FACTORS DETERMINING THE ADOPTION OF PRUNING AND BAGGING BY MAJOR MANGO PRODUCERS IN THE PHILIPPINES

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ABSTRACT

A total of 332 mango growers and contractors were interviewed about their attitude towards pruning and bagging. Grouped as adopters and non-adopters, the respondents were categorized as to age, experience in mango production, educational attainment, household income, and membership to organization. These characteristics along with economic, physical, technological and institutional factors were analyzed using probit analysis to determine their influence on the probability of adopting the technologies.

Trees grown in Luzon and Visayas were older than those in Mindanao, hence the negative effect on adoption of pruning and bagging. With regard to pruning the coefficient for number of trees grown was positive, indicative that respondents with a higher number of trees had a higher probability of adopting pruning.

Seven variables were found to have significant influence on the probability to adopt bagging among all respondents. The presence of technical assistance was the most significant predictor. In areas where technical assistance could not be adequately provided mango growers would remain ambivalent on adopting the bagging technology. The rate of adoption was higher in Visayas and Mindanao than in Luzon. A separate function for Luzon showed that the age and education of the respondents were negative and positive, respectively, contrary to the result of the adoption function for all respondents. Two other important determinants were household income and cost of chemical control. The coefficients were positive, as expected *a priori*. Bagging is expensive, thus, producers with more income have higher probability of adoption. Adopting will further be enhanced if the price of chemical control will continue to increase in the local market. Thus, pricing mechanism that would make the cost of chemical control more expensive relative to the cost of bagging could be an important instrument to increase bagging adoption.

Keywords: pruning, bagging, mango, adoption, determinants of adoption, probit analysis

1. INTRODUCTION

Carabao mango, popularly known as Manila Super Mango, is one of the most important fruit crops in the Philippines. Its fruit, sold fresh or in processed forms, is highly in demand both in the local and export market. While Philippine mango is considered a multi-million dollar export industry, it can not be denied that the industry is beset with problems specifically of how to sustain production of high quality fruits that could compete in the world market.

Cognizant of the bright prospects of the mango industry, the agricultural research organizations in the country continue to search for ways and means to further increase the productivity and reduce post-harvest losses. These efforts have resulted in the development of specific technologies or farm practices that are now being adopted, albeit to varying extent by mango growers and traders.

Several studies have been conducted in the past in an attempt to identify the characteristics of farmers as well as the other factors that have directly or indirectly influence adoption of recommended technologies but not on pruning and bagging technologies in mango production, hence this study was conducted.

Results of this study can provide evidence as to what factors can influence technology adoption, which in turn can be used by program planners and implementers in developing programs that will further enhance the mango industry. Specifically, results can be used as the basis for developing communication strategies in disseminating information on the recommended mango technologies.

2. METHODOLOGY

A total of 332 growers and contractors in top mango producing provinces in Luzon, Visayas and Mindanao were interviewed using ar interview schedule as guide. Secondary data were also obtained from key informants through focus group discussions. **Table 1** shows the number of respondents by group and location.

Table 1. Number of respondents by technology adoption and location

Location	Technology Adopters					
	Pruning only	Bagging only	Both pruning and bagging	All pruning adopters	All bagging adopters	Non-adopters
Luzon	17	6	28	45	36	45
Visayas			52		164	112
Mindanao			66		70	4
Total	17	6	148	165	270	159

Descriptive analysis was done on the physical, socio-economics, institutional and technological factors that have a priori effects on the adoption of pruning and bagging technologies in the study sites.

The process of technology diffusion was evaluated; as to period when the technologies were first learned and adopted initially and on continued basis. The extent of technology adoption was evaluated by comparing what are recommended and what were practised by the adopters.

The extent of the effects of socio-economic, physical, institutional and technological factors to the probability of adoption was determined using probit analysis. Probit analysis was used because the dependent variable is dichotomous: 1 if bagging or running was adopted and 0 if the technology was not adopted. A linear regression was not used in the study because of the heteroscedastic error problem that could arise when using values 0 and 1 limit. Because the

distribution function of the probit model is bonded between 0 and 1, the estimated probabilities using the model are presumed to be within a realistic range. Probability values were estimated using the software Econometric Views.

The empirical model used was of this form:

$$Y_1, Y_2 = \alpha_0 + \alpha_1 \text{ Age} + \alpha_2 \text{ Educ} + \alpha_3 \text{ Income} + \alpha_4 \text{ Years} + \alpha_5 \text{ Age tree} + \alpha_6 \text{ Total trees} + \alpha_7 \text{ Tech attributes} + \alpha_{18} \text{ Distance} + \alpha_9 \text{ Location dum} + \alpha_{10} \text{ Price} + \alpha_{11} \text{ Tech assist} + \alpha_{12} \text{ Labor source} + \alpha_{13} \text{ Costchem} + \alpha_{14} \text{ Cost fert} + \varepsilon$$

where:

Y_1^1	=	Adoption of pruning technology; 1 if adopted, 0 otherwise
Y_2	=	Adoption of bagging technology; 1 if adopted, 0 otherwise
Age	=	Age of respondents in years
Income	=	Household income in 2002 from all sources
Years	=	Years in mango production
Age tree	=	Age of trees in years
Total trees	=	Total number of trees grown or managed
Distance	=	Distance o planting, 1 if ≤ 8m x 8m, 0 otherwise
Tech attribute	=	Technology attributes of pruning or bagging as perceived by respondents
Location dum	=	Location dummy; 1 for Luzon and 0 otherwise
Price	=	Price of mango in pesos per kg
Tech assist	=	Presence of technical assistance, 1 if there is available technician and 0 otherwise
Labor source	=	Source of labor in pruning or bagging, 1 if within the locality and 0 otherwise
Cost chem.	=	Cost of chemical control in pesos per tree
Cost fert	=	Cost of fertilizer in pesos pe hectare
ε	=	Error term

3. RESULTS AND DISCUSSION

Pruning as a Technology in Mango Production

The recommended pruning technology

Mango is prone to attack by insects at all stages of development. Mango producers prefer to use chemical control primarily because of ease of application. The deleterious effects of chemicals on human beings and the environment has led research and development agencies to institute measures or control program that include destroying pests through judicious use of chemicals coupled with sound cultural management practices.

Pruning is one of the recommended technologies. It involves the removal of crowded and unnecessary branches including weak or pest and disease infested parts. Pruning improves light penetration, air circulation and discourages disease infestation. Pruning is recommended after harvest particularly during dry periods.

Pruning as a technology in mango production was first advocated in the 1940's in all locations but it was only in 1960's when the first adopters in Luzon, Visayas and Mindanao started practicing it. However, the number of adopters increased slowly but steadily only after one or two decades. This implies that most mango growers did not find the need to prune until trees were larger, the canopies closer to one another, had been infested by insects or diseases, or had been producing lower yields.

There are three pruning techniques such as conventional, center pruning and traditional pruning. Conventional pruning involves the cutting of small branches inside the canopy to facilitate the penetration of sunlight. Center pruning involves cutting of big branches at the center of the canopy and the remaining branches around the canopy. Center pruning results in better sunlight penetration at the center that promoted new twigs and flushes at the lower branches near the center. The technique also results in dwarfing that makes management of trees easier. On the other hand, traditional or sanitary pruning only involved cutting of dead or unproductive branches. Adoption of these techniques varied by location. About three quarters of the respondents in Luzon and Visayas reported conventional pruning, while 47 percent from Mindanao reported center pruning. Although the proper period for pruning trees and treatment of cut branches are important, less than 50 percent of the pruning adopters performed these practices, basically due to lack of information.

The attributes of pruning as a technology in mango production was perceived favorably by majority of the respondents. They were aware of its relative advantages, ease of application, compatibility with existing practices, environmental soundness, and trialability on a small-scale basis. However, more than 50 percent of the respondents from Luzon and Visayas did not practise pruning mainly because of lack of information, difficulty and riskiness of pruning century-old trees while others simply were not interested. Again, the reasons given by the respondents could imply insufficient knowledge on the proper procedures for pruning much less its advantages.

While the government technicians were cited by the respondents from Luzon as the major source of information about pruning technology, a significant proportion of respondents from Visayas and Mindanao gained the information from their friends and co-farmers. This could be one of the reasons for the differential adoption of the technology. Moreover, the possibility that the information they obtained could be incomplete cannot be discounted.

Bagging as a Technology in Mango Production

Bagging as a technology was already known to mango growers in Visayas and Mindanao as early as the 1970's, whereas in Luzon one farmer claimed to have known the technology a decade later (1980's). It took almost two decades, before the technology was actually put in practice. Bagging is not widely practiced in Luzon because of lack of trained baggers in contrast to Visayas and Mindanao where most of the fruits are bagged.

Bagging of fruits as per recommendation should be done 55 to 60 DAFI. At this stage, fruits are the size of a thumb or a teaspoon and still free from damages from pests and diseases. However, a number of farmers especially in Visayas bag at 45 to 50 DAFI, particularly when incidence of insect pests like cecid fly, capcid bug or mirid bug is relatively high. While early bagging can ensure a lower probability of damages from pests and diseases, a higher percentage of fruit dropping is likely occur.

While baggers in Candelaria, Palauig, Sta. Cruz, and Masinloc in Zambales have acquired the skills from relatives who were trained by baggers from Cebu, skilled baggers are still very few in Luzon. In fact in Pangasinan, baggers are hired from Zambales. Even mango growers from Zambales hire baggers from Cebu until recently. The lack of trained baggers in Luzon is indicative of the limited training opportunities given to interested individuals to develop such skill.

Determinants of Adoption of Pruning Technology

Probit analysis was done to estimate the effects of the different variables in the probability of adopting the pruning technology.

As shown in **Table 2**, the Mindanao dummy was positive and highly significant, whereas Luzon dummy was negative and insignificant. This means that the location of mango production have differential effects on the adoption of pruning. Mango producers from Mindanao have higher probability to adopt pruning technology than those in Luzon. The difference in adoption by location could be attributed to varying physical conditions of the mango farms and trees.

The respondents' age and educational attainment were also positive and significant. As the respondents grow older, it is plausible that they become more experienced and rational decision makers in mango production. Moreover, with higher education, they have better knowledge and understanding of the proper techniques to attain optimum benefits from pruning. Thus older mango producers with higher education have higher probability of adoption.

Age of trees was also significant but negative implying that owners of older trees have lower probability to adopt pruning technology than those with younger trees. Older trees are higher and are therefore riskier and more difficult to prune. Mango trees in Luzon and Visayas are significantly older than the trees of the respondents in Mindanao. This probably explains the lower adoption of pruning in Luzon and Visayas than in Mindanao.

Table 2. Probit analysis showing the variables affecting the probability of adopting pruning technology in mango production, all locations

Variables	Coefficient	t-value	Log likelihood
Intercept	-3.1969 ***	-3.8250	
Luzon	-0.6057	-1.4782	
Mindanao	1.5738 ***	4.3175	
Age	0.0229 **	1.9749	
Educational attainment	0.3695 **	2.5178	
Years in mango production	-0.0096	-0.8596	
Household income	-0.0000	1.0094	
Age of mango tree	-0.0091 **	-2.1806	
Total number of trees	0.0025 **	2.3522	
Distance of planting	-0.4480	-0.7551	
Presence of technical assistance	0.2913	1.0510	
Cost of chemicals	0.0001	0.2437	
Cost of labor in spraying	0.0003	1.2844	
Price of mango	0.0266	1.5141	
Compatibility to existing practice	2.9063 ***	6.9743	
			-96.18

*** Significant at 1 percent level
** Significant at 5 percent level

On the other hand, the number of trees owned or contracted by the respondents was positive Respondents with more number of trees have higher probability to adopt prunning. This is highly plausible especially if the trees are planted close to each other since pruning is required to improve ventilation and sunlight penetration.

The compatibility of pruning technology to the existing practices among other attributes have greater effect on the propensity to adopt pruning, hence the significant and positive coefficient. This supports the observation that Filipino farmers are less likely to adopt technologies requiring major changes in existing practices.

Determinants of Adoption of Bagging Technology

The same procedure to identify the determinants for pruning technology was done for bagging. Estimates was done for all locations, and a separate probit function was estimated for Luzon.

The estimate for all data in all locations are presented in **Table 3**. Seven variables were found to have significant to highly significant influence on the probability of adoption of bagging technology. These are age, education and years in mango production, and number of trees, price of mango and presence of technical assistance. Age of respondents and presence of technical assistance have positive MLE coefficients, while education of respondents, price of mango, number of trees and years in production have negative coefficients.

The presence of technical assistance is the most significant predictor of the mango producer's probability to adopt the bagging technology as indicated by the highest MLE coefficient. Understandably, mango growers will have the interest to do bagging, and hire skilled baggers, if they know the advantages the technology could provide in mango production. The technical assistance by experts could increase the likelihood of adopting the technology. Bagging

requires skill, thus the presence of experts and trained labor is important for the technology to be adopted. Bagging if done improperly can increase fruit dropping that could result in lower productivity. The experts are the source of information and knowledge on bagging technology, hence, their availability in the locality could promote information dissemination about the technology and consequently influence adoption.

Table 3. Probit analysis showing the variables affecting the probability of adopting bagging technology in mango production, all locations

Variables	Coefficient	t-value	Log likelihood
Intercept	1.6007	1.8043	
Age of respondents	0.0299 **	2.1362	
Educational of respondents	-0.4693 ***	-3.0229	
Years in mango production	-0.0582 ***	-4.1634	
Household income	0.0000	1.1669	
Age of mango tree	-0.0081 **	-2.1994	
Tota number of trees	-0.0023 *		
Presence of technical assistance	1.5369 ***	6.0858	
Price of mango	-0.0515 ***	-3.2775	
Cost of chemical control	0.0009	1.4352	
			-85.4948

*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Age of mango trees is associated with a negative coefficient, a similar situation seen with the pruning technique. The number of fruits increases with age of trees, but as trees get older they become larger and riskier to climb, hence more costly to do bagging technique.

Meanwhile, the respondents' education and years in mango production had negative MLE coefficients on the adoption of bagging technology. With longer experience in production, mango producers have acquired knowledge and skills to protect mangoes from pests and diseases through other means of control other than bagging. Even without bagging, higher productivity and good quality fruits can be attained through application of other management practices that they have known or acquired from years of experience in production. The resulting negative coefficient for education could be attributed to mango producers from Visayas and Mindanao who are less educated than their counterparts in Luzon, yet the rate of adoption of bagging technology is higher in these two areas than in Luzon. This implies that it is not education nor experience that could increase the likelihood of adoption..

Determinants of Bagging Technology in Luzon

Adoption of bagging technology was relatively lower in Luzon than in Visayas and Mindanao. Analysis of the determinants of adoption in Luzon was necessary to be able to understand the factors that could enhance adoption. Thus, this section presents the probit function for bagging adoption for Luzon.

The age of respondents and number of trees have significant but negative effects on the adoption of bagging technology among mango producers from Luzon (**Table 4**). Whereas,

education and income of producers, as well as the cost of chemical control in production have positive effects. Results showed dissimilarity in the signs of some of the determinants of bagging adoption in Luzon with that of the adoption function estimated for all location as shown in **Table 3**.

While age of respondents and education are both significant in both probit functions, the signs however are opposite. Age of respondents is negative and education is positive for the Luzon function. This implies that younger producers in Luzon are more likely to adopt bagging technology than their older counterparts. Moreover, those who have higher education are more likely to adopt the technology than those who are less educated. The number of trees is also negative and significant in the probit function for Luzon, similar with the result of the adoption function for all areas.

The two variables found significant (at 95% level) in the Luzon function but not in the estimated function for all areas were household income and cost of chemical control, with signs as expected *a priori*, i.e., positive. Mango producers with higher income have higher probability to adopt bagging technology. Producers with higher income could more likely afford financing production activities including bagging in mango. Bagging, especially the cost of labor, is relatively costly. Thus, the added cost of bagging could be financed by producers with higher income.

Cost of chemical control is likewise positive. One of the most important inputs in pest management of mango is pesticides consisting of insecticides and fungicides. Producers in Pangasinan and Zambales spray a mango tree with pesticides at least seven times per season to ensure fruit development and good harvest. The real price of chemicals have been increasing through time (David, 1999). More so, the price of individual brands in Region III and the entire country from 1993-1999 had been increasing (Orden, 2002). In fact, result of Orden's (2002) analysis revealed that retail prices of a number of insecticides in Region III is about P100/li higher than the average price for the country in general. Moreover, the price of chemicals is not expected to decrease in the future considering this trend and the highly volatile peso-dollar exchange. Given this scenario, mango producers will increase the likelihood of adopting bagging and other mechanical methods to control pests of mangoes to reduce cost of pest management in the future.

Table 4. Probit analysis showing the variables affecting the probability of adopting bagging technology in mango production, Luzon

Variables	Coefficient	t-value	Log likelihood
Intercept	-8.3819	-1.5524	
Age of respondents	-0.1464 *	-1.7049	
Education of respondents	2.2765 **	2.1356	
Years in mango production	0.1178	1.5694	
Household income	0.0000 **	2.6048	
Age of mango tree	-0.0077	-0.5744	
Total number of trees	-0.0097 *	-1.7293	
Distance	1.1049	0.0030	
Cost of chemical control	0.0016 **	2.0066	
Price of mango	0.034	0.0597	
Presence of technical assistance	1.7329	1.4088	
Technology advantage	10.0533	0.6957	
Triability of the technology on small scale	-0.9334	-0.4061	
Compatibility1	3.5876	0.1914	
Compatibiliy 2	7.8769	0.4197	
Easiness of technology to follow	7.6755	0.4272	
Health xof workers are not threatened	-9.9362	-0.9731	
Environment safe	3.0601	1.2633	
			-19.4304

*** Significant at 1 percent level
** Significant at 5 percent level

4. RECOMMENDATIONS AND POLICY IMPLICATIONS

The availability of technical assistance is one of the most important factors to enhance the probability of adoption of bagging technology. Greater technical assistance could be provided if mango producers are organized. Therefore, more impetus should be given by the government and the private sector in motivating farmers to organize themselves into a cooperative or organization. The cooperative could serve not only as a conduit for important support services (credit, marketing, and technical assistance among others) the farmers could get from the government or private sector, but could also effect a stronger bargaining power for the price of their products, whether sold to buying stations or to local markets.

Since one of the barriers to adoption of bagging technology is the lack of trained baggers locally, opportunities for training interested individuals should be provided. This is especially true in Luzon where there are few skilled baggers.

Most of the fruit bearing trees in Luzon and Visayas are big, tall and relatively old in which different pruning techniques are less applicable. Research on more appropriate pruning techniques for these trees should be conducted. Moreover, present techniques should be widely disseminated among growers in areas which are newly planted with mango trees.

Considering the risk involved in pruning or bagging big/tall mango trees, local manufacturers should be encouraged to design and manufacture low-cost but durable structures to be used in reaching branches to be pruned and fruits to be bagged. Moreover, access to life or accident insurance among workers should be looked into.

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