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Chapter 3
The Diffusion Process of a New Cash Crop: A Case Study of Melon in Rural Myanmar

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Abstract

While Myanmar's agricultural sector is still dominated by extensive cultivation of traditional crops, melon production and exports to China recorded notable growth in the past two decades. Drawing on the survey of producers in a melon producing region, this chapter elucidates the process of how producers adopted the new horticultural crop. Characteristics of early starters are revealed as follows. First, they started melon cultivation on a small scale that allowed them to manage the high unit production costs of melon. Second, early starters tended to begin melon cultivation at younger ages compared with latecomers, implying their higher tolerance for the risk associated with the adoption. Third, knowledge spillover of cultivation skills occurred among villagers. Overall, the empirical results suggest positive externalities of melon cultivation on the adoption of fellow villagers, which validates policy interventions to support model growers of melon in wider areas for the transition of Myanmar's agriculture to the intensive horticulture.

Key Words: Adoption of new crops; Horticulture; Melons; Myanmar

1. Introduction

As Myanmar's agricultural sector still centers on cereals such as rice, beans, and oilseed crops, melon (*Cucumis melo*) is one of a few high-value horticultural crops in the country. Melon cultivation in Myanmar began in the mid-1990s, and its export-oriented production targeting the Chinese market has gained momentum since the mid-2000s. China's strong demand for counter-seasonal fruits pulled Myanmar's melon export that reached 125,000 tons in 2017, making it one of the major export crops of the country.

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With the rural economic institutions geared towards extensive cultivation of traditional crops, the transition to intensive cultivation of horticultural crops such as melons entailed various challenges on producers. This chapter aims to elucidate what institutional developments mitigated the obstacles for producers to adopt this new cash crop.

This paper is structured as follows. The next section illustrates the research methodology. It is followed by the section outlining melon cultivation in the research site. The main body of this chapter comprises of one section about the results of the producer survey and another on its empirical analysis. The following section discusses and interprets the empirical results. The last section summarizes the analysis and concludes.

2. Research methodology

Chaung-U Township in Monywa District of Sagaing Region was selected as the research site for our investigation of the process how the new horticultural crop was diffused in rural Myanmar. Chaung-U Township is known as the hub of melon production. According to the producer census of the Myanmar Fruit, Flower and Vegetable Producer and Exporter Association (MFVP) in 2017, the number of melon growers in the Mandalay and Sagaing Regions totalled 1,700 households in 2017, and the acreage totalled 13,000 acres. Of these, Chaung-U Township accounted for 800 growers and 7,500 acres of melon cultivation.

Our field research comprised of two steps. Firstly, the scoping study was conducted in November and December 2019 that covered three out of 27 village tracts in Chaung-U Township as well as government offices in Chaung-U town. It included interviews with the officials of Department of Agriculture, Department of Agricultural Land Management and Statistics, and Irrigation Department under the Ministry of Agriculture, Livestock and Irrigation (MOALI), and village administration offices. Key informant interviews included senior members of the producer association (MFVP), melon producers, intermediaries, and dealers of agricultural supplies

Secondly, based on the scoping study, Village K—one of three villages in Village Tract M in Chaung-U Township—was selected as the site for the producer survey in January 2020. This village is suitable for the present research as melon cultivation in Chaung-U Township spread from it. Furthermore, this village has a high concentration of melon growers; 260 households out of the 450 households in the village grew melons.

After a pilot survey, a questionnaire was designed to shed light on the process of the diffusion of the new horticultural crop. The sample is melon producers only. From the producer list prepared by the producer association, 120 were randomly selected to collect data on individual household attributes and their melon cultivation, of which the data of 99 households are available for the analysis in this chapter.

Specific questions of the survey include household characteristics at the start of melon cultivation such as the age of the grower, scale of initial cultivation, means of financing production costs, and channels of cultivation skill acquisition. It also covers the household information of producers, specifically, the number of workforce in their household, the status of farmland ownership, and the educational attainment of the household head. Furthermore, our questionnaire includes questions about the relationship with the brokers and their representatives. Other focuses of the questionnaire include the current scale of melon cultivation, uses of farmland rental, and seasonal migration for melon cultivation away from their native village.

3. Outline of melon production in Chaung-U Township

Adoption of innovations by farmers has been a critical policy issue for rural development. Existing literature examines innovations including high-yield rice varieties and chemical fertilizers, as well as agricultural machinery such as tractors (Feder et al. 1985). Farmers face a variety of barriers to adopting innovation, and those with capabilities to overcome these barriers have adopted innovations. In addition, policy interventions that reduce the barriers are sought to foster the diffusion of innovation. Identifying the obstacles in order to design effective policy interventions has important policy implications.

Feder et al. (1985) summarize the barriers for farmers to adopt innovations. First is the financial costs of adopting innovations. It sometimes requires a large investment, which deters farmers. Second is tolerance for risk as innovation such as high yield crops often entails more volatile yields. Third is the capabilities of farmers to master new technologies that are often knowledge-intensive.

In Myanmar, as the conventional agriculture has been the extensive cultivation of cereals, legumes and oilseed crops, horticultural crops are considered as innovation of which adoption would entail at least three challenges on producers. The first is the high production costs. According to statistics from the Department of Agriculture, MOALI, the production cost of melons is 20 times higher than those of oilseed crops—sesame and

sunflower—that are widely grown in the Central Dry Zone in place of melons. As Myanmar's rural finance is still underdeveloped, raising working capital to finance melon cultivation imposes challenges on growers.

The second challenge is the uncertainty of revenues. Traditional crops in Myanmar are non-perishable and suitable for storage, whereas horticultural crops such as melons are perishable, and their price tends to fluctuate due to changes in supply and demand in the market. Moreover, in the earlier years, when the distribution channel was not established well, its sales could be highly uncertain considering the perishable nature of the produce.

The third challenge is to acquire the skills required for cultivating horticultural crops. Cultivation methods of horticultural crops are distinct from those of extensive agriculture of traditional crops in rain-fed fields. Melon cultivation employs mulching with plastic sheets, drip irrigation, fertilization with water-soluble fertilizers, as well as pest management.

Regarding the three challenges in adoption of horticultural crops, our scoping study in Chaung-U Township in December 2019 revealed the following facts. First, in 1995 the farmer-training program by the United Nations Development Programme (UNDP) aimed at the diffusion of horticultural crops in the Central Dry Zone for improvement of rural livelihood. The UNDP project dispatched four farmers to Chiang Mai, Thailand to attend a three-month training course in horticulture such as tomato, watermelon, and melon. One of the four dispatched farmers was from Chaung-U Township. After returning from the training course in Thailand, the project guided him to launch a demonstration farm for two years, where the total number of 160 farmers learned horticultural cultivation. However, the immediate result of the project was not encouraging. The high cost of melon cultivation discouraged them from growing the crops on a commercial scale. Moreover, sales channels had not been established in the 1990s.

The UNDP project eventually stimulated melon cultivation in an indirect way; a farmer from Village K—the site of our survey—hired an agricultural laborer of the UNDP demonstration farm and began cultivating tomatoes, watermelons, and melons on a small scale. This agricultural laborer transferred the cultivation skills to the employer. The pioneer farmer also had an acquaintance with a merchant native of Chaung-U Township who engaged in trading business in the town of Muse in Myanmar-China borderland who sold melons to buyers from China. The knowledge spillover from the pioneer farmer to

his fellow farmers in and nearby Village K bolstered melon cultivation in Chaung-U Township from 1997 onwards.

Village K is also blessed with two geographical conditions suitable for melon cultivation. Melon is prone to replant failure. As melon cultivation changes the balance of microorganisms in the soil, repeated cultivation on the same land makes the crop more susceptible to disease and lowers the yield. In this village, the annual flooding of the Chindwin River during the rainy season from July to October replenish nutrients in the soil, which makes the village suitable for continuous melon cultivation. The floodplain of Chaung-U Township covers 13,000 acres including the farmland in Village K.

In addition, the melon plants and fruits are vulnerable to fungal diseases coming from moisture, so the little rainfall in the Central Dry Zone is suitable for melon cultivation. The average annual rainfall in this region is approximately 700 mm, which is the lowest around the country. During the post-monsoon season from October to April, the rainfall in this region is almost zero.

Another key factor that boosted farmers' adoption of melon is fruit brokers in Muse, a town adjacent to Yunnan province of China. Brokers operate fruit auctions for buyers visiting from mainland China to Muse. In the late 2000s, a group of fruit brokers set up a large wholesale market under auspices of the then military government of Myanmar. Currently, there are more than 80 brokers operating auctions in the wholesale market. Some of these brokers have turned from melon producers in Chaung-U Township. As long as melon producers send fruits to Muse, brokers will find a buyer.

While brokers in the borderland are located is 600 km away from Chaung-U Township, their representatives in the melon producing villages link them with producers. Brokers nominate as their representative those experienced farmers in melon cultivation. Through representatives, brokers provide producers with inputs such as seeds and fertilizers on credit, for which the representatives manage screening and monitoring of producers. The representatives ensure producers to sell harvested fruits to the brokers, which allows the brokers to collect repayments from producers. The representatives can closely monitor producers through the personal network in the village, which alleviate asymmetric information between lenders (brokers) and borrowers (melon producers) and smoothen credit supply.

This distribution system employing representatives is convenient not only for brokers but also for producers. Inputs offered on credit through brokers' representatives are a means of financing a portion of the expensive melon production costs. In addition, producers can easily secure the sales channel of the crop through the representatives. In

addition, the representatives of brokers also instruct new producers who are unfamiliar with melon cultivation skills. In other words, the broker/representative system has become one of the channels for knowledge spillover.

Other notable aspects of melon cultivation include (1) the land rental system and (2) agricultural workers. Because melon is an annual crop and its vegetation period is as short as four months, cultivation using temporary rental of farmland is common. Producers take advantage of the high profitability of melon to offer high rents, which enables them to expand the scale of cultivation using leased farmland. Rent is typically set at a level that exceeds the net profits that the landowners can obtain from their conventional crops.

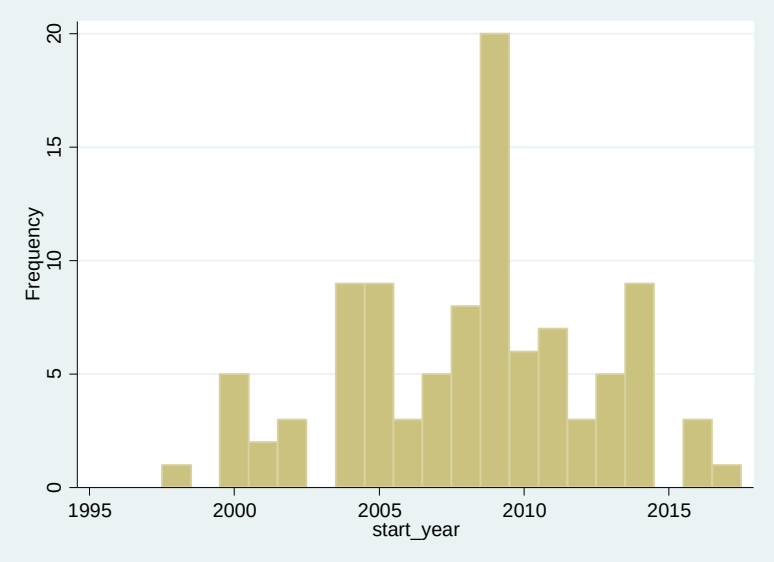
At the same time, melon cultivation employs a large number of agricultural laborers. This is because cultivation is more labor-intensive than conventional crops, and if the cultivation area exceeds 2 acres, family labor alone cannot cover it. Furthermore, as agricultural laborers who have accumulated melon cultivation skills move between producers, they serve as catalysts of knowledge spillover. New growers in melon cultivation may employ skilled agricultural laborers to acquire the techniques.

4. Results of the survey

This section summarizes the results of the survey to illustrate the process of how melon cultivation diffused in Chung-U Township. Particular focuses are on three points: (1) timing of producers' adoption of melon cultivation, (2) channels of cultivation skill acquisition, and (3) characteristics of households that started melon cultivation in earlier years.

First, the start years of melon cultivation is distributed as in Figure 3-1. There is a small peak around 2005 and then a large spike in 2009. As the answers of the survey respondents relied on their recall, a large number of them replied that they started production ten years ago, which yielded a peak of start year in 2009.

Figure 3-1 Distribution of the start year of melon cultivation.



Source: Own survey.

Second, Table 3-1 summarizes channels whereby producers acquired the skills necessary for melon cultivation. This table tabulates the results of the survey separately for landless households and farmers (households with land). Myanmar is known for its unequal distribution of agricultural land, and many landless households exist in rural areas. Landless households often engage in agricultural work such as paddy transplanting and harvesting as well as earn income from miscellaneous jobs in the rural economy. In our survey, 24 melon growers were landless households, and half of them acquired the skill through working as agricultural laborers in melon farms. On the other hand, out of 75 farmers, 80% of them have learned the skills by observing forerunners or receiving guidance from them. In other words, it can be seen that knowledge transfer from producers to producers occurred widely. By contrast, no producer pointed out the institutional training of the Agricultural Ministry or Non-Governmental Organizations (NGO) as a means of initial skill acquisition.

Table 3-1 Channels of cultivation skill acquisition

	Landless household	Farmer	Total
1. Working as agricultural laborer	12	5	17
2. Observation of other growers	5	27	32
3. Instruction by fellow growers including representatives of brokers	6	33	39
4. Sharecropping	0	2	2
5. Training by suppliers (dealers of fertilizers and pesticides)	1	8	9
6. Training by government or NGO	0	0	0
Total	24	75	99

Source: Own survey.

Third, regarding the primary financial sources utilized for their melon cultivation for the very first time, 66 respondents pointed out loans and input supplies on credit by brokers via their representatives in the village. Six respondents answered loans from relatives and acquaintances, while the remaining 27 respondents answered that they managed the initial expenses with their own savings. When brokers grant credit to producers via representatives in the village, they set a grace period up to two years if producers cannot make repayment due to crop failure. Given the profitability of melons, it is thought that the revenues from normal harvest in a year would exceed the total costs of melon cultivation for three consecutive years.[2]

Next, to show differences, if any, between those who started melon cultivation earlier and those who started later, Table 3-2 tabulates household data by grouping of cultivation start years: the early starters and the latecomers. First, between two groups, there is no statistically significant difference in terms of farmland ownership or the probability of self-financing. The proportion of landless households is close between the early starter and the latecomer groups. In addition, the proportion of the self-financing growers is not necessarily higher for the early starter group.

[2] Interview with a representative of a broker in December 2019.

Table 3-2: Comparison of melon producer household characteristics by the start year of melon cultivation

	Melon start before 2006		Melon start in 2007 and onward
No. of growers	32		67
Dummy variable			
Initial finance: self-finance	0.312		0.253
Land: landless	0.253		0.218
Landholding, total (acre)	7.75		9.7
Landholding in flooded area (acre)	3.36		3.22
Initial melon cultivation size (acre)	1.66		1.77
Current melon cultivation size (acre)	15.45	**	9.84
Age at initial melon cultivation (years old)	33.5	***	40.1
Labor force			
Men (persons)	1.86	**	1.45
Men and Women (persons)	3.34		3.04

Source: Own survey.

Note: *** and ** stand for the null hypotheses that two groups have the same mean value are rejected by the statistical significance level of 1% and 5%, respectively.

On the other hand, the early starter group producers tended to commence melon production at younger ages. The results are consistent with our conjecture that melon production was perceived as a risky business in earlier years and that younger producers had higher tolerance for risk to carry it out.

Moreover, those in the early starter group have a higher number of male workforce within household compared with those of the latecomer group. On average, melon growers started melon cultivation on a small scale less than 2 acres, and they gradually expanded the cultivation size. For their initial melon cultivation, a household with more male workforce seems to have had some advantage in starting melon cultivation as they could meet the labor needs with household members. It might be the case that such household labor was substituted by agricultural laborers as melon cultivation spread across the village.

Finally, the current cultivation size of the early starter group is statistically significantly higher than that of the latecomer group. This is again consistent with our

conjecture that melon producers started melon cultivation on a small scale and gradually increased the cultivated size by re-investing the profits.

5. Empirical analysis

To shed light on the process of how melon cultivation spread among the households in Village K, simple regression analyses were performed as shown in Table 3-3. The first estimate is a probit regression to identify the characteristics of early starters. The dependent variable is a dummy variable indicating whether the household had started melon cultivation by 2006 (Yes = 1; No = 0). The explanatory variables include the landholding size, the age of the principle melon grower at the start of melon cultivation, the number of male workforce in the household, and the educational attainment of the household head.

Table 3-3: Estimation results

Regression	Probit		OLS		Probit	
Dependent variable	Cultivation before 2006 (Yes=1, No=0)		2019 cultivation size		2019 migration (Yes=1, No=0)	
	Marginal effect	z-value	Coef.	p-value	Marginal effect	z-value
Land size in flooded area	-0.006	0.509	1.106	0.000	0.033	0.008
Age at start of melon cultivation	-0.021	0.000				
Duration of melon cultivation			0.528	0.072	0.014	0.205
No. of men in household	0.192	0.001	0.031	0.982	-0.007	0.885
Education of household head	-0.014	0.782	0.273	0.768	-0.015	0.764
Constant			1.588	0.708		
No. of obs.	99		99		99	
R-squared			0.142			
Pseudo R2	0.164				0.064	

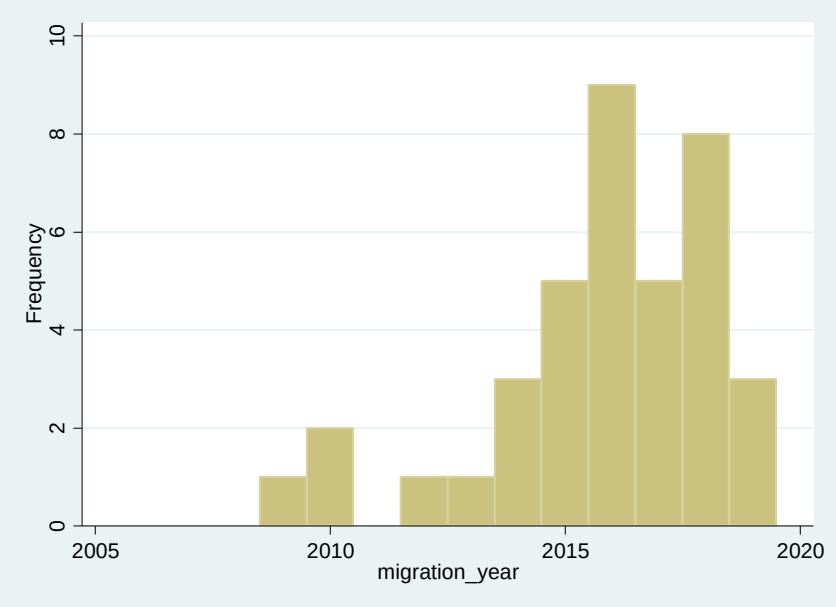
Source: Author's compilation.

The result of the regression is consistent with our observation of the descriptive statistics. Growers who began melon cultivation before 2006 often did so at younger ages. It can be inferred that in its early years, melon cultivation was considered a high-risk investment so that older people with less risk tolerance were less likely to grow melons than younger people were. Moreover, those households endowed with more male workforce tended to start melon cultivation in earlier years. In the initial stage of melon cultivation for each household, the cultivation scale was mostly less than 2 acres, so that family labor was the main labor force. The use of family labor allowed melon growers to retrench expenditures for agricultural laborers. Finally, the educational attainment of the household head is not correlated with the timing of the adoption of melon cultivation.

The second estimation employs Ordinary Least Square regression to examine the relationship between the current melon cultivation size of a household and its demographic and economic characteristics. The estimation result indicates that the cultivation size tended to increase as producers had more extended experience in melon cultivation. Apart from that, the current cultivation size was significantly positively correlated with the landholding size. It should be noted, however, that on average, their current cultivation size is larger than their landholding size. As shown in Table 3-2 in the previous section, the average landholding size is below 7.75 acres for the early starter group, while the average of their current cultivation size is 15.45 acres. These as a whole suggest that, regardless of whether farmers use it for melon cultivation themselves or lease to other growers, farmland in the flood zone brings in liquidity that helps growers to expand their cultivation.

The third regression analyzes producer behavior as to seasonal migration for melon cultivation outside Chaung-U Township. Melon growers have been expanding their cultivation size as they gain experience. As melon cultivation has congested in the flood plain in Chaung-U Township, an increasing number of producers have chosen to temporarily migrate to other townships for melon cultivation (Figure 3-2). As of 2019, such seasonal immigrants reached 32 out of 99 sample households.

Figure 3-2: Distribution of seasonal migration start year



Source: Own survey.

In this probit regression, the dependent variable is a dummy variable which takes the value of 1 when a melon producer cultivated melon outside of Chaung-U Township in 2019 season, and zero otherwise. The probit regression of migration indicates that the area of farmland in the flood zone is positively correlated with migration. This can be interpreted that the cash flow obtained by renting the farmland facilitates their seasonal migration for large-scale melon cultivation away from their native village.

6. Discussion

Several implications can be drawn from the empirical analyses. First, melon growers included both farmers (households with land) and landless household. Among melon growers, the landholding size was not a significant determinant for households whether to start melon cultivation in earlier years. In the existing literature (Feder et al. 1985), landholding is considered as an influential factor on the adoption of new technologies or new crops since it is correlated with the capacity of a household to finance the adoption cost. As far as melon is concerned, growers would start cultivation in a small scale less than 2 acres, and brokers would provide inputs on credit, so that landholding or self-financing capacity might be less influential on whether they start melon cultivation earlier

or not. Furthermore, for some landless households, melon provided an opportunity for them to grow crops on their own account, which raised their income.

Second, early starters tended to enter melon cultivation at younger ages compared with latecomers. This can be interpreted as that younger people had higher tolerance for risks associated with melon cultivation. As the forerunners verified the profitability of melon cultivation, latecomers entered it at their older ages. As such, it can be argued that the success of forerunners stimulates the adoption of new cash crops among fellow farmers.

Third, knowledge spillover among producers was evident. The result of the regression relating to the starting year of melon cultivation is that the educational attainment of the principle melon producer in the household was not statistically significantly correlated with an earlier start of melon cultivation. This result implies that the knowledge for melon cultivation has been shared among villagers.

Furthermore, the analysis suggests that melon cultivation has an agglomeration effect. As melon cultivation spreads in the village, some of the producers served as representatives of brokers and encouraged fellow villagers to enter melon cultivation. In fact, melon cultivation is more concentrated in Village K than the neighboring villages located on the floodplain with a similar geographical endowment. However, the concentration of melon cultivation also has a congestion effect, leading to the seasonal migration of villagers for melon cultivation outside Chaung-U.

7. Conclusion

In the past two decades, taking advantage of China's strong demand for counter-seasonal fruits, export-oriented melon production spread rapidly in the Central Dry Zone of rural Myanmar. This chapter examines the process of how smallholders adopted the horticultural crop that was entirely new for them. In particular, the adoption of this new crop is considered to have entailed three challenges, namely the high production cost, uncertainty of the revenues, and the new skills necessary for cultivation. The chapter elucidates the institutional development that has mitigated these challenges in producers' adoption of the new cash crop.

Major findings from our survey of melon producers in a village of principal melon producing area are summarized as follows. First, growers started melon cultivation on a small scale and expanded production gradually by re-investing the profits. Starting

farming on a small scale facilitated adoption in the face of the high unit production costs of melon. Second, among melon producers, early starters tended to begin melon cultivation at younger ages, which implied their higher tolerance for the risk associated with the adoption of the new crop. Latecomers starting melon cultivation at older ages might be assured of melon profitability by forerunners who also linked them with fruit brokers as well as transferred cultivation skills to them. Third, knowledge spillover between villagers underpinned the adoption of melon cultivation.

The findings above suggest agglomeration effects of melon cultivation; the more producers adopt melon, the further it boosts the adoption in that area. This is consistent with our observation that melon cultivation concentrates more in a village than others with a similar geographical endowment. Such positive externalities of melon cultivation might justify policy intervention to support model growers of melon in various villages for promotion of melon cultivation.

References

Feder, G., R.E. Just, and D. Zilberman (1985) Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change* 33(2), 255–298.