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Food Traceability in Agriculture Value Chain: Evidence from Pakistani Mango Growers

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Abstract: Several incidents, including food adulteration, misinterpretation of food characteristics, and, most recently, the spread of the Covid-19 disease, have stunned consumer confidence and bolstered the need for creating traceability in the Food Supply Chain. This study aims to assess the knowledge level of mango growers' food traceability and assess factors influencing their intention toward a scientific traceable value chain in Multan, Pakistan. The study also examines the perceived challenges in implementing a traceable value chain in the mango industry. However, 40 mango growers were purposively selected. Data were collected through interview schedules using structured and unstructured questionnaires. The empirical results show that respondents had a low level of knowledge regarding the mango traceable value chain. Also, the results from multiple regression analysis revealed that knowledge and attitude have a statistically significant positive impact on growers' intention toward the mango traceable value chain. However, the study highlighted a lack of awareness, skills, and resources as challenges preventing growers from implementing a scientifically traceable mango value chain. The findings provide valuable inputs for policymakers to design an effective training program to develop the culture of traceability practices among mango growers and other stakeholders in the industry in Pakistan.

Keywords: Traceability, mango, knowledge, attitude, intention, Multan.

1. Introduction

In recent years, the capacity to track the origin of food has emerged as a crucial tool for preventing foodborne illness outbreaks [1,2,3,4,5]. Several food safety scandals, such as those involving the Sudan Red colorant, melamine in baby formula and pet meals, species replacement of fish, counterfeit branded chocolates, and horsemeat in packages labeled as beef, have had a significant impact on the agro-food industry [6]. Similarly, the quality and safety of food items are threatened by the prevalence of food pollutants, the expansion of zoonotic diseases, and the high risk of food safety events [7]. Consumers and stakeholders are worried about food fraud and adulteration because it can have disastrous economic impacts, decrease consumer trust, and pose a danger to public health [8,9,10,11]. The quality and safety of food are jeopardized by other risks, such as radioactive contamination [8].

However, these dangers have led to the implementation of traceability in food legislation [2]. Traceability systems are a regulatory mechanism for tracking the origins of food in the event of a

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disaster [7]. In order to assure the consumer and other stakeholders of the authenticity and life history of the product and to improve crisis management in the case of a deviation from a standard method, it is necessary to gather, record, store, and apply information on all steps in the supply chain [12]. Whether it is assessing logistics and manufacturing costs or recording the chain of custody, this system responds to food security risks [13]. Furthermore, it allows supply chain participants and regulatory agencies to trace the origin of a food safety or quality issue and set in motion corrective measures [2]. By enhancing the management system's capacity for detecting, verifying, and isolating instances of non-compliance to principles, traceability helps create value and earn customers' confidence [12].

A considerable body of literature investigated consumers' attitudes, knowledge about traceable products, and willingness to pay for high-quality mango attributes [14,15,16,17]. For instance, [18] discovered that attitude, subjective norms, and experience substantially impacted consumer intent for traceable beef. Likewise, [19] found that farmers' experience is crucial for achieving behavioral change toward adopting OFFS methods in their study on farmers' awareness of common pests and pesticide safety in conventional cotton cultivation in Pakistan. Moreover, [20] explored the factor influencing Pennsylvania farmers to adopt GAPs (good agricultural practices). However, the authors demonstrated that mere exposure to technical information does not automatically inspire farmers to implement best practices. Another study [21] examined how likely small and medium-sized enterprises (SMEs) in the UK were to invest in tracking technology. They concluded that UK SMEs understand the importance of traceability systems and their role in reducing recall costs, speeding up recalls, and boosting food quality and safety. It was also shown that people have generally good knowledge of traceability in acknowledging its relevance but are suspicious about the capabilities of traceability systems in product recalls. Knowledge and attitude, however, have also been the subject of much research. This current study examines the producers' attitudes, knowledge, and intentions toward Pakistan's traceable mango value chain. Moreover, the study also assessed the growers' challenges in adopting a traceable value chain.

While addressing the research objectives, this study contributed to the body of knowledge on food traceability by assessing the knowledge level and intention of mango growers in Pakistan to adopt traceability. The findings will serve as a guide to policymakers in designing appropriate policies on food traceability.

The rest of the article is organized as follows; The next section presents the methodology. The next section is the results and discussions—the last section is the conclusion and recommendation.

2. Research Method

The data used in this article were collected from field research in Multan, Pakistan. Multan is prominent for mango production in the province of Punjab. The population of the study involves small, medium, and large mango growers. A simple random sampling technique was used to select 40 mango growers. Data was collected using structured and unstructured questionnaire surveys. The questionnaires were divided into three sections. Section A focused on the level of knowledge of the growers towards traceable mango value chain, which is measured on a five-point Likert scale ranging from 1 strongly disagree to 5 strongly agree. Section B deals with the growers' attitudes toward the traceable mango value chain. It is also measured on a five-point Likert scale. Section C was meant to assess the intention of growers toward implementing traceability, which is also measured on a five-point Likert scale. Finally, section D was designed to solicit a response on growers' socio-economic variables. However, the data were captured, coded, and analyzed using SPSS version 25. Descriptive and multiple regression analyses were carried out to assess the factors affecting growers' intentions toward scientific traceability.

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3. Results and Discussions

The survey data's validity and reliability were evaluated using statistical methods so that the impact of the chosen factors on future behavior within the mango traceable value chain could be better understood. For this purpose, Cronbach's alpha was used to examine the degree to which the items chosen to represent each construct were consistent. The reliability coefficients for the three variables were as follows: knowledge = 0.90, attitude = 0.93, and intention = 0.76. The values exceeded the minimum threshold of 0.60 [22].

The data collected were analyzed using SPSS software version 20. However, descriptive and inferential statistics were utilized to understand growers' socio-demographic characteristics, level of knowledge, attitudes, and intention toward the traceable mango value chain.

Table 1: Demographic Characteristics of Mango Growers (n= 44).

Variable	Items	Frequency	%
Farming Experience			
	Less than 10 year	11	25.0
	11-20 years	20	45.5
	Above 20 years	13	29.5
	Total	44	100.0
Age			
	Less than 20 years	1	2.3
	21-30 years	7	15.9
	31-40 years	17	38.6
	41-50 years	11	25.0
	51-60	7	15.9
	Above 60 years	1	2.3
	Total	44	100.0
Education			
	No formal education	2	4.5
	primary school	2	4.5
	Secondary school	16	36.4
	Intermediate	4	9.1
	Graduation	19	43.2
	Post-graduate	1	2.3
	Total	44	100.0
Income in Rupees per Month			
	Up to 50, 000 rupees	10	22.7
	5001-100,000 rupees	6	13.6
	100001-150,000 rupees	14	31.8
	150,001-200,000 rupees	12	27.3
	above 200,000 rupees	2	4.5
	Total	44	100.0
Category of Farm			
	Small Farmers	27	61.4
	Medium Farmers	14	31.8
	Large Farmers	3	6.8
		44	100.0

Source: Authors' computation based on Survey data, 2022

Table 1 presents the demographic characteristics of mango growers. As reflected, the highest proportion of the growers, 45.5%, have 11-20 years of experience in mango production, followed by 29.5% having more than twenty years of experience. Regarding age, 38.6 % of the respondents

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are within the age bracket of 31-40 years, followed by 25% between 41-50. In the area of education, interestingly, 43.2 % of the growers were found to be graduates, while 36.4 % attended secondary school. Moreover, 31.8 % of the growers' monthly income ranged between 100,000 to 150,000 rupees, whereas 27.3 % of monthly income is between 150,001 to 200,000 rupees.

Moreover, table 1 also shows the category of farms in the study area. It reflects that most of the respondents were small mango growers representing 61. 4 % of the respondents. Whereas 31% are medium farmers and the least are large farmers indicating that smallholder farmers are instrumental in the mango industry.

Table 2 depicts the frequency and %age of total land area in acres for mango production in the study area. The findings indicated that 25.0 % of the respondents have 15 to 25 acres for mango production. Besides, 22.7 % represent growers that cultivate 5 to 15 acres. In comparison, nearly 21 % of the growers are within the range of 10 to 15 acres.

Table 2: Mango Cultivated Area.

Total Land Area for Mango Orchard (Acres)	Frequency	%
1-2	1	2.3
2-5	2	4.5
5-10	10	22.7
10-15	9	20.5
15-25	11	25.0
25—35	6	13.6
35-45	4	9.1
55-65	1	2.3
Total	44	100.0

Source: Authors' computation based on Survey data, 2022

Table 3 shows the frequency of mango varieties grown in Multan. In mango production, varieties play an important role in determining the output volume and consumers' preferences. In this regard, the results show that 34.1% of the growers cultivate Dessi, and 21 % produce black chonsa and sindhri, whereas 15 % of the respondents grow Dosehri varieties.

Table 3: Varieties of Mango Grown.

Variables	Frequency	%
Langra	3	6.8
Dessi	15	34.1
Black chonsa	9	20.5
Dosehri	7	15.9
Sindhri	9	20.5
Answar Ratool	1	2.3
Total	44	100.0

Source: Authors' computation based on Survey data, 2022

Table 4 illustrates the source of input supply of nursery, fertilizer, pesticides, and packing materials for growers. The purpose was to determine whether these inputs are bought from certified firms. The findings indicated that 54.5 % of the respondents reported that they produce their nursery, while 45. 5 % indicated they sourced their nursery from the local market. These respondents indicated that the plantations are certified, given that they are purchased from recognized dealers. Likewise, in the case of fertilizer, the respondents stated that they bought from the local market,

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where they assumed the fertilizers were certified. Moreover, 65.9 % of the respondents reported using plastics as packing materials, whereas 34.1 % indicated that they use wooden materials for packing.

Table 4: Sources of Input Purchase.

Variables	Source	Frequency	%	Certified	Not Certified
Nursery	Self-stored	24	54.5	20.5%	79.5%
	Local market	20	45.5		
Fertilizer	Local market	44	100.0	100.0%	
Pesticides	Local market	44	100.0	100.0%	
Packing Materials	Wood	15	34.1	9.1%	90.9%

Source: Authors' computation based on Survey data, 2022

In traceability, recordkeeping is fundamental because it shows a sign of compliance with GAP. In essence, recordkeeping has multiple benefits, especially for growers. It helps them compare yield and access to credit. More importantly, it facilitates a quick response to data accessibility during fraud or food poisoning and builds consumer confidence. In this respect, respondents were asked about the recordkeeping of their production activities. However, table 5 shows that nearly 80 % of the respondents reported that they recorded their work manually or used different means other than computerized recording systems. It is probably due to limited knowledge of computers as growers do not use automated systems to record their farm activities.

Table 5: Recordkeeping for different Activities of the Orchard.

Variables	Items	Frequency	%
Manual record	Yes	35	79.5
	No	9	20.5
Computerize record	Yes	-	-
	No	44	100.0
Any other method	Yes	11	25.0
	No	33	75.0

Source: Authors' computation based on Survey data, 2022

Table 6 shows the response from the growers regarding their production practices, such as nursery, fertilizer, pesticides, harvesting, ripening, and packaging materials. The essence is to determine if these activities are certified or not. Therefore, regarding the production process, it is ideal not to limit it to only the input level but all stages of the production [23]. Given this, respondents reported that they do not keep a record of the origin and varieties of the nursery plants, and the nurseries were not certified. While for fertilizer, respondents indicated that records are kept, and products are bought from certified dealers. This is because receipts are issued to them during purchase to serve as evidence. Although 71% of the respondents reported that they did not know the chemical composition of the fertilizer used.

Regarding pesticides, respondent shows that they keep a record of purchase and that the insecticides are bought from certified dealers. Still, they do not know the chemical composition of pesticides and their harmful effect on humans. For harvesting, respondents (98%) reported that they use manual methods in harvesting mango. However, 55% of the respondents reported that they applied carbide in the ripening of their mango, while 36.4% indicated that they used ethylene. This suggests that growers are not following good agricultural practices because these chemicals are

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hazardous to human health. More specifically, good agricultural practice is not followed. This is more evidently shown in the use of wooden boxes 86.4% as packaging materials for their product.

Table 6: Records of the production Practices.

Variables	Items		Frequency	%
Nursery	Origin and type of Varieties	Yes	-	-
	Date of plantation	No	44	100.0
	Certified	Yes	-	-
Fertilizer	Source of purchase record	Yes	40	90.9
	Chemical Composition	Yes	13	29.5
	Application date and dose	Yes	22	50.0
Pesticide	Source of purchase record	Yes	40	90.9
	Certification Record	Yes	39	88.6
	Chemical Composition	Yes	2	4.5
		No	42	95.5
	Application date and dose	Yes	23	52.3
Harvesting	Harvesting Method	Manual	43	97.7
		Clipper	1	2.3
	Harvesting date	Yes	23	52.3
Ripening		Carbide	24	54.5
		Ethylene	16	36.4
		None	4	9.1
Packaging		wooden	38	86.4
		corrugated box	6	13.6
	Certified	Yes	6	13.6
		No	38	86.4

Source: Authors' computation based on Survey data, 2022

Table 7 present the results on factors influencing the traceability intention among mango growers were analyzed using multiple regression analysis. The variables, such as knowledge and attitude, were regressed against the dependable variable traceability intention. However, the coefficient of determination explains the extent to which variation in the dependent variable can be explained by the %age change in the dependent variable (growers' Intentions towards traceability) that is explained by the independent variables (Knowledge and Attitudes) $F(6, 303) = 40.59$ $P<.001$. In addition, the two independent variables explained 66.4% of the effect on traceability intentions among mango growers, as shown by the R square. Table 7 shows that knowledge about traceability was found to have a statistically significant positive effect on intentions toward traceability ($\beta = .361$, $t = 3.573p < .001$) on growers' intention towards traceability. This shows that an increase in the knowledge level of growers through skill acquisition will undoubtedly motivate the growers to practice traceability. These findings are consistent with those [24], who concluded that attitude is the most influential factor in predicting farmers' intentions for an on-farm license application.

Moreover, concerning attitudes, the table also shows a significant favorable influence ($\beta = .215$, $t = 2.947$ $p < .005$) on intentions towards traceability. This also confirms our hypothesis that the growers' attitude positively influences their intention toward a traceable mango value chain. These findings are consistent with the findings of [25]. Similarly, [26] indicated that attitude is fundamental in influencing intentions to perform different safe food-handling behaviors. They concluded that the food safety attitude of the community positively influences an individual's food safety behavior. This indicates that if growers are aware of the importance of traceability as a tool to

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increase customer-based profits, they are likely a chance for them to have a favorable attitude toward practicing traceability. However, our findings indicated a positive association between the two variables concerning the relationship between knowledge and attitudes. This supports our third hypothesis, which states that knowledge has a significant positive association. Therefore, we can make out of this that if growers are enlightened about the benefits of traceability, they will have a favorable attitude towards adopting it in their production practices.

Table 7: Regression Model Summary and Statistics.

Model						Collinearity Statistics	
		β	SE	t	Sig.	Tolerance	VIF
1	(Constant)	9.892	1.829	5.409	.000		
	Knowledge	.361	.101	3.573	.001*	.456	2.195
	Attitude	.215	.073	2.947	.005*	.456	2.195

Notes: *p< 0.1; **p< 0.05; ***p< 0.01 R^2 =. 664, Adjusted R^2=.648, F value =40.589, VIF= variance inflation factor

b. Predictors: (Intention), Attitude, Knowledge

Source: Authors' computation based on Survey data, 2022

Challenges in Adopting to Scientifically Traceable Value Chain.

Despite the potential benefits of increasing yields, attaining a better quality/quantity with cheaper production, optimizing the system and respecting the environment by lowering water consumption and other natural resource use, improving soil quality, and adapting agricultural production to the needs of a changing climate, the ecological footprint and environmental effect of agricultural methods remain significant concerns. Hence, growers highlighted some constraints that inhibited their adoption of traceable scientific value in mango production. Low awareness of traceability among farming communities hinders their adoption of agro-food traceability. According to [27], stakeholders' lack of knowledge, poor sector-wide collaboration, and insufficient capability among primary providers hinder their adoption of traceability. Also, growers reported insufficient resources and limited support services as barriers to adopting a traceable value chain. Also, [27] pointed out that insufficient resources are another obstacle among growers. Compliance with food safety standards may give smallholder farmers advantages, such as increased access to markets and opportunities to upgrade their farming techniques if they can overcome resource limitations and put them into practice. However, failure to comply may result in shutting out critical markets.

4. Conclusions and Recommendations

The aim of this study was to assess growers' knowledge, attitude and intention toward a traceable mango value chain. Moreover, the study also examined the challenges growers faced in adopting to the scientific traceability value chain. However, it shows that knowledge and attitude influence growers' intention to implement a scientific traceable mango value chain. This suggests that a comprehensive training program should provide growers with the necessary skills to adapt to traceability in their production processes. Likewise, the study also found a strong association between the knowledge and attitude of growers towards traceability. This indicates that if growers are enlightened on the benefits of traceability, they will be motivated to implement it. Therefore, we recommend that awareness campaigns be organized to sensitize stakeholders on the need for traceability adoption among growers. However, in recordkeeping, the study found that growers do not keep a record of their production activities and use locally available materials such as wooden

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boxes and plastic for packing their products. This signifies that they do not follow good agricultural practices.

The findings should serve as an advocacy tool for researchers and food safety authorities to design an educational program for growers and other stakeholders regarding handling their harvested products. The study also highlighted a lack of awareness, skills, and resources as the most significant challenges and impediment for growers to implement a scientific traceable mango value chain. However, future research could incorporate targeted educational programs based on the results and assess the outcome. Other stakeholders in future research are also essential to comprehensively understanding factors influencing intention towards traceability.

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