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BEYOND SUBSISTENCE: LINKING CITRUS SMALLHOLDERS TO HIGH-VALUE MARKETS FOR SUSTAINABLE SUPPLY CHAIN DEVELOPMENT IN PAKISTAN

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ABSTRACT

Recent evidence suggests that Modern Supply Chains (MSC) in the agrifood industry have the potential to improve production efficiency and scale. However, the inclusion of smallholders for Sustainable Supply Chain Development (SSCD) is a growing concern for policymakers aiming to increase the profitability of farming communities. This study investigates the efficiency and inclusiveness of farmers in the citrus supply chain at the upstream level and factors responsible for SSCD using survey data from the Punjab province of Pakistan. The study employs endogenous treatment effect and principal component analysis apart from the descriptive analysis to explore study objectives. Results indicate that large farmers with abundant resources tend to participate in MSC, whereas smallholders are more likely to be inclined to Traditional Supply Chain (TSC) networks. The study also finds that participating in MSC has a positive impact on farmers' efficiency, and factors such as off-farm income, orchard size, education level, and access to extension services significantly affect profitability. The results of the principal component analysis revealed that for SSCD, six sets of factors, such as performance and quality, risk and climate, economics and market exploitation, knowledge and information, geographic and transportation, and innovation capability, are addressable. Therefore, these results suggest that policymakers should provide training programs, agriculture extension services, improved infrastructure, and educational facilities in rural areas to help smallholders alleviate poverty by creating sustainability in the agri-food industry.

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INTRODUCTION

Over the past two decades, agriculture and food supply chains have experienced significant transformations due to changes in consumption patterns as a result of globalization (Porter and Reay, 2016). In developing countries, urbanization and increased per capita income have led to alterations in dietary preferences, shifting away from basic grains towards processed and high-value cereals, dairy products, fruits, and vegetables (Burki and Khan, 2011; Pingali, 2007). As a result, these countries must restructure their production and marketing systems to accommodate these evolving trends (Jayne et al., 2016) by connecting smallholders to Modern Supply Chains (MSC) to meet the growing local and international consumer demands (Montalbano et al., 2018; Naseer et al., 2019b). MSC refers to marketing channels that have the potential to elevate products to export levels or link products to processing levels for value addition (Davis, 2006; Henderson and Isaac, 2017; Maertens et al., 2012). In agro-based industries, the emergence of MSC has created opportunities for engagement among various stakeholders involved in activities from production to distribution, including processing and marketing. These MSCs have been conceptualized within these activities, ranging from production to distribution networks and global value chain frameworks. However, integrating smallholders into these MSC networks for both domestic and international markets raise several questions, such as who benefits and who suffers from this integration and how participating in MSC affects growers' efficiency. This study aims to address these questions.

The export of agri-food commodities from developing to developed countries has increased in recent years, but small landholders in these developing countries face numerous challenges to capturing high-value markets in developed countries (Naseer et al., 2019c). The literature on the causes of small landholders' participation in those high-value markets or MSC has produced mixed findings. Some studies, such as Sartorius and Kirsten (2007), Rao and Qaim (2011), Heijden and Vink (2013), Schuster and Maertens (2013), and Swamy and Dharani (2016) reported that smallholders are often excluded from profitable niche markets due to intense competition from different MSC in meeting global demand. In contrast, proponents of MSC, including Minten et al. (2009), Barrett et al. (2012), Birthal et al. (2017), and Montalbano et al. (2018) argued that modern institutional arrangements like contract farming could successfully include small landholders in MSC.

Small-scale farmers, also referred as subsistence farmers, face significant challenges in establishing supply chain networks due to factors like unfavorable weather conditions, difficulties in farm management, harvesting, and handling challenges, involvement of middlemen, quality standard complications, pest control, employment of untrained labor, sanitary and phytosanitary standards for premium markets, proper information dissemination to growers, energy deficits, and safety concerns in their countries (Malik et al., 2014). However, recent findings from developing countries indicate that engagement in MSC can enhance efficiency and productivity while addressing production and market-related challenges (Barrett et al., 2012; Birthal et al., 2017; Birthal et al., 2008; Chen et al., 2015; Montalbano et al., 2018; Mutura et al., 2016; Trifkovic and Farimagsgade, 2015).

For market expansion and more returns for farmers through value addition, governments support the involvement of private industry players that contribute to the growth of agri-food sectors by connecting small landholders with MSC (Siddique et al., 2018). While numerous studies have investigated factors influencing participation in existing supply chains and related issues, limited research exists on the effects of farmers' participation decisions on production efficiency, considering all relevant variables. In Pakistan, research on the citrus supply chain has primarily focused on marketing margins, constraint analyses, and factors hindering Sustainable Supply Chain Development (SSCD) (Siddique et al., 2018).

The present study aims to explore the determinants of small-scale farmers' engagement in agri-food supply chains and the subsequent impact on profitability, focusing on Pakistan's citrus supply chain. The study classifies all stakeholders who purchase from farmers into five distinct categories and further consolidates them into two groups: TSCs and MSC. The objectives of the study are to map farmer participation in various citrus supply chains, assess profitability across these chains, identify factors that affect farmers' efficiency and participation decisions, and identify the factors responsible for SSCD in Pakistan's citrus industry. The study's theoretical framework is presented in the next part of this section. Section two delves into the research area, data and variable definitions, analytical framework, and the empirical methods used. Section three presents and discusses the findings, followed by the final section that summarizes the conclusions and policy implications.

Theoretical Framework

The concept of market structure is grounded in the interaction between supply and demand stakeholders, leading to market equilibrium. For agricultural exporters and processors, the primary factor influencing purchasing decisions stems from derived demand. In line with the profit maximization principle, consumers equate input prices with the marginal value of the product, while suppliers equate product prices with marginal costs. Nonetheless, the standard economic theory may not always be applicable in agricultural contexts due to various reasons, such as specialized product suppliers being too dispersed to achieve economies of scale for buyers or quality standards not being effectively standardized, particularly for export products. Asymmetric information and unequal access to production technology may also place farmers at a disadvantage in meeting quality and quantity objectives. Thus, it's crucial to consider these factors when analyzing agricultural markets and address these challenges to ensure a fair and efficient market structure for all stakeholders (Briones, 2015).

One potential solution to address these challenges is upfront vertical integration, which consolidates land under the consumer's ownership. However, in the case of Pakistan, this may not be a viable solution due to land reforms that limit the size of agricultural farms and transfer land rights to tenants, potentially preventing land accumulation by larger farmers (Naseer et al., 2019a). Moreover, without land reforms, vertical integration may not resolve procurement issues (Hayami, 2010). In such situations, MSC presents a promising option for both agricultural product buyers and sellers. Farmers benefit as they receive prompt payment and receive technical support and advice when needed. In particular cases, MSC also have a contractual framework with producers, agreeing to purchase anticipated output by these networks, and farmers are bound to use specified input and technology and to sell their crop products back to them. Despite the advantages, several types of risks are also associated with MSC. For example, some prefer contracts with farmer groups rather than individual farmers. It has also been observed that MSC primarily operate in areas with better security and infrastructure facilities and avoid remote areas. However, in the case of the vegetable supply chain in Madagascar, quantity and quality standards were enforced in the farmer's filed at the farm level, training was provided, and operations were closely monitored by inspectors and technicians, which shows that MSC can function effectively (Minten et al., 2009).

In developing countries, farm size is a critical policy consideration, as small landholders are often excluded from MSC networks. There is no clear consensus among researchers on the impact of farm size on farmers' decisions to participate in specific agri-food supply chains. However, a multi-country case study by Cramb et al. (2017) suggested that if smallholders are provided with necessary facilities, including land tenure security, market infrastructure, research, extension, and finance, a vibrant small landholder sector can emerge and promote inclusive rural development. Various factors influence farmers' participation and farm efficiency, including farm and household resources, demographic characteristics, geographic location, and institutional factors. Farm resources include farmers' household conditions, such as alternative income sources, farm size, orchard size, and wealth. Geographic factors involve location and distance from the farm to the market, representing physical access and transportation costs. Demographic factors include age, education, family size, social networks, gender, and farming experience.

The literature indicates that small landholders' inclusiveness within the agri-food supply chain is influenced by various farm-level, farmer-level, institutional, and geographic factors (Henderson and Isaac, 2017; Jordaan et al., 2014). Figure 1 introduces an analytical framework that identifies farmers' inclusiveness in the agri-food supply chain and its impact on farm profitability. The analysis takes into account several factors related to the farm, farmer, geographic, and institutional context, along with farmers' participation in the supply chain. This approach offers a more comprehensive understanding of farmers' decision to participate in supply chains, enabling them to identify the reasons behind their behavior. It also provides them the possibility to change their decision and align with other stakeholders more effectively for successful participation in agri-food supply chains.

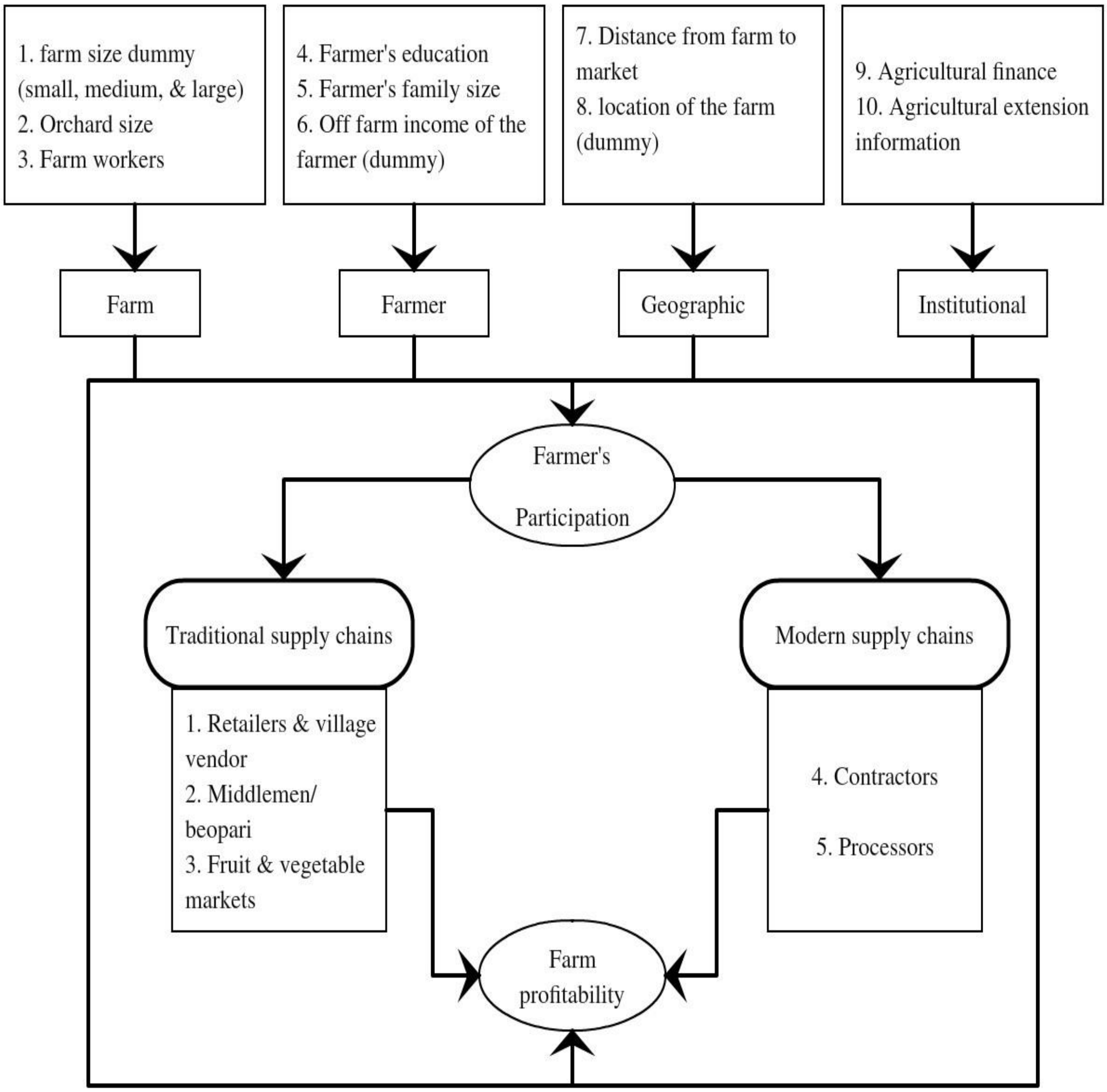

Figure 1. Conceptual framework for small landholders' participation in the citrus supply chain.

Literature also suggested that promoting farmers' involvement in high-value supply chains can increase their income and contribute to poverty alleviation (Cramb et al., 2017). It is essential to examine the economic consequences of growers' participation in agri-food supply chains from a policy perspective. If TSC participants are disadvantaged or in vulnerable situations, policy interventions may be required to support them. On the other hand, if MSC participants do not receive greater benefits or if TSC participants obtain equivalent benefits, policy interventions might not be justified or necessary (Romero Granja and Wollni, 2018).

This study aims to evaluate the economic impacts of farmers' supply chain participation, identify factors for SSCD and provide policy implications. The underlying assumption is that a farmer's production scale serves as the primary factor in their choice of supply chain involvement. Large farmers participate in high-value MSC, whereas small landholders are economically disadvantaged and typically sell their produce through informal channels or TSCs. Furthermore, farmers associated with MSCs generally earn higher profits than farmers who are connected with informal marketing channels or TSCs.

METHODOLOGY

Study Area and Data Description

Pakistan ranks as the 13th largest citrus producer globally (FAO, 2018) and the 6th largest exporter of mandarins (Naseer et al., 2019b). Mandarin (locally referred to as *Kinoo* or *Kinnow)* is a citrus variety commonly grown in Punjab, Pakistan (Naseer, 2019). In Pakistan, citrus leads in fruit production, yielding 2,360 thousand tons annually from 206.6 thousand hectares (Memon, 2017). Mandarin constitutes about 90% of Pakistan's total citrus production (GOP, 2018c). The principal Mandarin-producing region is Punjab Province, which is responsible for over 95% of the nation's total Mandarin output. Consequently, this study was conducted in the Punjab Province (GOP, 2018a). Punjab Province is not only the most populous but also the second-largest province in Pakistan in terms of area (GOP, 2018d; Naseer et al., 2016). It contributes the highest share of agricultural GDP compared to other provinces (GOP, 2018b). Sargodha district in Punjab was chosen for this study, as shown in Figure 2, as it represents around 53% of the province's total mandarin production (GOP, 2018d).

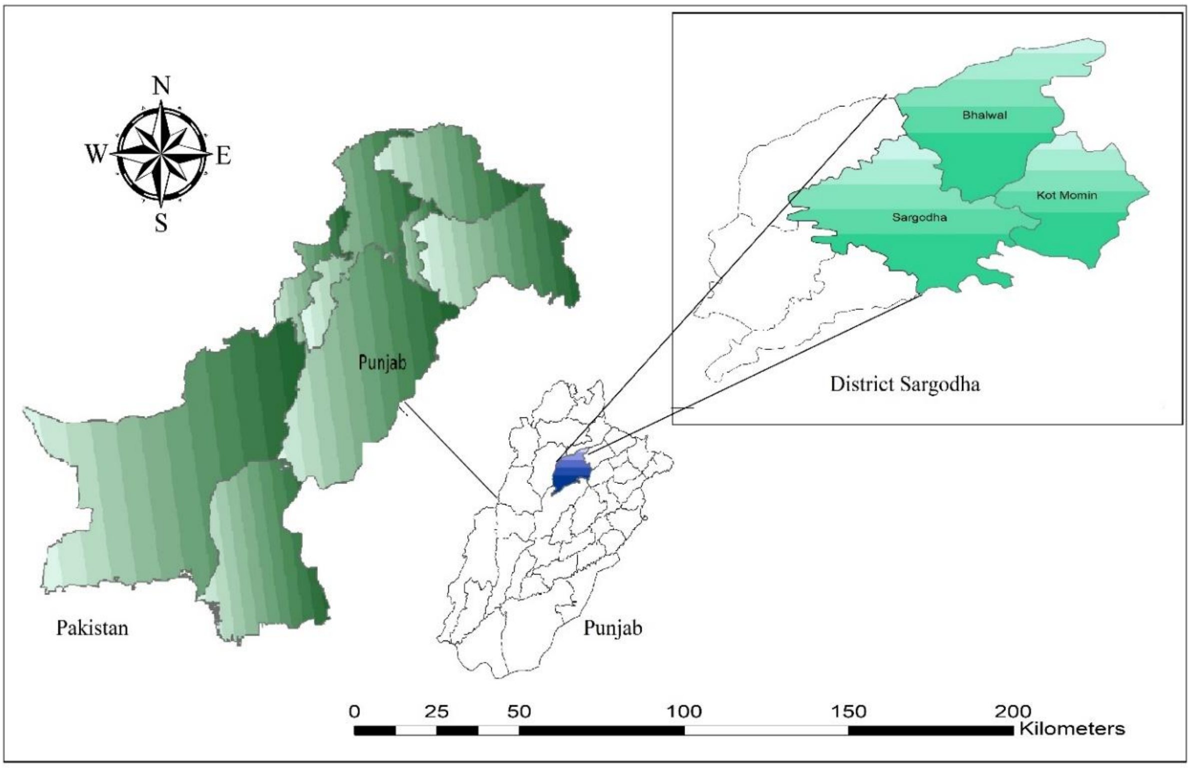

Figure 2. Map of the study area – district Sargodha.

A multistage random sampling technique was employed to select the study area and respondents. First, the Sargodha district was purposefully chosen due to its prominence in citrus production. Next, three Tehsils (Bhalwal, Kotmomin, and Sargodha) were randomly selected from a total of six Tehsils. Third, ten villages from each Tehsil were randomly chosen, and finally, at least ten respondents were interviewed using a well-structured questionnaire in the last stage as presented in Figure 3. The total sample size of the study comprised 300 respondents, representing a random mix of farmers associated with TSC and MSC and all farm size categories: small-sized farmers (less than 5 hectares), medium-sized farmers (5 to 10 hectares), and sized farmers (above 10 hectares) (Naseer, 2019). A semi-structured questionnaire was employed to gather quantitative and qualitative data on production and marketing-related factors of citrus farmers. The study also considers the ethics of data collection, and verbal consent was obtained from the citrus farmers to participate in the survey after explaining the purpose of the study to them. Respondents were also assured of their anonymity in their responses.

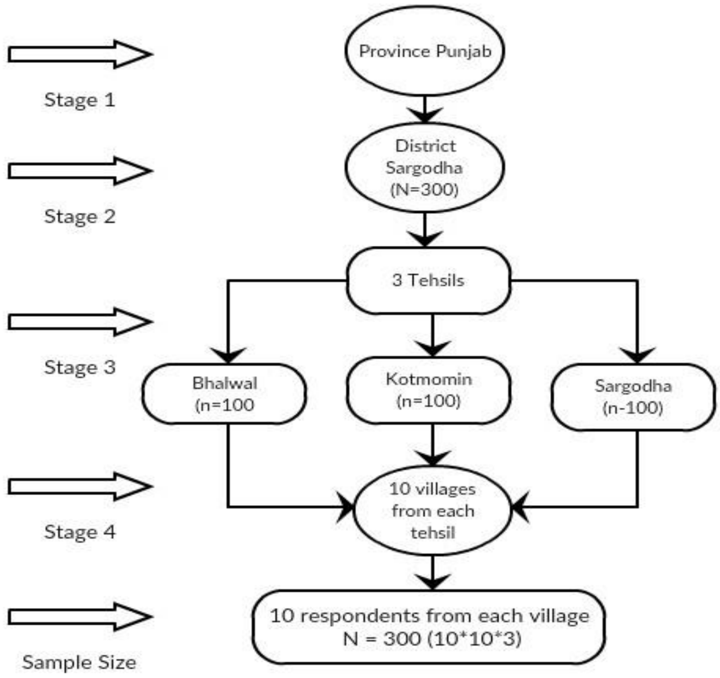

Figure 3. The multistage sampling technique used for the study.

Benfit Cost Ratio (BCR)

All the fixed and variable cost calculations are summed up, including pre-harvest and post-harvest costs, to calculate each farmer's total cost. Then, the total yield is multiplied by the price received by the farmer to calculate the total revenue. The farmers' benefit-cost ratio (BCR) participating in different supply chains was calculated according to the following formula.

$$BCR = \frac{TR_i}{TC_i} \qquad (1)$$

Econometric Models

Endogenous treatment effect

This study aims to explore the factors affecting the production efficiency of Mandarin farmers by taking their involvement in TSC or MSC as treatment variables. A significant issue to address is endogeneity, which can result in biased and inconsistent estimates in standard regression models due to the correlation of unobservable heterogeneities influencing both inclusiveness and profitability (Benali et al., 2018; Girma and Gardebroek, 2015; Vella and Verbeek, 1999). Maximum Likelihood Estimates (MLE) might also be inconsistent if a regressor is endogenous. Therefore, to maintain consistency, a two-step estimation method was employed in place of MLE (Cameron and Trivedi, 2022). In this regard, we utilized a linear model as proposed by Rao and Qaim (2011), Barrett et al. (2012), Salmon and Tanguy (2016), and Benali et al. (2018). A dichotomous variable, i.e., farmer's participation in TSC / MSC is considered a treatment variable in the first stage of this model and the equation is specified as:

$$SCP_i = \beta_o + \beta_i X_i + \delta_i I_i + \varepsilon_i \qquad (2)$$

In equation (1), X_i represents the list of independent variables that influence participation, while I_i denotes the instrumental variables, including location dummies and the distance from the town. The second stage equation concentrates on farm profitability (efficiency) of the citrus supply chain is as follows:

$$Y_i = \alpha_o + \alpha_i X_i + \theta_i E_i + \nu_i \qquad (3)$$

In the above equation (2), Y_i symbolizes the outcome variable, which is profitability, serving as an efficiency indicator. E_i refers to the independent variables that exclusively impact the profitability of citrus production.

To guarantee identification, this study employed location dummies and the distance between the farmer's village and the market as instruments in the selection equation. Farm and orchard size were used as indicators of the mandarin production scale in both the selection and outcome equations. These indicators also account for the farmers' resource endowments when deciding to participate in the supply chain. Other variables, such as farmer-level variables (e.g., age, education, family size, and profession), farm-level variables (e.g., available labor, orchard size, or farm size), institutional variables (e.g., extension information and agricultural credit), and geographic variables were used as independent variables.

Factor analysis

Literature has reported several factors in SSCD of agri-food industries (Chen and Paulraj, 2004; Sitek et al., 2017; Badar et al., 2015; Sharif et al., 2005; Nyaoga and Magutu, 2016; Briones, 2015; Yang and Shao, 2018). With the help of these studies, all important factors were subdivided into two distinctive categories of production and marketing-related factors, and a total of 30 factors were identified in this study. The respondents were asked to rank these factors according to the Likert scale from very disagree to very agree. After that, to determine the basic grouping of factors responsible for SSCD, Principal Component Analysis (PCA) was used. This statistical method was used to determine a relatively lesser number of factor sets that represent relationships between multiple interrelated sets of different variables (Norusis, 2008). This method is powerful, and many factors can be recombined by response factor scores and reduced to smaller and more critical factors (Li et al., 2011). However, before applying factor analysis, Kaiser-Meyer-Olkin (KMO) sampling adequate measurements and Bartlett spherical tests were used for the determination of the appropriateness of factor analysis. Cronbach alpha coefficient (α) helps to explain the reliability of factors arising from the dichotomy or Likert scale (Santos, 1999). Generally, the value of α must be no less than 0.70 for the scale to be reliable (Tavakol and Dennick, 2011), and in our case, it was 0.73.

RESULTS AND DISCUSSIONS

Farm Size Distribution

Table 1 displays the distribution of survey participants based on farm size and the average size of their mandarin and other citrus orchards. Medium-sized farmers make up 41% of the sample, and the mean farm size of medium farmers is 7.37 hectares, with 4.95 hectares allocated to mandarin orchards and 0.82 hectares to other citrus fruits. Farmers with more than 10 hectares of agricultural land comprise 26% of the sample and have an average of 13.65 hectares, dedicating 7.22 hectares to mandarin cultivation and 1.83 hectares to other citrus varieties. Small farmers, who possess less than 5 hectares of agricultural land, represent 33% of the sample. The data in Table 1 indicates a positive relationship between the size of mandarin orchards and the total agricultural land size. The emphasis on mandarin variety in this study is due to its significant presence in Pakistan's citrus orchards, with over 90% of production dedicated to mandarin (Ali, 2004). Moreover, the proportion of other citrus fruits is minimal compared to mandarin (Memon, 2017).

Farmer's Participation in Citrus Supply Chain

Mandarin farmers have a variety of options to sell their produce through different supply chain actors. The stakeholders participating in these supply chains were categorized into five primary channels: 1- direct sales (selling directly to consumers, village vendors, or retailers), 2- local middlemen or *'beopari'*, 3- commission agents in fruit and vegetable markets, 4- contractors, and 5- processors.

Table 1. Farmer's distribution by farm size (hectares).

	Farm Size		Ave. mandarin orchard	Other citrus fruits	Total citrus orchard
Category	Number	Mean (ha)			
Small	98 (33%)	3.60 (1.06)	3.16 (0.91)	0.26 (0.44)	3.42 (1.06)
Medium	123 (41%)	7.37 (1.46)	4.95 (1.47)	0.82 (0.78)	5.78 (1.72)
Large	79 (26%)	13.65 (2.74)	7.22 (1.73)	1.83 (1.14)	9.06 (2.14)
Total	300 (100%)	7.79 (4.25)	4.97 (2.08)	0.90 (1.01)	5.87 (2.72)

Note: The figures in parenthesis are the standard errors except percentages (%).

The data in Table 2 reveal that only a small percentage of farmers participate in channel 1 (direct sales to retailers, village vendors, and consumers), which is mainly limited to small and medium farmers in rural areas. Moreover, no citrus growers with orchards larger than 10 hectares engage in channel 1. Over 50% of farmers sell mandarin through channel 4 (contractors), signifying that it is the most commonly used marketing channel by citrus growers. These results align with previous research by Siddique et al. (2018) and Sabir et al. (2010), who observed that the most significant marketing channel for citrus and mandarin fruit in Pakistan involves pre-mature contractors with connections to large city markets, exporters, and sometimes their processing units in nearby locations.

The study found that around 18% of the total Mandarin is marketed through commission agents in fruit and vegetable markets (channel 3), and around 19% is marketed through local middlemen known as *'beopari'* (channel 2). Only 4.33% of farmers are directly linked to processors, which is attributed to the limited citrus processing industry in rural areas, leaving farmers with no choice but to select other available marketing channels.

Defining Supply Chain Networks

To facilitate a better understanding, the study grouped the five marketing channels into two categories: TSC and MSC, as presented in Table 3. In this context, TSC refers to local supply chains lacking the capacity to push the produce to the export level, while MSC represents the supply chain leading to exports (Davis, 2006; Henderson and Isaac, 2017; Maertens et al., 2012). The first three channels in Table 2 were classified as TSCs, while the last two channels (i.e., contractors and processors) were categorized as MSC. This categorization of the marketing channels was also based on the potential for value addition and exports of the mandarins produced by the farmers. The first three channels have limited opportunities for value addition and exports, while the last two channels offer greater potential in these areas.

The results indicate that about 58% of farmers of all farm size categories were inclined to the MSC, and the rest of the farmers are associated with TSCs.

According to Birthal et al. (2017), the primary indicators of supply chain efficiency at the upstream level include product yield, revenue, and output prices. Yield represents production efficiency, while profits and prices represent economic and marketing efficiency. The results of this study show that there is a slight variation in yield across farm size categories, suggesting that yield is invariant to production scale because of the fewer differences in the management practices of Mandarin farmers. These results are in line with Birthal et al. (2017), who studied the efficiency and inclusiveness of dairy value chains in Indian Punjab. However, some studies also found an inverse productivity to size relationship (Sharma, 2015). When we talk about the output prices, it is seen that farmers who sold their produce to the processors receive the highest prices. An interesting result was observed: small farmers with direct sales receive a higher price than the average price. This finding supports the theory of lesser market intermediaries with lesser marketing margins (Agbo et al., 2015; Fournier, 2018; Pokhrel and Thapa, 2007).

Table 2. Farmer's distribution across different all marketing channels.

Farm Category	Retailers/ consumers (1)	Middlemen/ beopari (2)	Fruits & vegetable markets (3)	Contractor (4)	Processors (5)	Total
Number of farmers						
Farm Size						
Small	3	20	18	54	3	98
Medium	8	25	18	66	6	123
Large	1	13	18	43	4	79
Total	12	58	54	163	13	300
Citrus Orchard Size						
≥ 5	7	30	26	80	4	147
5 to 10	5	23	19	64	7	118
< 10	0	5	9	19	2	35
Total	12	58	54	163	13	300
Percentage of farmers						
Farm Size						
Small	3.06	20.41	18.37	55.1	3.06	100
Medium	6.50	20.33	14.63	53.66	4.88	100
Large	1.27	16.46	22.78	54.43	5.06	100
Total	4.00	19.33	18.00	54.33	4.33	100
Citrus Orchard Size						
≥ 5	4.76	20.41	17.69	54.42	2.72	100
5 to 10	4.24	19.49	16.10	54.24	5.93	100
< 10	0.00	14.29	25.71	54.29	5.71	100
Total	4.00	19.33	18.00	54.33	4.33	100

Note: hectare is used as the unit for farm and orchard size.

Table 3. Supply chains classification with respect to farmer's participation.

Channel	Farmer's sale point	Supply chain	Value Addition	Exports
1	Retailers and village vendors	Traditional	×	×
2	Middlemen/ beopari	Traditional	×	×
3	Local fruit and vegetable markets	Traditional	×	×
4	Modern contractors	Modern	✓	✓
5	Processors/ factories	Modern	✓	✓

Mapping of Farmer's Participation in Citrus Supply Chain

In Pakistan, the agri-food supply chains are quite varied and include mandarin farmers as the primary producers. The private sector generally controls the mandarin fruit supply chain, but the government supports it with basic infrastructure and some sort of regulatory environment to facilitate marketing transactions (Siddique and Garnevska, 2018). However, intermediaries involved in marketing often exploit agricultural growers by charging high marketing costs, and the return on their investments become less (Ali, 2004). In the Mandarin supply chain, the grower is the primary producer, and different stakeholders are involved, with pre-harvest contractors having a dominant position. The farmer's participation in this diverse supply chain network of Punjab was mapped by the 300 Mandarin producer's data and presented in Figure 4, broadly speaking, there are two main mandarin marketing channels, i.e., TSC and MSC.

Traditional supply chain

As previously mentioned, supply chains that do not lead to the exports of fruits or their inability to be processed as value-added products are known as TSCs (Henderson and Isaac, 2017). During our survey, we observed that 41.3% of farmers were involved in TSCs, which had a Benefit-Cost Ratio (BCR) of 1.6. In TSCs, the final consumer of mandarin fruits is typically a local consumer who purchases fresh fruits. These supply chains involve farmers associated directly with consumers or local retailers, selling to the local middlemen *(beopari)*, and selling in fruit and vegetable markets through commission agents.

Modern supply chain

The MSC for Mandarin fruits refers to marketing channels that enable exports or value-added processing. Farmers in these supply chains sell their produce to processing plants or contractors with connections to exporters, traders, and processors. In contrast, traditional supply chains only involve local consumers and retailers, middlemen, and fruit and vegetable markets. According to the survey, about 58% of Mandarin farmers were associated with MSC, which had a BCR of 1.99, compared to 41.3% for TSCs with a BCR of 1.60. The end users of MSC may be the consumers of fresh fruits or its value-added products in the domestic or international market. Participation in MSC can increase farmers' income and profits and help in the development of the citrus industry through its exports and value-added products.

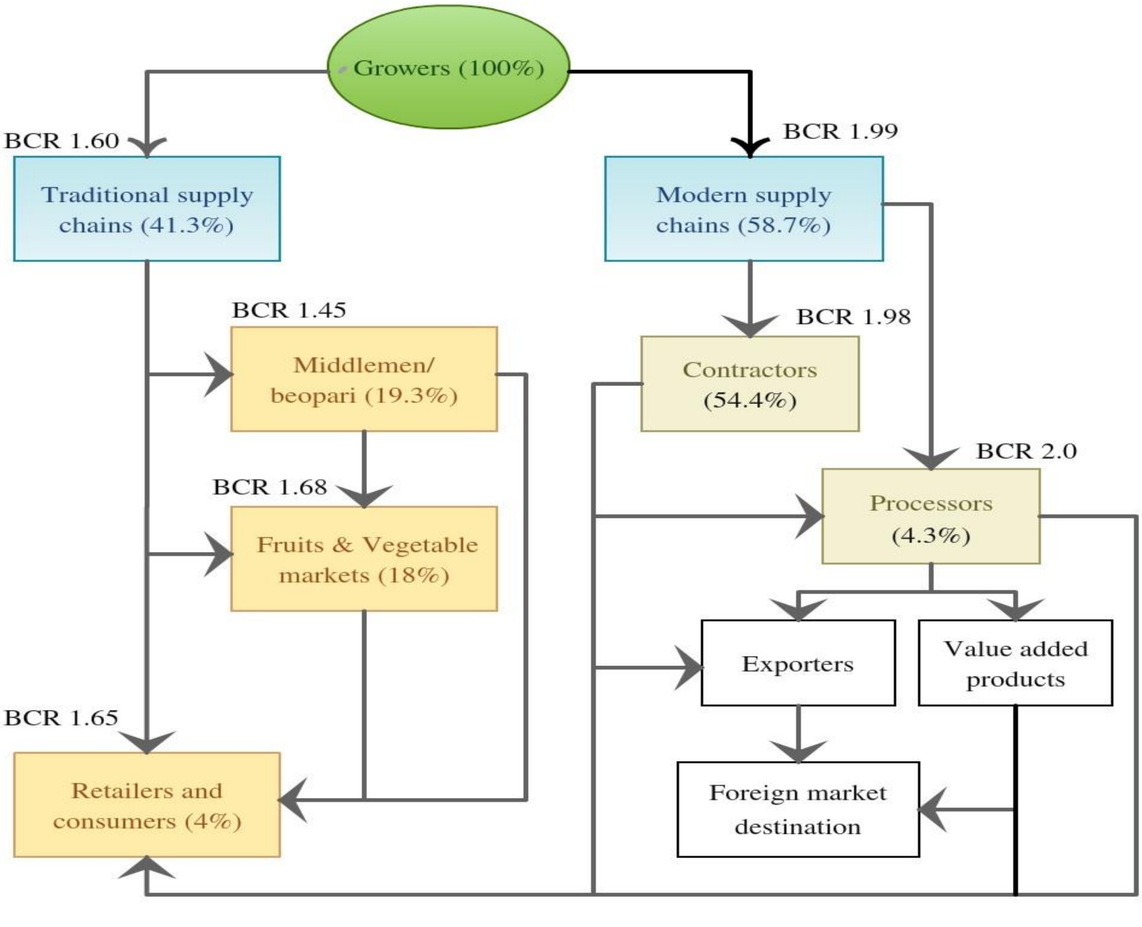

Figure 4. Supply chain mapping – farmer's participation in the citrus marketing channels.

Determinants of Farmers' Efficiency and Inclusiveness

The study observed that the value of the lambda coefficient in the treatment effect model indicated a statistically significant correlation between the error terms of selection and outcome equations, revealing selection bias, and it is also identified in previous studies by Sahara et al. (2015) and Slamet et al. (2017). Consequently, the research employed a treatment effect method, simultaneously estimating both equations (selection and outcome) to estimate the impact of different unexplored variables on profitability by taking the farmer's participation as a treatment variable. The coefficients in Table 5 represent the estimates for farmers' participation in the first stage equation and profit in the second stage equation. The value of the coefficient in the profit equation is positive and statistically significant, indicating that farmers participating in the MSC earn more profit than TSC participants. This result aligns with previous multinomial equation analysis findings, which revealed that farmers participating in contractor and processor marketing channels earned more profit than those in the other three traditional marketing channels. The study also discovered that large farmers, farmers' education, mandarin area, farming occupation, extension information access, and availability of agricultural credit significantly and positively impacted MSC participation and profitability.

The research determined that higher education levels positively influenced farmers' participation in the MSC, implying that educated farmers are more adept at adapting to new market demands and more likely to adopt MSC (Rao and Qaim, 2011; Schipmann and Qaim, 2010; Slamet et al., 2017). The study noted a significant impact of farm size dummies on both the selection and outcome equations, indicating that large farmers are more likely to tend towards MSC. Moreover, the mandarin orchard area had a significant positive effect, suggesting that farmers with larger mandarin areas are more likely to be inclined to agree with the MSC. These results emphasize the impact of resource endowments on farmers' participation and profitability in the MSC, where farmers rich in resources are more likely to incline with MSC and earn higher profits, while small landholders with poor resources are less likely to incline with MSC and earn lesser profits (Birthal et al., 2017; Birthal et al., 2008; Slamet et al., 2017). Results also revealed that the coefficient value of farming occupation is also significant, indicating that farmers primarily engaged in farming are more inclined with the MSC and earn higher profits compared to others. Access to information is critical in the contemporary world, as it allows farmers to identify and access new/modern markets and capture better prices. Furthermore, the study's findings showed that farmers with periodic extension information were more likely to align with MSC and generate higher profit. Similarly, those who obtained agricultural credit were also more likely to join the MSC and increase their profits. Similarly, agricultural credit and information access are essential tools for farmers to optimize their conventional practices, boost their earnings, and explore new markets (Elahi et al., 2018; Lothore and Delmas, 2009; Naseer et al., 2019c).

Environment and Supply Chain Sustainability

The principal component analysis technique was used for factor extraction to identify underlying groups of factors responsible for the SSCD. The factor loadings were greater than or close to 0.50; specifically, in our case, 23 out of 30 (77%) factor loadings were greater than 0.5. So, all these 30 listed constraints were subjected to factor analysis. Results also showed that the Bartlett sphericity test's value of chi-square is high, i.e., 393.5, and a significant value of 0.000. It indicated that the population correlation matrix is not an identity matrix, supporting the suitability of employing factor analysis.

The outcomes of factor analysis, employing Direct Oblimin rotation, revealed six underlying sets or components with eigenvalues exceeding 1, explaining 65.53% of the total variance in the data. It shows more than 50% of the variance is explained by these six sets of factors in SSCD.

Table 4. Regression analysis with endogenous treatment effects.

Independent variables	Participation in Supply Chain (TSC = 0 & MCS = 1)	Outcome Equation (Ln_profit)
Farm size as dummy variable & omitted category is large farmer		
Small (≥ 5 ha) = 1, & 0 otherwise	-0.6555** (0.5266)	-0.1072* (0.0637)
Medium (5 to 10 ha) = 1, & 0 otherwise	-0.4049 (0.6245)	-0.0900* (0.0495)
Education of farmers (Years)	0.0489* (0.1240)	0.0133*** (0.0087)
Education of farmers squared	-0.0018 (0.0390)	0.0006 (0.0006)
Family size (No.)	-0.0188 (0.6133)	0.0216 (0.0219)
Family size squared	-0.0020 (0.2153)	-0.0005 (0.0008)
Mandarin area (ha)	0.5003*** (0.3571)	0.0082** (0.0388)
Mandarin area squared	-0.0463 (0.9155)	-0.0033 (0.0027)
Farming as the main occupation = 1, & 0 otherwise	1.1506* (0.0222)	0.0568** (0.0704)
Permanent farm worker (Yes) = 1, & 0 otherwise	0.6823 (0.8593)	0.0377 (0.0859)
Access to extension information (Yes) = 1, & 0 otherwise	0.0645* (0.6710)	0.0955** (0.0459)
Agri Finance (Yes) = 1, & 0 otherwise	0.1304** (0.8335)	0.0199* (0.0227)
Farm to market distance (Km)	0.0878 (0.4624)	
Tehsil/Location (omitted Kotmomin) dummies		
Sargodha = 1, 0 otherwise	8.8803 (0.2292)	
Bhalwal = 1, 0 otherwise	3.7892 (0.8607)	
Participation in MSC = 1, & 0 otherwise		1.09368** (0.5311)
Constant Term	2.3881 (10.7996)	7.6421*** (0.1160)
Lambda	0.6027** (0.0921)	

Note: Standard errors are written in parentheses.; ***, **, and * represent significant levels at 1, 5, and 10 percent respectively.

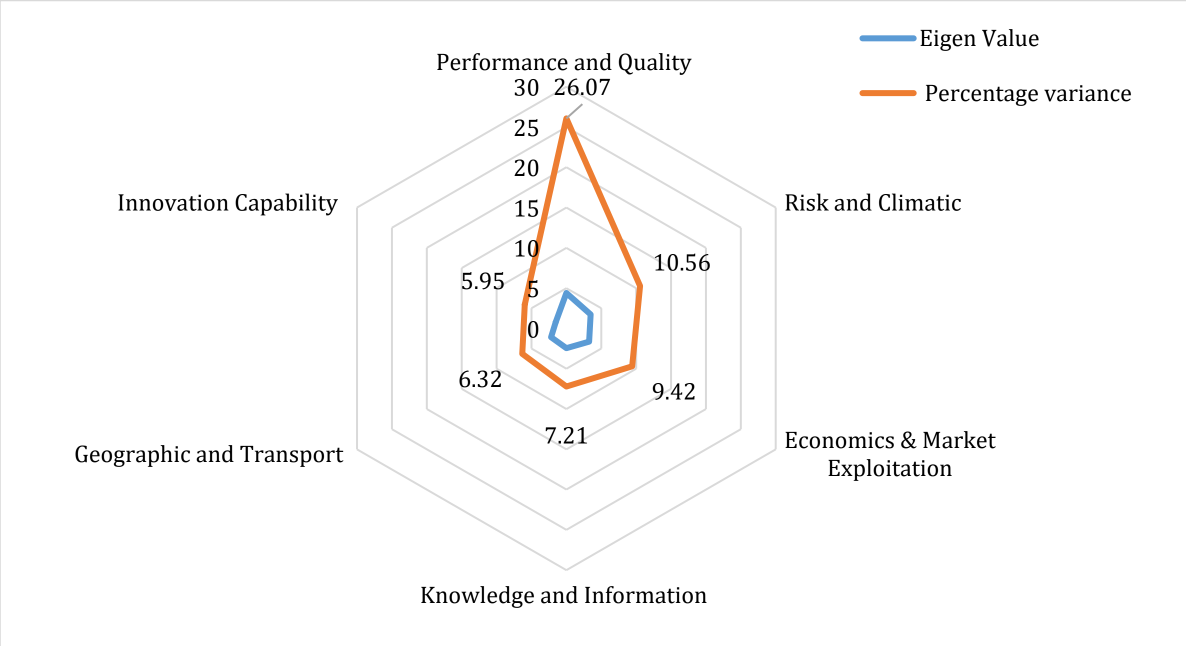

Figure 5. Factor groups responsible for SSCD; Source: Factor analysis (PCA) results.

In Figure 6, the performance- and quality-related set of factors in the sustainable citrus supply chain development comprises seven identified factors. These results are in line with Badar (2015) and Usman et al. (2018), who report that the quality of inputs is the crucial factor. Similarly, the lack of incentives is another major factor in the SSCD. Ozdemir (2000) defined incentives as "factors that motivate individuals to behave in specific ways." In the context of the SSCD, incentive acts as a catalyst for farmers to improve their practices, such as packaging and grading. Therefore, farmers might not adopt such practices without incentives from the industry (Darko et al., 2017).

The second important set of factors is climatic and risk-related factors in the SSCD of agri-food industries, and it is also evident from the previous literature as well (Harland et al., 2003; Leat and Revoredo-Giha, 2013). Hardaker et al. (2004) classified production and marketing-related risk as adopted separately. Leat and Revoredo-Giha (2013) also highlighted that production risks in agriculture may arise from uncontrollable factors like extreme weather events, pests, and disease outbreaks. Tummala and Schoenherr (2011) conceptualized some supply chain risks, specifically defined as "an event that negatively impacts supply chain operations, leading to performance measures."

Ghafoor et al. (2008) emphasized that citrus farmers in Pakistan face significant challenges, including high input prices and a lack of agricultural credit. The scarcity of agricultural credit and the high cost of inputs remain critical for sustainable citrus production (Ashraf et al., 2014). He also highlighted the costly nature of the latest technologies, leading farmers to rely on manual practices like spraying and other traditional mechanization methods. Usman et al. (2018) argued that citrus farmers encounter difficulties due to poor marketing facilities and high transportation expenses. Moreover, they observed a considerable disparity between the prices received by farmers and those paid by consumers, mainly attributed to market exploitation. As a result, economic factors and market exploitation emerge as the third most significant contributors to SSCD.

Several previous studies have identified knowledge & information and extension services as significant factors affecting farmers, particularly concerning production and marketing (Iqbal and Kamal, 2014; Siddique, 2015; Usman et al., 2018). Usman et al. (2018) emphasized the importance of improving road infrastructure, constructing bridges, and maintaining road spots to facilitate growers' access to local and destination markets. To foster integrity between remote rural areas (farms) and urban markets, there is a need for better policies that focus on the provision and enhancement of road networks (Arethun and Bhatta, 2012; Markelova et al., 2009). Additionally, another study highlighted the necessity of a more efficient transportation system to reduce transportation costs and travel time, thereby improving marketing opportunities and increasing production (Kedir, 2001), which ultimately addresses SSCD.

Researchers have noted that adopting poor quality assurance and traditional packaging practices can hinder the potential for higher profits (Iqbal and Kamal, 2014). Packaging processes for crops, vegetables, and fruits often lead to unavoidable losses linked to low productivity, inefficiencies, contamination, and damage to fresh products (Djekic et al., 2018). In a study focused on citrus constraints by Usman et al. (2018), inadequate storage facilities were identified as the second most significant constraint in enhancing the shelf life of fruits. The high cost of storage was also highlighted as a crucial issue that requires attention. Proper packaging emerges as a critical factor for improving farmers' decision-making in supply chain participation, contributing to the sustainability of agri-food industries (Djekic et al., 2018). They also emphasized the problem of inadequate incentive and proper packaging facilities in the citrus industry of Pakistan. Therefore, fostering innovation capability becomes essential to address SSCD.

CONCLUSIONS AND POLICY IMPLICATIONS

The growth of contemporary markets in developing countries and the evolution of marketing systems present both opportunities and challenges for farmers to engage in modern supply chains. These supply chains hold the potential to increase farmers' income and profitability. However, small-scale farmers encounter significant obstacles when attempting to join these modern supply chains, primarily due to resource limitations such as small orchard sizes, restricted access to credit, and limited extension services. Conversely, farmers with abundant resources, such as large farms and convenient access to financial markets, dominate the modern supply chains. Nevertheless, there is a possibility for small farmers to be incorporated into modern supply chains if they can establish more effective collaborations. Consequently, the industry must facilitate the organization of small farmers into larger groups, where they can achieve economies of scale and elevate their profitability. Furthermore, for SSCD the group of factors such as performance and quality, risk and climatic, economics and market exploitation, knowledge and information, geographic and transportation, and innovation capability are needed to be addressed.

Drawing from the study's findings, several policy implications can be outlined; first, there is a need to prioritize the development of modern supply chains in developing countries, especially for small-scale farmers. This can be accomplished by providing them access to financial resources, extension services, and market information. Second, the government and other stakeholders should promote collective action among small-scale farmers to achieve economies of scale and strengthen their bargaining power. Establishing producer organizations or cooperatives can help small farmers participate more efficiently in modern supply chains. Third, policies that incentivize the adoption of new technologies and innovative practices by small-scale farmers can also improve their productivity and profitability. This may involve offering subsidies or tax breaks for farmers who adopt sustainable and modern practices. Lastly, the government can play a role in enhancing infrastructure, such as transportation and storage facilities, to minimize post-harvest losses and boost the efficiency of the supply chain. Therefore, the study indicates the necessity for coordinated efforts from various stakeholders, including government, industry, and farmers, to increase the participation of small-scale farmers in modern supply chains.

REFERENCES

Agbo, M., Rousselière, D., Salanié, J., 2015. Agricultural marketing cooperatives with direct selling: A cooperative–non-cooperative game. J. Econ. Behav. Organ. 109, 56–71. https://doi.org/10.1016/j.jebo.2014.11.003.

Ali, T., 2004. Marketing of citrus fruit in Pakistan. Dissertation (PhD). Dep. Commer. Pakistan. University of Karachi, Pakistan, Karachi. http://142.54.178.187:9060/xmlui/handle/123456789/6876.

Arethun, T., Bhatta, B.P., 2012. Contribution of rural roads to access to-and participation in markets: Theory and results from northern Ethiopia. J. Transp. Technol. 2, 165–174. https://doi.org/10.4236/jtts.2012.22018.

Ashraf, S., Khan, G.A., Ali, S., Iftikhar, M., Mehmood, N., 2014. Managing insect pests & diseases of citrus: on farm analysis from Pakistan. Pakistan J. Phytopathol. 26, 301–307.

Badar, H., Ariyawardana, A., Somogyi, S., 2015. Value chain performance improvement for sustainable mango industry development in Pakistan. Sch. Agric. Food Sci. The University of Queensland, Brisbane, Australia. https://doi.org/https://doi.org/10.14264/uql.2015.430.

Barrett, C.B., Bachke, M.E., Bellemare, M.F., Michelson, H.C., Narayanan, S., Walker, T.F., 2012. Smallholder participation in contract farming: comparative evidence from five countries. World Dev. 40, 715–730. https://doi.org/10.1016/j.worlddev.2011.09.006.

Benali, M., Brümmer, B., Afari-Sefa, V., 2018. Smallholder participation in vegetable exports and age-disaggregated labor allocation in Northern Tanzania. Agric. Econ. 49, 549–562. https://doi.org/https://doi.org/10.1111/agec.12441.

Birthal, P.S., Chand, R., Joshi, P.K., Saxena, R., Rajkhowa, P., Khan, M.T., Khan, M.A., Chaudhary, K.R., 2017. Formal versus informal: Efficiency, inclusiveness, and financing of dairy value chains in Indian Punjab. J. Rural Stud. 54, 288–303. https://doi.org/10.1016/j.jrurstud.2017.06.009.

Birthal, P.S., Jha, A.K., Tiongco, M.M., Narrod, C., 2008. Improving farm-to-market linkages through contract farming: a case study of smallholder dairying in India. International Food Policy Research Institute, Washington, DC, USA. https://doi.org/https://www.ifpri.org/publication/improving-farm-market-linkages-through-contract-farming.

Briones, R.M., 2015. Small farmers in high-value chains: Binding or relaxing constraints to inclusive growth? World Dev. 72, 43–52. https://doi.org/10.1016/j.worlddev.2015.01.005.

Burki, A.A., Khan, M.A., 2011. Formal participation in a milk supply chain and technical inefficiency of smallholder dairy farms in Pakistan. Pak. Dev. Rev. 50, 63–81. https://doi.org/https://www.jstor.org/stable/23617434.

Cameron, A.C., Trivedi, P.K., 2022. Microeconometrics using Stata, 2nd edition. College Station, Tex.: Stata Press. https://doi.org/https://www.stata.com/bookstore/microeconometrics-stata/.

Chen, I.J., Paulraj., A., 2004. Towards a theory of supply chain management: the constructs and measurements. J. Oper. Manag. 22, 119-150. https://doi.org/10.1016/j.jom.2003.12.007.

Chen, K.Z., Joshi, P.K., Cheng, E., Birthal, P.S., 2015. Innovations in financing of agri-food value chains in China and India: Lessons and policies for inclusive financing. China Agric. Econ. Rev. 7, 616–640. https://doi.org/10.1108/CAER-02-2015-0016

Cramb, R., Manivong, V., Newby, J.C., Sothorn, K., Sibat, P.S., 2017. Alternatives to land grabbing: exploring conditions for smallholder inclusion in agricultural commodity chains in Southeast Asia. J. Peasant Stud. 44, 939–967 . https://doi.org/10.1080/03066150.2016.1242482.

Darko, A., Chan, A.P.C., Owusu-Manu, D.-G., Ameyaw, E.E., 2017. Drivers for implementing green building technologies: An international survey of experts. J. Clean. Prod. 145, 386–394.

Davis, J., 2006. How can the poor benefit from the growing markets for high value agricultural products? MPRA Paper. https://mpra.ub.uni-muenchen.de/26048/.

Djekic, I., Sanjuán, N., Clemente, G., Jambrak, A.R., Djukić-Vuković, A., Brodnjak, U.V., Pop, E., Thomopoulos, R., Tonda, A., 2018. Review of environmental models in the food chain-Current status and future perspectives. J. Clean. Prod. 176, 1012–1025.

Elahi, E., Abid, M., Zhang, L., ul Haq, S., Sahito, J.G.M., 2018. Agricultural advisory and financial services; farm level access, outreach, and impact in a mixed cropping district of Punjab, Pakistan. Land use policy 71, 249–260. https://doi.org/10.1016/j.landusepol.2017.12.006.

FAO, 2018. Statistical Bulletin of Crops. Online access. Retrieved online from: https://www.fao.org/3/CA1796EN/ca1796en.pdf.

Fournier, A.J., 2018. Direct-selling farming and urban externalities: What impact on product quality and market size? Reg. Sci. Urban Econ. 70, 97–111. https://doi.org/https://doi.org/10.1016/j.regsciurbeco.2018.03.001.

Ghafoor, U., Muhammad, S., Chaudhary, K., 2008. Constraints in availability of inputs and information to citrus (kinnow) growers of tehsil Toba Tek Singh. Pak. J. Agri. Sci. 45, 520-522.

Girma, J., Gardebroek, C., 2015. The impact of contracts on organic honey producers' incomes in southwestern Ethiopia. For. Policy Econ. 50, 259–268. https://doi.org/10.1016/j.forpol.2014.08.001.

GOP, 2018a. Agriculture marketing and information service (AMIS). Government of Punjab, Pakistan. Lahore, Pakistan.

GOP, 2018b. Economic Survey of Pakistan 2017-18. Ministry of Finance, Government of Pakistan. Islamabad, Pakistan.

GOP, 2018c. Final crop estimates data book. Directorate of Agriculture, Crop Reporting Service, Punjab. Lahore, Pakistan.

GOP, 2018d. Population Census 2017. Pakistan Bureau of Statistics, Government of Pakistan. Islamabad, Pakistan.

Hardaker, J.B., Lien, G., Anderson, J.R., Huirne, R.B.M., 2004. Coping with risk in agriculture: applied decision analysis CAB International Wallingford, United Kingdom.

Harland, C., Brenchley, R., Walker, H., 2003. Risk in supply networks. J. Purch. Supply Manag. 9, 51–62.

Hayami, Y., 2010. Chapter 64 Plantations Agriculture11This chapter develops a synthesis of my ideas on this theme, which have been advanced in several earlier publications (Hayami, 1994, Hayami, 1996a, Hayami, 2001a, Hayami, 2001b, Hayami, 2002), in: Handbook of Agricultural Economics. Elsevier, pp. 3305–3322. https://doi.org/https://doi.org/10.1016/S1574-0072(09)04064-X.

Heijden, T. Van Der, Vink, N., 2013. Good for whom? Supermarkets and small farmers in South Africa – a critical review of current approaches to increasing access to modern markets. Agrekon 52, 68–86. https://doi.org/10.1080/03031853.2013.778466.

Henderson, H., Isaac, A.G., 2017. Modern value chains and the organization of Agrarian production. Am. J. Agric. Econ. 99, 379–400. https://doi.org/10.1093/ajae/aaw092.

Iqbal, S., Kamal, T., 2014. Factors Affecting Citrus Productivity in District Dir Lower. J. Econ. Sustain. Dev. 5, 197–200.

Jayne, T.S., Chamberlin, J., Traub, L., Sitko, N., Muyanga, M., Yeboah, F.K., Anseeuw, W., Chapoto, A., Wineman, A., Nkonde, C., Kachule, R., 2016. Africa's changing farm size distribution patterns: the rise of medium-scale farms. Agric. Econ. 47, 197–214. https://doi.org/https://doi.org/10.1111/agec.12308.

Jordaan, H., Grové, B., Backeberg, G.R., 2014. Conceptual framework for value chain analysis for poverty alleviation among smallholder farmers. Agrekon 53, 1–25. https://doi.org/https://doi.org/10.1080/03031853.2014.887903.

Kedir, A.M., 2001. Rural poverty report 2001: the challenge of ending rural poverty edited by the International Fund for Agricultural Development (IFAD). (Oxford: Oxford University Press, pp. 266). https://doi.org/10.1002/jid.1013.

Leat, P., Revoredo-Giha, C., 2013. Risk and resilience in agri-food supply chains: The case of the ASDA PorkLink supply chain in Scotland. Supply Chain Manag. An Int. J. 18, 219–231.

Li, Y.Y., Chen, P.-H., Chew, D.A.S., Teo, C.C., Ding, R.G., 2011. Critical project management factors of AEC firms for delivering green building projects in Singapore. J. Constr. Eng. Manag. 137, 1153–1163.

Lothore, A., Delmas, P., 2009. Market access and agricultural product marketing: Promoting farmer initiatives. Insights from the Working Group on "Market access and agricultural product marketing". The Agence Française de Développemen (AFD), Paris, Farnce.

Maertens, M., Minten, B., Swinnen, J., 2012. Modern food supply chains and development: Evidence from horticulture export sectors in sub-Saharan Africa. Dev. Policy Rev. 30, 473–497. https://doi.org/https://doi.org/10.1111/j.1467-7679.2012.00585.x.

Malik, A.U., Amin, M., Asad, H.U., 2014. Advances and challenges in value chain development in'Kinnow'mandarin and mango industries of Pakistan, in: XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): 1128. pp. 277–284.

Markelova, H., Meinzen-Dick, R., Hellin, J., Dohrn, S., 2009. Collective action for smallholder market access. Food Policy 34, 1–7.

Memon, N.A., 2017. Citrus Fruit (Kino): Punjab produced 98% of production, Exclusive on Kino. Pakistan Food J. Jan-Feb 2.

Minten, B., Randrianarison, L., Swinnen, J.F.M., 2009. Global retail chains and poor farmers: Evidence from Madagascar. World Dev. 37, 1728–1741. https://doi.org/https://doi.org/10.1016/j.worlddev.2008.08.024.

Montalbano, P., Pietrelli, R., Salvatici, L., 2018. Participation in the market chain and food security: The case of the Ugandan maize farmers. Food Policy 76, 81–98. https://doi.org/https://doi.org/10.1016/j.foodpol.2018.03.008.

Mutura, J.K., Nyairo, N., Mwangi, M., Wambugu, S.K., 2016. Analysis of determinants of vertical and horizontal integration among smallholder dairy farmers in lower central Kenya. Int. J. Agric. Food Res. 5. https://doi.org/http://asianonlinejournals.com/index.php/AJEER/article/view/202/180.

Naseer, M.A. ur R., 2019. Farmers' efficiency, inclusiveness, and competitiveness of citrus supply chain of Pakistan. Dissertation (PhD) Thesis, Inst. Agric. Resour. Econ. University of Agriculture Faisalabad, Pakistan.

Naseer, M.A. ur R., Ashfaq, M., Abid, M., Razzaq, A., Hassan, S., 2016. Current Status and Key Trends in Agricultural Land Holding and Distribution in Punjab, Pakistan: Implications for Food Security. J. Agric. Stud. 4, 14–27. https://doi.org/https://doi.org/10.5296/jas.v4i4.9670.

Naseer, M.A. ur R., Ashfaq, M., Hassan, S., Abbas, A., Razzaq, A., Mehdi, M., Ariyawardana, A., Anwar, M., 2019a. Critical issues at the upstream level in sustainable supply chain management of agri-food industries: evidence from Pakistan's Citrus Industry. Sustainability 11, 1326. https://doi.org/https://doi.org/10.3390/su11051326.

Naseer, M.A. ur R., Ashfaq, M., Hassan, S., Adil, S.A., Ariyawardana, A., 2019b. Outlook on the global trade competitiveness of Pakistan's mandarin industry: An application of revealed symmetric comparative advantage framework. Outlook Agric. 48, 66–74. https://doi.org/https://doi.org/10.1177/0030727018817788.

Naseer, M.A. ur R., Mehdi, M., Ashfaq, M., Hassan, S., Abid, M., 2019c. Effect of marketing channel choice on the profitability of citrus farmers: Evidence form Punjab-Pakistan. Pak. J. Agric. Sci 56, 1–9. https://doi.org/https://doi.org/10.21162/PAKJAS/19.8671

Norusis, M., 2008. SPSS 16.0 advanced statistical procedures companion: Pearson College Div. New Jersey, USA.

Nyaoga, R., Magutu, P., 2016. Constraints management and value chain performance for sustainable development. Manag. Sci. Lett. 6, 427-442. https://doi.org/10.5267/J.MSL.2016.4.002.

Ozdemir, M.H.,2000. An alternative incentive system to improve productivity at the Turkish Naval Shipyards. Naval Postgraduate School Monterey CA. https://apps.dtic.mil/sti/pdfs/ADA381075.pdf.

Pingali, P., 2007. Agricultural growth and economic development: a view through the globalization lens. (Author abstract) (Report). Agric. Econ. 37, 1. https://doi.org/https://doi.org/10.1111/j.1574-0862.2007.00231.x.

Pokhrel, D.M., Thapa, G.B., 2007. Are marketing intermediaries exploiting mountain farmers in Nepal? A study based on market price, marketing margin and income distribution analyses. Agric. Syst. 94, 151–164. https://doi.org/https://doi.org/10.1016/j.agsy.2006.08.004

Porter, S., Reay, D., 2016. Addressing food supply chain and consumption inefficiencies: potential for climate change mitigation. Reg. Environ. Chang. 16, 2279–2290. https://doi.org/https://doi.org/10.1007/s10113-015-0783-4.

Rao, E.J.O., Qaim, M., 2011. Supermarkets, farm household income, and poverty: insights from Kenya. World Dev. 39, 784–796. https://doi.org/https://doi.org/10.1016/j.worlddev.2010.09.005.

Romero Granja, C., Wollni, M., 2018. Dynamics of smallholder participation in horticultural export chains: evidence from Ecuador. Agric. Econ. 49, 225–235. https://doi.org/https://doi.org/doi:10.1111/agec.12411

Sabir, H.M., Khan, M.B., Hussain, Z., 2010. Marketing Margin of Mandarin: A Case Study of Sargodha Region, Pakistan. Pakistan J. Soc. Sci. 30. https://doi.org/https://pjss.bzu.edu.pk/index.php/pjss/article/view/75.

Sahara, S., Minot, N., Stringer, R., Umberger, W.J., 2015. Determinants and Effects of Small Chilli Farmers' Participation in Supermarket Channels in Indonesia. Bull. Indones. Econ. Stud. 51, 445–460. https://doi.org/https://doi.org/10.1080/00074918.2015.1110851.

Salmon, C., Tanguy, J., 2016. Rural electrification and household labor supply: Evidence from Nigeria. World Dev. 82, 48–68. https://doi.org/https://doi.org/10.1016/j.worlddev.2016.01.016.

Santos, J.R.A., 1999. Cronbach's alpha: A tool for assessing the reliability of scales. J. Ext. 37, 1.

Sartorius, K., Kirsten, J., 2007. A framework to facilitate institutional arrangements for smallholder supply in developing countries: An agribusiness perspective. Food Policy 32, 640–655. https://doi.org/https://doi.org/10.1016/j.foodpol.2007.03.001.

Schipmann, C., Qaim, M., 2010. Spillovers from modern supply chains to traditional markets: product innovation and adoption by smallholders. Agric. Econ. 41, 361–371. https://doi.org/https://doi.org/10.1111/j.1574-0862.2010.00438.x.

Schuster, M., Maertens, M., 2013. Do private standards create exclusive supply chains? New evidence from the Peruvian asparagus export sector. Food Policy 43, 291–305. https://doi.org/https://doi.org/10.1016/j.foodpol.2013.10.004.

Sharif, M., Farooq, U., Malik, W., Bashir, M., 2005. Citrus Marketing in Punjab: Constraints and Potential for Improvement. Pak. Dev. Rev. 44, 673-694. https://www.jstor.org/stable/41261125

Sharma, V.P., 2015. Determinants of Small Milk Producers' Participation in Organized Dairy Value Chains: Evidence from India. Agric. Econ. Res. Rev. 28. https://doi.org/https://doi.org/10.5958/0974-0279.2016.00004.5.

Siddique, M.I., Garnevska, E., 2018. Citrus value chain (s): A survey of Pakistan Citrus industry, Agric. Value Chain. IntechOpen, 37, 37-58.

Siddique, M.I., Garnevska, E., Marr, N.E., 2018. Factors affecting marketing channel choice decisions of smallholder Citrus growers. J. Agribus. Dev. Emerg. Econ. 0. https://doi.org/https://doi.org/10.1108/JADEE-03-2016-0014.

Sitek, P., Wikarek, J., Nielsen, P., 2017. A constraint-driven approach to food supply chain management. Ind. Manag. Data Syst. 117, 2115-2138. https://doi.org/10.1108/IMDS-10-2016-0465.

Slamet, A.S., Nakayasu, A., Ichikawa, M., 2017. Small-Scale Vegetable Farmers' Participation in Modern Retail Market Channels in Indonesia: The Determinants of and Effects on Their Income. Agriculture 7, 11. https://doi.org/https://doi.org/10.3390/agriculture7020011.

Swamy, V., Dharani, M., 2016. Analyzing the agricultural value chain financing: approaches and tools in India. Agric. Financ. Rev. 76, 211–232. https://doi.org/https://doi.org/10.1108/AFR-11-2015-0051.

Tavakol, M., Dennick, R., 2011. Making sense of Cronbach's alpha. Int. J. Med. Educ. 2, 53.

Trifkovic, N., Farimagsgade, Ø., 2015. Vertical coordination and aquaculture farm performance: the case of Catfish sector in Vietnam, in: International Conference of Agricultural Economists. https://ageconsearch.umn.edu/record/211930/.

Tummala, R., Schoenherr, T., 2011. Assessing and managing risks using the supply chain risk management process (SCRMP). Supply Chain Manag. An Int. J. 16, 474–483.

Usman, M., Ashraf, I., Chaudhary, K.M., Talib, U., 2018. Factors impeding citrus supply chain in Central Punjab, Pakistan. Int. J. Agric. Ext. 6, 1–5.

Vella, F., Verbeek, M., 1999. Estimating and interpreting models with endogenous treatment effects. J. Bus. Econ. Stat. 17, 473–478. https://doi.org/https://doi.org/10.2307/1392404.

Yang, Y., Shao, X., 2018. Understanding industrialization and employment quality changes in China: Development of a qualitative measurement. China Econ. Rev. 47, 274-281. https://doi.org/10.1016/j.chieco.2017.08.009.