
Community-based Diversified Farming Systems Improve the Profitability of Goat-Rice- Vermicompost Production in Bataan, Philippines

Hermogenes M. Paguia^{1,2}, Ma. Florinda O. Rubiano¹ and Mark Nell C. Corpuz^{1,3*}

¹ Research and Development Office, Bataan Peninsula State University, Balanga City, Philippines.

² College of Agriculture, Bataan Peninsula State University, Abucay, Bataan, Philippines.

³ Institute of Fisheries and Aquatic Sciences, Bataan Peninsula State University, Orani, Bataan, Philippines.

*Corresponding author email id: marknellcorpuz@yahoo.com

Abstract – To address the prevailing problems in farm efficiency and productivity, a diversified farming system using slaughter goat, aerobic rice technology, vermicompost production was conducted in Bataan, Philippines from October 2018 to December 2019. The application of packaged technologies in agriculture through a community-based participatory action research program of the Philippine government was standardized for the ten experimental rice-based farms (5,000 m² per farm). In a one-year production cycle, the project generated an overall mean net income of \$ 651.12, yielded from three agricultural commodities, including \$ 112.70 for aerobic rice, \$ 415.47 for slaughter goat, and \$ 122.95 for vermicompost (\$ 1= Ph Pesos 48.80). Overall, a significant increase of 66.17 % in the mean profit was realized after a one-year production cycle. The return of investment for rice (27.50 %), slaughter goat (53.36 %), and vermicomposting (30 %) were also found feasible. The result of this project can serve as a model for farmers who want to adopt goat-rice-vermicompost integrated farming schemes for improved farm outputs and profitability.

Keywords – Aerobic Rice Technology, CPAR, Technology Adoption, Organic Fertilizer.

I. INTRODUCTION

In 2019, the agriculture sector shared nearly 9 % of gross domestic product and employed 23.40 % of the total population in the Philippines [1]. Despite the contribution of agriculture in the Philippines, this sector is still facing challenges as to the efficient transfer and adoption of agricultural technologies to the stakeholders [2]. Moreover, the lack of science-based interventions among the small-scale farmers has remained to be general issues that could result in low profitability of agricultural commodities [3]. Despite of the advent of the technological revolution and innovations, the backyard farms are still behind in terms of economic benefit and opportunities due to limited access to technology, improved production practices, inputs/stocks, and marketing support [2].

To address this concern, the Philippine government develops and launches agricultural technologies as a package with multiple components [4]. The community-based participatory approach project (CPAR) involves the community to participate in resource management for the improved farming systems that are suited for a definite agro-climatic environment. It also promotes the holistic management of production systems, focusing on diversification and complementation of agricultural commodities [5]. Similarly, crop-livestock diversification has been an emerging innovative farming system [6], which can contribute to improving food security and sufficiency, local livelihood, and biodiversity [5], [7]. It is a cost-effective and eco-friendly approach that intends to improve farmers' practice and productivity, e.g., optimized use of land and water use production systems [8], [9]. In other disciplines, CPAR facilitates support mechanisms for improved biosecurity measures [10], aquasilviculture (mangrove-crab-fish culture) [11], and disease prevention [12].

Despite the abovementioned advantages, reports about the cost-effectiveness of CPAR - diversification farmi-

-ng protocol in the Philippines and in Southeast Asia are scanty in scientific peer-review journals. Hence, this paper documented the outcome of packaged technologies of CPAR on slaughter goat, aerobic rice, and vermicompost production and profitability in Bataan, Philippines.

II. MATERIALS AND METHODS

A. Study Areas

The project was conducted in ten participating farms in Bataan, Philippines (14° 41' 0.6" N; 120° 25' 55" E), namely Nazareno, Culis, Bacong, New San Jose, Pentor, San Jose (two farms), Pagalangang (two farms) and San Benito. These locations are classified as lowland rain-fed rice fields, with two pronounced seasons — dry season (December to May), and wet season (June to November). The farm locations are abundant with readily available farm resources and production areas that can be utilized for an integrated farming system.

B. Package of Technologies

Summary of the farming technologies and protocols standardized for all the ten technology demonstration farms (5,000 m² in each participating farm) is presented in Table 1. The project commenced in October 2018 and terminated in December 2019.

C. Production Parameters

The cost-benefit analysis was calculated based on the performance indicators presented in Table 2. The production and economic variables after the implementation of the project were compared with the baseline data (farmers' conventional method) of the commodities. The mean of net income of farms before and after the project implementation was compared statistically using t-test ($p < 0.05$).

Table 1. Package of technologies employed for each agricultural commodity.

Rice Production	Slaughter Goat Production	Vermicompost
NPK analysis in soil	Dissemination of island-born Anglo-Nubian Buck (six heads doe)	African nightcrawler (ANC) – 5 kg for each farm
Basal application of 10 bags of organic fertilizer and vermicompost	rapid rotational grazing (RRG)	Construction of five vermin beds (1.0 m x 4.0 m)
Use of aerobic rice varieties (NSIC RC-27 and NSIC RC-23) , 2 sacks for each variety	Conventional goat house made from local-based materials	Utilization of goat manure, rice straws, and farm residues as compost materials
Application of effective microorganism – activated solution (EMAS) twice per week	Establishment of 50 m ² forage garden (<i>Trichanthera gigantea</i> , <i>Desmodium cinereum</i> (Rensonii), and Hybrid <i>Pennisetum purpureum</i>)	Use of EMAS for rapid pre-composting of bedding materials
Use of tractor-drawn rice hill-seeder	Provision of a urea-molasses mineral block, silage and concentrates supplementation	Harvesting - 15 days after ANC stocking

*aerobic rice varieties are early-maturing and drought-tolerant rice varieties.

Table 2. Production parameters for the component commodities of CPAR.

Aerobic Rice Production	Slaughter Goat Production	Vermicompost
Mean production costs (\$)	Mean birth weight (kg)	Mean weight of vermicompost and vermicast (kg)
Mean cost per kg (\$)	Mean number of kids	Mean vermin produced (kg)
Mean yield/ harvest (kg)	Mean live weight in 1 month (kg)	Mean cost of production (\$)
Mean market price (\$ per kg)	Mean live weight in 6 months (kg)	Mean total expenses (\$)
Mean gross sales (\$)	Mean weaning weight (kg)	Mean net income (\$)
Mean net income (\$)	Mean mortality (%)	ROI (%)
ROI (%)	Mean cost per kg of live weight produced (\$)	

III. RESULTS AND DISCUSSION

A. Aerobic Rice Production

Production and economic performance for aerobic rice production are summarized in Table 3. It was apparent that the project was able to reduce the mean production cost, resulting in an increase in net income by 21.65 % after CPAR intervention. While the use of drought-resistant rice varieties was proven to be cost-effective, some farmers were not initially accustomed to the farming protocol for aerobic rice technology. As a repercussion, the gross sales were reduced due to a decrease in the yield of some experimental farms. Despite that, the project demonstrated that the technology is a viable option for non-cultivated rice fields, and can be optimized during the dry months where there is a limited water supply for rain-fed rice culture. The aerobic rice technology may not only sustain rice production in the rainfed areas but essentially, a contribution to rice demands for domestic consumption [13]. The water-saving efficiency of this eco-friendly technology was reported elsewhere [14].

Table 3. Mean yield performance of aerobic rice technology in ten participating farms in the one-year production cycle.

Production and Economic Parameters	Farmer's Conventional Practice	CPAR Project	Difference
mean production cost (\$)	528.85	409.84	(-) 119.01
mean cost per kg	14.70	11.33	(-) 3.37
yield per harvest (kg)	1,750	1,500	(-) 250
mean market price (\$ per kg)	0.35	0.35	0.00
gross sales (\$)	621.14	522.54	(-) 98.60
net income (\$)	92.29	112.71	20.06
ROI %	14.91	27.50	12.59

B. Slaughter Goat Production

Goat production data considerably improved under the CPAR-diversified farming protocol (Table 4). After the project, mean birth weight and live weight improved by around 60.40 %, and 63.84 %, respectively. The mortality rate was reduced by 50%. Furthermore, the average gain in weight of 42 g day⁻¹ had improved to 65 g day⁻¹. The evident results are attributed to good husbandry practices, application of biosecurity measures, deworming activities, and vitamin supplementation. Also, provision of proper housing, island-born cross-bred

buck, and forage garden as sources of quality fodders was found to be cost-effective methods for improved goat raising. These protocols were also similar to several management approach that have been employed in other ruminants [15]. While no data is presented for ROI % in the pre-implementation phase, 53.36 % of ROI post-project implementation is highly remarkable for a business.

Table 4. Slaughter goat production performance of ten participating farms in the one-year production cycle

Production Parameters	Farmer's Conventional Practice	CPAR Project	Difference
Mean birth weight (kg)	1.49	2.39	0.90
Mean number of kids	2	2	0
Mean live weight in 1 month (kg)	3.30	4.40	1.10
Mean live weight in 6 months (kg)	20.05	32.85	12.80
Mean weaning weight (kg)	5.81	9.50	3.69
Mean mortality (%)	40	20	(-) 20
Mean cost per kg of live weight produced (\$)	3.00	2.41	(-) 0.59
ROI (%)	no data	53.36	-

C. Vermicompost Production

The initial trial conducted by technology adopters produced a mean weight of 640 kg for organic fertilizers (vermicompost and vermicast) and 20 kg for ANC. The mean total sale for the two products was \$ 491.80, and a mean net income of \$ 81.97. Considering the revenue and the total expenses for the operation of the vermicomposting business, 30.00 % of mean ROI was attained. The technology demonstration on vermicompost production is a complementing enterprise for goat-rice farming systems, primarily to maximize the utilization of farm wastes, crop residues, and animal manures for a more efficient production scheme. The productivity and profitability of vermicomposting is also reported in other study [16]. This paper also provided a piece of evidence as to the efficacy of the use of an effective microorganism-based solution to hasten the vermin-induced composting process.

D. Profitability Analysis

After one-year production cycle, a notable increase in overall mean net income was achieved ($t = -2.84$; $p = 0.01$) (Fig. 1). The integrated rice-goat-vermicompost production systems contributed to a 66.91% increase in the overall mean profit of the ten participating farms ($\$ 5,301.30 \pm 541.27$).

Similar to other reports on integrated farming [17], [5], [9], the present results also demonstrated the positive effect of diversification of agricultural commodities in transforming conventional rice farming into a promising agribusiness venture. These approaches when extensively disseminated for adoption by among rice-based farmers can precisely improve farming systems and economic performance of the farms [18], [19]. For this package of technologies to become effective in improving the production gaps, the appropriate capacity development strategy for farmers must be employed [18], [20]. As such, the adoption of practical and reliable technology will be easier and more evident among small-scale farmers.

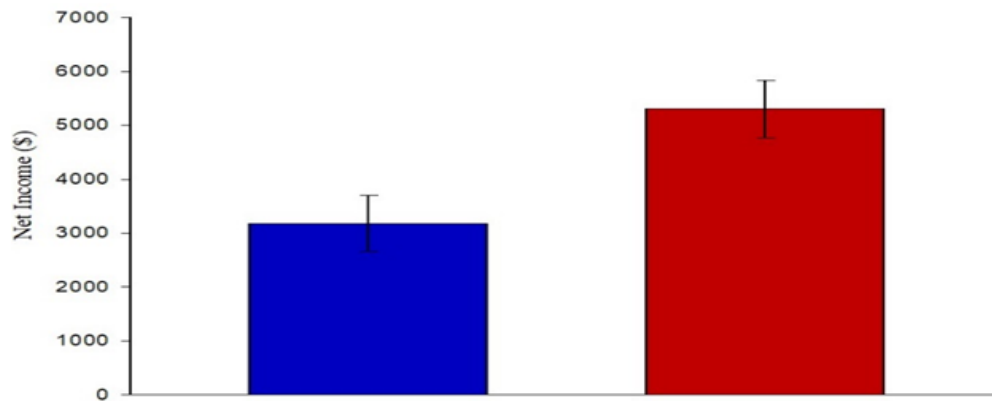


Fig. 1. Overall mean net income of ten participating farms (before and after the implementation of a CPAR-based integrated farming system). Error bar = SEM.

IV. CONCLUSION

This innovation is basically a practical but cost-effective and environment-friendly approach that improved farmers' practice and productivity. The established ten technology demonstration farms of CPAR for rice-goat-vermicompost production were served not just as a show window of integrated farming system, but essentially as a community based-technology incubator that will build partnerships and cooperation among smallholder farmer groups in the farming community. Although the implementation is limited to Bataan, this project is eyeing to become a sustainable platform for technology transfer for pro-poor agricultural sector in the Philippines.

ACKNOWLEDGMENT

The authors are grateful for the funding of the Department of Agriculture – Regional Field Office III; to the extended technical and administrative support from Local Government Units of Dinalupihan and Hermosa, Bataan, and the beneficiaries of the CPAR project.

REFERENCES

- [1] PSA, 2019, Philippine Statistics Authority, Available: https://psa.gov.ph/sites/default/files/crs_palay2013.pdf.
- [2] F.C. Sanchez, 2016, Challenges faced by Philippine agriculture and UPLB's [University of the Philippines Los Banos] strategic response towards sustainable development and internalization. *International Society for Southeast Asian Agricultural Sciences*, 21(2): 191–199.
- [3] M.J. Mariano, R. Villano, E. Fleming, 2012, Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. *Agricultural Systems*, 110: 41–53.
- [4] DA-BAR, 2012, Department of Agriculture- Bureau of Agricultural Research, Available: <https://www.bar.gov.ph/index.php/programs/major-programs/community-based-participatory-action-research>.
- [5] M. Herrero, P.K. Thornton, A.M. Notenbaert, S. Msangi, H. Freeman, D. Bossio, J. Dixon, M. Peters, J. Van de Steef, J. Lynam, P. Parthasarathy Rao, S. Macmillian, B. Gerard, J.J. McDermott, C. Sere, M. Rosegrant, 2010, Smart investments in sustainable food production: revisiting mixed crop-livestock systems. *Science*. 377: 822–825.
- [6] M. Herrero, P.K. Thornton, A. Notenbaert, S. Msangi, S. Wood, R. Kruska, J. Dixon, D. Bossio, J. Steeg van de, H.A. Freeman, X. Li, P. Parthasarathy Rao, 2012, Drivers of change in crop–livestock systems and their potential impacts on agro-ecosystems services and human wellbeing to 2030: A study commissioned by the CGIAR System wide Livestock Programme. ILRI Project Report. Nairobi, Kenya: ILRI. Available: <https://hdl.handle.net/10568/3020>.
- [7] M. Moraine, M. Duru, P. Nicholas, P. Leterme, O. Therond, 2014, Farming system design for innovative crop–livestock integration in Europe. *Animal*, 8(8): 1204–1217. Available: <https://doi.org/10.1017/S1751731114001189>.
- [8] H. Liniger, S. R. Mekdaschi, C. Hauert, M. Gurtner, 2011, Sustainable land management in practice: guidelines and best practices for Sub-Saharan Africa: field application. Rome: FAO.
- [9] H.M. Paguia, J.P.B. Tuazon, M.M. Rosano, E. Abella, A. Cabutaje, R. Lopez, M.N.C. Corpuz, 2019, Effects of community-based farming on the productivity and profitability of mango (*Mangifera indica*, Linn.) in Bataan, Philippines. *International Journal of Agriculture Innovations and Research* 7(6): 605–609. Available: <https://ijair.org/index.php/issues?view=publication&task=show&id=1278>.
- [10] R.C. Flores, M.N.C. Corpuz, F.E. Tungol, A.A. Villafuerte, S.S. Antonio, 2015, Assessment of aquaculture bio security measures in Bataan, Philippines. *International Journal of Life Sciences, Biotechnology, and Pharma Research*, 4(4): 189–192.
- [11] R.C. Flores, M. N. C. Corpuz, J.M. Salas, 2016, Adoption of aquasilviculture technology : a positive approach for sustainable fisheries

- and mangrove wetland rehabilitation in Bataan, Philippines. *International Journal of Food Engineering*, 2(1): 79–83. Available: doi: 10.18178/ijfe.2.1.79-83.
- [12] Z. Faridi, J.A. Grunbaum, B.S. Sajor Gray, A. Franks, E. Simoes, 2007, Community-based participatory research: necessary next steps. *Preventing Chronic Disease*, 4(3): 1–4. Available: www.ncbi.nlm.nih.gov/pmc/articles/PMC1955426/
- [13] B.C. Pinheiro, E.M.D. Castro, C.M. Guimaraes, 2006, Sustainability and profitability of aerobic rice production in Brazil. *Field Crops Research*, 97: 34-42.
- [14] K. Jana, 2018, Aerobic rice cultivation system: eco-friendly and water saving technology under changed climate. *Agricultural Research and Technology*, 13(2). Available: <http://dx.doi.org/10.19080/artoaj.2018.13.555878>.
- [15] G. Alexandre, E. González-García, C.H.O. Lallo, E. Ortega-Jimenez, F. Pariacote, H. Archimède, N. Mandonnet, and M. Mahieu, 2010, Goat management and systems of production: global framework and study cases in the Caribbean. *Small Ruminants Research*, 89: 193–206. Available: doi: 10.1016/j.smallrumres.2009.12.043
- [16] D. Devkota, S. C. Dhakal, D. Dhakal, D.D. Dhakal, R.B. Ojha, 2014, Economics of production and marketing of vermicompost in Chitwan, Nepal. *International Journal of Agricultural and Soil Science*, 2(7): 112–117.
- [17] W.Y. Ramrao, S.P. Tiwari, P. Singh, 2005, Crop-livestock integrated farming system for augmenting socio-economic status of smallholder tribal farmers of Chhattisgarh in Central India. *Livestock Research for Rural Development*, 17(90), Available: <http://www.lrrd.org/lrrd17/8/ramr17090.htm>
- [18] M. Ferreira, F. Gendron, 2011, Community-based participatory research with traditional and indigenous communities of the Americas: historical context and future directions. *International Journal of Critical Pedagogy*, (3)3: 153–168. Available: digitalcommons.wayne.edu/cgi/viewcontent.cgi?article=1001&context=nfsfrp
- [19] S. Nalubwama, M. Vaarst, F. Kabi, M. Kiggundu, F. Bagamba, C. Odhong, A. Mugisha, N. Halberg, 2014, Challenges and prospects of integrating livestock into smallholder organic pineapple production in Uganda. *Livestock Research for Rural Development*, 26(113). Available: <http://www.lrrd.org/lrrd26/6/nalu26113.htm>.
- [20] W. Mekuria, K. Mekonnen, 2018, Determinants of crop–livestock diversification in the mixed farming systems: evidence from central highlands of Ethiopia. *Agriculture and Food Security*, 7(60): 1–5. Available: <https://doi.org/10.1186/s40066-018-0212-2>.

AUTHOR'S PROFILE



First Author

Hermogenes M. Pagnia, Ph.D. is a University Professor at Bataan Peninsula State University (BPSU). He earned his Doctor of Philosophy in Agricultural Sciences at the Pampanga Agricultural State University (PSAU). He had been a grantee of scholarships in Israel, Netherlands, and the United Kingdom. Currently, he is the Vice President for Research, Extension and Training Services of BPSU. He is also the President of the Philippine Agriculturists Association of Central Luzon Tamarind Chapter. He published several research in refereed journals and authored several books and manuals.



Second Author

Ma. Florinda Oconer-Rubiano is an Assistant Professor at Bataan Peninsula State University (BPSU). She completed the academic requirements for the Doctor of Philosophy in Nursing Education from at the Holy Angel University. Currently, she is the OIC-Director of BPSU's Research and Development Office. She is a member of the International Association of Research Ethics Across Discipline and a member of the Technical Review Board of the Central Luzon Health Research and Development Consortium (CLHRDC). She was able to publish papers in collaboration with the Middle Sex University on cultural aspects of compassion in nursing.



Third Author

Mark Nell C. Corpuz, MSc is an Associate Professor at Bataan Peninsula State University and currently the Head of the Center for Research on Aquaculture and Aquatic Resources in Brackishwater Systems. He is a Regular Member of the National Research Council of the Philippines, and a technical consultant or Resource Person in various State University and Colleges, national government agencies, and private organizations. He was able to publish various scientific papers on zoology, environmental science, and aquaculture in several journals indexed in Web of Science and SCOPUS. He is also involved in community development activities focused on mangrove rehabilitation, aquaculture bio security, Fishery Law awareness, and milkfish processing technology transfer for poverty reduction.