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Socioeconomic Characteristics Associated with Farming Practices, Food Safety and Security in the Production of Fresh Produce—A Case Study including Small-Scale Farmers in KwaZulu-Natal (South Africa)

Tashiana Beharielal [1,2], Joyce Thamaga-Chitja [2] and Stefan Schmidt [1,*]

[1] Discipline of Microbiology, School of Life Sciences, University of KwaZulu-Natal, Pietermaritzburg 3201, South Africa
[2] Discipline of Food Security, School of Agriculture, Environmental and Earth Sciences, University of KwaZulu-Natal, Pietermaritzburg 3201, South Africa
* Correspondence: schmidts@ukzn.ac.za; Tel.: +27-33-260-5523

Abstract: Farmer practices may influence the microbial quality and safety of fresh produce. The increasing demands to create ready-to-eat (RTE) fresh produce while providing potential niche markets for smallholder farmers might be contributing to increased numbers of fresh produce-associated foodborne disease outbreaks. This study determined the demographic and socioeconomic characteristics and farmer hygiene practices of farmers using open-ended questionnaires and key informant interviews. Additionally, the relationships between farmer socioeconomic characteristics and hygiene practices were statistically analyzed. The semi-organic smallholder farmer population and the farmworkers of the organic farm were female-dominated. Tertiary education was a predominant characteristic in the organic and semi-conventional workforces. While the semi-organic and semi-conventional farms relied on a combination of 'store-bought' synthetic and composted organic fertilizers, the organic farm owner only used composted organic fertilizer. The irrigation water sources varied amongst the farm types. However, most of the semi-organic farmers did not pre-treat irrigation water prior to use. The irrigation water source and fertilizer type selected by farmers varied and might affect the microbial quality and safety of fresh produce. Socioeconomic factors such as gender and education may influence farmer hygiene practices. These characteristics should therefore be considered when planning farmer support interventions.

Keywords: sustainable farm practices; socioeconomic characteristics; fresh produce; food safety; food security; organic; conventional

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1. Introduction

There is a strong pressure to increase food production and availability globally due to population growth; another factor is the presence of nearly 811 million people being identified as food insecure and 768 million being classified as chronically undernourished [1,2]. The FAO recorded the sharpest increases in moderate and severe food insecurity in the year 2020, with more than one-third (282 million) of this tally being identified in Africa [2]. Agriculture is essential to meet these demands; however, sustainable production methods need to be employed in order to meet these demands without negatively affecting the environment [3–6]. Furthermore, sustainable agriculture must also produce food that is safe for consumption and of good quality to negate public health concerns [3,6]. COVID-19 lockdowns have exposed the weaknesses in international and local food supply chains and have directed attention to the proximity of the food producers and consumers [5,7,8]. Fresh produce consumption is an essential part of the human diet and provides micronutrients and vitamins, which are essential in contributing to the nutritional dimension of food security [5,8,9]. Consumption trends and government recommendations have increased the demand for fresh and ready-to-eat produce due to the apparent health benefits [5,9]. In light of the COVID-19 pandemic, the importance of more robust immune systems and the necessity of access to a healthy diet has become even more apparent [2,5]. Despite the positive narrative, fresh produce has been a cause of global food-borne disease outbreaks, highlighting the need for safer, sustainable production practices [3,6,10]. In developing countries such as South Africa with dual agricultural systems, conventional commercial farming is practiced by fewer individuals but contributes to a larger proportion of the agricultural output. However, the larger number of individuals practicing semi-organic, sustainable agriculture produce smaller but still crucial outputs [11]. Such subsistence/smallholder farmers have been earmarked as potential contributors in alleviating food insecurity in South Africa through their potential participation in supplying local markets and retailers [12,13]. In addition, these smallholder farmers could become an important factor in overcoming the underrepresentation of fresh fruits and vegetables in the African diet by supplying their communities [5]. Furthermore, smallholder farming has been identified as an important player in achieving sustainable development goals [4,14].

The agricultural methods employed in fresh produce farming are diverse and include conventional practices, organic practices, and an array of hybrid methods. Considering the potential role of primary production practices for the quality and safety of fresh produce, conducting evaluations of the farming systems and employed practices are essential for safeguarding consumers' health [3,5,6,10]. In developing countries such as South Africa, pressure from large retailers and the formal market system, especially for high-value products such as fresh produce, has led to the development of a "structured agrifood system" [15]. However, dual agrifood systems [11] are prevailing in South Africa wherein modern practices, typically involving regular monitoring to maintain fresh produce safety on a larger scale, co-exist with the traditional sustainable farming systems; these traditional systems mostly yield produce without appropriate safety and quality certifications [15]. Studies comparing the farming systems and practices have often focused on which farming system produces higher yields, contributes to less degradation of the environment, or—in the view of food safety—which system has a greater tendency for microbial contamination potentially affecting consumer health [16–18]. Although smallholder farming has a vital role to play in feeding communities, a limited number of studies have focused on the socioeconomic factors that may contribute to a farmers' decision on which farming systems or farming practices to utilize, especially in the small-scale production of fresh produce [12,19,20]. With the majority of South African farmers being identified as smallholder farmers [21], challenges facing such farmers, while not being identical across the entire country, may be similar in nature.

South African smallholder farmers are often characterized by similar socioeconomic characteristics, such as limited access to education or reliance on social grants as their income sources [21]. Socioeconomic characteristics have been highlighted as some of the most influential aspects in the farmers' decision-making processes, including their adoption of farming practices, the type of farming systems utilized, and even what is farmed [22]. South African farmers, especially smallholder farmers, display various socioeconomic characteristics that have been reported to be crucial contributors to their decision-making processes, particularly concerning the adoption of certain farming production practices and market participation [23,24]. Socioeconomic characteristics, such as gender, age, education level, and income sources, have been previously reported to affect production practices, including fertilizer and pesticide use, irrigation water sources, and the area (size) of land farmed [25]. A study on smallholder farmers and their access to market channels in Myanmar reported that factors such as gender, age, and income affected the market channel participation [26]. European studies on the characteristics that affect farmers' adoption of organic farming practices highlighted financial constraints, land farm size, and age as prominent socioeconomic characteristics influencing decision-making [27]. Understanding the socioeconomic backgrounds of the farmers, especially South African smallholder farmers, is imperative in designing facilitation strategies to improve food safety, sustainable production, and graduation into supplying more formalized markets.

A recent report on the state of food security in South Africa highlighted that the South African provinces characterized as predominantly rural with high levels of poverty, such as KwaZulu-Natal, were often the provinces where most households were involved in agricultural activities [13]. KwaZulu-Natal, contributing to 8.5% of South Africa's total agricultural production, is home to almost one-fifth of all South African smallholder farmers [21]. Of the households involved in agriculture in KwaZulu-Natal, 8.1% relied on agricultural activities as a source of income, with a large number of them (16.2%) practicing agriculture as an additional food source [21]. The South African National Development Plan [28], considering the state of South African food security and the high proportion of smallholder agricultural households, has recognized agricultural productivity and rural development as an essential priority for employment, economic growth, poverty reduction, and is essential in alleviating food insecurity.

This case study determined and compared, for the first time, the demographic and socioeconomic characteristics and farming practices used by selected organic, semi-organic, and semi-conventional farmers involved in fresh produce farming in the uMgungundlovu District of KwaZulu-Natal, South Africa. Additionally, the demographic and socioeconomic characteristics of the farmers, particularly those of the informal smallholder farmers, were evaluated in view of their potential to influence the adopted farming practices, and how this may affect fresh produce microbial quality, food safety, and potential market access.

2. Materials and Methods

2.1. Study Site

The study was conducted from 2018 to 2020. It included three different study sites within the uMgungundlovu District of KwaZulu-Natal, namely an organic farm (Karkloof), a semi-conventional farm that was part of a school community garden project (Howick), and a semi-organic farm (Appelsbosch), all located in KwaZulu-Natal, South Africa (Figure 1). More than one-third (38%) of the uMgungundlovu District's population resides in rural areas, many of whom are characterized as subsistence smallholder farmers. The livelihoods of such farmers, particularly the semi-organic farmers from Appelsbosch, depend on agricultural activities [29].

Figure 1. The three study sites, located in the uMgungundlovu District Municipality of the KwaZulu-Natal province in South Africa (adapted from https://commons.wikimedia.org/w/index.php?curid=15195874, accessed on 1 July 2022. CC BY-SA 4.0, and https://commons.wikimedia.org/w/index.php?curid=15195930, accessed on 1 July 2022. CC BY-SA 4.0.

2.2. Sampling Procedures and Data Collection

The research approach employed a case study methodology, comprising a mixed method of both qualitative and quantitative data collection due to the limited number of farmers available in two of the three farming systems in this study. Purposive sampling was used in order to include suitable farmers from each farming system, namely, semi-organic, organic, and semi-conventional farmers. Data collection tools included key informant interviews (qualitative method) and open-ended questionnaires (quantitative method) to collect information and provide insight into the farmers' socioeconomic characteristics, decision-making processes, and personal beliefs regarding hygiene-oriented farming practices. Key informant interviews were held with the owner of the organic farm and the manager and staff of the semi-conventional farm. The open-ended questionnaire (Supplementary Table S1) was administered to semi-organic informal smallholder farmers (n = 40), and an alternate open-ended questionnaire (Supplementary Table S2) was developed and used specifically for the smaller groups of farmworkers of the organic (n = 6) and semi-conventional (n = 5) farms. The questionnaires that were administered were initially prepared in English and later translated into isiZulu. Additionally, on-site native-speaking isiZulu translators were present for all study sessions.

The informal smallholder farmers mainly classified themselves as practicing "organic farming" methods. Their products were thus "organically produced", referring to produce that is produced using low and more sustainable agricultural inputs, such as composted and organic fertilizers and limited organic pesticides, but does not meet the certified organic production guidelines outlined by the respective organic certification organizations (e.g., SGS (Société Générale de Surveillance) Woodmead, South Africa (Pty) Ltd. and Ecocert, Cape Town, South Africa). For the remainder of this paper, the smallholder farmers are thus referred to as semi-organic farmers and their farms as semi-organic farms. Farmers, including both farmers that were already supplying markets and farmers that were interested in supplying markets, made up the purposively sampled informal smallholder sample population. In addition, the school community garden project will hereafter be referred to as the semi-conventional farm site and farmers, as the manager identified with more conventional farming methods, making use of pesticides and store-bought fertilizers more frequently (Table S3).

2.3. Data Analysis

Data were coded, captured, and analyzed using IBM's Software Package for Social Scientists (SPSS (V.27), 2021 (Chicago, IL, USA) and Graph Pad Prism (V.8) (San Diego, CA, USA). Sample descriptions were generated using descriptive statistics, including the frequency analysis. The normality of data distribution was assessed using the Shapiro–Wilk and Anderson–Darling tests at an alpha value of 0.05. The Spearman's rank correlation coefficient (ρ) was used to evaluate the relationships between the selected pre- and post-harvest practices (e.g., pre-treatment of water/compost prior to use) and relevant nominal or categorical demographic and socioeconomic variables [30]. p-values of <0.05 were considered to be significant.

3. Results

The current study sought to determine the demographic and socioeconomic characteristics of farmers and their farming practices from three different farming sectors. Furthermore, the associations between the demographic and socioeconomic factors and selected farming practices were identified. This approach was employed to evaluate whether these characteristics do affect farmer practices, especially with respect to practices that potentially contribute to the microbial contamination of fresh produce, thereby affecting food safety and potential market access.

3.1. Demographic and Socioeconomic Characteristics of Farmers

For the smallholder farmer sample population representing semi-organic farmers, we identified the sample population to be female-dominated (82%). Similarly, while a male owned the organic farm, female workers (67%) dominated the workforce. Contrastingly, the semi-conventional farm was again managed by a male but consisted of only male workers (100%). The semi-organic farmer population displayed an aging population, with 32% of respondents aged between 55 and 65 years. Interestingly, the age group that made up the sample's second-highest proportion (30%) was over 65 years old. However, the organic and semi-conventional farms displayed younger workforces, mainly consisting of workers aged under 45 years old (Table 1). The semi-organic farmers of this study presented themselves as an educated sample, with a large amount (43%) of the participants having received a secondary level of education. Similarly, the organic and semi-conventional farm staff had all received formal education up to the secondary level. Both the owner and manager of the organic and semi-conventional farm reported having obtained a tertiary education. The income sources of the semi-organic farmers showed a reliance on governmental grants, with 35% of respondents relying solely on grants and a further 38% relying on a combination of government grants and farming as income sources (Table 1). Contrastingly, the workers representing the other farming systems received wages or salaries as income. The interest level in farming among the semi-organic farmers differed, with many farmers (42%) being only interested in farming as a means to earn additional income. Only 10% of the semi-organic farmers displayed a high interest in farming, as it was their sole source of income. The farmers in all of the farming sites sampled were exposed to some sort of farmer training (Table 1), while discussions revealed that many had received farmer training to varying extents and on a variety of different farming aspects (e.g., composting processes, intercropping, and soil health) (Supplementary Table S3).

Table 1. Frequency table of smallholder farmer demographic and socioeconomic variables.

Demographic and Socioeconomic Variables	Characteristics	Semi-Organic Farmers (*n* = 40)	Organic Farm Workforce (*n* = 6)	Semi-Conventional Farm Workforce (*n* = 5)
Gender	Male	7 (18%)	2 (33%)	5 (100%)
	Female	33 (82%)	4 (67%)	0 (0%)
Age	<45 Years Old	4 (10%)	5 (83%)	5 (100%)
	45 ≤ 55 Years Old	11 (28%)	0 (0%)	0 (0%)
	55 ≤ 65 Years Old	13 (32%)	1 (17%)	0 (0%)
	>65 Years Old	12 (30%)	0 (0%)	0 (0%)
Marital Status	Single	10 (25%)	2 (33%)	2 (40%)
	Married	27 (67%)	3 (50%)	3 (60%)
	Divorced/Widowed	3 (8%)	1 (17%)	0 (0%)
Level of Education	No Formal Education	9 (22%)	0 (0%)	0 (0%)
	<Grade 7	14 (35%)	0 (0%)	0 (0%)
	Grade 8–12	17 (43%)	4 (67%)	2 (40%)
	>Grade 12	0 (0%)	2 (33%)	3 (60%)
Income Source	Combination of Farming and Grants	15 (38%)	0 (0%)	0 (0%)
	Government Grants	14 (35%)	0 (0%)	0 (0%)
	Farming	9 (22%)	1 (17%)	0 (0%)
	Wages/Salary	2 (5%)	5 (83%)	5 (100%)

Table 1. *Cont.*

Demographic and Socioeconomic Variables	Characteristics	Semi-Organic Farmers (*n* = 40)	Organic Farm Workforce (*n* = 6)	Semi-Conventional Farm Workforce (*n* = 5)
Monthly Income Bracket	<R1000	9 (22%)	0 (0%)	0 (0%)
	R1000–R1500	9 (22%)	0 (0%)	0 (0%)
	R1501–R3500	17 (43%)	0 (0%)	0 (0%)
	>R3500	5 (13%)	6 (100%)	5 (100%)
Main Livelihood Strategy	Farming	22 (55%)	1 (17%)	0 (0%)
	Casual/Permanent Employment	11 (28%)	5 (83%)	5 (100%)
	Combination of Farming and Self-employment	5 (12%)	0 (0%)	0 (0%)
	Combination of Farming and Casual labor	2 (5%)	0 (0%)	0 (0%)
Interest Level in Farming	Only for Consumption	5 (12%)	0 (0%)	0 (0%)
	Interested if there was no Alternative	7 (18%)	0 (0%)	0 (0%)
	Interested in Consumption and Sale	7 (18%)	0 (%)	0 (%)
	Interested in Additional Income	17 (42%)	0 (%)	0 (%)
	Very Interested, Sole Source of Income	4 (10%)	0 (%)	0 (%)
Membership in a Farmer's Group	Yes	36 (90%)	0 (0%)	0 (0%)
	No	4 (10%)	6 (100%)	5 (100%)
Involved/Exposed to Farmer Training	Yes	40 (100%)	6 (100%)	5 (100%)
	No	0 (0%)	0 (0%)	0 (0%)
Type of Farming Practiced	"Organic"	17 (43%)	n/a	n/a
	Conventional	23 (57%)	n/a	n/a

Percentages were rounded to the nearest whole number.

3.2. Farmer Practices

General farm practices that have previously been reported to contribute to microbial contamination of fresh produce, such as the type of irrigation water used, fertilizer, and preparation of the fertilizers employed, were the focal points of the current study. The irrigation water sources were found to vary (Figure 2), with semi-organic farmers reporting the use of multiple sources such as river water (48%), rainwater (30%), "grey wash water" (13%), and in some instances a mixture of these source waters (10%). However, the organic and semi-conventional farmers reported only using two irrigation water sources; the organic farmer owner used dam and river water, while the semi-conventional farmers used municipal tap and rainwater. The fertilizer types used by the farmers included synthetic "store-bought" fertilizers, organic composted fertilizers, and a combination of both in some instances. Semi-organic farmers used the greatest variety of fertilizer types when compared to the other farm systems, with the organic farmer solely relying on organic, composted fertilizer.

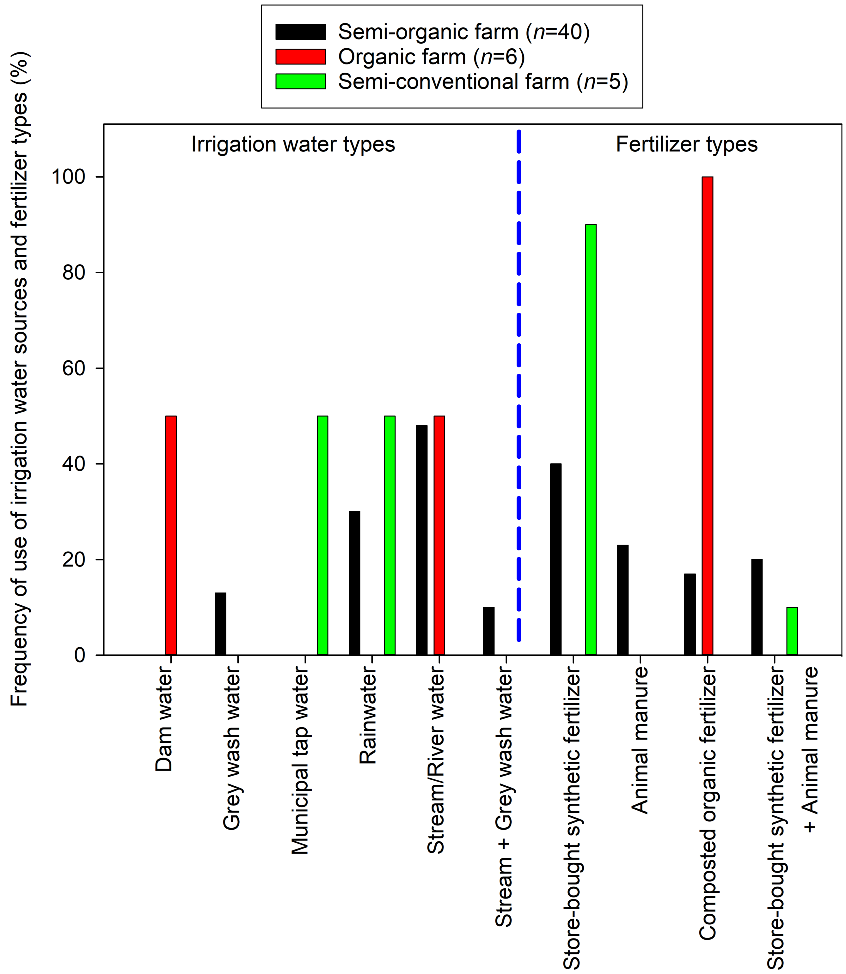

Figure 2. Frequency of the irrigation water sources and fertilizer types used by the different farming systems.

Farmers and farmworkers from the organic and semi-conventional farms frequently acknowledged farming equipment, soil, and water as potential sources of bacterial contamination (Figure 3). Contrastingly, only the semi-organic farmers frequently acknowledged soil as a potential contamination source. At least 23% of the semi-organic farmers did not acknowledge any consequences of fresh produce bacterial contamination. However, nearly half of the population (48%) deemed the loss of trust of customers as a consequence of bacterial contamination. Washing hands prior to entering the farm was a general hygiene practice observed by a high percentage of individuals belonging to each of the different farms (Figure 3). The washing of pre- and post-harvest equipment was a practice that was more commonly observed among the semi-organic farmers (63%), followed by semi-conventional farmers (40%), whereas the organic farmer did not report the washing of farming equipment before use. A low percentage of semi-organic farmers reported pre-treating irrigation water (25%) prior to use, with pre-treatments including the boiling of water or the addition of household bleach products before use (Table S3). More than half of the semi-organic farmer sample population (53%) did not pre-treat manure prior to use (Figure 3).

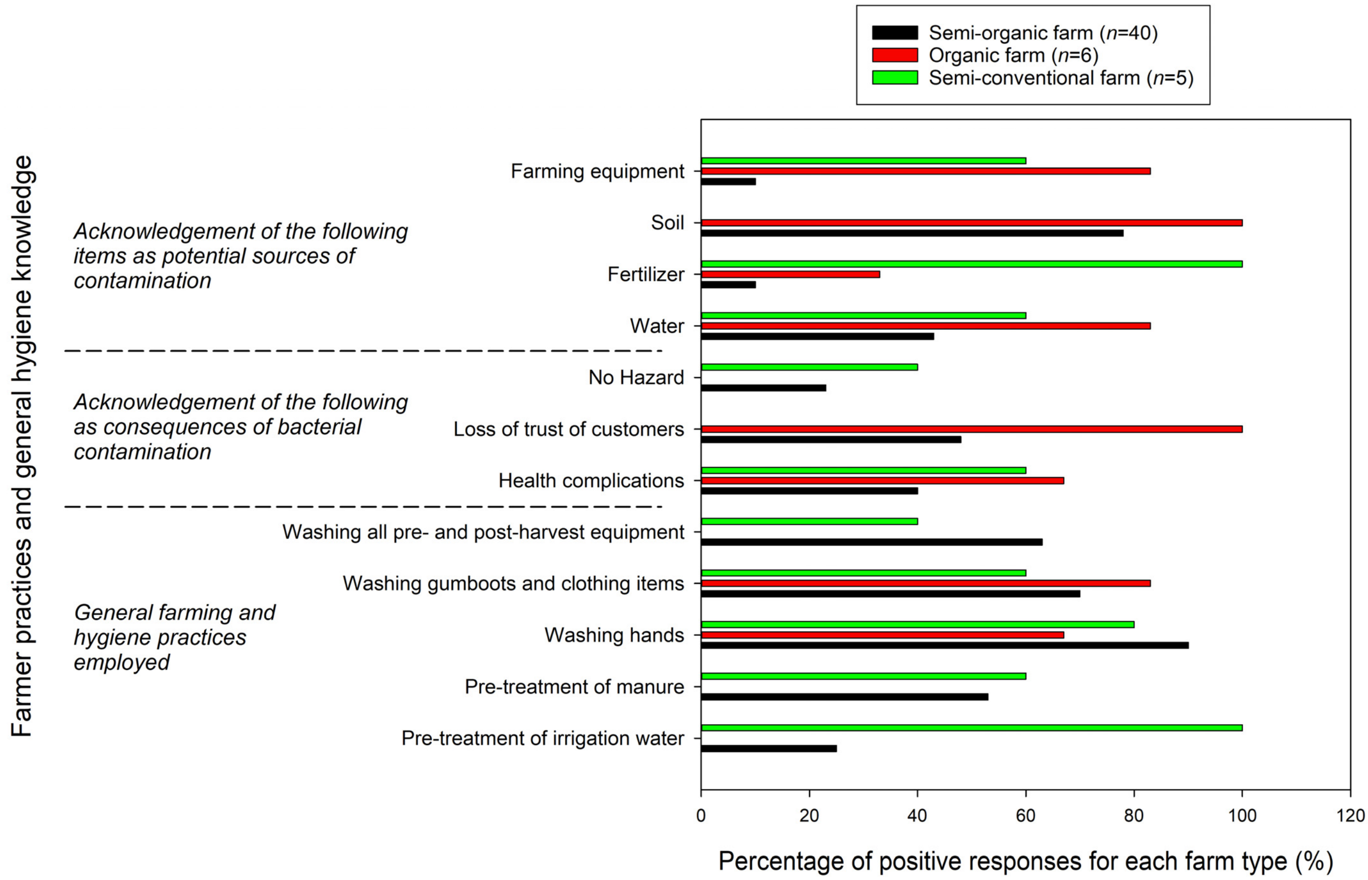

Figure 3. Responses on the general farmer practices and general hygiene opinions of farmers from the different farming systems.

3.3. Relationships between Farming Practices and Socioeconomic Characteristics of the Farmers from the Different Farming Sectors

Among the socioeconomic characteristics analyzed, gender, education level, income source, and income bracket displayed statistically significant relationships with selected farming practices employed by the 40 semi-organic farmers (Table 2). Statistically significant relationships were not observed between socioeconomic characteristics and farming practices for the semi-conventional and organic farming systems. Additionally, for the 40 semi-organic farmers, the ρ-values observed may indicate possible, though weak, associations between demographic and socioeconomic characteristics and selected hygiene practices and beliefs. For example, the ρ-value for education and the type of irrigation water used ($\rho = -0.253$, 95% CI = −0.530–0.074, $p = 0.116$) was not significant. At the same time, the confidence interval (CI) indicated the absence of a relevant relationship between these two variables. Thus, some demographic and socioeconomic characteristics may affect selected hygiene practices and beliefs, though not at a significant level (Figure 4).

Table 2. Correlation between the selected farming practices and demographic and socioeconomic characteristics of the semi-organic farmers ($n = 40$).

Selected Farming Practices	Spearman's Rank Correlation Coefficient (ρ)				
	Gender	Age	Education Level	Income Source	Income Bracket
Type of Farming Practiced	0.403 * (0.095–0.640)	−0.242 (−0.522–0.084)	0.023 (−0.299–0.341)	0.036 (−0.287–0.352)	0.002 (−0.318–0.322)
Type of Fertilizer Used	−0.200 (−0.489–0.128)	0.183 (−0.146–0.475)	−0.067 (−0.379–0.258)	0.073 (−0.253–0.384)	−0.479 ** (−0.693–−0.188)

Table 2. *Cont.*

Selected Farming Practices	Spearman's Rank Correlation Coefficient (ρ)				
	Gender	Age	Education Level	Income Source	Income Bracket
Pre-treatment of Fertilizer	0.438 ** (0.137–0.665)	0.000 (−0.320–0.320)	−0.090 (−0.399–0.237)	0.403 ** (0.095–0.640)	−0.016 (−0.334–0.306)
Pre-treatment of Irrigation Water	0.190 (−0.139–0.481)	−0.170 (−0.465–0.159)	0.430 * (0.127–0.659)	0.203 (−0.126–0.491)	0.016 (−0.306–0.334)
Harvest Time	0.317 * (−0.004–0.578)	−0.165 (−0.461–0.163)	−0.086 (−0.395–0.241)	0.389 * (0.079–0.631)	0.196 (−0.132–0.486)

** $p < 0.01$, * $p < 0.05$. The numbers in parentheses represent the 95% confidence interval (CI) for ρ.

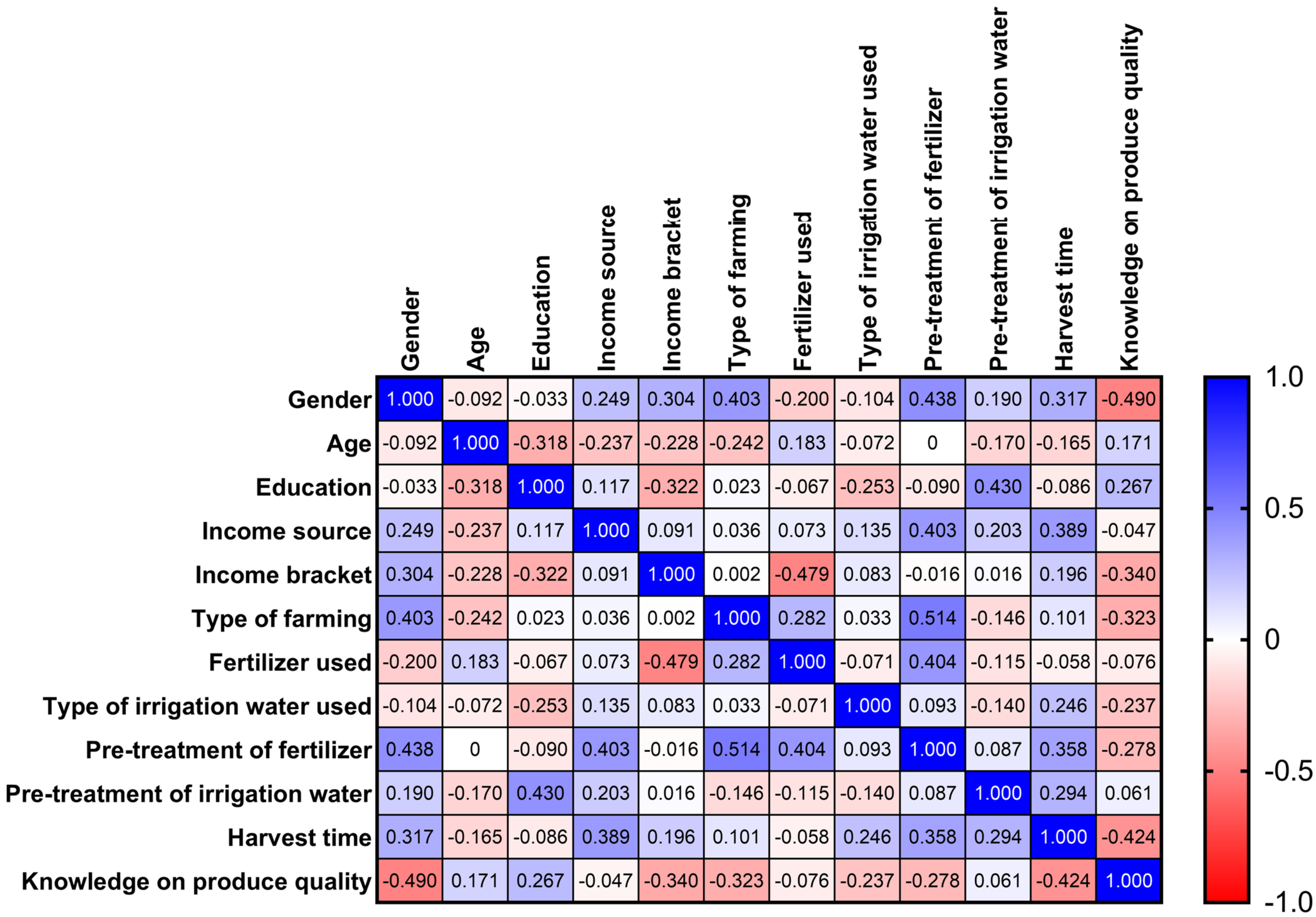

Figure 4. Spearman rank correlation matrix of 12 selected demographic and socioeconomic characteristics, farm hygiene practices, and knowledge of quality for the semi-organic farmers ($n = 40$).

4. Discussion

4.1. Demographic and Socioeconomic Characteristics of the Different Farming Populations

4.1.1. Gender

Agricultural surveys and studies, especially those focusing on smallholder farming, often found that females represent the majority of participants involved in smallholder farming [13,25,31]. Because of females being more involved in smallholder farming, programs supporting smallholder farm models have been directed toward female participants, such as the Awards Incentives and Competition (AIC) in South Africa and the "buy from women" initiative in Rwanda. There have been continuous suggestions that female participants have been the primary recipients of improvement initiatives, such as training or funding [32–34]. The current study displays a similar finding where a majority of the semi-organic farmer population, as well as the organic farmworkers, were female (Table 1). The high proportion of female farmers in the current study mirrors the findings of a recent South African report, which highlights that among most of the South African households involved in agriculture, ≈53% are headed by females [13]. Additionally, there was a significant correlation between gender and knowledge of fresh produce quality ($\rho = -0.490$, 95% CI = -0.700–-0.201, $p < 0.01$) (Figure 4), suggesting that higher involvement rates of females in farming are associated with female farmers being more knowledgeable regarding farming practices. Two recent studies [26,35] investigated the impacts of socioeconomic characteristics on smallholder farmers in Myanmar and Indonesia and found, with similar observations to the current case study for the semi-organic farmers, that females comprised the majority of the smallholder farmer population. Unsurprising, considering the essential role of female smallholder farmers, aspects of the farmers' gender are often crucial for the success of agricultural interventions and development due to the specific roles and responsibilities of each gender in the agricultural system [36].

4.1.2. Age

The low percentage of younger farmers among the semi-organic farmers in the current study (10%) has been mirrored in a South African study in the Free State [37], which reported that only 8% of the farmers were under the age of 35 years. A study focusing on the socioeconomic challenges facing European agriculture also found that many farmers were older than 55 years (≥31%), with only ≈6% being younger than 35 years [38]. Factors such as the limited availability of other professions in rural areas have been regarded to impact the number of younger people involved in the smallholder farming sector in developing countries similar to South Africa. Sumberg et al. [39] also suggested that the low involvement of African youth in agriculture may be attributed to their migration to urban areas in search of better opportunities. The younger workforces of the organic and semi-conventional farms sampled in this study could be attributed to similar causes, where the younger individuals, although not participating in farming on their own, were participating in farming as a source of income.

4.1.3. Education Level

Education in the South African farming sector has often been characterized by large-scale commercial farmers having higher education levels, even leading up to and including tertiary education [40]. Synonymous with such reports, several organic and semi-conventional farmers in this study have reported having tertiary-level (e.g., > grade 12) education qualifications. The rural resource-poor farmers of South Africa have often been reported to have limited access to education [11]. However, many (43%) of the semi-organic farmers in the current study reported having education up to at least the secondary level. The importance of education in the current study is highlighted by the correlation between education and the practice of pre-treating irrigation water ($\rho = 0.430$, 95% CI = 0.127–0.659, $p < 0.01$). Contrastingly, similar studies on the socioeconomic characteristics of informal South African smallholder farmers have reported populations with mostly lower levels of education [25,41]. Furthermore, the South African Department of Cooperative Governance and Traditional Affairs has described the education levels of low-income households to be cyclic in nature [29]. Low levels of education limit individuals from receiving better employment opportunities and higher wages; however, the wage level directly affects the spending capacity of the individual and the related household. Due to the limited incomes and thus limited spending capacity, children from low-earning households are more likely to drop out of school [29].

4.1.4. Income Source

Multiple studies [13,23,37] have noted that incomes from fresh produce farming contribute a relatively small amount to total household incomes. This challenge was similarly displayed by the semi-organic farmers in the current case study, where 35% of farmers relied on government grants as the primary source of income. These findings are concurrent with the findings of the uMgungundlovu District profile report, which highlighted a high dependency ratio within the district, and assigned a high expenditure on social grants [29]. Alternate income sources such as wages, social grants, and remittances have been reported to make up the majority of income streams for these farming households [21,24,41]. As both the income source and income bracket of semi-organic farmers significantly correlated with the selected farming practices (Table 2), the financial situation of such farming households is an essential socioeconomic parameter. According to a recent South African General Household Survey, government grants are the primary source of income for about one-fifth of South African households [21].

4.1.5. Interest in Market Access

The expansion of modern markets has important implications for agriculture in many developing countries as it provides both opportunities and challenges for smallholder farmers [26]. The interest in market access for the organic farmer was not of importance in this study, as the farm was already a supplier of organic produce to fresh produce markets and a retail store (Supplementary Table S3). Similarly, the semi-conventional farmers did not have market access concerns, as the main interest in farming was reported to be that of consumption rather than sale (Supplementary Table S3). The semi-organic farmers varied in their degrees of interest in farming for an intended market access, with many (42%) only being interested in farming for additional income purposes. An Indonesian study found that socioeconomic factors had significant associations with smallholder farmers' decisions on market participation [35]. Therefore, market access remains one of the confounding factors affecting not only South African smallholder farmers, but also farmers in Myanmar and Indonesia [25,26,35], countries that are currently at a similar developmental level as South Africa.

4.1.6. Farmer Group Memberships and Training

Membership in a farmer's group or associations are a common relationship observed among smallholder farmers. Semi-organic farmers in the current study were no different, with a majority (90%) of farmers reporting membership in a farmer group. Although not belonging to formal organizations, fresh produce farmers have been reported to form "farmer groups" with family and neighbor networks [42]. Such networks allow smallholder farmers to engage with each other in different manners, such as in educational initiatives, support networks, and even the collective marketing of products, thus affecting their farming practices, the type of markets they supply, and the income that can be earned [43]. However, the organic and semi-conventional farmer or the respective workers did not belong to any farmers' group. All farmers and farmworkers in the current study were exposed to some farmer training (Table 1 and Supplementary Table S3). Amongst the semi-organic farmers, exposure to training is not surprising, as many extension programs aimed at facilitating smallholder farmers have engaged in the training of farmers.

4.2. Farmer Practices

4.2.1. Irrigation Water

Irrigation water is a critical component in the production of fresh produce and has been highlighted as one of the primary contamination sources in fresh produce farming [44,45]. However, access to safe, good-quality water is progressively becoming a challenge in South Africa, resulting in potentially increased food safety risks and decreased production yields [13,46,47]. Figure 2 highlights the multiple irrigation water sources used by the different farmers surveyed in the current case study. Dam and stream/river water have previously been highlighted as irrigation water sources used by fresh produce farmers in South Africa [25,46,47]. Rainwater, utilized by semi-conventional farmers and at least 30% of the semi-organic farmers (Figure 2), has been described as an irrigation water source that is currently gaining popularity among farmers due to its eco-friendly nature and affordability [48]. While rainwater is frequently used by farmers worldwide and in South Africa, it was found in South Africa to contain higher microbial indicator counts than what is considered acceptable for safe irrigation [44,46,48,49]. From a food security perspective, microbial contamination of ready-to-eat fresh produce is concerning, given that the uptake of enteropathogens via contaminated fresh produce can lead to severe diarrhea, which in turn can affect nutrient uptake [50]. The use of rainwater as an irrigation water source should thus be carefully monitored to avoid the transfer of further microbial contamination to fresh products, as this could affect microbial safety and saleability. Wastewater reuse, or the use of "grey wash" water, has been described as a possible means to cope with the depletion of conventional water resources, particularly in areas where water is mainly assigned for direct human use [51,52]. In South African rural areas, safe tap water is frequently scarce, and if available, most municipal water is required for direct human use [53]. Therefore, the use of "grey wash" water and mixtures of stream and "grey wash" water by at least 13% of farmers and 10% of the semi-organic farmers in this study is not surprising. A study from South Africa [46] similarly illustrated that fresh produce farmers used process wash water (e.g., "grey wash" water) as a source of irrigation. The pre-treatment of irrigation water sources other than potable tap water was overall low in the current study, with the organic farmer and under 50% of the semi-organic farmers pre-treating such irrigation water types prior to use (Figure 3); this is especially relevant, with most of the irrigation water sources not being municipal potable water. Pre-treatment of irrigation water, such as through boiling, filtration, and SODIS, has often been correlated with safer production and thus, a higher quality of fresh produce [54,55].

4.2.2. Fertilizer

Fertilizers are an essential component of crop production, with the fertilizer type being used to distinguish between conventional and organic farming. Organic agriculture relies on the use of biological soil amendments (BSAs) (partially, non-composted, or "raw" animal manure), whereas conventional agriculture is reliant on synthetic fertilizers [56]. A common practice used by farmers across all farming systems in the current case study was the use of animal manure as a component of fertilizer or, in the case of the semi-organic smallholder farmers, sometimes directly as a substitute for fertilizer (Figure 2). While BSAs have positive effects on agricultural soils [57], the use of partially composted or "raw" manure has been linked to an increased prevalence of pathogenic microorganisms in agricultural soils, compared with soils that only utilize synthetic fertilizers [58]. Livestock manure may carry pathogenic bacteria such as *E. coli* O157:H7 and *Salmonella* spp., which can contribute to fresh produce contamination if the manure is directly applied as a fertilizer [25,58]. A previous study evaluating the rural fresh produce farmer practices similarly highlighted the potentially risky use of so-called "raw" manure as a substitute for fertilizer [25]. Appropriate composting of manure is crucial for the production of safe, ready-to-eat (RTE) fresh produce in organic farming, as there is typically no "inactivation step" (such as cooking) that takes place between harvest and consumption [59,60]. In the current study, pre-treatment of fertilizer displayed a significant correlation ($\rho = 0.404$, 95% CI = 0.097–0.641, $p < 0.01$) with the type of fertilizer used by the semi-organic farmers (Figure 4). The preparation time of fertilizers comprising manure differed for the farm systems, with the organic farmer using a six-month minimum preparation time for the fertilizer to be applied directly to soils (Supplementary Table S3). Contrastingly, the semi-conventional farmer, due to more frequent use of "store-bought" synthetic fertilizer, did not prepare organic fertilizer comprising of manure before use (Supplementary Table S3). The appropriate preparation and use of organic manure-based fertilizers are imperative in sustainable fresh produce production to avoid possible health risks due to microbial contamination and the subsequent effects on fresh produce food safety and saleability [61,62]. The path toward producing good quality and hygienically safe fresh produce should include the development of efficient sanitizing treatments for biological solids (including animal and human wastes), particularly when used as a source of fertilizers, with the treatments adapted to the demographic and socioeconomic situation of the farmer [57,63].

4.2.3. General Hygiene Practices

A study by Bartz et al. [64] investigating the routes of contamination of fresh produce on farms identified soil, hands of farmworkers, and farm equipment as potential sources of contamination. An official European Union guidance document highlighted the microbiological risks that can affect the safety and quality of fresh produce at the primary production level in the absence of appropriate hygiene procedures, and noted similar sources (e.g., soil, water, and farmworker hygiene) [65]. In the present study, the organic farmer and farmworkers most often recognized farming equipment, soil, irrigation water, and fertilizer as potential sources of microbial contamination (Figure 3) compared with individuals from the other two farming sectors. Mdluli et al. [25] found that the farmer's knowledge of the sources of bacterial contamination differed among trained and untrained farmers of the uMbumbulu District in South Africa. However, the sources of contamination recognized in that study also included soil, water, and equipment. The consequences of bacterial contamination were more often recognized by the individuals of the organic farm in the current study (Figure 3). The loss of customers' trust as a consequence of bacterial contamination was the most recognized consequence by the individuals of the organic farm, which may be a direct result of them already being market participants (Supplementary Table S3). Contrastingly, the individuals of the semi-conventional farm did not acknowledge the loss of customer trust as a consequence of bacterial contamination, potentially resulting from their minimal interest in gaining market access (Supplementary Table S3). The semi-organic farmers often did not link health complications or customer trust with bacterial contamination and were the only group to identify "no hazards" as a result of bacterial contamination. So far, only a limited number of studies is available [25,66] in the South African context, with respect to those specifically focusing on farmer hygiene practices and the awareness required for the microbiological safety of fresh produce when farming, and thus the implications of these factors on food safety and market access. Therefore, the implementation of good farming hygiene practices and the raising of awareness of potentially risky agricultural practices among smallholder farmers is essential for enabling their access to regulated markets.

4.3. Relationships between Farmer Socioeconomic Characteristics and Farming Practices

Gender has continually been highlighted as an influential factor governing smallholder farmer decision-making [35,67,68] and was also identified as a critical factor affecting food security [13,69]. In the current study, gender displayed the largest degree of significant association with the selected farmer practices (Table 2). Age has previously been described as a demographic and socioeconomic characteristic affecting farming practices among smallholder farmers [25,27], but it did not display a significant relationship with any farming practices in any of the farming systems that we studied. The farmer's education level has been described as a crucial characteristic in agricultural settings [27]. A significant correlation between the education and pre-treatment of irrigation water among the semi-organic smallholder farmers was observed in the current study (Table 2). Kyaw et al. [26] reported that higher education levels of smallholder farmers correlated with their adoption of better general farm management and hygiene practices. Reports by the South African Agricultural Research Council (ARC) have highlighted that poor education levels and illiteracy continue to be important contributing factors that prevent smallholder South African farmers from meeting retailers' requirements of record-keeping and safety standards [70]. The income bracket that the farmers belonged to was another observed socioeconomic characteristic of the semi-organic farmers, and was significantly associated with the type of fertilizer that they used (Table 2). Often, the financial status of a farmer dictates the type of farming practices that are used [23]. Studies undertaken in Europe have highlighted that financial characteristics often impact farmers' decisions to adopt organic farming practices, which are considered to be more costly than conventional farming practices [27]. Additionally, the education levels of the semi-organic farmers displayed a significant correlation with the farmer's income bracket ($\rho = -0.322$, 95 CI = -0.582– -0.003, $p < 0.05$). This may suggest, similarly, that farmer income may also impact the level of education that farmers have had access to or aspire to achieve.

5. Conclusions

Farming systems and practices are known to contribute to the microbial contamination of fresh produce. This case study showed that the farming systems assessed mainly differed in terms of the fertilizer type and irrigation water sources used, as well as the methods of fertilizer preparation. These differences are important in fresh produce production, as they have been previously highlighted as potential contributors to the microbial contamination of fresh produce, which in turn may affect food safety, food security, and market access. Additionally, this study highlights the potential role of demographic and socioeconomic characteristics in influencing farmer practices. Gender was one of the demographic characteristics that most affected farming practices. Considering the female-dominated farmer population of both the semi-organic and organic farm samples analyzed, policy and development initiatives that focus on improving sustainable farming practices should closely consider the gender dynamic to allow for the participation of female farmers given their other time-consuming productive roles.

A limitation of the current case study was the restriction on traveling and social interactions imposed by the South African government due to the COVID-19 pandemic, which restricted the size of the sample population. This limitation made it impossible to identify the specific practices of conventional farmers. It is noteworthy that farmers already supplying regulated markets, such as the organic farmer in the current case study, could disseminate information on good agricultural practices to informal smallholder farmers, resulting in improved microbiological quality and saleability of the fresh produce generated.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su141710590/s1. File S1. Table S1: Questionnaire 1, administered to the semi-organic farmers; Table S2: Questionnaire 2, administered to the organic and semi-conventional farmworkers; Table S3: Summary of the responses from key-informant interviews with the organic farm owner, semi-conventional farm manager, and key themes within the semi-organic farmer surveys. File S2. Farmer data.

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