Journal of Agriculture, Food Systems, and Community Development
ISSN: 2152-0801 online
https://www.foodsystemsjournal.org

Farmers' willingness to pay for operating a collective postharvest refrigeration unit in an eastern Mediterranean rural community

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Submitted August 27, 2018 / Revised January 11, March 1, March 22, and April 18, 2019 / Accepted April 18, 2019 / Published online July 24, 2019

Citation: Maalouf, A., & Chalak, A. (2019). Farmers' willingness to pay for operating a collective postharvest refrigeration unit in an eastern Mediterranean rural community. *Journal of Agriculture, Food Systems, and Community Development, 9*(1), 89–99. https://doi.org/10.5304/jafscd.2019.091.012

Abstract

One-third of crops harvested globally is lost due to inadequate or lack of postharvest storage facilities. This paper explores farmers' willingness to pay (WTP) for a common refrigeration unit to reduce postharvest losses in the Bekaa valley, a Lebanese breadbasket. Using the contingent valuation (CV) method—a survey-based economic technique used mainly for the valuation of nonmarket environmental and public goods—this study was conducted with a sample of farmers in selected village municipalities in the area under study. The results indicate that most farmers (72%) are highly concerned about postharvest losses, and that 80% were willing to pay varying amounts for the proposed initiative, with most WTP values falling within the range of US$21–US$30 per month (31%). By contrast, a considerable proportion of the farmers (20%) were not willing to pay any fee for establishing the common refrigeration unit. Results further establish the different small-scale farmers' characteristics and factors affecting WTP. Some factors including longer farming experience, higher variable costs associated with farming operations, working year-round in farming, and access to wholesale markets, significantly increased WTP for access to a common refrigeration unit, depending on the type of cultivated crops. These results are of particular interest for developing relevant policies and informing decision-making intent to solve postharvest management issues in developing economies. This study establishes the importance of offering refrigeration services at discounted or subsidized prices to smaller farmers as a public good aimed at promoting agrarian and rural development.

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Keywords
Small-scale Farmers; Farmers' Willingness to Pay; Postharvest Loss; Contingent Valuation Method; Policy Analysis; Developing Economies

Introduction

One-third of crops harvested globally, equivalent to 1.3 billion metric tons per year, is lost throughout the food supply chains, from agricultural production to final consumer level (Food and Agriculture Organization of the United Nations [FAO], 2011). Food losses in developed economies and developing economies are comparable, yet are concentrated in different levels of the food value chain. In the former, more than 40% of losses occur at consumer and retail levels (FAO, 2011), whereas in the latter, around the same percentage of losses occurs due to inadequate or lacking postharvest storage facilities (FAO, 2011). The myriad ramifications of food losses, not least at the postharvest level, are socially and economically debilitating, and contribute significantly to the reliance on food imports, environmental problems and concerns, land abandonment, food insecurity, failed rural development, and the instability of farmers' livelihoods.

As part of the wider discourse on pro-poor agricultural growth and development, there are ongoing debates on the viability of small-scale farming (Bush, 2016; FAO, 2017; Henson, Jaffee, Cranfield, Blandon, & Siegel, 2008). This is fundamental to sustain equitable growth for rural smallholder farmers in developing countries. However, such farmers remain vulnerable in their livelihoods due to the multiple challenges and bottlenecks that plague farming in in the developing world.

While small-scale farmers have a competitive advantage over large-scale commercial producers—principally through lower costs in accessing and managing family labor as well as superior local knowledge—the small scale of their operations leads to greater costs in virtually all non-labor inputs (Poulton, Dorward, & Kydd, 2010). For instance, non-labor costs are mainly associated with access to resources and services (e.g., capital, farm inputs and output markets, technical information, seasonal finance, and quality assurance). These factors, including postharvest services, are increasingly undermining the survival prospects of small-scale farming in increasingly competitive agri-food markets (Poulton et al., 2010). Therefore, over the past decades, many developing countries and development agencies have shifted their efforts to increasing smallholder participation in higher-value agro-food markets (World Bank, 2010). This can be an essential step for meeting economic development and poverty reduction objectives.

In Lebanon, agriculture and the related agri-food sectors play a significant role in the economy of the fertile Bekaa Valley, the country's foremost farming area and breadbasket. The rural population of the Bekaa region, largely consisting of small-scale farmers, depends on farming to sustain their livelihoods (FAO, 2017). According to the U.S. Agency for International Development (USAID), "Lebanon has the highest proportion of cultivable land, per capita, in the Arab world" (USAID, 2014b, para. 1). This study is motivated by the notion that any response to challenges in the agricultural sector requires the support of small-scale or family farmers. Ultimately, postharvest challenges can affect a large proportion of the food supply chain for the entire population. Previous field research, assessment, and preliminary key informant interviews were conducted in many communities of the Bekaa region. The findings indicated the need to respond to the postharvest challenges faced by farmers.

Globally, a third of crops harvested are lost due to inadequate postharvest storage facilities or their absence (FAO, 2011). For developing economies, preharvesting management, processing, storage infrastructure, and market facilities are either not accessible or insufficient (World Bank, 2011). Locally, small-scale farmers are excluded from coordinated supply chains, attributable to their lack of access to storage facilities, in parallel with failures in policies set up to this end, if any. This contributes to the relatively weak competitiveness of small-scale farmers in the market, postharvest losses, and an increase in food waste, coupled with the exacerbation of waste management problems (FAO, 2017). In contrast, reducing postharvest losses would reduce the reliance on imported food and reduce environmental concerns, and decrease land abandonment, strengthen food security, and

improve rural development and farmers' livelihoods (Hodges, Buzby, & Bennett, 2010; Ulrich et al., 2012).

Within the agro-food sector, many studies (Abass et al., 2014; Adeoye, Odeleye, Babalola, & Afolayan, 2009; Basappa, Deshmanya, & Patil, 2007; Basavaraja, Mahajanashetti, & Udagatti, 2007; Buyukbay, Uzunoz, & Bal, 2010; Buzby, Farah-Wells, & Hyman, 2014; Sharmaa & Singhb, 2011; Tefera, 2012; Tefera et al., 2011) have conducted economic analyses of postharvest losses of different types of produce. Other studies have used survey-based stated preference (SP) tools, such as contingent valuation (CV) (Brugarolas, Martinez-Carrasco, Bernabeu, & Martinez-Poveda, 2009; Da Costa & Santos, 2016; Garming & Waibel, 2009; Khan & Damalas, 2015; Posri, Shankar, & Chadbunchachai, 2006) and choice experiments (CE) (Chakir, David, Gozlan, & Sangare, 2016; Jin, Wang, He, & Gong, 2017; Mahadevan & Asafu-Adjaye, 2015; Travisi & Nijkamp, 2008), to estimate the willingness to pay (WTP) to prevent the potential environmental and health risks arising from pre- or postharvest practices. In addition, these methods have mainly been used in agro-food marketing for analyzing WTP for residue-free food products. However, to our knowledge, none of the existing studies has estimated farmers' WTP to reduce postharvest-related challenges.

Agricultural producers use a variety of refrigeration systems to extend the shelf life of perishable materials. Cooling not only reduces the potential for spoiling due to bacterial growth, but also reduces the humidity levels for some products. Accordingly, a refrigeration unit may be used in common by groups of farmers as a type of cooperative commercial infrastructure for the storage of agricultural commodities. The unit is used to store wholesale produce prior to distribution and to help reduce the producers' postharvest losses.

This paper evaluates the potential for operating a common refrigeration unit to address small-scale farmers' challenges related to postharvest losses in a selection of municipalities in the Baalbek region of the Bekaa valley. Farmers are presented with a hypothetical scenario where they are provided full subsidies for purchasing the cooling room, but are expected to cover operational and maintenance costs. Using a CVM survey, the benefits of these units were elicited using farmers' WTP to access the postharvest common refrigeration facility.

Methodology

Survey Design

We designed and administered a survey instrument to a sample of 130 small-scale farmers in different rural communities of the Bekaa. According to the 2010 agricultural census conducted by the Ministry of Agriculture[1] in Lebanon, there are 3,206 farmers operating in the study area. We developed a first draft of the questionnaire and pretested it with five farmers selected randomly from small-scale farmers' communities. The pretest was conducted in order to check the respondents' general understanding of the questionnaire. The instrument was further refined before it was deemed suitable for use. The range of hypothetical fees for using the refrigeration unit to be randomly assigned to the respondents was devised after a rapid assessment of the market for locally existing refrigeration units. The units considered are already established for farmers who refrigerate a part of their produce. Results from the assessment indicated that farmers pay approximately US$3 to US$5 per approximately 22 to 33 lb. (10 to 15 kg) of produce (every 3 months), with some fluctuations depending on the refrigeration facility or types of crops. Accordingly, a small-scale farmer would pay between US4300 and US$450 per metric ton of produce stored in refrigerators for the three-month period, which is equivalent to US$100 to US$150 per month. It is important to note that respondents were informed that the proposed initiative would be financially covered through external sources of funding. Participating farmers would jointly have to pay for the operation and maintenance costs of the common fresh produce refrigeration units. These units will allow access to temporary storage for crops and therefore will help the farmer defer selling until the local market price becomes satisfactory.

[1] The raw dataset was kindly provided by the Ministry of Agriculture.

The questionnaire consisted of three sections. The first section gathered farmers' demographic profiles and socio-economic conditions (e.g., level of education, years of involvement in agriculture, income level, surface land cultivated, type of crops cultivated, etc.).

The second section gathered information on the farmers' attitudes and levels of concern over postharvest losses and their access to postharvest storage facilities. Other questions gauged the farmers' views on the most suitable solutions to increase agricultural production and revenue (e.g., processing facilities, postharvest storage, increasing the area under cultivation, crop diversification).

The third section of the questionnaire contained the WTP scenario. Prior to the WTP questions, the CV survey clearly informed the farmers that they would be expected to pay a modest monthly fee to access the refrigeration facility. Subsequently, 6 payment categories were proposed, taking into consideration that the current fee paid per farmer is between US$100 and US$150 per month. The degree of seriousness of respondents was assessed by the interviewer as a means in order to help in evaluating the validity of the WTP question. The interviewer assessed this measure by determining whether the respondents spent enough time pondering the WTP question for the proposed initiative.

Field Interviews

Our study area consisted of villages falling within the Baalbek district of the Northern Bekaa region, a region which is the breadbasket of Lebanon. This district is the largest in the country and encompasses about 95 municipalities and occupies a total area of around 573,037 acres (2,319 km^2).

This study was designed to ensure that neither the survey sampling nor the questionnaire design introduced significant biases. The sampling design was based on data collected from municipalities, which are used to identify local small-scale farmers actively engaged in farming. Sampling was conducted using the snowball technique, whereby a small group of initial informants is used to nominate—through their social networks—other small-scale farmers who could potentially contribute to the study.

We collected data from the 16 villages that were randomly selected. These villages are characterized by several prevailing factors that vary greatly across them, such as cultivated area, type of cultivated crops, socio-economic characteristics, age groups, and access to adequate support (e.g., access to agricultural inputs and to information on agricultural practices or advanced techniques). Of the 130 face-to-face interviews, 110 were fully completed from start to end. Overall, the response rate was about 84%.

The Contingent Valuation Method

The contingent valuation (CV) method is an established method for nonmarket valuation (Misra, Huang, & Ott, 1991; Weaver, Evans, & Luloff, 1992) that gauges respondents' preferences and values for public goods and services by relying on their responses to contingent circumstances embedded in an artificially structured market (Seller, Stoll, & Chavas, 1985). The CV method has been applied traditionally in environmental valuation but has been extended to other sectors, including the agro-food sector (Venkatachalam, 2004). The aim of the CV method is to administer surveys to determine how respondents will value changes to the provision not only of private goods, but also of public goods, such as environmental improvements, landscape amenities, or community development schemes (Fuks & Chatterjee, 2008; Mitchell & Carson, 1989).

In this study, we adopted the CV method to estimate farmers' WTP toward the operating expenses of a cooperatively owned, postharvest refrigeration unit. The goal is to determine small-scale farmers' interest in the common refrigeration unit as a means to reduce their challenges relating to postharvest losses. To help explain the respondents' stated answers and establish their validity, survey participants were asked their opinions and attitudes concerning the cooperative refrigeration unit.

In our study, we establish whether respondents are willing to incur an increase in their costs of production in return for access to temporary refrigerated storage that may allow them to reduce food losses, decide on the terms of sale, and indirectly improve their rural livelihoods. This survey proposes a cold storage solution to small-scale

farmers' postharvest challenges and elicits their maximum WTP for it. The resulting data are used to propose alternatives to reduce the challenges encountered by small-scale farmers and are linked to the different characteristics of small-scale farmers and their challenges. The different characteristics include socio-economic factors such as household income, level of education, type of cultivated crops, farming experience, access to wholesale market, and cultivated land surfaces. Other variables include the price they are willing to pay and the characteristics of small-scale farmers that are mainly formalized as categorical variables.

Results and Discussion

Survey and Sample Characteristics

Table 1 summarizes all variables included in the

Table 1. Summarized List of Selected Variables Considered in the Data Analysis

Variable	Symbol	Description	Re-coded variables
Age	age	Categorical variable; age of the respondents/farmer	Age
Gender	gender	Sex of the respondents/farmer	Gender
Education	education	Categorical variable; education level of the respondent/farmer	Knowledge1: no or lower education Knowledge2: secondary and higher education
Cultivated land size	land_cult	Categorical variable; cultivated lands total surface (in m^2)	Land1: Less than 40,000 square meters Land2: 40,000 square meters and more
Experience in farming	inv_duration	Categorical variable; duration of involvement in agricultural production (years)	Experience1: less than 10 years Experience2: 10-20 years Experience3: more than 20 years
Working season	season	Categorical variable; seasonality of employment in the agricultural sector (Months/year)	Season1: 0-3 months Season2: 3-6 months Season3: 6-9 months Season4: all year round
Cultivated crops	cultivated_crops	Type of cultivated crops (apple, grape, potato, onion, cherry, apricot/peach, vegetables, wheat, rose, almond, olive, grains)	(type of crop)1: 0=no (type of crop)2: 1=yes
Number of workers	people_engaged	Categorical variable; number of HH members involved in agricultural production	people_engaged1: 3 or less people_engaged2: more than 3
Ownership characteristics	land_operation	Categorical variable; agricultural land ownership characteristics	Ownership1: owner of land Ownership2: renter of land Ownership3: sharecropper of land
Income source	main_income_source	Agriculture as a main source of income	main_income_source1: no main_income_source2: yes
Share of income from agriculture	Share_inc	Categorical variable; share of income from agriculture from total income	Percentage1: more than 50% of total income Percentage 2: less than 50% of total income
Access to wholesale market	wholesale_market	Framers have access to wholesale market	Wholesale_market1: no Wholesale_market2: yes
Concern to postharvest storage	concern	Categorical variable; farmers have concern about having access to adequate postharvest storage facility	Concern1: concerned Concern2: not concerned
Concern to postharvest loss	concern_post_harv_loss	Categorical variable; concern relating to postharvest losses	Concern_post_harv_loss1: concerned Concern_post_harv_loss2: not concerned Concern_post_harv_loss3: strongly concerned
Willingness to pay	WTP	Willingness to pay (yes, or no)	Wtp1: no Wtp2: yes
Amount willing to pay	WTP_dollars	Categorical variable; maximum amount that farmers are willing to pay (US$)	Price
Farmers not WTP	not_support	Cause for which farmers are not supportive of the initiative	
Income	income_cat	Categorical variable; monthly household income category (US$ per month)	Income1: less than US$1,000 Income2: US$1,000 and more
Seriousness	serious	Categorical variable; level of seriousness of the respondents	Seriousness1: high seriousness Seriousness2: low seriousness

dataset. A correlation test was applied to identify potentially multicollinear variables. Accordingly, variables that were found to have a correlation coefficient larger than 0.4 in absolute value were examined separately in a preliminary model, and only variables that were more significant (with a lower *p* value) were included in the final model.

Table 2 presents the socio-demographic characteristics of the sample. The greatest percentage of surveyed farmers were male (98%), despite the fact that the agricultural labor is performed substantially by women. Indeed, this is expected given the nature of farming in Lebanon and the region, which is male-dominated when it comes to land tenancy and decision-making. Ages of interviewed farmers ranged from 18 to 60 years old, with most farmers (36%) between the ages of 30 to 50, and 22% above 60, while only 13% were between 18 and 30. About 88% of the farmers have some formal education, although the percentage of farmers with higher education does not exceed 25%.

Results in Table 2 indicate that only 39% of the farmers rely solely on income generated from agricultural production and farming activities with no access to alternative income generation opportunities. Thirty-five percent have a monthly household income ranging between US$1,500 and US$2,000.

Cultivated land surface area varied within the sample, with 80% of respondents cultivating less than 10 acres (4 hectares) of land. It is worth noting that small-scale farmers were purposefully selected to ensure that the results of this study would specifically serve to address the challenges encountered by small-scale farmers. Moreover, results showed that 66% of the farmers have been involved in farming activities for more than 20 years. About 62% of the farmers reported active involvement of at least three household members in farming activities, and 84% of farmers reported to be landowners. Indeed, most of these farmers inherited these lands from their ancestors and continued their engagement in agricultural production. However, their level of engagement in farming seems to be changing over time, with many farmers (35%) only seasonally (3–6 months) employed in farming. About 29% of the farmers practice farming throughout the different seasons of the year. Results also showed that 91% of farmers have direct access to wholesale markets, suggesting that production resulting from farming activities is intended to be sold at local markets and not only for personal domestic consumption.

The survey included questions to assess farmers' concerns about postharvest losses and access to postharvest refrigeration prior to eliciting their WTP to have access to postharvest refrigeration units. While 72% of the farmers showed a high level of concern about postharvest losses, 56% were concerned about postharvest storage.

Turning to WTP elicitation, two consecutive questions were administered to respondents. The first asked farmers whether they are willing to pay to have access to postharvest refrigeration. Those who indicated yes were asked a second question that gauged approximately how much they would

Table 2. Socio-Demographic Characteristics of the Sample

Characteristics	Percentage
Demographic profile of the farmers	
Age between 30 and 50 (years)	36
Male	98
Monthly household income between 1,500 and 2,000 (USD)	35
Agriculture as a main source of income	39
Level of education (educated)	88
Farming characteristics	
Cultivated land size less than 40,000 square meters	80
Farming experience with more than 20 (years)	66
Number of workers more than 3	62
Working season between 3-6 (months)	35
Landowners	84
Access to wholesale market	91
Concern/ Attitude	
Strongly concerned about postharvesting storage	56
Strongly concerned about postharvest losses	72
WTP	
Framers willing to pay	80
Respondents seriousness	
Very Serious	39

be willing to pay monthly to have access to this refrigeration facility. Results indicated that 80% of farmers were willing to pay to have access to the refrigeration unit.

Farmers' Willingness to Pay

Table 3 tabulates farmers' WTP distribution across price levels. The table shows that 20% of farmers, out of 110 respondents, were not willing to pay any premium at all. The mean WTP was categorized into several price ranges. Considering the mid-points of the ranges, US$25/month constituted the major (31%) preferred category of the respondents. The average WTP is around US$29. Because the maximum WTP values are left-censored at zero and right censored at 70, and are reported on US$10 intervals between these two bounds, an interval regression model was used for model and WTP estimation. Variables tested to exert multi-collinearity were dropped from the model.

When farmers were asked for the reasons they objected to the payment vehicle, four main groups of answers were obtained: (1) the respondent faces postharvesting challenges but lacks resources to invest in the proposed initiative; (2) the respondent does not face postharvesting challenges; (3) the respondent does not think the proposed initiative will have any positive income on their rural livelihood; and (4) the respondent faces postharvesting challenges but prefers investing in other areas related to the agricultural sector. Many iterations were attempted to arrive at the final model specification, whose estimated coefficients are shown in Table 4. All coefficients are highly statistically significant and have the expected sign, and all variables are categorical.

The coefficients for all-year working season, apple cultivation, access to wholesale market, concern over postharvest losses, and vegetable cultivation are positive and highly statistically significant. This indicates that farmers involved all year in agriculture production, with high

Table 3. Distribution of Willingness to Pay (WTP) Across Price Levels

Price in US$	Frequency	Percent	Cumulative
0	22	20	20
21–30	34	31	51
31–40	25	23	74
41–50	15	14	87
51–60	7	6	94
61–70	4	4	98
>71	2	2	100
Total	*110*	*100*	

Note: The range between 1 and 20 was not selected by any of the respondents.

Table 4. Model Estimation Results for the Interval Regression Analysis

Variable	Description	Coefficient	Std. Error
Seriousness	Not serious (0) Highly serious (1)	0 (base) 39.281***	7.715
Working season	9 months or less (0) All year round (1)	0 (base) 10.213***	4.793
Experience in farming	More than 20 years (0) 20 years or less (1)	0 (base) –7.836**	3.759
Cultivated land size	40,000 square meters and more (0) Less than 40,000 square meters (1)	0 (base) –9.365*	5.209
Cultivated crops	Do not cultivate apples (0) Cultivate apples (1)	0 (base) 8.455**	3.896
	Do not cultivate vegetables (0) Cultivate vegetables (1)	0 (base) 7.056*	4.291
Access to wholesale market	No (0) Yes (1)	0 (base) 14.479**	7.038
Concern to postharvest loss	Low or no concern (0) Highly concerned (1)	0 (base) 9.121**	3.957
Number of workers	More than 3 (0) 3 or less (1)	0 (base) –11.795***	3.643
_cons		–18.84	13.7

Note: *Significant at $p<0.1$. ** Significant at $p<0.05$. *** Significant at $p<0.01$ Log likelihood= -199; 22 left-censored observations at price<=0; 88 uncensored observations; 0 right-censored observations

concern over postharvest storage and losses, are willing to pay significantly to have access to such a postharvest unit. Similarly, farmers who cultivate apples or potatoes and have access to wholesale market have a significantly higher willingness to pay. On the other hand, other variables such as level of experience, surface land cultivated, and number of people engaged in agriculture showed a negative sign with highly significant impact. This indicates that farmers who have less experience, as well as smaller cultivated land surface area and fewer household members engaged in agriculture, are willing to pay less to have access to the postharvest storage unit.

Table 5 presents the expected mean values of the WTP at each covariate level evaluated at the sample means of the remaining covariates, taking into account censoring at zero. Results are indeed in line with the interval regression model estimates reported above. Only across cultivated land sizes and types of cultivated crops were differences insignificant at the 5% significance level. For the remaining covariates, WTP values were significantly and sizably different across levels. Starting with seriousness, highly serious respondents had an expected mean WTP value that is nearly 10 times that of the less serious respondents, which validates the model and WTP findings. In terms of working season, respondents who work all year round reserve a WTP (~US$18/month) that is around 80% higher than those who work less than 9 months (~US$10/month). As for experience, results suggest that respondents who have farmed longer than 20 years have a WTP that is 55% larger than that of less experienced farmers. Interestingly, respondents with access to a wholesale market have a WTP that is more than double that of those who do not have access. This result no doubt arises from the added value that the two types of facilities would afford the farmer when offered together. Equally important is cultivated land surface areas, whereby farmers who cultivate approximately 10 acres (40,000 square meters) or more have a WTP that is higher than those who cultivate less, which indicates that WTP increases, as expected, with this indicator of farmers' wealth. Respondents highly concerned about postharvest losses have considerably higher WTP values compared to those who have low or no concern, lending further validity to the model. WTP values were also affected by the type of cultivated crops. For instance, farmers who cultivate apples and vegetables have a WTP that is about 54% higher than those who do not. Finally, farmers who employ more than three workers have a WTP that is nearly double that of those with less than three workers. Indeed, this suggests that higher variable costs associated with farming operations (labor and possibly other costs) are highly conducive to WTP for reducing postharvest losses.

What these results imply, in terms of policy, is that farmers highly value setting up refrigeration units along the lines proposed in this CVM survey. This is established by the fact that four-fifths of our sample would be willing to pay a substantial

Table 5. Expected WTP Values at Various Covariate Levels (US$/month)

Variable	Description	Margin	Std. Error
Seriousness	Not serious	3.18	2.58
	Highly serious	30.77	4.07
Working season	9 months or less	9.97	4.09
	All year round	17.55	4.76
Experience in farming	More than 20 years	16.57	4.9
	20 years or less	10.75	3.82
Cultivated land size	40,000 square meters and more	17.2[a]	5.79
	Less than 40,000 square meters	10.24[a]	3.36
Cultivated crops	Do not cultivate apples	10.54[a]	3.58
	Cultivate apples	16.82[a]	5.20
	Do not cultivate vegetables	11.00[a]	4.47
	Cultivate vegetables	16.25[a]	4.22
Access to wholesale market	No	8.66	4.71
	Yes	19.35	4.12
Concern to postharvest loss	Low or no concern	10.32	4.07
	Highly concerned	17.09	4.58
Number of workers	More than 3	18.21	5.07
	3 or less	9.47	3.55

Note: Margins sharing a letter (a) in the group label are not significantly different at the 5% level.

amount to access such a service. Moreover, our preliminary assessment of commercial refrigeration units that exist in the area suggests that in view of their monopolistic position, they are able to charge farmers storage fees as high as US$150 per ton per month. This is further proof that farmers are willing to incur large costs to acquire this service if they have to. Yet when contrasted to our empirical findings, the results indicate that farmers clearly suffer from prevailing market fees for cold storage that seem to be highly overpriced. Our study results, therefore, indicate the need to set up non-commercial refrigeration units on the grounds that they not only offer a critical added-value service to farmers, but also provide a 'public good' offered at discounted and/or subsidized price to help bring down general refrigeration costs in this area, especially for smaller farmers.

Conclusion

This study examines farmers' willingness to pay (WTP) to operate a common refrigeration unit to reduce postharvest losses, which was assessed by means of a farmer survey in selected municipalities in the Northern Bekaa district of Baalbek, a breadbasket of Lebanon. Using the contingent valuation methods (CVM), the results indicate that most farmers (72%) are highly concerned about postharvest losses, and 80% were willing to pay varying fees for the proposed initiative. Most stated WTP values were around US$25 per month (for nearly a third of the sample), while a considerable proportion of farmers (20%) were not willing to pay any fee. Having a high income associated with agriculture and having a high level of education were associated with high WTP. Similarly, farmers with more than 20 years' experience in farming have a WTP that is 55% higher than that of less experienced farmers. Equally significant, respondents who work all year round have a WTP that is around 80% higher than those who work fewer than 9 months. Other factors, such as type of cultivated crops, also affected farmers' WTP, whereby farmers who cultivate apples or potatoes with access to a wholesale market had a WTP that is more than double that of those who do not. A large cultivated land surface area was also a significant predictor of positive WTP, indicating that farmers' wealth is a significant driver of WTP. Results also suggest that higher variable costs associated with farming operations (e.g., number of laborers) are highly conducive of WTP for reducing postharvest losses. For instance, farmers who employ more than three workers have a WTP that is nearly double that of those with fewer than three workers. Finally, our study establishes not only the importance of refrigeration as a value-added service highly valued by farmers, but also that it is highly overpriced in the existing market, not least from the perspective of small-scale farmers. Therefore, this study recommends that this service be offered at discounted or subsidized prices to smaller farmers (by municipalities, for example) in order to help enhance the viability of their businesses. The importance of such a goal to agrarian and rural development cannot be overstated.

Acknowledgments

We greatly appreciate the municipalities of Baalbek District for their approval and assistance in sample selection and data collection. Special thanks are extended to Ms. Alam Janbein for her assistance during the data-collection process and her valuable discussions during data analysis.

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