages of production where production is very critical.

Credit plays an important role in the production chain, and it contributes to agricultural development. Credit access as noted by Kohansal et al. (2008) plays a critical role in eliminating some of the farmer's challenges in investing in farm activities, improving productivity and adopting technologies. Accessibility to credit improves the quality and quantity of farm produce but limited access constrains the budget balance. Access to credit is operationalized in the study to mean receiving credit. The results of the relationship between credit access and the adoption categories are presented in Table 11. The results show that, the *p-value* for access to credit by adoption of pre-emergence practice is less than 0.05, the null hypothesis is therefore rejected at 5% significance level in favour of the alternative and concluded that access to credit and adoption of pre-emergence practice are related. The *p-value* for access to credit by adoption of post-emergence practice is less than 0.10. This implies that access to credit and adoption of post-emergence practice are related. The pre-emergence and post emergence practices could be both labour and capital intensive and a farmer's access to credit could absorb some of the production costs that need to be borne by the farmer. Perez *et al.* (2017) reported that in the developed world, farmers are able to manage the challenges faced in production through the use of right technologies and access to financial resources but the reverse is found in Africa and hence make it difficult for farmers to mitigate these risks in production.

Table 12 presents results on the relationship between point of marketing and adoption of the improved production practices. The *p-value* for place of sale by adoption of post-emergence practices is less than 0.05, This

suggests that, place of sale is associated with adoption of post-emergence practice. Easy access to markets and favourable prevailing market conditions as noticed by Tanguy et al. (2017) could encourage farmers to risk and expend their resources; both physical and financial to adopt practices and reap the benefits thereof. The point of sale may affect the adoption of post-emergence practices because this is a critical stage in the tomato life cycle where much care is needed for proper seedling establishment.

Constraints to all year round tomato production

The results of the constraints that could militate against dual production within the year revealed that availability of water and market demand for the produce were the main limiting factors as shown on Figure 3. Though diseases pressure and rainfall distribution have been cited by Melomey *et al.,* 2019; van Asselt *et al.,* 2018; Eshun *et al.,* 2011 and Robinson, and Kolavalli, 2010 as limiting factors to all year round tomato production, these were least recognized by producers. Majority of the farmers; 88.1% and 100 %, respectively, identified diseases and pests, but these had no adverse effect on their production. The results therefore confirm why 28.6% preferred cultivating tomato in only one season within the year. This finding conforms to Melomey et al. (2019), Perez *et al.* (2017) and Adu-Dapaah and Oppong-Konadu (2004), who cited insufficient or erratic water supply as one of the limiting factors to sustainable tomato production in Ghana and within the sub-region.

Conclusion/ Recommendations

This paper examined the relationship between socioeconomic and institutional factors and the adoption of pre-emergence, post-emergence and field management practices in the Ada West and Central Tongu Districts. The results showed that tomato production though dominated by males had an appreciable proportion of female farmers involved. Production is also dominated by majority of economically active houseold members which confirmed that the sector is attractive to the youth and with majority having formal education. Irrigation was found to be a critical constraint to sustainable tomato production. The adoption rates for the pre-emergence, post-emergence and field management practices were about 48%, 50% and 64%, respectively, which were found to be encouraging. Adopters and non-adopters had similar charcteristics except for the number of times the crop was cultivated annually. Both socio-demographic and institutional factors such as form of education, farm sizes, land tenure arrangements, access to extension services, access to credit and point of sale were significantly associated with the adoption of the best production practices. This implies that, these are some of the factors researchers and policy makers must be aware of as they draw up their dissemination plans and formulate policies to boost the tomato sub-sector.

There is therefore the need for extension officers and researchers to focus their dissemination messages on improved tomato production practices through appropriate channels and build farmers' capacity on the improved practices for enhanced food security and incomes of smallholder tomato farmers in Ghana. Extension agents must be equipped physically and financially to serve the growing needs of farmers and reach out to more farmers within the regions and districts. Furthermore, some empirical studies have confirmed some of these characteiristics by even establishing the direction of effect and magnitude. It is recommended that further studies evaluate these packaged technologies in more tomato growing areas and sample more respondents to empirically evaluate the causal effect of these factors on adoption of

improved tomato technologies.

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