

Effects of Community-Based Farming on the Productivity and Profitability of Mango (*Mangifera indica*, Linn.) in Bataan, Philippines

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Abstract – The Science and Technology community-based farming of mango in Bataan aimed to promote the adoption of science - based interventions for increased mango productivity and profitability. This 2-yr project applied the appropriate integrated crop management protocol for mango farming including sanitary/corrective and center pruning, paclobutrazol application, fertilization, flower induction, need-based spray program, bagging, and field sanitation. Fifteen mango farms participated in this project; seven in Balanga cluster (mean number of tree = 83) and eight in Abucay cluster (mean number of tree = 140). After two production cycles, the project significantly improved the mango production in two farm clusters, with a mean yield increase of 231.54% (3.36 kg ha⁻¹ to 7.78 kg ha⁻¹). Moreso, significant highest mean yield was achieved in the 2nd year, albeit the mean total yield between the two farm clusters was not significantly different ($P > 0.05$). The mean net income was significantly increased by 470.46%, valuing from \$ 216.30 to \$1,1017.64 (1\$ = Php 53). Mean net income was not statistically different between farm clusters ($P > 0.05$). This study demonstrated the potential of Science and Technology community-based interventions as an effective strategy for improved mango farming, which can be adopted by local mango farmers in the Philippines.

Keywords – Mango Production, Community-Based Farm, Integrated Crop Management, Technology Transfer.

I. INTRODUCTION

In terms of production, Mango (*Mangifera indica*, Linn.) is one of the priority commodities of the Philippines as well as in the province of Bataan [13]. It is considered as one of the most important export crops of the country based on export volume and value with promising outlook and opportunities [14]. Mango production paved the way through fast expansion of growing areas in commercial and backyard plantations. In current practice, farmers are engaged and invested in mango production using the grafted carabao mango seedlings. The Food and Agriculture Organization listed the top mango producing country in the world and the Philippines ranked 10th place with annual production of 825,676 metric tons [15]. On January to March 2015, production of mango reached 148,085 tons with Central Luzon provided 30,112 tons or 20.20% of the national total. Carabao mango variety dominated the yield of the total mango production in the country with a share of 83% [4]-[13].

The Philippines had experienced a decreasing volume of production for carabao mango (from 669, 520 MT in 2010

to 630,596 MT in 2012). The volume of production in Bataan also decreased from 1,836 MT in 2010 to 1,550 MT in 2012. A reduction in the exportation of mango was noted in 2013. Mango exports at 7,886 metric tons dropped by 57.2% and value at US\$ 13.30 million was down by 12.7%. Likewise, the share of mango was reduced to 0.2% [13].

One of the reasons for the decrease in mango yield in Central Luzon is due to the infestation of cecid fly (*Procantarina* sp.). This dipteran insect that commonly laid eggs on the fruit surface and young mango leaves where the larva bores into the fruit and feeds on it. The infestation inflicts circular spots or holes on the fruit that negatively affects the physical and market quality of mango [2]. Application of insecticide and other chemical control measures against pests is costly maintenance on mango production [1]. Over the years, mango production became increasingly dependent on chemicals or conventional approaches to control pests [6] and flower inducer. However, limited skills and knowledge of farmers on the appropriate pesticides to use, and rate of application to cost-effectively control insect and diseases have prompted to excessive and improper application of such pesticides. As a repercussion, development of pest resistance and resurgence occurs that often lead to low yield and poor fruit quality [11].

The proper adoption of science & technology community-based interventions such as pruning, field sanitation, need-based spray of pesticides and bagging as interventions against insect pests and diseases are recognized to be effective in reducing the excessive use of pesticides, and in turn, achieved economic gains [9]. Ideally, the project was implemented to address the gaps on low production performance and profitability of mango farming in Bataan, Philippines.

II. OBJECTIVE

The project aimed to evaluate the effect of Community-Based Science and Technology interventions on the production and economic factors of the participating mango farm clusters after two production cycles.

III. MATERIALS AND METHODS

A. Project sites

A total of 15 commercial farm sites were selected in two

farm clusters in Bataan; seven from the city of Balanga (14°41'N, 120°32'E) and eight from Abucay (14°44'N, 120°32'E). The farm sites were served as replicates in each commercial farm cluster. The STCBF project was tested under actual operating conditions, which offered insight into the real-world application of this technology. However, several variables were still considered for site selection including the similarity in the age and height of trees, land feature, and the willingness of farmers to adopt the technology. The project was carried out from January 2014 to February 2017.

B. Application of Community-Based Science & Technology Interventions

The cultural practices and mango production management scheme of each project site are summarized in Table 1. The application of STCBF for mango production was standardized in all farm sites following the protocol of the Philippine Department of Agriculture [3] and Philippine Council Agriculture, Aquatic, Resources, Research and Development.

C. Sanitary and Corrective Pruning

Tagging of trees was done to ensure that the production performance of the trees as to flushing, response to flower induction, flowering, fruit retention and yield were religiously recorded. Sanitary and center pruning were done through the removal of overlap branches, diseased and pests-infected stems and branches. The purposes of this method are to improve sunlight penetration and stimulate flushing. The period of pruning was recorded to ensure the appropriate time for the application of a growth regulator.

D. Flower Induction

To break the normal fruiting habit, mango trees were induced to promote profuse flowering and fruiting anytime of the year. The 2-3% KNO₃ or Ca (NO₃)₂ was applied

preferably in the afternoon. Higher concentration was recommended during off-season and lower rates during on-season. Follow-up spray of low dose (1.0 to 1.5%), three (3) days after flower induction was also done for it can improve flowering response, especially during off-season production

E. Fertilization

The nutrients in soil were analyzed using a soil test kit for NPK. Improvement on soil fertility was done using a combination of commercial fertilizers including urea (NPK: 46-0-0, 1.5 kg per ha) and complete fertilizer (NPK: 14-14-14, 1 kg per 1 ha) was applied during the onset of wet season (3rd to 4th week of May), while the same fertilization rate was applied prior to the start of the dry season (3rd to 4th week of January).

F. Paclobutrazol Application

Paclobutrazol is a chemical substance that retards the vegetative growth of mango trees. This enhances the flowering intensity of mango. The desired amount of Paclobutrazol solution was diluted (1 gal 4ml-1; formulated product per linear meter of canopy diameter) in sufficient amount of tap water and was applied to drench the trees within the active root zone.

G. Data Analyses

The number of mango fruits harvested were recorded and sold at the end of the experimental trial. The mean yield, gross income, and net income were compared among production cycles (ANOVA, P < 0.05). Tukey's Honestly Significant Difference Test was used to compare production and profit data between the two farm clusters with unequal replicates (P < 0.05). The initial production and cost data were also compared to the first and second production cycles using ANOVA (P < 0.05). Statistical analyses were performed in SPSS, version 17.

Table 1. Integrated Crop Management (ICM) of selected participating mango farms in Bataan, Philippines

		Integrated Crop Management in Pre-trial										
Production Scheme		Pruning	Fertilization	Flush Induction	Growth Regulator	Field Sanitation	Flower induction	Bagging	Pesticide Application	System of Buying	Disease control	
Balanga												
Farm 1	CS	no	no	no	no	seldom	Spray contractor	no	CS	sorted	no	
Farm 2	CS	no	no	no	no	seldom	Spray contractor	no	CS	sorted	no	
Farm 3	CS	no	no	no	no	seldom	Spray contractor	no	CS	sorted	no	
Farm 4	OPM	no	no	no	no	grazing	KN ₃	no	CaS	sorted	no	
Farm 5	OPM	yes	yes	no	yes	yes	KN ₃	yes	CaS	sorted	no	
Farm 6	OPM	no	yes	no	no	no	KN ₃	no	CaS	assorted	no	
Farm 7	CS	no	no	no	no	seldom	KNO ₃	no	CaS	sorted	no	
Abucay												
Farm 1	CS	no	no	no	no	seldom	KNO ₃	no	CaS	sorted	no	

Integrated Crop Management in Pre-trial											
	Production Scheme										
		Pruning	Fertilization	Flush Induction	Growth Regulator	Field Sanitation	Flower induction	Bagging	Pesticide Application	System of Buying	Disease control
Farm 2	OPM	yes	no	yes	no	yes	CaNO ₃	no	CalS	sorted	no
Farm 3	OPM	no	no	no	no	yes	KN0 ₃ / Ca(NO ₃) ₂	no	CalS	sorted	no
Farm 4	OPM	yes	yes	yes	no	yes	KN0 ₃	no	CalS	sorted	no
Farm 5	OPM	no	no	no	no	yes	KN0 ₃	no	CalS	sorted	no
Farm 6	CS	no	no	no	no	seldom	KN0 ₃	no	CalS	sorted	no
Farm 7	CS	no	no	no	no	yes	KN0 ₃	no	CalS	sorted	no
Farm 8	CS	yes	yes	yes	no	yes	KN0 ₃	no	NBS	sorted	no

OPM = own production management, CS = contract spraying, CalS = calendar spray, NBS = Need-based spray.

IV. RESULTS

The production performance and economic variables from participating commercial farms are presented in Table 2. It is observable that there were improvements in key production indicators including total yield, gross income, and net income. Between the two farm clusters, the mean yield and gross income of either pre-trial or post-trial were statistically similar ($P > 0.05$). While the apparent difference in such performance variables was not statistically significant between farm clusters, a significant increase was

realized between pre-trial and after the two production cycles ($P < 0.01$, Figure 1).

Taking the operational expenses and gross income into consideration in the computation of net income, the effectiveness of the Community-Based S&T modality becomes greatly evident (Table 2). In Abucay cluster, the net income increased by 405.77%, and 1,492.33% in the first, and second production cycle, respectively. Similar results were also observed in Balanga cluster, with 160.13%, and 536.26% increase in the net income in the first and second production cycle, respectively.

Table 2. Performance variables of mango farm clusters subjected to Community-Based S&T Interventions after two production cycle periods (1\$ = Php 53)

Variables	Abucay			Balanga		
	Pre-trial	1 st cycle	2 nd cycle	Pre-trial	1 st Cycle	2 nd Cycle
No. of Trees	139	77	77	85	58	58
Age of Trees	20	20	20	20	20	20
Cost Tree ⁻¹ (\$)	8.25	20.54	11.96	10.89	25.51	14.33
Cost kg ⁻¹ of Fruit (\$)	0.34	0.18	0.12	0.27	0.19	0.12
Mean Gross Cost	1,147.50	1581.64	921	925.72	1,479.72	831.42
Mean Total Yield (MT)	3.35	8.75	7.95	3.37	7.71	6.71
Mean Gross Income (\$)	1,259.38	2,147.50	2,702.50	1,154.29	2,074.29	2,285.71
Mean Net Income (\$)	111.88	565.86	1,781.50	228.57	594.57	1,454.29

The Science & Technology (S & T) interventions resulted to apparent significant increase in average total yield ($F = 4.11$, $P < 0.05$) and mean gross income ($F = 5.70$, $P < 0.05$) after two production cycles (Figure 2). The analysis takes into account all participating mango farms. Significant increase in mean net income (240.85%) was

achieved from pre-trial to first production cycle ($Q = 3.15$, $P < 0.05$), and so as with pre-trial to second production cycle (850.44% increase) ($Q = 3.71$, $P < 0.05$). There was also an increase of 178.84% from the first cycle to the second production cycle, but the mean net income was not significantly different ($P > 0.05$).

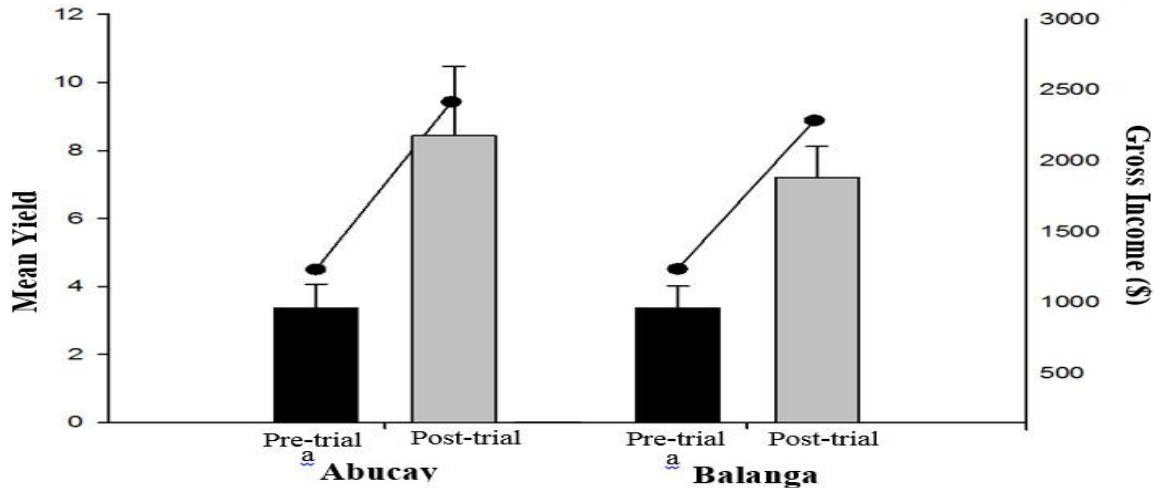


Fig. 1. Mean yield (bar) and gross income (line) of two participating mango farm clusters before and after the interventions. Similar letter indicates no statistical difference ($P > 0.05$). Error bar = SE.

V. DISCUSSION

The study showed that appropriate application of Science & Technology Interventions will improve the yield and income of mango production. Further, the considerable increase of yield and profit gains were observed during the two production periods at the two mango clusters. It is also noteworthy to mention that several farm sites experienced major intervening variables including cloudy weathers, low

temperature and occasional rain showers during the full bloom stage of mango.

The increase in production and profit can be attributed to the applied interventions such as; field sanitation, pruning, which deters insect pest proliferation [7] - [6]. The intervention also promotes limited use of chemicals to address pests and can be otherwise applied with a suitable chemical mixture as needed.

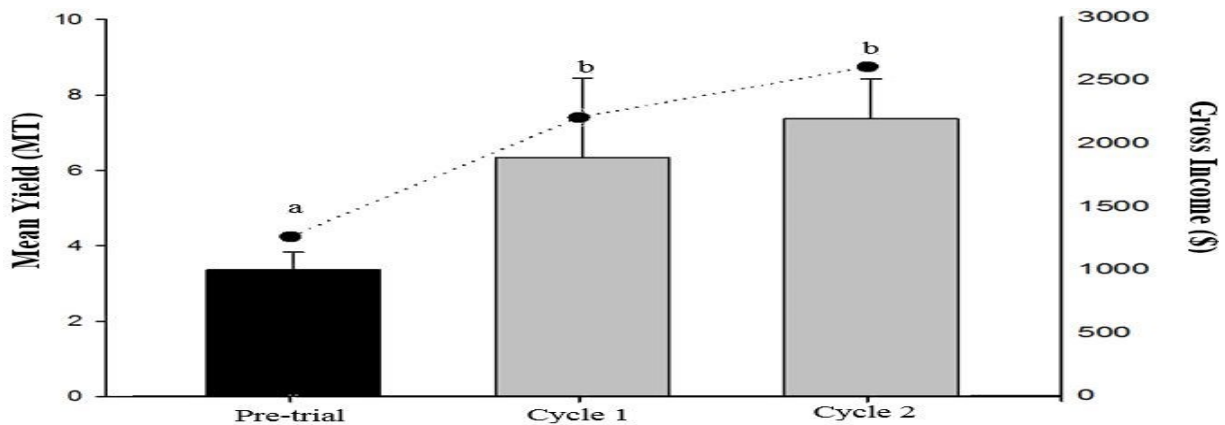


Fig. 2. Improvement in the mean yield (bar) and gross income (line) in the first and second production cycle of all participating mango farms.

It was demonstrated that adequate maintenance of sanitation and timely application of mixed chemicals was proven to be effective in the significant reduction of severe diseases and increase in mango yield [5].

The present study demonstrated the effectiveness of S&T-interventions strategies and provides insight into the feasibility of a cost-effective approach for mango farming. Pruning increased the yield of mango by thinning crowded foliage and lightening the center of the tree which helped the trees to absorb more photons of light which is one of the requirements for the production of food in the process of photosynthesis [8]. Reference [3] stated that KNO_3 was merely responsible for budbreak of existing floral buds, thus increasing flower intensity. As the onset of flowering, close pests monitoring and application of pesticide through

the need-based spray is done. Young fruits (45-55 DAFI), are bagged to protect against insect damage. These interventions significantly increased yield performance of the 15 mango farms although this protocol is applied only in Bataan, it is suggested that the technology can also be implemented in the commercial mango farms. The study provides relevant data for backyard mango orchards for most residents with farmlands to seriously consider tending to their mango trees and look into the entrepreneurial potential of the crop. The local government with the assistance of agricultural agencies should also provide activities that would encourage start-ups and entrepreneurs to consider mango growing and production as a lucrative business.

VI. CONCLUSION

The community-based science and technology farming modality was found to be an effective strategy in transforming the mango production from the traditional practices of farmers into scientific and technology based farming systems. The results proved that the adoption of S&T- interventions through farmer participatory approach significantly improved the mean gross and net income of the participating farms as well as the reduction on cost of production per tree of the two clusters. The improvement on yield and productivity of the participating mango farms were attributed to the adoption of the improved crop management protocol of farmers in their respective techno-demo mango farms. The community based approach of technology transfer remarkably improved both the appreciation and adoption rate of farmers on the technology interventions. The results of the study disclose that the science and technology interventions would be the ultimate solution to achieve the productivity and sustainability of mango production.

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REFERENCES

- [1] Akotsen-Mensah C., Ativor, I.N., Anderson, R.S., Afreh-Nuamah, K., Brentu, C.F., Osei-Safo D., Boakye, A.A. and Avah, V. (2017). Pest management knowledge and practices of mango farmers in Southeastern Ghana. *Journal of Integrated Pest Management* 8(1): 1-7.
- [2] Amouroux, P., Normand, F., Nibouche, S., and Delatte, H. (2013). Invasive mango blossom gall midge, *Procontarinia mangiferae* (Felt) (Diptera: Cecidomyiidae) in Reunion Island: ecological plasticity, permanent and structured populations. *Biological Invasions* 15:1677-1693.
- [3] Arceo, A.J., Golez, H.G., Masbang, R.T., Vinuya, E.S., Salio, A.P., Maningding, A.B., Ombao, K.M.R. and Escalante, P.A.P. (2005). *Cultural Management Practices of Mango Production*. Agricultural Training Institute, Diliman, Quezon City, Philippines. 22 p.
- [4] Delmo, G. (2010). Carabao mango: Philippine's sweet pride. Retrieved from the [http:// www.fareastagriculture.com/crops/agriculture/carabao-mango-philippines-sweet-pride](http://www.fareastagriculture.com/crops/agriculture/carabao-mango-philippines-sweet-pride).
- [5] Freeman, S., Maymon, M., Biton, A., Levin, A., and Shtienberg, D. (2014). Management of mango malformation disease based on a novel strategy of timing of fungicide applications combined with sanitation. *Crop Protection* 61: 84-91.
- [6] Golez, H. G. (2003). Technology Updates on Major Fruits: Mango. 3rd Mindanao Fruit Industry Conference, Davao City, Philippines.

- [7] Golez, H.G., Opina, O.S., Medina, J.R.Jr., De Jesus, L.R.A., and Calumpang, S.M.F. (2000). *Integrated Pest Management of Mango* (Pocket Guide No. 1). PCARRD-DOST, Los Banos, Laguna.
- [8] Gross, Emil R. (1997). Pruning mango to increase yield. *ActaHortic.* 455, 538-542 DOI: 10.17660/ActaHortic.1997.455.70. <https://doi.org/10.17660/ActaHortic.1997.455.70>
- [9] Mananghaya KMV. (2016). STCBF on mango production in Bataan. Retrieved from the <http://www.pcaarrd.dost.gov.ph/home/portal/index.php/quick-information-dispatch/2765-stcbf-on-mango-production-in-bataan>.
- [10] Mariano, M., Villano, R. and Fleming, E. (2012). Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. *Agricultural Systems* 110: 41-53.
- [11] Prakash, O. (2011). IPM Schedule for Mango Pests. Retrieved from the <http://midh.gov.in/technology/IPM-Mango-Revised-Sept2011.pdf>
- [12] Protacio, C.M., R.D. Jr Bugante, J.E. Quinto, G. Molinyawe, and G. Paelmo. (2000). Regulation of Flowering in 'Carabao' Mango Trees by Paclobutrazol. *Philippine Journal of Crop Science* 25(2) 27-33.
- [13] PSA (Philippine Statistics Authority) (2016). Retrieved from <http://psa.gov.ph/>
- [14] Philippine Statistics Authority (PSA). (2017). *Crop Statistics of the Philippines 2011-2015 (National and Regional)*. Quezon City Philippines. 248 pages.
- [15] The Daily Records (2019). Top 10 largest mango producing countries in the world. Retrieved from the <http://www.thedailyrecords.com/2018-2019-2020-2021/world-famous-top-10-list/world-largest-mango-producing-countries-world/12793/>.

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Hermogenes M. Pagua. Currently Professor VI and Vice-President for Research Extension and Training Services of the Bataan Peninsula State University, Philippines. He took and completed his Doctor of Philosophy on Agricultural Sciences major in Animal Science at Pampanga Agricultural College in 2006 degree. He conducted different researches and Science and Technology Based development projects on poultry nutrition, Mango and livestock production, farming systems and policy on agricultural programs and was made a reality through the initiatives and devoted support of his institution. In his twenty five years of experience in the field of Agriculture, he is still passionate for more solutions for the common, small scale farmers and growers. Being actively engaged on extension, he is optimistic that the technology to be developed from his researches can be of aid to those who are in need of scientific solutions in enhancing the productivity and sustainability of mango production.



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