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Evaluating the Impacts of Smallholder Farmer's Participation in Modern Agricultural Value Chain Tactics for Facilitating Poverty Alleviation—A Case Study of Kiwifruit Industry in Shaanxi, China

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Abstract: Market-based initiatives like agriculture value chain (AVC) are becoming progressively pervasive to support smallholder rural farmers and assist them in entering larger market interventions and providing a pathway of enhancing their socioeconomic well-being. Moreover, it may also foster staggering effects towards the post-era poverty alleviation in rural areas and possessed a significant theoretical and practical influence for modern agricultural development. The prime objective of the study is to explore the effects of smallholder farmers' participation in the agricultural value chain for availing rural development and poverty alleviation. Specifically, we have crafted the assessment employing pre-production (improved fertilizers usage), in-production (modern preservation technology), and post-production (supply chain) participation and interventions of smallholder farmers. The empirical data has been collected from a micro survey dataset of 623 kiwifruit farmers from July to September in Shaanxi, China. We have employed propensity score matching (PSM), probit, and OLS models to explore the multidimensional poverty reduction impact and heterogeneity of farmers' participation in the agricultural value chain. The results show that the total number of poor farmers who have experienced one-dimensional and two-dimensional poverty is relatively high (66.3%). We also find that farmers' participation in agricultural value chain activities has a significant poverty reduction effect. The multidimensional poverty level of farmers using improved fertilizer, organizational acquisition, and using storage technology (compared with non-participating farmers) decreased by 30.1%, 46.5%, and 25.0%, respectively. The multidimensional poverty reduction degree of male farmers using improved fertilizer and participating in the organizational acquisition is greater than that of women. The multidimensional poverty reduction degree of female farmers using storage and fresh-keeping technology has a greater impact than the males using storage and improved storage technology. Government should widely promote the value chain in the form of pre-harvest, production, and post-harvest technology. The public–private partnership should also be strengthened for availing innovative technologies and infrastructure development.

Keywords: smallholder; agricultural value chain activities; multidimensional poverty; Heckman model; technology

1. Introduction

Agriculture serves as a vital part of the domestic economies in several developing nations. It fosters an ever-growing population by supplying food, fiber, and nutrition and can control a significant proportion of the total GDP of any nation [1,2]. Moreover, the sector is also responsible for providing working opportunities in terms of both agricultural and nonagricultural supportive employment opportunities. Amid swift trends of expansion and economic divergence, remain supportive for quantifying utmost employment opportunities for more than 60% of the overall inhabitants and generates 27% of the gross national product within South-Asian nations [3,4]. Moreover, agriculture remains a vital mechanism for long-term growth and poverty alleviation. These profound sectors are currently facing some threatening situations like ever-increasing populations, climate change, and continuous degradation of natural resources. Those challenges become a greater burden for the rural farmers, particularly smallholder farmers [5,6] holding land plots smaller than 2 hectares [7,8]. The smallholder farmers rely primarily on family workers, which is why small-scale farms could be one of the best drivers for fostering food security, mall nutrition, and poverty elevation [9,10]. By the end of 2019, nearly 3 million marginalized poverty-stricken people experienced the risk of returning to poverty due to education and illness [11,12]. Among them, most are economically vulnerable and food-deprived, with minimal opportunities to participate within the marketplace and utility exposure [13,14]. Nevertheless, their expanding options are limited; however, they play a valuable role in feeding a significant proportion of the global inhabitant [15,16]. Besides, these vulnerable, poverty-stricken people are engaged in the traditional market with insufficient competitive advantages of agricultural products and increased risk of fostering inefficiencies [17,18]. Due to high agricultural management costs, outdated industrial facilities, short agricultural industry value chain, and low added value of agricultural products, the profit mechanism of farmers participating in the agricultural industry value chain is imperfect, and the risk of returning to poverty is increased [19,20]. The effective connection between smallholders' participation in the agricultural value chain and poverty alleviation is also one of the key links in the rural revitalization and sustain rural economic development.

In China, around 98 percent of farmers foster smallholdings less than 2 hectares of land, which accounted for almost one-third of the global smallholders [21,22]. China has been making great efforts to promote the poverty reduction strategy and has made some remarkable achievements to quantify poverty reduction goals [23]. Currently, parallel with several emerging nations like India and Brazil, the Chinese government has also developed and implemented the poverty alleviation strategies of relief poverty alleviation, development-oriented poverty alleviation, guaranteed poverty alleviation, and targeted poverty alleviation [24,25]. The government has immensely supported the poverty-stricken counties and villages and millions of smallholders within the mechanism of targeted poverty alleviation projects to bring them out of poverty within a short time [26,27]. However, poverty is vulnerable, persistent, and dynamic, and multidimensional changes do not mean that the poverty reduction work will be completed once and for all. It is necessary to support the smallholders by developing supportive industries for agricultural products, enhancing the integration between industry and smallholders by practising value chain mechanisms. Those eventually will increase the income opportunities of small farmers, consolidate the achievements of poverty alleviation, and prevent smallholders from returning to poverty [28–30]. Therefore, the academic and political circles should emphasize achieving high-quality and sustainable poverty alleviation by fostering the mechanism, pathways, and avails of critical case studies for making a smooth transition of global agriculture.

Agricultural economies are quickly modernizing, developing shifting trends of demand, facilitating emerging production methods, modernizing the marketing, supply, and distributional channel [31–33]. Modern agricultural development is largely influenced by the smooth transition of agricultural value chains and becomes sophisticated as most emerging countries tend to become industrialized and strengthen their global market position [3,34]. The agriculture value chain concept has been used since the beginning of the millennium, although there is no universally accepted definition for the term. The World Bank's definition of the term "value chain" describes the full range of value-adding activities required to bring a product or service through the different production phases, including procurement of raw materials and other inputs [35]. A value chain is a set of linked activities that add value to a product; it consists of actors and actions that improve a product while linking commodity producers to processors and markets [36]. A value chain encompasses the flow of products, knowledge, information, finance, payments, and the social capital needed to organize producers and communities.

Producers, entrepreneurs, policymakers, and the private sector should work closely to foster integrated and effective production structures that further embed smallholders along with marginal and medium agribusinesses through a smooth distribution network in ways that increase their connection to the retail sector, create good jobs, and render healthy foods [37,38]. Recent studies comprised a strong correlation between the agricultural value chain and poverty alleviation [39–41]. While some studies have focused on participating farmers' organization in the form of cooperative [42–44], effective management of farms input [45–47], and improved storage facilities [48–50] might have a vital impact on maintaining productivity and eventually provide a better income opportunity for farmers. Farmer cooperatives have a long history in availing better negotiation power and play an important medium to enter improved market participation. Thus, the farmer cooperatives' collective action and joint management facilities could also be vital for fostering better income opportunities. At the same time, improved storage facilities are expected to contribute to better quality and longer-lasting grains and reduce the risk of aflatoxin contamination [51–53]. Moreover, as innovations and technology are frequently upgrading, it has also been expected that the effective management of farm inputs like improved fertilizer will reduce transition costs and boost productivity eventually [54,55]. However, there have some controversies regarding fertilizers usage and productivity in the long run [56].

Producers, entrepreneurs, policymakers, and the private sector should work closely to foster integrated and effective production structures that further embed smallholders along with marginal and medium agribusinesses through a smooth distribution network in ways that increase their connection to the retail sector, create good jobs, and render healthy foods [37,38]. Recent studies comprised a strong correlation between the agricultural value chain and poverty alleviation [39–41]. There is a staggering significance that the policymaker and practitioners need to grasp the interdependencies among the participation in value chain approaches and poverty reduction tactics. This was necessary for fostering economic viability and proved effective for availing better lifestyles for households and those inhabiting with them. Though rich literature could be found covering poverty alleviation research on the agriculture domain in China [57–61], the effects of smallholder farmers' participation in agricultural industry value for facilitating poverty reduction are relatively rare. This could be because large-scale micro survey data is not easily available, and it is also difficult to measure the poverty reduction effect of farmers' participation.

At present, few studies are analyzing the poverty reduction effect of value chain activities from multiple perspectives of prenatal, mid, and post-natal analysis. Moreover, whether participation in value chain activities affects poverty alleviation and how it fosters is not grasped by prior research. Therefore, this article takes the kiwifruit industry in Shaanxi Province, China, as an example and analyzes the impacts and heterogeneity of pre-production purchases of improved fertilizers, in-production kiwifruit storage and preservation technologies, and post-production industrial organization participation on the multidimensional poverty reduction of growers. To the best of our knowledge, it could be considered as the first attempt within the aspects of the agribusiness domain.

The rest of the article is designed as follows: Section 2 represents the underlined theoretical background and an extensive literature review. Section 3 denotes the representation of the associated model, data, and variables of the study. Section 4 portrays the result of the study. The concussions and policy recommendations have been presented in Section 5.

2. Literature Review and Theory Construction

2.1. Implication and Classification of the Agricultural Value Chain

The UN Food and Agriculture Organization (FAO) defined the value chain as a mechanism or activity that brings agricultural products from farm production to final consumption and adds value at each stage [62]. As agriculture is a dynamic industry, agricultural value chains have a complex interaction among the key players such as buyers, intermediaries, and consumers [63,64]. Agricultural value chain theory involves all types of links and activities, including value chain and supporting activities, which constitute the industrial value chain [65,66]. Chen Guping [67] considered that the value chain is a process of input, transformation, and output, emphasizing competition and optimal resource allocation within enterprises. The activities of farmers cover production, procurement, processing, storage and transportation, wholesale, retail, and other links, through which the agricultural product is finally available for consumers [68].

Academic research on the agricultural industry value chain is mainly focused on participation model analysis [69,70], participation efficiency [71,72], measurement and development of value chain position [73,74], value chain financing model [75,76], and performance study of value chain participation [29,77]. The widely existing new agricultural business entities and social service organizations actively assist farmers in joining the agricultural value chain. Compared with other Asian countries, China's agricultural value chains are relatively weak, short, and narrow [78]. The development of rural logistics is slow, and warehouses' construction with electronic trading platforms is also complex and hard [79]. Webber & Labaste [35] thought that agricultural labor skills would enhance value chain appreciation in value chain appreciation. In the paper, farmers' participation in the agricultural industry value chain is limited to the linking mechanism between farmers and downstream traders, including specialized cooperatives, hypermarkets, etc. The results showed that farmers encounter a weak market position and production and insufficient supply of financing products in the value chain. In reality, industry organizations' representation is diverse, so no specific cooperative organization is selected as the research object, but the research is centered on the services provided by industry organizations. Smallholders can be integrated into the value chain by industry organizations through various interest linkage means [18,80,81]. Through field survey, it was found that the integration links mainly include the following: (1) Farmers use the fertilizers (mainly organic fertilizers provided by industry organizations, and the industry organizations send special personnel to inform farmers of how to use the fertilizers on a specific date, which can be considered that farmers are integrated into the pre-production link of the agricultural industry value chain. (2) Kiwifruit is often sold in the market in a concentrated time, which is easy to squeeze down its price. In order to ensure the freshness of high-quality agricultural products, farmers refrigerate these agricultural products, such as kiwifruit, which can be considered as farmers' integration into the in-production link of the agricultural industry value chain. (3) The industry organizations sell high-quality kiwifruit that meets the procurement standards, which can be considered farmers' integration into the agricultural industry value chain's post-production link.

2.2. Poverty Reduction Mechanism of Smallholders' Participation in Agricultural Value Chain Activities

The agricultural industry value chain is divided into three segments: using fertilizers provided by industry organizations, procurement by industry organizations, and refrigeration of agricultural products. The first two segments affect farmers' multidimensional poverty in the following four ways: Improving the cooperation efficiency mechanism. Qualified "leading' enterprises and rural cooperative economic organizations are the important carriers for the agricultural industry value chain's operation. The higher the degree of carrier organization, the larger the operating efficiency has been found, and the more timely communication between scattered smallholders and "leading" enterprises [82,83]. Small farmers searching for suitable carriers in the agricultural industry value chain can reduce the uncertainty and transaction risk in the farmers' market and improve cooperation efficiency and production efficiency. This promotes the right shift of the labor demand curve so that the common system followed can more easily promote smallholders to obtain revenue opportunities and reduce the risk of income-producing poverty, thus realizing the goal of poverty reduction [84]. The second one is to form a stronger risk-sharing system.

As "leading" enterprises, the organization carriers in the agricultural industry value chain interact closely with farmers based on common trading interests, thus forming a strong contractual relationship and a community of shared interests [85,86].

On the one hand, industry organizations will supply high-quality fertilizers needed by smallholders free of charge or at a price below the market price. Fertilizers with better effect, easier absorption, and environmental protection will improve crop quality and yield and improve soil quality [87,88]. Farmers will get higher per mu yield with lower input of production factors, optimize the land allocation efficiency and improve the per mu profit [89]. Based on the above analysis, this paper puts forward the following hypothesis.

Hypothesis 1. *Using fertilizer provided by industry organizations will reduce the probability of kiwifruit farmers falling into multidimensional poverty and reduce the extent of multidimensional poverty.*

In the agricultural industry value chain banner, farmers carriers' various relationships such as "organization + farmer", "intermediary + farmer", and stable production and marketing relationship. The specialized, intensive, and large-scale production integrates agricultural resources, improves the allocation efficiency of agricultural resources, and reduces production costs to promote farmers' income and play a vital role in poverty reduction [35]. Moreover, farmers can extend logistics chain management with the help of the industrial organization. First of all, organizational value chain management should be expanded. It can reduce agricultural production and management costs and promote the industrial chain and logistics system's optimal functions [90]. Secondly, the logistics chain management should be extended. It can promote the effective organization of decentralized farmers; promote farmers' participation in many links before, during, and after production. Moreover, it should integrate agricultural industries and reduce farmers' demand for logistics services in the fields of supply and marketing, transportation, and technical consultation to produce agricultural products. It also needs to coordinate and disperse farmers and industry organizations, prevent price risk due to uncertainty in the future market, gradually cut trading links, reduce transaction costs, promote the decline of the value of agricultural products and enhance the market competitiveness of agricultural products [91]. Finally, a smooth transition of information sharing platforms should be expanded. Due to the lack of funds, technology and information, it is difficult for farmers to adjust agricultural products and agricultural industry organizations, which is easy to cause the fluctuated supply of agricultural products [28]. However, information chain management can promote the production of agricultural products to adapt to market demand, ease the contradictions in the supply–demand structure of agricultural products, stabilize the supply and demand of agricultural products, reduce the risk of price fluctuations of agricultural products, ensure stable incomes of the farmers and effectively reduce the risk of poverty. Therefore, farmers' participation in the agricultural industry value chain has a certain poverty reduction effect before, during, and after production. The following hypotheses are made:

Hypothesis 2. *Participation in procurement by industry organizations will reduce the probability of kiwifruit farmers falling into multidimensional poverty and reduce the extent of multidimensional poverty.*

The value chain of agricultural products, i.e., production, storage and transportation, processing, and sales, has the nature of a 'half-smile curve'. Due to smallholders' constrained capacity, it is difficult for them to integrate into the high-end links, such as processing and sales downstream of the value chain, and it is even more impossible for them to carry out high-value industrial chain activities such as agricultural product brand building. Consequently, low-temperature refrigeration can effectively delay the softening and ageing of kiwifruit, maintain the storage quality of kiwifruit, and be one of the main ways to encourage farmers to join the agricultural product brand building. Tilahun et al. [92]

found that kiwifruit can be stored at (4 ± 0.5) °C after ripening to 9.5% soluble solids, which can effectively inhibit the respiratory rate and ethylene release rate on the shelf after refrigeration, reduce the loss of fruit nutrients, maintain the balance of antioxidant content and reactive oxygen metabolism, and then reduce the rotting rate and prolong the refrigeration period. Mature refrigeration facilities can prolong the shelf life of pome and the time of fruit supply in the market [93,94], which is beneficial for farmers to obtain price difference due to different supply time, expand orders with industry organizations, effectively increase farmers' income and alleviate poverty to a certain extent [95]. Therefore, the following hypothesis is proposed:

Hypothesis 3. *Using refrigeration technology can reduce the probability of kiwifruit farmers falling into multidimensional poverty and reduce the extent of multidimensional poverty.*

3. Model, Data, and Variables

3.1. Measurement of Multidimensional Poverty

In this paper, the "dual boundary method" (A-F method) developed by Alkire & Foster [96] has been used for reference to measure multidimensional poverty. Firstly, poverty lines of different dimensions are determined and used to determine individual farmers' poverty status in each dimension. Then the critical value of multidimensional poverty is selected, and farmers with the measured value of poverty exceeding the set threshold are determined as the poor. This method has the advantages of accurately identifying farmers of multidimensional poverty and their poverty degree and can incorporate discrete data and continuous data into the model system [97], making the model calculation results more accurate. Ten indexes are established to measure farmers' multidimensional poverty using an equal weight of 0.1 by considering the accessibility of sample data (Table 1).

A farmer conforming to one item in Table 1 is defined as a multidimensional poverty household IP and assigned the value of 1. For farmers defined as multidimensional poverty households, if any two indexes agree, they should be defined as two-dimensional poverty and assigned the value of 2, and so on, until 10 indexes are conformed, assigned the value of 10.

Table 1. Index of multidimensional poverty and definition criteria.

Level I Index	Weight	Poverty Standard	Assignment
Per capita net income	0.1	Per capita net income of the family in 2018	1 = income < 3200 0 = income ≥ 3200
Educational years of the householder	0.1	The educational years of the householder are six years	1 ≤ 6 years 0 ≥ 6 years
The enrollment rate of children	0.1	At least one six-year-old child in the family does not go to school	1 = yes, 0 = no
Drinking water	0.1	The drinking water of the family is not from groundwater more than 5 m below the ground or water plant (assigned the value of 1)	1 = yes, 0 = no
Toilet	0.1	The toilet is flush toilet	1 = pit toilet, 0 = flush toilet
Electricity supply	0.1	No electricity or frequent power failure	1 = no electricity, 0 = frequent power failure
Cooking fuel	0.1	Main cooking fuel for the family	1 = straw, coal and firewood, 0 = LPG, gas, natural gas, electricity, etc.
Fixed asset	0.1	More than two items among motorcycle, television, washing machine, electric bicycle, computer, camera, mobile phone, and air conditioner	1 = number of fixed assets ≤ 2 0 = number of fixed assets > 2
Housing condition	0.1	No self-owned house or homestead, or the house is made of wood and thatch	1 = yes, 0 = no
Medical coverage	0.1	At least one person over six years old who is not insured	1 = yes, 0 = no

3.2. Model Building

The first model used in the study is propensity score matching (PSM model). The degree of farmers to use improved fertilizer, industrial organization acquisition, and storage technology is usually determined by their own and family characteristics as well as the production and management characteristics. These characteristics will inevitably impact their poverty level, resulting in endogenous problems in the estimation of poverty indicators related to the model. Thus, the study tends to use the propensity score matching method to solve the deviation problem caused by self-selection. The average effect ATT of the treatment group can be expressed as

$$ATT = \frac{1}{N_i}\Sigma_{iD_{i=1}}(y_{ii} - y_{oi})\frac{1}{N_i}\Sigma_{iD_{i=1}}y_{ii}y_{oi} \quad (1)$$

Basic treatment steps are as follows: firstly, the propensity score of probability that growers use three value chain activities is estimated by using the related poverty reduction effect from growers actively selecting three value chain activities (treatment group) (y_{1i}), the related income of these growers if they do not use three value chain activities (control group) (y_{0i}) and correlated variables Xi such as Di, and then the propensity score is matched according to the probability, and the standard deviation of each component of the correlated variable Xi is controlled

$$\frac{\left|\overline{X}_{\text{treat}} - \overline{X}_{\text{control}}\right|}{\sqrt{\left(s^2_{x,\text{treat}} - s^2_{x,\text{control}}\right)/2}} \quad (2)$$

where in, $\overline{x}_{\text{treat}}$ and $\overline{x}_{\text{control}}$ mean the sample average of the treatment group and the control group after matching, and $s^2_{x,\text{treat}}$ and $s^2_{x,\text{control}}$ mean the sample variance of variables x of the treatment group and the control group. The standard deviation of matching variables is controlled under 10%, and finally, the average treatment effect of sample matching results is calculated according to the matching variable. In the paper, the average treatment effect of matching results is calculated mainly by using neighbor matching, radius matching, kernel matching, and local linear regression matching. The matching result is relatively robust if the matching result obtained by different matching methods is similar.

In the second model, the explained variable in this paper is whether the farmers are multidimensional poverty households. The extent of multidimensional poverty is divided into 1~10. The larger the value, the more serious the farmers fall into multidimensional poverty. Therefore, the Probit model is used to estimate multidimensional poverty identification. Li et al. [98] suggested that when the index of multidimensional poverty is greater than 5, it is generally considered that the difference between linear regression and orderly discrete regression is getting smaller and smaller. Consequently, the OLS model is used to estimate the relationship between the farmer's participation in the value chain and the extent of multidimensional poverty. The regression equation is

$$\text{IP}_\text{i} = \alpha + \beta_1\text{VC} + \beta_2\text{X} + \varepsilon \quad (3)$$

$$\text{MP}_\text{i} = \varphi + \gamma_1\text{VC} + \gamma_2\text{X} + \mu \quad (4)$$

IP_i is the multidimensional poverty identification of farmers, with a value of 1 or 0 as the variable; MP_i is the multidimensional poverty index of farmers, with a value between 1 to 10. VC refers to farmers' three behaviors in the value before, during, and after production; namely, whether farmers use fertilizers provided by industry organizations, whether farmers accept procurement by industry organizations, whether farmers refrigerate kiwifruit, 1 for 'yes' and 0 for 'no'. In this paper, Formulas (1)–(4) are fitted and estimated by Stata15.0 software, and the fitting result of the poverty reduction effect of farmers' participation in the value chain can be obtained.

3.3. Data Source

The empirical data used in the study are crafted from the household survey of kiwifruit growers in Shaanxi Province of China from July to August 2019. The data has been collected from Mei County, Zhouzhi County, and Wugong County, the main kiwifruit-producing areas in Shaanxi Province. We purposely choose these three areas for field investigation; because kiwifruit is native to Qinling mountain area, Shaanxi Province, China. Since ancient times, the area has a history of kiwi fruit production, known as the "hometown of kiwi fruit in China", and considered the largest kiwi fruit production area in the world [99,100]. Moreover, Meixian County, Zhouzhi County, and Wugong County are represented as the National production and sales demonstrated zone of kiwifruit. The method of stratified sampling and random sampling was used to select kiwifruit growers. The specific sampling process was as follows: 6–8 townships were randomly selected, 2–4 villages were selected from each township, and 30–40 kiwifruit growers were selected from each village. A total of 700 questionnaires were collected, of which 623 were valid, and the effective rate was 89.00%. We investigated doujiabao village, Ningqu village, Huangjiapo village, Qinghua village, Qiangjiabao village, Gucheng village, Heping Village, Jiebei village, Koujiabao village, Sunjiayuan village, Yujia village, Zaolin village, and Zhangjia village in Meixian, Zhouzhi, and Wugong. The main way of the investigation was a face-to-face interview. The questionnaire covers part-time growers and large-scale professional growers with a certain production scale, including family characteristics, kiwifruit production, marketing, participation in value chain activities, etc.

Before the formal survey, we have conducted a pre-survey in June 2019 to get familiar with the survey area and revised the questions related to the questionnaire in combination with the actual survey practice. The indicators of value chain participation and poverty in the questionnaire were modified, such as farmers' willingness to participate in refrigeration activities and medical investment. Through the pre-survey, all the researchers have a comprehensive understanding of the questionnaire and the survey area. Moreover, to ensure farmers' participation and improve the questionnaire's effectiveness, we randomly selected 30 villages for pre-survey and finally selected 13 villages with kiwi fruit as the leading industry and high degree of farmers' cooperation as the research object. Through the pre-survey, the questionnaire recovery rate and the quality of the questionnaire were improved. In order to ensure the comparability between farmers, this paper only takes Xuxiang single-variety kiwifruit farmers for correlation analysis, and the number of these farmers is 475. Moreover, before taking the interviews, the respondent briefly explained the contents of the questionnaire, which could be one of the major reasons for the high response rate.

3.4. Variable Selection and Descriptive Statistics

The study mainly comprises the impact of smallholders' integration into the value chain on multidimensional poverty. According to the survey area's actual conditions, farmers' participation in value chain activities is mainly evaluated from three aspects: purchasing fertilizer from industry organizations before production, using preservation technology during production, and accepting procurement after production. Therefore, the above three value chain activities are taken as core explaining variables, and their impacts on farmers' multidimensional poverty identification and extent of multidimensional poverty are analyzed. In the article, the main way for farmers to purchase fertilizer from industrial organizations is the local large-scale leading enterprises. By asking farmers whether they can get the whole process guidance and selecting fertilizer according to their soil actual conditions, the scientific and reliable fertilizer sources from industrial organizations can be determined. These leading enterprises have better kiwifruit plantation experience and have scientific expert teams, which can provide a scientific proportion of organic fertilizer according to the actual needs of kiwifruit growers. Moreover, it also helps to improve the common problems of excessive application of chemical fertilizer, soil hardening, and environmental pollution, which is conducive to improving the quality of fruits.

The individual characteristics of farmers and the characteristics of production and operation are selected as the main control variables. These variables mainly include sex, age, and planting years of the householder; number of workers; family size; whether farmyard manure improves kiwifruit quality; the unit price of fertilizer; whether to join leading enterprises; income of Xuxiang kiwifruit; purchase of bagging; irrigation cost; machinery operation cost; planting years of Xuxiang kiwifruit; the yield of Xuxiang kiwifruit; machinery procurement cost; and social network (Table 2). As shown in Table 2, 78% of the farmers have experienced multidimensional poverty, 42.5% use improved fertilizers, 25.3%s use preservation technology, and 92.7% accept procurement by industry organizations. By contrast, the main form of farmers' participation in agricultural value chain activities is procurement activities.

Table 2. Descriptive statistics of variables.

Variable	Implication	Mean	SD
Multidimensional poverty identification	Yes = 1, No = 0	0.780	0.414
The extent of multidimensional poverty	Overall degree of multidimensional poverty	1.258	0.955
Whether to use improved fertilizers	Whether to use fertilizers purchased by industry organizations before production, Yes = 1, No = 0	0.425	0.495
Whether to participate in the procurement	Whether to accept procurement by industry organizations after production	0.927	0.261
Whether to use preservation technology	Whether to use preservation technology during production, Yes = 1, No = 0	0.253	0.435
Individual characteristics of farmers			
Sex of the householder	Male = 1, female = 0	0.315	0.464
Age of the householder	The actual age of the householder (years)	56.92	10.78
Years of the householder engaged in agriculture	Subject to the actual survey data (years)	32.32	16.609
Number of workers	The actual number of adult workers in the family	0.255	0.548
Characteristics of production and operation			
Whether farmyard manure improves kiwifruit quality	Yes = 1, No = 0	0.875	0.439
The unit price of fertilizer	The unit price of fertilizer purchased (Yuan)	147.54	63.569
Leading enterprises	Whether to join leading enterprises, Yes = 1, No = 0	0.143	0.693
The income of Xuxiang kiwifruit	Actual income of Xuxiang kiwifruit (Yuan)	3670.38	10,942.42
Purchase of bagging	Purchase cost of bagging (Yuan)	321.343	860.922
Irrigation cost	Actual irrigation cost (Yuan)	707.379	1364.053
Machinery operation cost	Actual machinery operation cost (Yuan)	320.622	762.191
Planting years of Xuxiang kiwifruit	Actual planting years of Xuxiang kiwifruit (years)	14.93	8.32
The yield of Xuxiang kiwifruit	Actual yield of Xuxiang kiwifruit (Jin)	6394.85	7920.70
Machinery procurement cost	Actual machinery procurement cost (Yuan)	1383.62	3937.54
Social network	Frequency of association with relatives and friends, 1 = seldom, 2 = sometimes, 3 = average, 4 = relatively frequent, 5 = often	2.534	1.215
Risk attitude	Willing to adopt new agricultural technology, 1 = totally unwilling, 2 = unwilling, 3 = willing	1.764	1.011

Data source: Survey data.

4. Results

4.1. Measurement Results of One-Dimensional Poverty and Multidimensional Poverty

Table 3 shows the measurement results of the one-dimensional poverty of kiwifruit farmers in Shaanxi. The sample results show that the income of 51.8% of the farmers is below the national poverty line, 33.3% are in education-producing poverty, 12.2% are in poverty due to children's enrollment. While 13.3% have at least one person over six years old who is not insured, 9.5% have difficulty in accessing drinking water, 5.4% fail to meet the standard of toilet quality, and 0.7% have hazards in their housing conditions.

Table 3. Measurement results of one-dimensional poverty.

Dimension	Poverty Incidence	Dimension	Poverty Incidence	Dimension	Poverty Incidence
1 Per capita net income	51.8%	Drinking water	9.5%	7 Cooking fuel	0
2 Education years of the householder	33.3%	5 Toilet	5.4%	8 Fixed asset	0
3 Enrollment rate of children	12.2%	6 Electricity supply	0	9 Housing condition	0.7%
10 Medical coverage	13.3%				

Data source: Survey data.

Table 4 shows the measurement results of multidimensional poverty of kiwifruit farmers in Shaanxi. The sample results show that 22% of the farmers have not experienced poverty, and the multidimensional poverty farmers are concentrated in one-dimensional and two-dimensional poverty, with a cumulative poverty incidence of 66.3%. 10.5% of the farmers are in three-dimensional poverty, and only 1.2% are in four-dimensional poverty.

Table 4. Measurement results of multidimensional poverty.

Dimension	Poverty Incidence	Dimension	Poverty Incidence
No poverty experience	22%	Three-dimensional poverty	10.5%
One-dimensional poverty	43%	Four-dimensional poverty	1.2%
Two-dimensional poverty	23.3%	Five-dimensional poverty	0%

Data source: Survey data.

Table 5 shows the measurement results of multidimensional poverty of kiwifruit smallholders participating in agricultural value chain activities in Shaanxi. The sample results show that 80.6% of the farmers who do not use improved fertilizer are in multidimensional poverty, and the extent of multidimensional poverty of these farmers is greater than that of farmers who use improved fertilizer. About 86.4% of the farmers who do not participate in procurement by industry organizations are in multidimensional poverty, and the extent of multidimensional poverty of these farmers is greater than that of the farmers who participate in procurement by industry organizations; 83.7% of the farmers who do not use preservation technology are in multidimensional poverty, and the extent of multidimensional poverty of these farmers is greater than that of the farmers who use preservation technology. According to the extent of multidimensional poverty of farmers participating in the agricultural value chain, the extent of multidimensional poverty of farmers who do not use improved fertilizer, participate in the procurement, or use preservation technology is higher than that of farmers who do so.

Table 6 shows the measurement results of smallholders' participation in agricultural value chain activities in different poverty dimensions. The samples show that farmers who have no poverty experience, one-dimensional poverty, two-dimensional poverty, three-dimensional poverty, and four-dimensional poverty have a higher mean value of participating in procurement than using improved fertilizer or using preservation technology. This indicates that farmers in different multidimensional poverty participate in agricultural value chain activities to accept procurement by industry organizations after production.

Table 5. Measurement of multidimensional poverty of smallholders participating in agricultural value chain activities.

	Whether to Use Improved Fertilizers		**Whether to Participate in the Procurement**		**Whether to Use Preservation Technology**	
	Yes	No	Yes	No	Yes	No
Multidimensional poverty identification	0.745	0.806	0.773	0.864	0.611	0.837
Extent of multidimensional poverty	1.075	1.394	1.212	1.841	0.875	1.388

Data source: Survey data.

Table 6. Measurement of smallholders' participation in the agricultural value chain in different poverty dimensions.

	Whether to Use Improved Fertilizers	**Whether to Participate in the Procurement**	**Whether to Use Preservation Technology**
No poverty experience	49.2%	95.5%	43.2%
One-dimensional poverty	48.4%	95.4%	39.8%
Two-dimensional poverty	34.3%	91.4%	33.6%
Three-dimensional poverty	23.8%	82.5%	20.6%
Four-dimensional poverty	28.6%	57.1%	28.6%

Data source: Survey data.

4.2. Influence of Smallholders' Participation in the Agricultural Value Chain on Multidimensional Poverty

Table 7 shows the estimated results of farmers' participation in three kinds of value chain activities on the multidimensional poverty of farmers' families. As far as the use of improved fertilizer is concerned, the average treatment effect (ATT) obtained by using the nearest neighbor matching method is −0.294, and it is significant at the 5% level. The results of the four matching methods are similar, which verifies the robustness of the results and verifies the positive impact of improved fertilizer on reducing the multidimensional poverty of farmers. The multidimensional poverty level of the farmers who did not use the improved fertilizer was 30.1% lower than that of the farmers who used it. In terms of whether or not to adopt preservation technology, the average treatment effects of the treatment groups using nearest neighbor matching, radius matching, kernel matching, and local linear regression matching were −0.233, −0.226, −0.301, and −0.241, respectively, and were significant at 5% and 1% levels. This shows that the results are also relatively stable. The multidimensional poverty degree of the farmers who do not use the preservation technology is 25.0% higher than that of the farmers who use the preservation technology. Regarding the industrial acquisition, the average processing effects of the treatment groups using nearest neighbor matching, radius matching, kernel matching, and local linear regression matching were −0.455, −0.452, −0.488, and −0.464, respectively, which were significant at 5% and 1% levels. The average multidimensional poverty degree of kiwifruit growers without industrial organization acquisition is 46.5% higher than that of those who participate in industrial organization acquisition.

In order to ensure the quality of propensity score matching results, a balance test is further performed on the four matching methods to determine whether there is a systematic difference between the growers of the treatment group and the control group after matching, and the results are shown in Table 8. The results show that after using these four matching methods, their Pseudo R^2 values are all close to 0, and the likelihood ratio (LR) is significant at the level of 1% before matching. The null hypothesis is rejected, but the hypothesis after matching is not rejected. The mean bias and median bias (medbias) are greatly reduced, and the B values in the four matching methods are all less than 25. From the above, it can be concluded that propensity score matching significantly reduces the significant deviation of observable variables between the treatment group and the control group. The balance test indicates that the propensity score estimate and the sample matching are successful.

Table 7. Treatment effect of three value chain activities on growers' multidimensional poverty degree.

Independent Variable	Matching Method	Treatment Group/Control Group	Average Treatment Effect	SD	T-Value
Improving fertilizer	Neighbor matching	216/259	−0.294 **	0.125	−2.31
	Radius matching (caliper 0.05)	216/259	−0.314 **	0.128	−2.69
	Kernel matching	216/259	−0.290 **	0.121	−2.45
	Local linear regression matching	216/259	−0.311 **	0.155	−1.99
	Mean	—	−0.301	—	—
Fresh-keeping technology	Neighbor matching	200/275	−0.233 **	0.116	−2.00
	Radius matching (caliper 0.05)	200/275	−0.226 **	0.103	−2.20
	Kernel matching	200/275	−0.301 ***	0.099	−3.08
	Local linear regression matching	200/275	−0.241 **	0.136	−1.99
	Mean	—	−0.250	—	—
Organizational acquisition	Neighbor matching	198/277	−0.455 **	0.131	−1.99
	Radius matching (caliper 0.05)	198/277	−0.452 **	0.117	−2.20
	Kernel matching	198/277	−0.488 ***	0.113	−2.58
	Local linear regression matching	198/277	−0.464 **	0.172	−1.94
	Mean	—	−0.465	—	—

Note: **, and *** respectively represent being significant at the level of 10%, 5%, and 1%. On the premise of not affecting the balance test results, the caliper in radius matching is 0.05.

Table 8. Balance test results.

Independent Variable	Matching Method	Pseudo R^2	LRchi2	Mean Bias	Medbias	B Value
Improving fertilizer	Before matching	0.051	35.31 ***	12.2	6.2	42.4
	Neighbor matching	0.001	1.91	5.5	4.5	19.1
	Radius matching (caliper 0.05)	0.002	0.35	1.6	0.8	7.3
	Kernel matching	0.005	0.54	1.5	1.7	6.22
	Local linear regression matching	0.006	4.8	5.7	3.8	15.8
Fresh-keeping technology	Before matching	0.055	32.45 ***	13.1	12.1	43.3
	Neighbor matching	0.006	1.62	3.9	3.6	17.5
	Radius matching (caliper 0.05)	0.001	0.32	1.9	1.1	8.1
	Kernel matching	0.002	0.23	1.6	1.1	5.2
	Local linear regression matching	0.004	3.17	2.9	3.2	14.4
Organizational acquisition	Before matching	0.053	32.78 ***	11.2	6.2	43.1
	Neighbor matching	0.009	3.21	2.4	2.7	20.3
	Radius matching (caliper 0.05)	0.001	0.38	2.2	2.1	8.6
	Kernel matching	0.004	0.46	1.8	1.2	7.46
	Local linear regression matching	0.004	5.2	3.9	4.5	15.5

Note: *** respectively represent being significant at the level of 10%, 5%, and 1%.

4.3. Heterogeneity of Multidimensional Poverty Reduction Effect of Smallholders' Participation in the Agricultural Value Chain in Different Families

In the previous section, the influence of farmers' participation in the agricultural value chain on the extent of multidimensional poverty has been studied, and it is concluded that farmers' participation in the value chain is conducive to reduce multidimensional poverty. However, the above conclusion on the poverty reduction effect is only drawn from all samples, while the differences between sex and age are not considered. For this purpose, the heterogeneity of the impact of farmers' participation in the agricultural value chain on their multidimensional poverty is examined concerning different sexes and ages. The estimation results are shown in Appendix A (Table 1).

As shown in Appendix A (Table 1), model (2) shows that the influence coefficient of male farmers using improved fertilizer on multidimensional poverty is −0.328. In contrast, model (8) shows that female farmers' influence coefficient using improved fertilizer on multidimensional poverty is −0.272, which indicates that the multidimensional poverty reduction effect of male farmers is better than that of female farmers in this regard. The possible reason is that organic fertilizer is rich in organic matter, but the pure nutrient per unit volume is much lower than that of chemical fertilizer [101]. Therefore, the application rate per mu is relatively higher, which requires higher physical strength of workers [102]. However, compared with women, men have stronger physical strength, so they have a greater poverty reduction effect.

Model (4) shows that the influence coefficient of male farmers participating in procurement on multidimensional poverty is −0.596 if men acquire, while model (10) shows that the same of female farmers participating in procurement on multidimensional poverty is −0.575. This indicates that the poverty reduction effect of male farmers is greater than that of female farmers. In China, men are often involved in the whole production process, engaged in heavy physical labor. At the same time, traditionally, Chinese women are often in the position of assistance, with productive and social difficulties, which has become the cultural epitome of traditional Chinese society [103]. In contrast, traditional cultural values may become a restrictive factor for women to participate in social affairs (such as industrial organization acquisition). Therefore, the poverty reduction effect of women's participation in industrial organization acquisition is less than that of men [100].

Model (6) shows that male farmers' influence coefficient using preservation technology on multidimensional poverty is −0.426. In contrast, model (12) shows that the same of female farmers using preservation technology on multidimensional poverty is −0.476, which indicates that the multidimensional poverty reduction effect of female farmers is greater than that of male farmers in this regard. The possible reason is that storage technology is a supporting production activity, and it needs fine management to prevent kiwi fruit from losing quality during storage [104,105]. Through the family division of labor, women have a comparative advantage in this kind of work with less physical labor consumption, and women are better at using storage technology [106]. Therefore, the effect of women using storage technology might reduce poverty moreso than that of men.

The main contribution of the article is first to measure the current multidimensional poverty of kiwifruit growers. Then use the data of kiwifruit growers to verify the multidimensional poverty reduction effect of the value chain activities before, during, and after delivery, and find that the poverty reduction effects of different value chain activities are heterogeneous. Based on the above empirical analysis, this article puts forward policy recommendations to strengthen the cultivation of various industry organizations, develop storage and preservation technologies, and other measures to comprehensively promote growers' participation in the value chain activities of kiwi fruit.

5. Conclusions

The study measures the Multidimensional Poverty of Kiwi farmers by employing a combination of propensity score matching, probit, and OLS model to empirically study the multidimensional poverty reduction impact and heterogeneity of farmers' participation in the agricultural value chain. The results show that: (1) 51.8% of the farmers' income is below the national poverty line, 33.3% of the farmers have lower education level, 12.2% of the farmers' children are tented to drop out of school, 13.3% of the farmers' families have at least one child over six years old who has not participated in medical insurance. Around 9.5% of the farmers have difficulty in drinking water, 5.4% of the farmers' family toilets are not up to standard, and 0.7% of the farmers' families have hidden dangers in housing conditions. Interestingly, 22% of the farmers have never experienced poverty, and 66.3% have experienced one-dimensional and two-dimensional poverty. (2) In contrast, farmers' participation in the agricultural value chain has a significant poverty reduction effect. Compared with farmers who do not use improved fertilizer, who do not participate in purchasing, and who do not use storage and preservation technology, the multidimensional poverty of farmers who use those value chain activities decreased by 28.6%, 50.3%, and 25.7%, respectively. (3) The multidimensional poverty reduction degree of men farmers using improved fertilizer and participating in purchasing is greater than that of women using improved fertilizer. The multidimensional poverty reduction degree of women using storage and fresh-keeping technology should be greater than that of men using storage and fresh-keeping technology.

Based on the above findings, we have the following policy implications from the poverty alleviation perspective: (1) due to the multidimensional factors of farmers' income, education, and children's enrollment rate, poverty is the most serious. Therefore, it is apparent that improving the income of kiwifruit growers and level of education play an important role in poverty alleviation in the post-era. Based on this, the government should popularize high school and vocational education in rural areas to lay the foundation for promoting human capital in rural areas and to provide free vocational training and expand income channels for low-income families who have not entered junior high school. Secondly, the government should improve the coverage rate of the new rural cooperative medical system and medical insurance for urban and rural residents, increasing the proportion of medical reimbursement for the poor, increasing the investment in medical resources in poor areas, strengthening the investment in medical staff in rural areas, and providing some security for the disabled. Finally, we should pay attention to children's early education, increasing the level of security for children in rural areas, improving the strength of early childhood education teachers, creating a good learning atmosphere for children, and giving some preferential policies for children from low-income families in rural areas. (2) From the perspective of value chain activity participation, the government should support the farmers to integrate into the value chain of different links by formulating relevant policies to help farmers in all aspects of the value chain before, during, and after production, and promoting smallholder farmers to better integrate into the value chain activities. Secondly, the government should promote various production organizations (such as production cooperatives, wholesalers, purchasers, and retailer channels), improving the degree of organizational participation, and adapting collecting behavior. The public-private should also need to be straightened for facilitating new technology and infrastructure building within rural areas. The diverse demonstration zone should also need to formulate a better transitional effector demonstrating new technologies and eventually teach farmers to adopt those. Finally, cold storage has the characteristics of large investment and slow recovery cost, but cold storage kiwi fruit is the key infrastructure for industrial development. Therefore, the government needs to establish large-scale official cold storage, hiring experienced practitioners to carry out systematic kiwi fruit training lectures, further carrying out training facilities triggering storage and fresh-keeping technology.

The core empirical setup of the study relies on the data collected from rural areas of an emerging nation. Therefore, there is a possibility of biasness in the data. Though the study comprised its findings with some robust tactics, if the data could have been evaluated with some structural modeling (e.g., structural equational modeling, FUZZY base model), it could have been more interesting. Future studies should explore the underlined reasons that hinder the adoption and participation in the agricultural value chain. We also found a profound literature gap that can present an in-depth review of the literature regarding agricultural value chain participation and poverty reduction. As the variables selected by exploring the past literature and current socioeconomic conditions of the surveyed regions, there may be some chances to miss some important factors. Future researchers should utilize some robust models to avoid those issues (e.g., interpretive structural equation modeling).

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Data Availability Statement: The data will be provided upon request by the corresponding author.

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Appendix A

Table 1. Influence of smallholders' participation in the agricultural value chain on different dimensions of poverty.

	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**	**Model (6)**
Male	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty
Whether to use improved fertilizers	−0.526 ** (0.230)	−0.328 ** (0.140)				
Whether to participate in the procurement			−0.338 (0.380)	−0.596 ** (0.243)		
Whether to use preservation technology					−0.778 *** (0.246)	−0.426 *** (0.137)
Control variable						
Pseudo R^2	0.247		0.227		0.270	
R^2		0.231		0.231		0.249
Adj R^2		0.168		0.169		0.187
Prob> chi2	0.000	0.000	0.000	0.000	0.000	0.000
=LR chi2(14)	56.15		51.67		61.54	
	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)	Model (12)
Female	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty
Whether to use improved fertilizers	−0.136 (0.173)	−0.272 ** (0.084)				
Whether to participate in the procurement			−0.529 (0.447)	−0.575 *** (0.165)		
Whether to use preservation technology					−0.681 *** (0.238)	−0.476 *** (0.126)
Control variable						
Pseudo R^2	0.285		0.288		0.304	
R^2		0.259		0.262		0.266
Adj R^2		0.232		0.236		0.239
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
LR chi2(14)	111.18		112.13		118.60	
	Model (13)	Model (14)	Model (15)	Model (16)	Model (17)	Model (18)
Aged above 50 years	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty
Whether to use improved fertilizers	−0.203 (0.173)	−0.304 *** (0.090)				
Whether to participate in the procurement			−0.710 * (0.394)	−0.717 *** (0.165)		
Whether to use preservation technology					−0.601 ** (0.213)	−0.397 *** (0.117)
Control variable						
Pseudo R^2	0.291		0.297		0.307	
R^2		0.199		0.214		0.202
Adj R^2		0.171		0.186		0.199
Prob> chi2	0.000	0.000	0.000	0.000	0.001	0.000
LR chi2(14)	116.44		118.80		123.04	
	Model (19)	Model (20)	Model (21)	Model (22)	Model (23)	Model (24)
Aged below 50 years	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty	Multidimensional poverty identification	The extent of multidimensional poverty
Whether to use improved fertilizers	−0.059 (0.219)	−0.197 (0.125)				
Whether to participate in the procurement			−0.142 (0.445)	−0.277 (0.265)		
Whether to use preservation technology					−0.942 ** (0.277)	−0.536 *** (0.152)
Control variable						
Pseudo R^2	0.178		0.178		0.232	
R^2		0.165		0.158		0.211
Adj R^2		0.095		0.087		0.145
Prob > chi2	0.000	0.005	0.000	0.009	0.000	0.000
LR chi2(14)	38.98		39.01		50.83	

Note: *, **, and *** indicate significance at the statistical levels of 10%, 5%, and 1%, respectively, and the value in the bracket is standard regression deviation.

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