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Factors influencing smallholder orange farmers for compliance with GobalGAP standards

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ABSTRACT

The inability of farmers to comply with global good agricultural practices (GlobalGAP) standards has led to food safety issues harmful to human health and sustainable agriculture. This study aimed to assess the extent of GlobalGAP compliance among orange farmers and investigate barriers associated with compliance. Data were collected with structured questionnaires from 238 orange farmers. The findings showed that the farmers' rate of adherence to the GlobalGAP standards was moderate (mean 3.58). Using factor analysis, the following four groups were identified as key barriers to compliance: personal and economic barriers, awareness and information barriers, institutional-support barriers, and infrastructure barriers. Institutional support barriers were deemed most important by farmers in compliance decisions (mean 4.29), followed by personal and economic barriers (mean 3.89). Therefore, a focus on the barriers faced by smallholder farmers would be crucial to improve their adoption of food safety standards. This can enhance the quality of agricultural commodities, customers' safety, and the livelihood of smallholder farmers.

1. Introduction

The agricultural sector plays a key role in the Egyptian economy, despite a decline in its relative importance in recent decades. It accounted for approximately 11 percent of the gross domestic product (GDP) in 2018, compared to 20 percent in the early 1980s (World Bank, 2018). However, this does not correspond to a decrease in the entire working population, and the sector still employs about 29 percent of the entire workforce. The majority of landholdings (61.3%) are owned by small scale farmers (with a landholding lower than 5 ha) (FAOSTAT, 2018).

Over the past decades, intensive agriculture has increased the productivity of agricultural commodities and significantly reduced food insecurity and poverty (Shah et al., 2019; Zeweld et al., 2017). Despite this promising success, this increase in intensive farming led to the loss of biodiversity, soil degradation, pollution of natural water resources, and climatic changes (Luo et al., 2016; Raza et al., 2019). Besides these impacts, the food industry has been faced with challenges arising from outbreaks of foodborne diseases, food contamination, and pest infestations (Annor, 2018). The concerns to human health and the environment from these issues have increased the importance of food safety and quality measures in the global food trade (Aydin and Aktürk, 2018; Islam et al., 2012; Som et al., 2017). One of the widely employed food quality assurance standards is global good agricultural practices (GlobalGAP) (Mushobozi, 2010; Holzapfel and Wollni, 2014). The GlobalGAP protocol develops high-quality agricultural practices for preharvest activities (Annor, 2018; Pandit et al., 2017). Based on the hazard analysis critical control point (HACCP) principles, the GlobalGAP standards aim to reduce risks associated with the use of agricultural inputs by taking into account environmental sustainability. These standards also incorporate the principles of the International Labor Organization (ILO), which ensure workers' health and welfare (GLOBALG.A.P, 2017). Despite the fact that GlobalGAP is a voluntary standard, it has become a gateway to access international markets and the European Union (EU), in particular (Annor, 2018).

This study considers the implementation of GlobalGAP for orange cultivation in Egypt. Orange is the most grown crop in
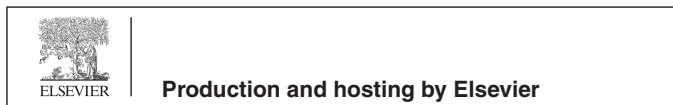
Egypt, occupying 154,200 ha (2017/18 season) of the total culti-vated area. The total annual production of oranges was around 3.4 million tons (2017/18 season) in Egypt, which made the coun-try the sixth largest orange producer in the world. Egypt is also the second largest exporter of oranges in the world after Spain, with exports accounting for 1.555 million tons (2017/18 season) (Omar and Tate, 2018). The delta region (old lands) and new reclaimed regions (Nubaria and Salhia) are the main producing areas of oranges in Egypt. Forty percent of orange production comes from small scale farmers, mainly in the delta region (Abobatta, 2018). Oranges are exported from the middle of Novem-ber to the end of January. Additionally, of all the orange varieties, the Valencia orange grown in the newly reclaimed areas comprises around 94% of the total orange exports (Abu Hatab and Nsabimana, 2016). According to Egypt's Sustainable Agricultural Development Strategy 2030, Egypt aims to sustainably promote the competitive-ness of orange by increasing the implementation of the GlobalGAP standards (MALR, 2016).

Farmers' compliance with GlobalGAP depends on various eco-nomic, regulatory, and human incentives, such as reducing produc-tion costs, maximizing profit, increasing capital estimation of farm assets, reducing risks, community development, responsibility rules, and enhancing farmers' skills (Mushobozi, 2010; Pongvinyoo, 2015). In order to gain these benefits, it is essential to engender technological changes through long-term investments in inputs and producers' skills, particularly in the fruit and fresh vegetable sector (Annor et al., 2016; Kersting and Wollni, 2011). Since small-scale farmers are less likely to implement these changes under international standards, they are excluded from access to high-value markets worldwide (Holzapfel and Wollni, 2014). According to studies, the inclusion of small-scale farmers in GlobalGAP certification schemes ultimately depends on the role of exporters in giving assistance to farmers and the type of public–private partnerships (PPP) developed (Holzapfel and Wollni, 2014; Kersting and Wollni, 2011; Tran and Goto, 2019). Clearly, the implementation of these strategies is affected by multiple factors (internal or external), which may influence the farmer's decision to comply with GlobalGAP standards (Annor et al., 2016; Pongvinyoo, 2015). Studies have attempted to identify factors influencing farmers' adoption of good agricultural practices. Demo-graphic variables such as age, education, and the membership in farmer organizations were found to influence farmers' decisions (Annor et al., 2016; Ganpat et al., 2014; Holzapfel and Wollni, 2014; Kersting and Wollni, 2011; Kibet et al., 2018; Marine et al., 2016; Pandit et al., 2017; Parikhani et al., 2015; Pongvinyoo et al., 2014; Srisopaporn et al., 2015; Suwanmaneepong et al., 2016). Other factors comprise institutional support (Ganpat et al., 2014; Holzapfel and Wollni, 2014; Islam et al., 2012; Kersting and Wollni, 2011; Marine et al., 2016; Parikhani et al., 2015; Pongvinyoo, 2015; Srisopaporn et al. 2015), infrastructure (Kersting and Wollni, 2011; Pandit et al., 2017; Parikhani et al., 2015), economic impact variables (Annor, 2018; Aydin and Aktürk, 2018; Ganpat et al., 2014; Islam et al., 2012; Jelsma et al., 2019; Kersting and Wollni, 2011; Kibet et al., 2018; Marine et al., 2016; Nirmala, 2015; Ochieng et al., 2019; Pongvinyoo et al., 2014; Srisopaporn et al., 2015; Suwanmaneepong et al., 2016), and knowledge and attitudes levels of producers (Ding et al., 2019; Kibet et al., 2018; Nirmala, 2015; Pandit et al., 2017; Pongvinyoo, 2015; Som et al., 2017; Suwanmaneepong et al., 2016).

Although GlobalGAP standards are indicative of food safety in the international markets, few Egyptian growers implement these standards, even for the products sold in EU markets (Tellioglu and Konandreas, 2017). As smallholder farming is the dominant form of agriculture in Egypt, exploring the current situation of compli-ance of small-scale orange farmers to GlobalGAP standards will be useful, especially in the light of limited literature on this subject. This study seeks to contribute to the literature by assessing the extent of GlobalGAP compliance among orange farmers and by investigating barriers associated with compliance. The findings could be useful for Egyptian policymakers when suggesting poten-tial reforms and developing long-term advisory programs for enabling small-scale farmers to participate in GlobalGAP implementation.

2. Materials and methods

2.1. Study area

The current study was carried out in El Nubaria region, Egypt. This region has a total area of 5670 km^2 (Abou-Hadid et al., 2010), as shown in Fig. 1, and is divided into four governorates: Giza, El Monoufia, Alexandria, and El Beheira. The region is com-posed of six districts: Al-Bustan, Al-Hammam, West Nubaria, Ban-gar Al-Sukkar, Taiba, and Al-Entelak. Each district has several small villages, with about 500 to 1000 farmers in each village (Badr, 2019). El Nubaria was selected for this study because this area pro-duces a large amount of oranges (orange accounts for 51.1% of the total farming area and 42.3% of the total fruit production) (CAPMS, 2018). This region grows a wide range of fruits, vegetables, and aromatic plants over a total area of 305,600 ha. The current crop-ping pattern in El Nubaria comprises citrus, grapes, apples, olives, bananas, peaches, tomatoes, watermelons, potatoes, squash, pep-pers, and eggplants (Abou-Hadid et al., 2010). The surface irriga-tion system on the River Nile is the main source of irrigation in the region. Water is distributed to different locations by the Nubaria canal. Additionally, drip or sprinkler irrigation is used to cope with water shortage, especially, in lands located far away from the canal (Abdelraouf and El Habbasha, 2014). There are two main types of soil in the region; calcareous soil is the main type of soil in the northern and eastern parts, and sandy soils are distributed in the southern and western areas (Abbas et al., 2012).

2.2. Sampling and data collection

Three districts were randomly selected in the region; Taiba, Al-Bustan, and West Nubaria. The population comprised small-scale orange farmers (<10 ha) from the three districts (N = 698). These farmers are not certified GlobalGAP initiative. Using Cochran's for-mula and a multi-stage sampling strategy, a sample of 249 farmers was selected. However, due to incomplete data in some question-naires, 11 farmers were excluded from the sample, resulting in a sample of 238 farmers in the final analyses. Four villages were ran-domly selected from each district to represent all geographical areas. Orange farmers were randomly chosen from the selected 12 villages. Data were collected through face-to-face interviews with farmers using a questionnaire, during the period from Octo-ber to December 2018.

2.3. Instrument

A questionnaire was divided into three sections to obtain infor-mation on the study's objectives. The first section comprised farm-ers' demographic information such as age, education, farming experience, membership in marketing or exporting organizations, having off-farm income, access to loans, annual farm income, and orange yield. Section two assessed farmers' compliance with the GlobalGAP standards using a 5-point Likert scale (1= "very low," 2= "low," 3= "intermediate," 4= "high," and 5= "very high"). Based on the GlobalGAP manual [39], we assigned a Likert score to the target farmers for each item. Respondents were asked to determine
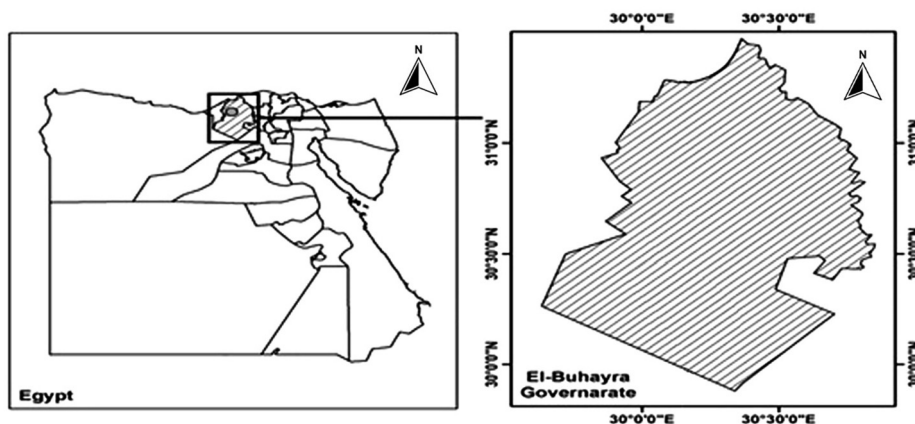
Fig. 1. Map of the study area (El Nubaria region).

their compliance level for each practice. Constraints to farmers' compliance with the GlobalGAP standards were presented in section three. Twenty-eight constraints were identified based on the literature (Annor, 2018; Parikhani et al., 2015; Raza et al., 2019; Suwanmaneepong et al., 2016). A panel of 10 experts from the Horticulture Research center, and Agricultural Research Center (ARC) examined the validity of the instrument. The respondents were asked to rank the impact of these constraints on production on a Likert-type scale (ranged from 1 = not very important to 5 = very important). Furthermore, the questionnaire was pre-tested on a sample of 20 farmers. Accordingly, the authors modified the questionnaire to ensure that it is comprehendible and in compliance with the local farming context. Cronbach's Alpha coefficient was calculated to assess the reliability of the instrument. The reliability was 0.81 and 0.85 for sections on the standards and constraints, respectively, indicating a good level of consistency.

2.4. Data analysis

Descriptive statistics comprising frequency, percentage, mean, and standard deviation were used to analyze the data and describe the results. Factor analysis was used to examine the underlying patterns of constraints that are highly interrelated (factors) and reduce them to more manageable levels. By the method of the main analysis components, using Varimax rotation, we obtained a cut-off point of 1 for eigenvalues and factor loadings greater than 0.50. The Friedman's test was used to examine the extent of variance in the responses of farmers regarding the ranks of each factor. To assess significant differences in farmers' compliance with GlobalGAP standards (extracted from factor analysis), according to their socio-economic characteristics, a t-test was used for dichotomous variables, while a one-way analysis of variance (ANOVA) was used in the case of interval variables. Data were analyzed using SPSS 25.0.

3. Results

3.1. Sample characteristics

Table 1 shows the personal attributes of the respondents. Most farmers (42.9%) were aged 40–55 years, with a mean of 44.6 years. In the sample, more than one-third of farmers (37%) had a university degree and 32.8 farmers had secondary education, while 13% of the respondents had no formal education. The mean farming experience of the farmers was 18.2 years, and the highest proportion of farmers (62.6%) belonged to the farming experience category 15–25 years. More than half of the farmers (57.6%) owned

Table 1
Socio-economic characteristics of the respondents.

Variable (n = 238)	Frequency	Percentage
Age (mean = 44.6)		
Less than 40 years	96	40.3
From 40 to 55 years	102	42.9
More than 55 years	40	16.8
Education		
No education	31	13
Elementary	41	17.2
Secondary school	78	32.8
University	88	37
Farming experience (mean = 18.2)		
Less than 15 years	34	14.3
From 15 to 25 years	149	62.6
More than 25 years	55	23.1
Size of orange farm (mean = 6.1)		
Less than 3 ha	60	25.2
From 3 to 7 ha	137	57.6
More than 7 ha	41	17.2
Family labor force		
Yes	72	30.3
No	166	69.7
Membership of marketing or exporting organizations		
Yes	48	20.2
No	190	79.8
Having off-farm income		
Yes	56	23.5
No	182	76.5
Access to loans		
Yes	59	24.8
No	179	75.2
Annual farm income (mean = $3888.4)		
Less than $3000	81	34
From $3000 to $6000	109	45.8
More than $6000	48	20.2
Orange yield (mean = 26.1 tons/ha)		
Less than 20 tons	38	16
From 20 to 40 tons	138	58
More than 40 tons	62	26

3–7 ha, with a mean of 6.1 ha. A high proportion of the respondents (69.7%) reported that they did not use the family labor force for performing agricultural activities. More than three-quarters (79.8%) of the respondents did not join marketing or export organizations. The majority of the respondents (76.5%) had no off-farm income. Some farmers (24.8%) had access to loans. Most farmers (45.8%) earned US$3000–6000 as annual income from orange cultivation, with an average annual income of US$3888.4. The average orange yield was about 26.1 tons per ha; most of the farmers (58%) yielded 29–40 tons of oranges per ha.

3.2. Farmers' compliance with global GAP standards

The mean scores of farmers' compliance with GlobalGAP are shown in Table 2. The results indicated that orange farmers in the study area moderately implemented the requirements of GlobalGAP (average score = 3.58). Standards pertaining to site history and site management, traceability, soil management, propagation materials, and equipment have been found to have satisfactory compliance (mean ≥ 4). Farmers have partially complied with the standards on fertilizer management (mean 3.94), water management (mean 3.95), plant protection products (PPPs) (mean 3.34), integrated pest management (mean 3.12), and harvesting and produce handling (mean 3.05). The farmer exhibited the least compliance with the requirements of health safety and welfare, with a mean of 1.99.

3.3. Factor analysis

Factor analysis (Table 3) was conducted to identify obstacles to the implementation of GlobalGAP standards by orange farmers. To determine the suitability of our data for structure detection, the Bartlett' test of sphericity (BTS) and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy were performed. BTS was 2133.788 (p < 0.01), indicating that the population correlation matrix is not an identity matrix. KMO was 0.791, suggesting that the data were suitable for factor analysis. Table 3 shows the four factors; they were labeled according to the characteristics of the constructs. The factors comprised personal and economic factors, awareness and information factors, institutional- support factors, and infrastructure factors, which explained 20.9%, 12.6%, 18.1%, and 10.2% of the total variance in responses, respectively. These extracted variables accounted for 61.8% of the total explained variation.

Factor 1 comprised of five items loading significantly. These items were "low literacy levels," "low risk of motivation for the application GAP," "the high cost of labor," "the high cost of input supplies," and "the high-level of chemical fertilizers used." Based on content of the items, factor 1 was named "personal and economical barriers," with an eigenvalue of 4.09. Factor 2 included four variables loading significantly. These variables were "lack of sufficient knowledge and skills on post-harvest techniques," "lack of information about export specifications," "high infection from pests and diseases," and "the high need for integrated databases and concise records for different operations." Since these variables were directly related to the way in which a farmer acquires and uses the information on his farming context, this factor was labeled "awareness and information barriers"; it had an eigenvalue of 3.11. Factor 3 consisted of seven variables loading significantly. These variables were "no governmental guarantee programs for product

safety," "a lack of linkage with citrus packaging houses," "lack of access to export-oriented extension services," "residues of pesticides in the product," "lack of access to loans," "low prices of orange," and "Low quality orange." This factor was termed "institutional-support barriers"; it had an eigenvalue of 3.74. Factor 4 had four items, representing physical aspects of the farm and facilities needed for compliance with GlobalGAP standards. These items were "lack of affordable storing and cooling facilities," "lack of equipment and facilities for using GAP technologies," "poor water quality," and "lack of quality of packaging." Therefore, this factor was termed "infrastructure barriers"; it had an eigenvalue of 2.59.

Results of the Friedman's test indicated that there were significant differences in the response of farmers regarding the importance of the extracted factors (p < 0.01) (Table 4), confirming that the ranks of extracted factors were not equal. Institutional-support barriers were deemed most important by farmers in compliance decisions (mean 4.29), followed by personal and economic barriers (mean 3.89), awareness and information barriers (mean 3.45), and infrastructure barriers (mean 3.05).

3.4. Factors associated with farmers' compliance with GlobalGAP

There were no significant differences in the opinions of the farmers regarding barriers faced when complying with GlobalGAP standards in terms of age, farm size, and family labor force (Table 5 and Table 6). The one-way ANOVA (Table 5) showed significant differences (p < 0.01) among education groups in terms of barriers faced by farmers when complying with GlobalGAP. Farmers with university education (mean 3.82) tended to consider "awareness and information barriers" more important than farmers with less education. For different factors, an examination of farming experience indicated a wider difference among the farming experience groups. In descending order, less-experienced farmers attached importance to "personal and economical barriers," "institutional-support barriers," and "awareness and information barriers," with means of 3.92, 3.85, and 3.84, respectively, when considering compliance with GlobalGAP. Concerning annual farm income, farmers who had higher income attached importance to "awareness and information barriers" and "infrastructure barriers," with means of 4.22 and 4.11, respectively. The importance of considering "awareness and information barriers" when making a compliance decision varied significantly in regard to the orange yield (p < 0.01). Farmers with more than 40 tons (mean 3.81) of yield attached more importance to "awareness and information barriers," compared to farmers with less than 20 tons.

Results of the t-test (Table 6) showed that "awareness and information barriers" and "institutional-support barriers" were considered important by farmers who did not belong to any export

Table 2
Farmers' compliance with GlobalGAP standards.

GlobalGAP requirements	Compliance (%)					Mean	SD
	None	Very low	Low	Medium	High		
Site history and site management	–	2.5	10	64.2	23.3	4.08	0.65
Traceability	–	–	23.9	50	26.1	4.14	0.18
Soil Management	–	–	4.2	90.8	5.0	4.00	0.30
Propagation materials	–	6.3	13.9	38.6	41.2	4.14	1.05
Fertilizer management	–	–	10.8	84.2	5.0	3.94	0.39
Water management	–	–	10.00	85.0	5.0	3.95	0.38
Equipment	–	–	3.3	91.7	5.0	4.00	0.29
Plant protection products (PPPs)	–	20	18.9	65.1	–	3.34	0.60
Integrated pest management	–	3.5	55.8	25.2	15.5	3.12	0.21
Harvesting and produce handling	15.0	11.7	27.5	45.0	0.8	3.05	1.09
Workers' health safety and welfare	40.0	36.7	7.5	15.8	0.00	1.99	1.05
Overall mean						3.58	0.58

Table 3
Factor analysis for grouping compliance with GlobalGAP.

Item	Factor loading	Mean	SD	Rank
Personal and economic (Eigenvalue 4.09, % of variance = 20.9, Alpha = 0.74)				
Low levels of literacy	0.545	3.68	0.31	9
Low risk of motivation for application GAP	0.533	3.33	0.79	12
The high cost of labor	0.688	3.84	0.36	4
The high cost of input supplies	0.782	3.81	0.48	5
The high-level of fertilizer use	0.705	3.36	0.8	16
Awareness and information (Eigenvalue 3.11, % of variance = 12.6, Alpha = 0.78)				
Lack of sufficient knowledge and skills on post-harvest techniques	0.766	3.51	0.64	11
Lack of information about export specifications	0.655	3.51	0.59	10
High infection from pests and diseases	0.581	3.67	0.58	8
The high need for integrated databases and concise records for different operations	0.548	2.88	0.81	20
Institutional- support (Eigenvalue 3.74, % of variance = 18.1, Alpha = 0.81)				
No governmental guarantee programs for product safety	0.692	3.98	0.128	1
Lack of linkage with citrus packaging houses	0.771	3.89	0.384	2
Lack of access to export-oriented extension services	0.828	3.8	0.528	6
Residues of pesticides in the product	0.844	3.9	0.34	3
Lack of access to loans	0.657	3.7	0.55	7
Low prices of orange	0.711	3.29	0.92	13
Low quality orange	0.644	3.13	0.93	17
Infrastructure (Eigenvalue 2.59, % of variance = 10.2, Alpha = 0.73)				
Lack of affordable storing and cooling facilities	0.522	3.08	0.88	18
Lack of equipment and facilities for using GAP technologies	0.633	3.28	0.79	14
Poor water quality	0.505	3.67	0.75	15
Lack of quality of packaging	0.536	3.23	0.84	19

Table 4
Ranking extracted factors of compliance with GlobalGAP.

Factor	Friedman Mean Rank	Mean	SD	Rank
Personal and economic	3.89	3.6	0.55	2
Awareness and information	3.45	3.39	0.65	3
Institutional- support	4.29	3.67	0.54	1
Infrastructure	3.05	3.31	0.81	4

Chi-Square: 491.66, Significance: 0.00.

organization, with means of 3.44 and 3.27, respectively. Results also revealed that farmers who did not have off-farm income (mean 3.34, $p < 0.05$) considered "infrastructure barriers" more important than farmers who had off-farm income. Farmers who did not have access to loans (mean 2.72, $p < 0.01$) attached importance to "infrastructure barriers."

4. Discussion

This study highlighted the barriers affecting orange farmers' compliance with GlobalGAP standards in El Nubaria region. The following four factors were identified as determinants of farmer' compliance: personal and economic barriers, awareness and information barriers, institutional-support barriers, and infrastructure barriers. The adoption of GlobalGAP standards has been viewed as an effective approach for facilitating a transition to sustainable agricultural production (Nicetic et al., 2010). Our study indicated that farmers are adequately compliant with the GlobalGAP standards, specifically, in regard to traceability, site history and site management, soil management, propagation materials, and equipment. We included smallholder farmers in the study because they have been exporting oranges to international markets, such as Arab countries and Russia, which have lower specifications than EU. The results appear to be in line with previous studies, clarifying the average level of farmers' adoption of good agricultural practices (Nirmala, 2015; Pandit et al., 2017; Pongvinyoo et al., 2014; Suwanmaneepong et al., 2016).

Many orange farmers from the region were partially following GlobalGAP standards during the usage of plant protection products (PPPs). This result reflects that orange farmers may be facing

export issues. In this regard, a report by the Ministry of Agriculture and Land Reclamation (MALR, 2018) showed that, during the period (2015–2017), orange exporters mainly faced challenges arising from the high pesticide residue content. Moreover, another study conducted by Badr et al. (2019) confirmed moderate levels of contamination by pesticide residues in orange samples collected from the local market. Clearly, farmers consider pesticide use a quick and easy remedy to pest control and for increasing yield (Oyekale, 2018; Sharifzadeh et al., 2018). In the same vein, the findings showed that farmers were partially compliant with integrated pest management (IPM). This result might be attributed to the fact that farmers still have limited knowledge of IPM as an environmentally friendly technology, and hence lack skills to implement the technology. Accordingly, farmers rely on their own experiences when selecting, mixing, and spraying pesticides (Talukder et al., 2017). Hence, the importance of community awareness programs must be highlighted to modify farmers' pesticide use behavior, thus contributing to food safety. Furthermore, extension platforms must also be established; this could include the establishment of farmer field schools that already have been tested and achieved success in international and local contexts in explaining the principles of integrated pest management. Although harvesting and produce handling were considered main issues hampering product quality and marketing in the international value chain, they were moderately considered according to the recommendations of the GlobalGAP standards. This result can be attributed to the fact that the export value chain, in the case of non-certified global gap farmers in Egypt, mainly depends on middlemen who collect the crop from the farms and transport it to citrus packaging houses (Elmansy, 2018). According to Sausman et al. (2015), these houses are responsible for implementing a

Table 5
Results of F test for examining differences in barriers that face respondents to comply with GlobalGAP according to their socio-economic characteristics.

Variable	Personal and economic barriers Mean	Awareness and information barriers Mean	Institutional- support barriers Mean	Infrastructure barriers Mean
Age				
Less than 40 years	3.31	3.42	2.93	3.04
From 40 to 55 years	3.38	3.5	3.05	3.18
More than 55 years	3.32	3.49	3.1	3.1
F test	0.18 ns	0.25 ns	0.12 ns	0.28 ns
Education				
No education	3.29	3.15	3.41	2.89
Elementary	3.26	3.28	3.39	3.00
Secondary school	3.29	3.44	3.37	3.05
University	3.35	3.82	3.45	2.84
F test	0.4 ns	4.88**	0.4 ns	0.62 ns
Farming experience				
Less than 15 years	3.92	3.84	3.85	3.57
From 15 to 25 years	3.71	3.66	3.78	3.59
More than 25 years	3.42	3.49	3.29	3.55
F test	7.4**	8.1**	6.9**	0.3 ns
Size of orange farm				
Less than 5 ha	2.88	3.05	3.1	2.83
From 5 to 10 ha	2.81	2.9	3.25	2.98
More than 10 ha	2.85	3.2	3.27	2.95
F test	0.9 ns	1.1 ns	1.3 ns	1.4 ns
Annual farm income				
Less than $3000	3.25	3.45	3.59	3.28
From $3000 to $6000	3.15	3.88	3.65	3.77
More than $6000	3.28	4.22	3.52	4.11
F test	0.45 ns	8.3**	0.55 ns	9.2**
Orange yield				
Less than 20 tones	3.55	3.4	3.35	3.28
From 20 to 40 tones	3.6	3.49	3.3	3.39
More than 40 tones	3.62	3.81	3.38	3.25
F test	0.48 ns	4.9**	0.32 ns	0.26 ns

* Significant at $p < 0.05$, ** significant at $p < 0.01$, and ns: not significant.

Table 6
Results of *t* test for testing differences in barriers that face respondents to comply with GlobalGAP according to their socio-economic characteristics.

Variable	Personal and economic barriers Mean	Awareness and information barriers Mean	Institutional- support barriers Mean	Infrastructure barriers Mean
Family labor force				
Yes	3.58	2.88	3.12	2.96
No	3.51	2.86	3.17	2.98
t test	0.33	0.13 ns	−0.25 ns	−0.21 ns
Membership of marketing or exporting organizations				
Yes	3.55	2.88	3.08	2.91
No	3.51	3.44	3.27	2.94
t test	0.35 ns	−5.8**	−2.3*	−0.17 ns
Having off-farm income				
Yes	3.52	3.68	3.08	3.12
No	3.55	3.6	3.12	3.34
t test	−0.33 ns	0.5 ns	0.42 ns	− 2.5 *
Access to loans				
Yes	2.61	2.28	2.51	2.25
No	2.65	2.34	2.55	2.72
t test	−0.18 ns	−0.25 ns	0.2	−6.4**

* Significant at $p < 0.05$, ** significant at $p < 0.01$, and ns: not significant.

traceability system for sorting; they are also responsible for implementing the HACCP quality control process. Exporters receive oranges that meet with standards and regulatory requirements of international markets and organize transportation with logistics firms. The rejected oranges in the packaging houses are sold in local markets.

Findings also revealed that farmers had low compliance with the requirements of workers' health safety and welfare. This result was in line with the results of Pandit et al. (2017). However, other studies (for example Annor et al., 2016) found that smallholder farmers fully complied with workers' health and welfare. According to EU (2012), ensuring personal hygiene of agricultural workers is critical to minimizing biological hazards among other workers or spreading diseases directly or indirectly through the contamination of food, water, toilet, and other facilities. Inspection of workers appears to be a low priority in agricultural sector in many countries (ILO, 2016). Since smallholder farmers mainly depend on wages during the harvest season, it could be difficult to provide health and safety training and maintaining health records. The welfare of agricultural workers is essential for the workers' wellbeing and the productivity of the farm. In fact, smallholder farmers are less likely to establish adequate sleeping quarters, hygienic

kitchen facilities, and toilets and hand washing facilities; they are also less concerned with storing clean food, compared to big farms (Ehlert et al., 2011).

The results appear to be in accordance with those of previous studies, concerning the importance given to personal and economic factors when deciding compliance with good agricultural practices (Annor, 2018; Aydin and Aktürk, 2018; Ganpat et al., 2014; Jelsma et al., 2019; Kersting and Wollni, 2011; Kibet et al., 2018; Marine et al., 2016; Nirmala, 2015; Ochieng et al., 2019; Parikhani et al., 2015, Pongvinyoo et al., 2014; Srisopaporn et al., 2015; Suwanmaneepong et al., 2016). In fact, low-risk orientation primarily influences farmers' compliance with standards (Razzaghi Borkhani et al., 2011). This orientation is mainly affected by economic motivation or the financial capital of the farmers (Parikhani et al., 2015). The significance of this issue was observed in the case of the respondents who had a farmland area less than 7 ha, more than three quarters had no off-farm income, and more than 75% had no access to loans. Furthermore, it is worth mentioning that after the implementation of a new Egyptian policy of economic adjustment and floating currency in 2016, the prices of all agricultural inputs doubled without governmental subsidies. Under this context, the input supplies' prices mainly affected farmers' compliance with GlobalGAP. Moreover, the results indicated the role of institutional-support barriers in explaining variance in compliance among farmers. This result implied that farmers attached a higher importance to such barriers when deciding their compliance. In this regard, Torero (2011) confirmed that there is a need to strengthen the institutional partnerships between smallholder farmers and other actors in the agricultural value chain to support farmers' production and marketing competitiveness and to improve their compliance with food safety standards. In a study in Thailand, Pongvinyoo (2015) found that institutional partnerships did not encourage the farmers to continuously produce GAP-based coffee. To increase the adoption of GlobalGAP among farmers, it is recommended to develop public–private partnerships, which will certify safety during production, strengthen the role of extension, and provide incentives such as loans and facilities (Ferris et al., 2014; Parikhani et al., 2015).

Farmers who did not join marketing or export organizations tended to consider awareness and information barriers more important than farmers who joined marketing organizations. As mentioned by Aku et al. (2018), farmer organizations play a key role in providing market information and improving market access to best practices in the areas of production, storage and transport, import requirements of the major markets, and certification. Accordingly, members of marketing organizations get specific information that enables them to develop their export-oriented business. In the same vein, farmers who did not join marketing or export organizations tended to consider institutional support barriers more important than farmers who had joined marketing organizations. Farmers' organization is helpful for mobilizing collective action; they link farmers with other organizations in the agricultural value chain. Hence, farmers with less interaction with other institutions may not overcome production and marketing problems, which hamper their exports. Consequently, it is recommended that an enabling policy environment that establishes and strengthens export-oriented organizations must be established. This will assist in transforming small-scale farming into viable business ventures through the adoption of GlobalGAP standards. Findings are consistent with previous studies that indicated the importance of farmer organizations in supporting certification (Holzapfel and Wollni, 2014; Snider et al., 2017).

Farmers who did not have off-farm income tended to consider "infrastructure barriers" more important than farmers who had off-farm income. This result implies that the farmers with lower income failed to self-finance their farming operations using their own resources; thus, they may have found it difficult to establish facilities needed for GlobalGAP compliance, particularly in the light of a lack of governmental support in the form of agricultural input subsidies in Egypt. The results of our study are in agreement with the findings of Annor et al. (2016), who reported that off-farm income positively influenced farmers' GAP compliance decisions. Similarly, farmers who did not get access to loans tended to consider infrastructure barriers more important than farmers who got access to loans. The availability of agricultural credit and modern technology are critical to sustainable agricultural production (Saqib et al., 2018). Hence, the lack of access to finance keeps smallholder farmers from meeting the requirements of certification. These results are in agreement with the results of Islam et al. (2012), who reported that farmers who did not practice GAP lacked access to credit for investment.

Farmers with higher education tended to consider "awareness and information barriers" more important than farmers with less education. Farmers with higher education had a higher awareness of the importance of complying with GlobalGAP standards and their role in increasing the annual income food safety; hence, these farmers considered information and awareness barriers when deciding compliance with GlobalGAP standards; additionally, they obtained the necessary information from various channels, such as exporters, experts, extension agents, and other certified farmers. These findings are in line with those of previous studies (Ganpat et al., 2014; Pongvinyoo et al., 2014; Pandit et al., 2017). These studies confirmed that education is the main determinant affecting farmers' compliance with good agricultural practices.

Farmers with less farming experience tended to consider personal and economical barriers, awareness and information barriers, and institutional-support barriers more important than farmers with higher farming experience. In fact, farmers with low experience lacked knowledge of the contemporary farming context and hence failed to cope with GlobalGAP. They may suffer from different barriers when meeting the import requirements of different countries. These results are consistent with the results of Ganpat et al., (2014) and Suwanmaneepong et al., (2016). They reported that the farming experience of smallholder farmers enables them to cope with GAP. Thus, farming experience plays a key role in decision-making and developing a positive attitude toward meeting food international standards.

Farmers with a higher income considered "awareness and information barriers" and "infrastructure barriers" more important than those with a lower annual farm income. One possible explanation for this finding might be that farmers with a higher income have more access to export-oriented information as well as a financial power. Hence, they could establish the facilities needed to meet GlobalGAP requirements. According to Krause et al. (2016), farm income is one of the motivation factors that increase farmers' compliance with sustainability standards and good agricultural practices. Farmers with a high yield showed a tendency to consider awareness and information barriers more important than farmers with lower production. This implies that the acquisition of knowledge decreases uncertainly and doubts about the application of the standards. Accordingly, information on the local context and GlobalGAP requirements for smallholder farmers would reduce negative attitudes toward adoption; it will also and enhance farmers' skills, which is required for efficient and effective adoption of good agricultural practices.

5. Conclusion

Ensuring farmers' adherence to GlobalGAP requirements is critical to reducing health and environmental hazards associated with non-compliance; hence, this study analyzed factors explaining

orange farmers' compliance with GlobalGAP standards in El Nubaria region. It was found that orange farmers still need support to comply with the standards; particularly, support is required for fertilizer management, water management, plant protection products (PPPs), integrated pest management, harvesting and product handling, and workers' health safety and welfare. A specific set of four groups of barriers to farmers' compliance with standards was presented. Farmers attached the highest importance to institutional-support barriers and personal and economic barriers when deciding their compliance. However, an in-depth examination of relationships between each of the four groups of barriers and various socio-economic characteristics of farmers reveals an interesting interplay between these components. The evidence highlights that farmers with less experience were more influenced by personal and economic barriers, awareness and information barriers, and institutional barriers. Highly educated farmers emphasized awareness and information when explaining non-compliance to the standards. Our findings also demonstrate the role of the marketing organization in reducing barriers of information and institutional support. Farmers with less access to loans and annual farm income considered farm infrastructure as the main barrier to compliance. Based on the findings, this study recommends the role of the development of agricultural extension platforms and collaboration with exporters in organizing farmers in groups. In addition, it is important to facilitate knowledge sharing among farmers on the consequences of compliance with GlobalGAP. This can be achieved by organizing platforms such as farmer-to-farmer platforms and farmer field schools. Future research analyzing the value chain of orange would be interesting; this focus would further clarify factors influencing farmers' compliance with food standards.

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References

Abbas, H.H., El- Hussiney, O.H., El-Maghraby, T.A., Harvey, M.M., 2012. Maize production in El-Nubaria soils as affected by agricultural practices and water management. J. Soil Sci. Agric. Eng. 3 (1), 95–110.

Abdelraouf, R.E., El Habbasha, S.F., 2014. Wheat production in the arid regions by using drip irrigation system. Int. J. Adv. Res. 2 (3), 84–96.

Abobatta, W.F., 2018. Challenges for citrus production in Egypt. Acta Sci. Agric. 2 (8), 40–41.

Abou-Hadid, A.F., Abdrabbo, M.A., Khalil, A.A., Hassanein, M.K., 2010. Monitoring land-cover in the new reclaimed area: a case study in EL-Nubaria, Egypt. Nat. Sci. 8 (12), 115–122.

Abu Hatab, A., Nsabimana, A., 2016. A dynamic analysis of Egyptian orange exports to Russia: a Co-integration analysis. Agric. Econ. Rev. 7 (2), 38–54.

Aku, A., Mshenga, P., Afari-Sefa, V., Ochieng, J., 2018. Effect of market access provided by farmer organizations on smallholder vegetable farmer's income in Tanzania. Cogent Food Agric. 4 (1), 1560596.

Annor, B.P., Mensah-Bonsu, A., Jatoe, J.B., 2016. Compliance with GLOBALGAP standards among smallholder pineapple farmers in Akuapem-South, Ghana. J. Agribus. Develop. Emerg. Econ. 6 (1), 21–38.

Annor, P.B., 2018. Smallholder farmers' compliance with GlobalGAP standard: the case of Ghana. Emerald Emerg. Markets Case Stud. 8 (1), 1–21.

Aydın, B., Aktürk, D., 2018. Energy use efficiency and economic analysis of peach and cherry production regarding good agricultural practices in Turkey: a case study in Çanakkale province. Energy 158, 967–974.

Badr, A.N., Ahmed, M.B.M., Amer, M.M., Thang, V.N., Fouzy, A.S.M., 2019. Pesticides evaluation in Egyptian fruits and vegetables: a safety assessment study. J. Environ. Sci. Technol. 12 (2), 81–91.

Badr, M., 2019. Farmers' willingness to pay for agricultural extension service: a case study of Nubaria's farmers, Egypt. Asian J. Agric. Extens. Econ. Sociol. 30 (2), 1–13.

CAPMS (Central Agency for Public Mobilization and Statistics), 2018. Agricultural annual report. CAPMS, Cairo, Egypt.

Ding, J., Moustier, P., Ma, X., Huo, X., Jia, X., 2019. Doing but not knowing: how apple farmers comply with standards in China. Agric. Hum. Values 36, 61–75.

Ehlert, C., Mithöfer, D., Waibel, H., 2011. Food Production Standards, Farm Size and Farm Worker Welfare in Kenya. Paper presented at the Better Work Conference, Workers, Businesses and Government: Understanding Labor Compliance in Global Supply Chains, 26–28 October. International Finance Corporation, Washington DC. https://pdfs.semanticscholar.org/d05d/a19762f366ebd5074cf9c8ee298ea448de4d.pdf (accessed June, 14, 2019).

Elmansy, A.A., 2018. Extension needs for citrus farmers in the field of export agriculture in Dakhalia Governorate Ph.D. thesis. Mansoura University, Egypt.

EU, 2012. Protecting health and safety of workers in agriculture, livestock farming, horticulture and forestry. https://osha.europa.eu/en/tools-and-publications/publications/protecting-health-and-safety-workers-agriculture-livestock (Accessed August, 21, 2018).

FAOSTAT (Food and Agriculture Organization of the United Nations: Statistical Database). 2018. Trade domain crops and livestock products. http://faostat.fao.org/site/535/default.aspx#ancor (Accessed April, 5, 2019).

Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., Wei, E., 2014. Linking smallholder farmers to markets and the implications for extension and advisory services. MEAS Discussion Paper 4, USAID, Washington, D.C.

Ganpat, W., Badrie, N., Walter, S., Roberts, L., Nandlal, J., Smith, N., 2014. Compliance with Good Agricultural Practices (GAPs) by state-registered and non-registered vegetable farmers in Trinidad, West Indies. Food Sec. 6, 61–69.

GLOBALG.A.P. 2017. 2016-2017 GlobalGAP Manual Version 5.0. GLOBALG.A.P, Cologne, Germany. http://www.sunnyridge.com › jill › GlobalGapBlueberryManual2017verG (accessed on july, 5, 2018).

Holzapfel, S., Wollni, M., 2014. Is GlobalGAP certification of small-scale farmers sustainable?: Evidence from Thailand. J. Develop. Stud. 50 (5), 731–747.

ILO, 2016. Safety and health in Agriculture. ILO. Geneva. https://www.ilo.org/wcmsp5/groups/public/—ed_protect/—protrav/—safework/documents/publication/wcms_110193.pdf (Accessed November, 5, 2020).

Islam, G.M.N., Arshad, F.M., Radam, A., Alias, E.F., 2012. Good agricultural practices (GAP) of tomatoes in Malaysia: evidences from Cameron Highlands. African J. Bus. Manage. 6 (27), 7969–7976.

Jelsma, Idsert, Woittiez, Lotte S., Ollivier, Jean, Dharmawan, Arya Hadi, 2019. Do wealthy farmers implement better agricultural practices? An assessment of implementation of Good Agricultural Practices among different types of independent oil palm smallholders in Riau, Indonesia. Agric. Syst. 170, 63–76.

Kersting, S., Wollni, M., 2011. Public-private partnerships and GLOBALGAP standard adoption: Evidence from small-scale fruit and vegetable farmers in Thailand. Paper prepared for presentation at the EAAE 2011 Congress Change and Uncertainty, Zurich, Switzerland, August 30 to September 2. https://ideas.repec.org › ags › eaae11 (Accessed August, 5, 2018).

Kibet, N., Obare, G.A., Lagat, J.K., 2018. Risk attitude effects on Global-GAP certification decisions by smallholder French bean farmers in Kenya. J. Behav. Exp. Finance 18, 18–29.

Krause, H., Lippe, R., Grote, U., 2016. Adoption and income effects of public GAP standards: evidence from the horticultural sector in Thailand. Horticulturae 2 (4), 18.

Luo, L., Qin, Wang, Y., Wang, Q., 2016. Environmentally-friendly agricultural practices and their acceptance by smallholder farmers in China: a case study in Xinxiang County, Henan Province. Sci. Total Environ. 571, 737–743.

MALR (Ministry of Agriculture and Land Reclamation), 2016. Sustainable agricultural development strategy 2030. MALR, Cairo, Egypt.

MALR (Ministry of Agriculture and Land Reclamation), 2018. Annual report of the export and import of agricultural commodities. MALR, Cairo, Egypt.

Marine, S.C., Martin, D.A., Adalja, A., Mathew, S., Everts, K.L., 2016. Effect of market channel, farm scale, and years in production on Mid-Atlantic vegetable producers' knowledge and implementation of Good Agricultural Practices. Retrieved March, 10, 2019 from Cornell University, SHA School site: https://scholarship.sha.cornell.edu/articles/1108 (Accessed November, 5, 2020).

Mushobozi, W., 2010. Good Agricultural Practices (GAP) on horticultural production for extension staff in Tanzania. FAO, Rome.

Nicetic, O., van de Fliert, E., Chien, H., Mai, V., Cuong, L. 2010. Good Agricultural Practice (GAP) as a vehicle for transformation to sustainable citrus production in the Mekong Delta of Vietnam. Paper presented to 9th European IFSA Symposium, 4-7 July, Vienna. http://ifsa.boku.ac.at › file admin › Proceeding2010 › 2010_WS4.4_Nicetic.pdf (accessed December, 21, 2018).

Nirmala, G., 2015. Impact of Good Agricultural Practices (GAP) on small farm development: Knowledge and adoption levels of farm women of rainfed areas. Indian Res. J. Ext. Edu. 15 (4), 153–156.

Ochieng, J., Schreinemachers, P., Ogadac, M., Dinssad, F.F., Barnose, W., Mndigaf, H., 2019. Adoption of improved amaranth varieties and good agricultural practices in East Africa. Land Use Policy 83, 187–194.

Omar, S., Tate, B., 2018. Egypt citrus annual: Egyptian orange exports continue to expand. USDA foreign agriculture service report, USDA, Washington, D.C. https://gain.fas.usda.gov › Citrus Annual_Cairo_Egypt_12-10-2018 (accessed on August, 8, 2019)

Oyekale, A., 2018. Cocoa farmers' compliance with safety precautions in spraying agrochemicals and use of personal protective equipment (PPE) in Cameroon. Int. J. Environ. Res. Public Health 15 (2), 327.

Pandit, U., Nain, M.S., Singh, R., Kumar, S., Chahal, V.P., 2017. Adoption of Good Agricultural Practices (GAPs) in basmati (scented) rice: a study of prospects and retrospect. Indian J. Agric. Sci. 87 (1), 36–41.

Parikhani, M.P., Borkhani, F.R., Fami, H.S., Motiee, N., Hosseinpoor, A., 2015. Major barriers to application of Good Agricultural Practices (GAPs) technologies in sustainability of livestock units. Int. J. Agric. Manage. Develop. 5 (3), 169–178.

Pongvinyoo, P., 2015. Development of Good Agricultural Practices (GAP) in Thailand: A case study of Thai National GAP selected products. PhD thesis, Hiroshima University. https://ir.lib.hiroshima-u.ac.jp › list › doctoral_thesis (accessed on January, 21, 2019).

Pongvinyoo, P., Yamao, M., Hosono, K., 2014. Factors affecting the implementation of Good Agricultural Practices (GAP) among coffee farmers in Chumphon Province, Thailand. Am. J. Rural Develop. 2 (2), 34–39.

Raza, M.H., Abid, M., Yan, T., Naqvi, S.A.A., Akthar, V.S., Faisal, M., 2019. Understanding farmers' intentions to adopt sustainable crop residue management practices: a structural equation modeling approach. J. Cleaner Prod. 227, 613–623.

Razzaghi Borkhani, F., Shabanalifami, H., Rezvanfar, A., Pouratashi, M., 2011. Application of IPM practices by Paddy farmers in Sari County of Mazandaran Province, Iran. Afric. J. Agric. Res. 6 (21), 4884–4892.

Saqib, S.E., Kuwornu, J.K., Panezia, S., Ali, U., 2018. Factors determining subsistence farmers' access to agricultural credit in flood-prone areas of Pakistan. Kasetsart J. Soc. Sci. 39 (2), 262–268.

Shah, S.I., Zhou, J., Shah, S.A., 2019. Ecosystem-based Adaptation (EbA) practices in smallholder agriculture: Emerging evidence from rural Pakistan. J. Cleaner Prod. 218, 673–684.

Sharifzadeh, M., Abdollahzadeh, G., Damalas, C., Rezaei, R., 2018. Farmers' criteria for pesticide selection and use in the pest control process. Agriculture 8 (2), 24.

Snider, Anna, Gutiérrez, Isabel, Sibelet, Nicole, Faure, Guy, 2017. Small farmer cooperatives and voluntary coffee certifications: Rewarding progressive farmers of engendering widespread change in Costa Rica?. Food Policy 69, 231–242.

Som, S., Burman, R.R., Sharma, J.P., Sangeetha, V., Lenin, V., Iquebal, M.A., Thoke, N.J., 2017. Assessment of stakeholders' knowledge and attitude towards good agricultural practices for grapes. Indian J. Agric. Sci. 87 (2), 273–277.

Srisopaporn, S., Jourdain, D., Perret, S.R., Shivakoti, G., 2015. Adoption and continued participation in a public Good Agricultural Practices program: the case of rice farmers in the Central Plains of Thailand. Technol. Forecast. Soc. Chang. 96, 242–253.

Sausman, C., Garcia, M., Fearne, A., Felgate, M., Mekki, A., Cagatay, S., et al., 2015. From value chain analysis to global value chain analysis: Fresh orange export sector in Mediterranean partner countries. In: Petit, M., Montaigne, E., El Hadad-Gauthier, F., García, Álvarez-Coque J., Mattas, K., Mili, S. (Eds.), Sustainable Agricultural Development. Cooperative Management, Springer, Cham.

Suwanmaneepong, S., Kullachai, P., Fakkhong, S., 2016. An investigation of factors influencing the implementation of GAP among fruit farmers in Rayong Province, Thailand. Int. J. Agric. Technol. 12 (7.2), 1745–1757.

Talukder, A., Sakib, M., Islam, M., 2017. Determination of influencing factors for integrated pest management adoption: a logistic regression analysis. Agrotechnology 6, 163–166.

Tellioglu, I., Konandreas, P., 2017. Agricultural policies, trade and sustainable development in Egypt. International Centre for Trade and Sustainable Development (ICTSD), Geneva, in cooperation with FAO Regional Office for the Near East and North Africa, Cairo. https://www.ictsd.org › files › research › agriculture_and_trade_in_egypt (accessed on august, 12, 2019).

Torero, M., 2011. A framework for linking small farmers to markets. Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture, 24–25 January, International Fund for Agricultural Development (IFAD), Rome.

Tran, Duc, Goto, Daisaku, 2019. Impacts of sustainability certification on farm income: Evidence from small-scale specialty green tea farmers in Vietnam. Food Policy 83, 70–82.

World Bank. 2018. WDI (World Development Indicators). Accessed April 2019. http://data.worldbank.org/data-catalog/world-development-indicators (accessed August, 2, 2019).

Zeweld, W., Huylenbroeck, G.V., Tesfay, G., Speelman, S., 2017. Smallholder farmers' behavioural intentions towards sustainable agricultural practices. J. Environ. Manage. 187, 71–81.