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Climate-Resilient Agri-fisheries (CRA) Assessment, Targeting & Prioritization for the Adaptation and Mitigation Initiative for Tarlac Province

Lilibeth B. Laranang[1,a)], Ermalyn D. Galo[2,b)], and Orlando H. Locading, Jr.[3,c)]

[1] Rootcrops Research and Training Center, Tarlac Agricultural University, Philippines
[2] College of Engineering and Technology, Tarlac Agricultural University, Philippines
[3] College of Business and Management, Tarlac Agricultural University, Philippines

[a)] lilibeth717@gmail.com
[b)] Corresponding author: ermalyngalo@gmail.com
[c)] ohlocading@tau.edu.ph

Abstract. This study is part of the Adaptation and Mitigation Initiative in Agri-fisheries (AMIA) Project of the Department of Agriculture (DA) and International Center for Tropical Agriculture (CIAT) to operationalize the goal of making agriculture and its stakeholders adapt and mitigate the effects of climate change. The outputs of this study were vital in the implementation of the next phase of AMIA: climate-risk vulnerability (CRVA) map and investment brief. The CRVA map was developed to identify the vulnerable areas in Tarlac. The CRVA map considered three factors: climate-risks sensitivity, exposure, and adaptive capacity given a 15-15-70 weighted percentages, respectively. The municipalities of Ramos, La Paz, Bamban and Victoria were identified as highly vulnerable to the effects of climate change. Three investment briefs were prepared for policy makers for possible funding and implementation. They were developed by identifying climate-resilient agricultural practices in the province which are the use of climate smart varieties, crop rotation-minimum tillage combination, and alternate wetting and drying method. These practices were evaluated using the CBA Tool and were found to be sustainable. Social net present value was also determined taking into account the externalities, which was given a value through interview of experts.

INTRODUCTION

The Philippines is highly vulnerable to the adverse impacts of climate change as the country's backbone is agriculture [1]. The effect of intense and longer droughts, increase in temperature, erratic rainfall distribution and natural hazards that affects earth's ecosystem as well as health, livelihood, social systems and economy. Agriculture is one of the most vulnerable sectors on the impact of climate change and farmers who are directly dependent on their lands for survival are the most affected. Climate change mitigation and adaptation to climate change is crucial particularly in agriculture sector, thus, different adaptive strategies are being done to cope up with its impacts. One of the activities in the strategic actions of food security for 2011-2028 is to enhance site-specific knowledge on the vulnerability of agriculture and fisheries [2].

The Adaptation and Mitigation Initiative in Agriculture (AMIA) seeks to enable the Department of Agriculture (DA) to plan and implement strategies to support local communities in managing climate risks – from extreme weather events to long-term climatic shifts. Spearheaded by the DA System-wide Climate Change Office (DA SWCCO), AMIA Phase 1 in 2015-16 to implement activities to strengthen DA's capacity to mainstream climate change adaptation and mitigation strategies locally and in national scale. With AMIA Phase 2, making climate-resilient agri-fisheries (CRA) an operational approach through field-level action that directly involves, and influences on the livelihoods of farming communities is one of the next big task for the program. AMIA2 aims to invest in the launching of CRA communities in Tarlac province as the initial target site for action learning, supported by an integrated package of climate services within a broader food value chain setting. The program is launching an integrated and multi-stakeholder effort to operationalize CRA at the community level in 10 target regions. Successful implementation of AMIA2 at the regional level requires the strong collaboration and support of key research and development institutions within the region. This proposed project enables AMIA2 to establish and mobilize regional teams, each led by a local State University/College (SUC), and in partnership with the corresponding Department of Agriculture - Regional Field Office (DA-RFOs).

Climate-resilient agriculture/agri-fisheries (CRA) aims to achieve food security and broader development goals under a changing climate and increasing food demand [3]. With the three pillars: productivity, adaptation, and mitigation, CRA initiates sustainably increase productivity, enhance resilience, and require planning to address tradeoffs and synergies [4]. To enable to assess, plan and pilot climate-risk prone agri-fisheries communities in pursuing sustainable livelihoods while effectively managing the impacts of climate variability. Thus, one of the Region to initiates the CRA strategic framework was Region 3 or Central Luzon specifically in

Tarlac province to identify key climate risk and vulnerable areas and to assess the current status of CRA as well as the cost and benefits of these practices and technologies. Therefore, the study aims to establish and mobilized team in Region III for AMIA 2 in order to operationalized AMIA strategies in managing climate risk in Tarlac province. Specifically is to enhanced capacities of AMIA partner organizations in the Region, developed geospatially referenced data on climate-risks in Tarlac, generate profile on community's CRA strategies, and perform costs-benefits & trade-offs for these CRA practices. The result of the study will serve as guide in piloting community action research in establishing community-level research and development interventions.
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MATERIALS AND METHODS

Study Area

The study was established in the province of Tarlac. The study covered an area of 273,660 hectare and is located between latitude 15º 10'15" N to 15º 52'52" N, longitude 120º 8'4" E to 120º 46'27" E. The study area has flat to undulating topography, with the eastern part of the province being plain and the western part to be hilly to mountainous. Tarlac has two distinct seasons, the wet and the dry seasons. It has unimodal rainfall pattern, having high monsoon peaks in the wet season (WS) and negligible rainfall in the dry season (DS). Recorded annual rainfall varies from 2,030 mm to 4,060 mm in the northwestern portion [5].

Tarlac is basically an agriculture-based economy, located in the heart of Central Luzon with a total land area of 305,345 ha, constitutes 16.75% of the regional land area and 1.0 % of the total national land area with 112,997.57 hectares concentrated on agricultural production. Rice and corn are the top 2 commodities planted in the province planted in 2 to 3 cropping a year. There are 102,178.06 ha planted to rice, which are irrigated, rainfed and in upland areas. On the other hand, there are 16,458.98 ha planted to corn. Of these, only a small portion, are planted with white corn while the rest are planted with the yellow corn. With this vast track of land concentrated in agriculture, Tarlac likewise grows lowland vegetables and root crops. Of the lowland vegetables grown in the region, tomato occupies the largest area with 215.81 has while sweet potato is the largely grown rootcrops with a production area of 3,641.58 ha. Both crops are grown after rice usually during the onset of the dry season when rice has been harvested. Orchard occupies 10,498.65 hectares planted with our local fruit trees. The most common is mango that is planted in an area totaling to 25,660.03 hectares [6].

Framework of AMIA 2 Project

The project seeks to contribute to the overall AMIA2 program framework, by contributing specific outputs to targeted national-level research projects. It has four key components: (1) Capacity strengthening for CRA research & development, (2) Geospatial assessment of climate risks, (3) Stakeholders' participation in climate adaptation planning, and (4) Documenting & analyzing CRA practices. These project components were designed to be directly aligned with the research agenda of three AMIA2 projects: 1) climate-risk vulnerability assessment (CRVA), 2) decision-support platform for CRA, and 3) institutional and policy innovations. Figure 1 shows the framework for this study.

Component 1 - Capacity strengthening for CRA research & development

The regional project team participated in a series of trainings, workshops and learning events organized by AMIA2 projects. These were focused on three key methodologies: 1) CRVA, 2) CRA prioritization, and 3) CRA M&E. The project provided training support to key research and development stakeholders in the region, by organizing an intra-regional training that covers key learning contents from the national-level trainings. The CRA monitoring and evaluation was later included in the phase two of the AMIA2 which is currently handled by the Department of Agriculture Regional Field Office 3 in Victoria, Tarlac. The town was one of the identified vulnerable areas in the province.

Component 2 - Geospatial assessment of climate risks

The project team collected and organized geo-referenced data on vulnerability to climate risks of the region's agri-fisheries sector. These datasets, from both primary and secondary sources, were used on the methodological guidelines provided by the AMIA2 CRVA project – covering climate-risk exposure, sensitivity and adaptive capacity. Preliminary analysis – using GIS software and climate modelling tools – was undertaken at the regional level. The project team also participated in a national-team level joint analysis of cross-regional data.

Component 3 - Stakeholders' participation in climate adaptation planning

The regional project team organized a series of stakeholders' meetings and focus group discussions to collect supplementary data and validate preliminary results of CRVA, as well as in identifying CRA prioritization and planning. These activities were guided by process facilitation using the MaxEnt and CBA Tool developed by the AMIA2 projects on CRVA and CRA decision-support platform.

Component 4 - Documenting & analyzing CRA practices

A semi-structured survey with local stakeholders was conducted to identify and document CRA practices, as well as collect existing CRA-relevant statistical and other secondary data. Focus group discussion with farmers, farmer-leaders, technician, municipal and provincial agriculturists, and representative of provincial government of Tarlac were done on four separate occasions to gather data, validate and present the results, and revalidation of results. These data was systematized and analysed using cost-benefit and trade-off analyses tools as input to AMIA2 CRA prioritization and investment planning. A CBA Tool was made available online by the CIAT to facilitate the computation of cost, benefits, and others. These contributed to developing knowledge products, such as searchable online portal, under the AMIA2 project on CRVA decision-support platform.
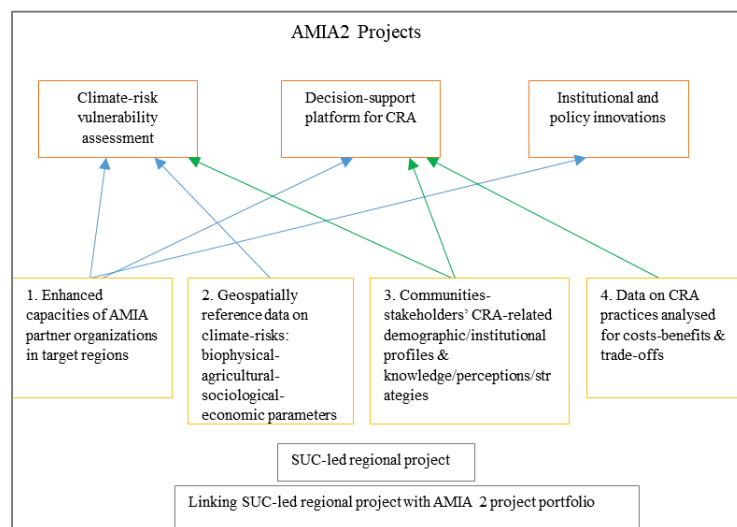

FIGURE 1. Framework of the Study

Data Acquisition

Collection of secondary data for exposure-sensitivity and secondary-primary data for adaptive capacity was done from different agencies such as the Provincial Agriculture Office, Municipal Agriculture Offices, and data from the AMIA2 outputs. Data collection started with gathering of primary and secondary data, that includes those from focus group discussion (FGD), key informant interviews (KII) and municipality surveys.

CRVA Framework

The vulnerability mapping was done which follows the Climate-Risk Vulnerability Assessment (CRVA) framework. It starts with the identification of the vulnerability determinants (hazard, sensitivity, and adaptive capacity) and their respective indicators. This framework was the standardized procedure followed by different SUCs involved in the project. Data collection started in gathering the primary and secondary data, that includes those from focus group discussion (FGD), key informant interviews (KII) and municipality surveys. The identified priority crops of the province are rice, corn, tomato, and mango. Sweet potato was an additional crop prioritized by the team because it is one of the crops planted on the second cropping season after rice and corn.

CRA Practices

Key informant survey on climate-resilient agri-fisheries (CRA) practices in the province of Tarlac. These were gathered from a series of Focus Group Discussions with municipal agriculturists, representatives of the Office of the Provincial Agriculturists and Local Farmer Technicians. From the list of CRA practices, key

informants identified three priority practices. The interview guide provided by CIAT was modified to fit the scope of the study before it was given to the group of key informants. Data gathered were used in the evaluation of CRA practices using the CBA Tool. CRA practices with the incorporation of externalities was given priority in the study.

RESULTS AND DISCUSSIONS

Enhanced Capacities of AMIA Partner Organizations in the Region

Series of trainings, workshops and learning events were organized for AMIA2 project teams in an intra-regional training that covers key learning contents from the national-level trainings as shown in Table 1.

Climate Risk Vulnerability Assessment (CRVA)

The vulnerability mapping was based on the Climate-Risk Vulnerability Assessment (CRVA) framework. It started with the identification of the vulnerability determinants (sensitivity, hazards, and adaptive capacity) and their respective indicators.

Sensitivity Analysis

In developing the impact of climate change to crop suitability, a crop distribution model was used and the factors associated are the 20 bioclimatic variables and the existing crop location. Sensitivity index was used in the sensitivity analysis to determine the sensitivity of crops to changes in temperature and precipitation.

The aggregated sensitivity of crops for rice, maize/corn, tomato, mango, and sweetpotato are given equal weights of 20% as shown in Figure 2 (a). It appears that the sensitivity index of the province generally ranges from -5% to -50% which means that it is sensitive to highly sensitive as influenced by the bioclimatic variables. On the other hand, improved varieties of crops, water conservation and soil conservation technologies that are being practiced by farmers mitigate the effect on crop yield.

Hazards Vulnerability

The natural hazards that were added to come up with the hazard vulnerability index are tropical cyclone/typhoon, flood, drought and erosion which are given the corresponding weights of 35%, 35%, 27% and 3%, respectively. The areas of San Manuel, Anao, Moncada, and La Paz are highly vulnerable to hazards as shown in Figure 2 (b). These areas experiences flooding on the onset of monsoon rain especially during typhoon because of geographically low areas of the province and become the catchment basin of the nearby provinces.

Adaptive Capacity Analysis

The adaptive capacity indicators considered in the assessment of the province's readiness to withstand the effects of climate change. These seven capitals are economic, natural, human, physical, anticipatory, social and institutional. Figure 2 (c) on the adaptive capacity illustrates the economic, natural, human, physical, anticipatory, social and institutional capital of every municipality. These seven (7) capitals of the adaptive capacity were given the same weight to come up with the aggregated adaptive capacity map.

The adaptive capacity of the province shows the readiness to adapt to climate risk. Concepcion and Gerona were found to have very high adaptive capacity while the municipalities of Ramos, San Jose, La Paz, and Bamban have very low adaptive capacity.

Climate-Risk Vulnerability

The climate-risk vulnerability map was developed by adding the sensitivity index, hazard index and the adaptive capacity index with their corresponding weights. A national experts' meeting composed of agriculturists, policy makers, and scientist, agreed the 15-15-70 percentage of weight for the sensitivity, hazard and adaptive capacity, respectively. The formula used in the development of climate-risk vulnerability map is stated in Equation 1:

$$
\begin{aligned}
\text{Climate - risk vulnerability} = \text{Sensitivity index} * 0.15 + \\
\text{Hazard index} * 0.15 + \\
\text{Adaptive capacity index} * 0.70
\end{aligned}
\tag{1}
$$

Figure 3 show the vulnerability to climate-risk is very high in the municipalities of Ramos, Bamban and La Paz; high in San Jose, Victoria and Pura; lowest in Tarlac City. The factor that has the major contribution in the vulnerability assessment is the adaptive capacity given a weight of 70% compared to sensitivity and hazards with 15% weights each. The perspective of giving a high percentage to the adaptive capacity is the thought of the ability of every municipality being able to cope with extreme events like temperature, rainfall, typhoon, flood, drought, erosion and other natural hazards because these municipalities are equipped with facilities and structures, and services for the adaptation.

The maps developed in the CRVA assessment was presented to a focus group discussion (FGD) with the stakeholders from the Provincial Agriculture Office (PAO), Municipal Agriculture Office (MAO), Farmers and other agencies. From the FGD and field visit conducted, the participants agreed that the maps developed are similar to the actual situation in their municipality. Vulnerable areas due to risks of climate was mentioned in the study of Dikitanan, et al. (2017).

TABLE 1. Capability Building Training, Seminars and Workshop Attended by the Regional Team

| Title	Date	Venue
Training on Climate Risk Vulnerability Assessment	June 6-8, 2016	Torre Venezia Hotel, Quezon City
Cost- Benefit Analysis (CBA) on Climate Resilient Agriculture Practices	August 6-8, 2016	Torre Venezia Hotel, Quezon City
Methodology for Evaluating Social and Environmental Benefits, in Agricultural Systems	December 2, 2017	Tarlac Agricultural University, Camiling, Tarlac
Climate Risk Vulnerability Assessment (CRVA) Mapping & and Adaptive Capacity Mapping	January 10-12, 2017	SEARCA, UPLB, Los Banos, Laguna
AMIA2-CIAT Project: Results Sharing and Validation Workshop on CRVA & CRA Decision Support	February 6-7,2017	Parklane International Hotel, Cebu City
Workshop on Finalizing Results on CRA and Prioritization and Extended CBA	March 1-3, 2017	B Hotel, Quezon City
Completion Review of BAR Funded Climate Change Projects	May31-June 2, 2017	Partido State University, Goa, Camarines Sur
AMIA2-CIAT Project: Workshop on Outcome Monitoring and Evaluation of Community-Based Action Research	June 21-22, 2017	Sequoia Hotel, Quezon City
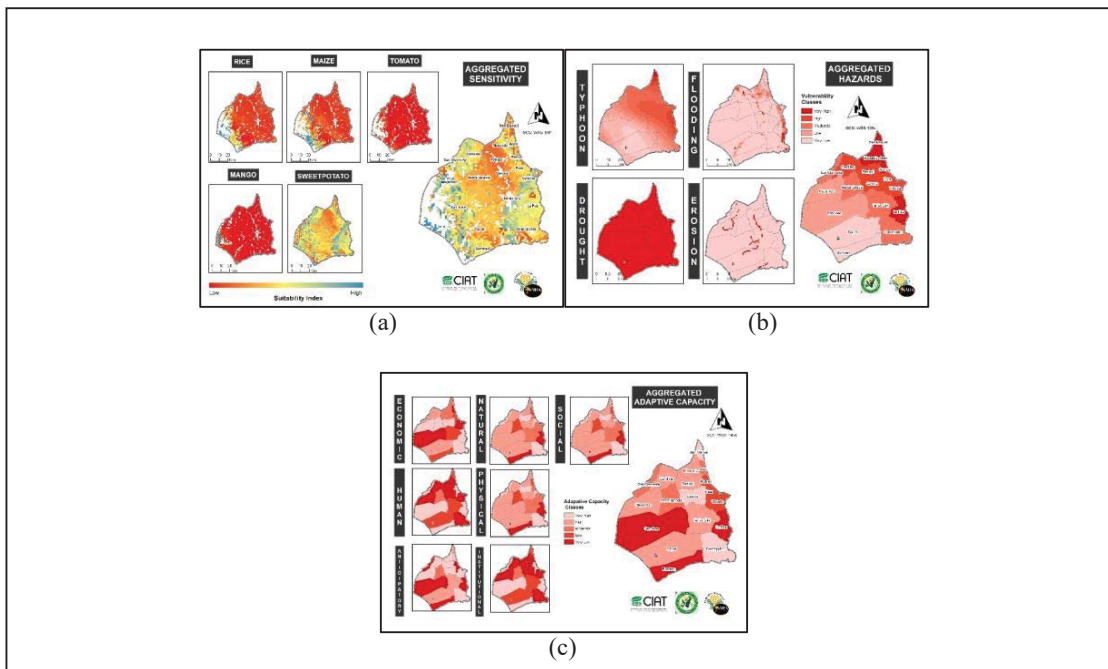
FIGURE 2. Maps on sensitivity, hazards and adaptive capacity to produce CRVA map: (a) Aggregated Sensitivity; (b) Aggregated Hazards; and (c) Aggregated Adaptive Capacity
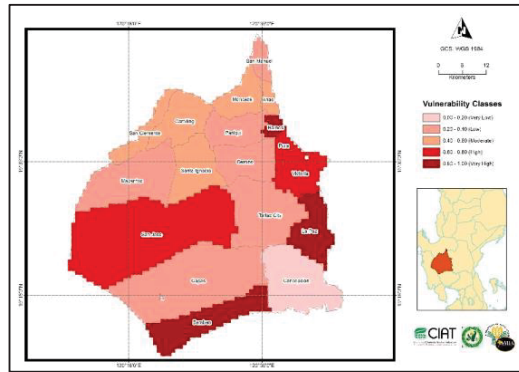
FIGURE 3. Climate-Risk Vulnerability Map of Tarlac

Cost-Benefit Analysis (CBA) of CRA Practices

The identified climate-resilient practices in the province of Tarlac which are the following: Organic agriculture, climate smart varieties/lines, water conservation technology, adaptive crop calendar/crop switching, soil conservation technology, intercropping/crop rotation, community-based management, crop insurance/weather adverse condition insurance, and improved housing for animals. The identification of CRA practices were gathered through interview. The list was trimmed and validated through a series of FGDs with municipal agriculturists, representatives of the Office of the Provincial Agriculturists, local farmer technicians and farmers. CRA practices have also been priorities in the study of Dikitanan, et al. (2017).

From the list of CRA practices, key informants identified three priority practices: climate smart varieties, crop rotation, and water conservation technology particularly the alternate wet and dry method (AWD). The interview guide provided by CIAT was modified to fit the scope of the study before it was given to the group of key informants. Data gathered were used in the evaluation of CRA practices using the CBA Tool. Validation of data was done by seventy one (71) municipal agriculturists, farmer leaders and farmer technicians participated in the Focus Group Discussions. The cost and benefits derived from the CRA practices were confirmed. These data were used to analyse the profitability and sustainability of the CRA practice. The three prioritized practices are the climate smart varieties, crop rotation and water conservation technology because of the immediate effects and perceived potential benefits to the farmers, food security and, mitigation and adaptation to climate change. Investment prioritization brief were also prepared for policy makers to support the climate-resilient agriculture practices in the provinces as shown in Figure 4. Researchers and extensions' personnel must use the investment brief for dissemination and reference for further validation or research in a specific area.

Climate Smart Varieties

Yield of crops is affected by extreme changes in climatic conditions such as flooding, and drought and attack of insect pests and diseases. Farmers and agricultural technologists favor climate smart varieties because of its high yield and its capacity to withstand varied climatic conditions. The Green Super Rice lines (GSR 8, 15, 21, and 22) earned special mention among farmers who have experienced growing it due to its resiliency especially during typhoons and floods, drought, and attack of insect pests and diseases. Farmers who planted GSR lines attested the resilience of these lines to typhoon and submergence. Yield was not likewise affected.

Crop Rotation

Crop rotation was chosen mainly because farmers could switch from rice to other crops (corn, sweet potato, etc.) depending on availability of water, soil conditions, and other climactic factors. Crop rotation also means reduction in pest occurrence due to non-availability of the host.

Water Conservation Technology

To address problems on scarcity of water supply or limited access to water sources in the upland, rainfed, and other areas, water conservation technologies are resorted to. The Alternate Wet and Dry (AWD) Method was specially mentioned because it utilizes materials readily available and can be constructed easily by the farmer. Some parts of the province depend on shallow tube wells and Tarlac Ground (TG) water as their main

source of irrigation. In these areas, one of the main expenses incurred by farmers is gasoline that is used to run pumps. This practice was chosen because it allows farmers to irrigate at the proper time. The intermittent drying of fields enables the farmers to save on time and money.

FIGURE 4. Investment Brief for Climate Smart Agriculture Practices

CONCLUSION

The two major output of this study are: climate-risks vulnerability map and investments briefs. The map was used to identify pilot area of climate smart village. The Department of Agriculture Regional Field Office 3 chose the municipality of Victoria as the pilot climate-smart village in the province of Tarlac. DA RFO3 based the selection on the result of the climate-risk vulnerability mapping and willingness of the local government unit to support the project. Victoria is considered as one of the high vulnerable municipalities that is sensitive to changes in climate, vulnerable to hazards and has less adaptive capacity to cope up with the phenomenon. Victoria is a 2nd class municipality of the province of Tarlac with 26 barangays and is located at the eastern part of the province. Majority of the total land area is devoted to agricultural activities and livestock production.

The climate resilient agriculture practices identified in the prioritization is being adopted in areas in the province for further testing and evaluation in the suitability of a CRA practices in an area. The investment briefs were presented to Department of Agriculture and Office of the President as a support for decision- and policy-making.

ACKNOWLEDGEMENT

REFERENCES

1. L.E. Ngilangil, S.O. Olivar and M.L.A. Ballesil. E-International Scientific Research Journal **5**(3), 74(2013).
2. Environmental Management Bureau-Climate Change Division. *National Climate Change Action Plan 2011-2028*, http://climate.emb.gov.ph.
3. R. Dikitanan, G. Grosjean, A. Nowak, and J. Leyte. *Climate-Resilient Agriculture in Philippines. CSA Country Profiles for ASIA Series,* http://cgspace.cgiar.org
4. Food and Agriculture Organization of the United Nations (FAO). *Climate-Smart Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation*, http://fao.org.
5. E.M. De Guzman, A.N. Espino, Jr., M.E. Agulto and V. Malamug, *A GIS-Aided Decision Support System for Small Farm Reservoirs*, MS thesis. (Central Luzon State University, 2013).
6. Provincial Agricultural Office. "Tarlac Agricultural Profile". Tarlac Province (2016).