Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rain-fed Areas of Central Luzon

(CHED-NAFES PROGRAM)

TARLAC AGRICULTURAL UNIVERSITY
Malacampa, Camiling, 2306, Tarlac

August 2021-January 2023

Contents

REPORT ON SOCIO-ECONOMIC PROFILE OF SMALL FARM RESERVOIR FARMERS IN SELECTED RAINFED AREAS OF CENTRAL LUZON

A. BASIC INFORMATION

1. **Program Title:** Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project 1 Title: Socio Economic Profile of Small Farm Reservoir and Fishpond Farmers in Selected Rainfed Areas of Central Luzon

2. **Researcher(s):**
   Project Leader: Orlando H. Locading Jr.
   Project Staff: Maribel C. Ramales
   Sonny A. Santos

3. **Implementing Agency/Station**
   Lead Agency – Tarlac Agricultural University
   Cooperating Agency – Central Luzon State Univesity, Provincial and Local Government
   Units of Central Luzon
   Project Site(s): Central Luzon (Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)
4. **Technology Level:** Applied
5. **Sector:** Agriculture
6. **Commodity Classification**: Agriculture
7. **Research Discipline**: Social
8. **Target Beneficiaries**: 2200 Beneficiaries composed of the following
   2100 small farm reservoir farmers
   50 Agricultural Technologist/Agriculturist
   5 graduate Students
   45 undergraduate students
9. **Funding Agency**: CHED-NAFES
10. **Duration**
   Date Started: August 2021
   Date Ended: February 2023
11. Financial Reports
   Total Approved Budget: ₱ 9,500,000.00
   Actual Released Budget: ₱ 6,142,182.00
   Actual Expenditures: ₱ 2,723,762.50 as of August 2022.

B. TECHNICAL REPORT

I. Rationale

The small farm reservoir (SFR) is a small water impounding earth dam structure to collect rainfall and runoff, designed for use in single farm, and typically has an area of about 300-2,000 square meters. The embankment height above ground level is less than 4 meters.

Water storage in small farm reservoir was use in rainfed growing areas to provide supplemental irrigation water during rainy season and off-season rice production. Aside from irrigation, water in small farm reservoir could be used for small scale fish production, livestock watering and groundwater recharging. To maximize the potential of SFR's in rainfed areas of Central Luzon, this program is proposed. The main objective of the program is to establish technology demonstration for Small Farm Reservoir-based Tilapia Production in Rainfed Areas of Central Luzon, specifically, it aims to improve the income generating capacity of Small Farm Reservoir through engineered aquaculture production, and to disseminate the results of project through seminar, training and hands-on workshop.

The program started with the socio-economic profiling of SFR's farmers. Information such as size of SFR, The profile will be used to propose the training needs of farmers. The training will capacitate the farmers to regard aquaculture a way to mitigate income from rice and vegetable farming. Technical and business skills will be given to farmers for

The total beneficiaries of the program will be 2,100 SFR's owners and farmers from Aurora, Bulacan, Nueva Ecija Pampanga, Tarlac and Zambales.

II. Objectives

The general objective of the study is to determine the socio-economic profile of SFR farmers in Central Luzon.

Specifically, it to aims to:

1. To describe the socio-economic profile SFR farmers in terms of:
   a. Location
   b. Number of household members
   c. Number of years in farming
   d. Crops cultivated/ livestock raised
   e. Area of SFR and farm
   f. Income from farming and other sources;
2. To establish the benefits derived from small farm reservoir;
3. To know the problems encountered by farmers using SFR; and
4. To propose extension needs of SFR and fishpond farmers.

III. **Expected Output**:

1. Products
   a. Directory of DA LGU in Central Luzon
   b. Training modules
2. Places and Partnership
   a. Provincial and Municipal LGUs of Central Luzon
3. People Services
   a. Trained farmers
4. Publication

IV. **Research Highlights**

1. Procedure/Methodology

Framework of the Study

Figure 1. SFR farmers training needs analysis

Methodology

The project started coordinating with the Department of Agriculture RFO III to identify areas with SFR and contact details of concerned Provincial Agriculture Office. A written request was given to PAO to introduce the project and to get information from the local agriculture office. Then, a written request was given to DA-LGU to obtain a list of SFR farmers in their area.

In close coordination with the local DA office, appointment was set to conduct focus group discussion and individual farmers and farmer organizations. The project utilizes face to face interviews to gather the socio–economic profile and the problems encountered by SFR farmers. Base on the conducted FGDs and interviews, a training proposal will be prepared. The training of SFR farmers will be part of the project on value chain development of SFR-based aquaculture. This endeavor will strengthen the farmers, and capacitate agricultural extensionists to monitor the progress of SFR farmers in their areas.

2. Findings

A. Socio- demographic profile of SFR Farmers

i. Location

Table 1. Location of respondents

Address	Frequency	Percentage%
Tarlac	469	58.33
Pampanga	46	5.72
Nueva Ecija	134	16.67
Zambales	20	2.49
Aurora	91	11.32
Bulacan	44	5.47
	804	100

Most of the SFR owners interviewed are located in the Province of Tarlac, some are located in Nueva Ecija and there are only a few (20) from Zambales. (Table 1). Bataan was not included in the study because a similar study was conducted in the area.

ii. Average household size

Table 2. Average household size

Size	Frequency	Percentage%
5 members and Below	576	71.64
5-10	205	25.50
10 members and above	23	2.86
	804	100

Most of the SFR owners belong to a family with a household size of 5 members and below while very few have a household size of 20 members and above. (Table 2)

iii. Number of years in farming experience

Table 3. Years of farming experience

Size	Frequency	Percentage%
5 years and below	115	14.30
6-10 years	85	10.57
11-15 years	59	7.34
16-20 years	115	14.30
21 years and above	430	53.49
	804	100

Table 3 shows that majority (430) of the SFR owners have been farming for more than 21 years, some (115) are just new or have been to farming for 5yrs and below, and few (58) have been farming for about 11-15 years.

iv. Crops cultivated/ livestock raised

Table 4. Crops and livestocks owned by the respondents

Size	Frequency
Crops	
Rice	804
Rice-corn	60
Rice- vegetables	204
Rice- rootcrops	240
Rice-corn-vegetables	200
Livestocks	
Cattle	351
Goat	276
Rabbit	55
Sheep	16
Pig	160
Poultry	356
Fish	

- multiple response

All of the respondents cultivate rice as the main crop. Most of the farmers practice crop- rotation because of lack of irrigation during the 2nd cropping. Water from SFR was used to augment the water requirements of their crops. Majority of the farmers also grew livestocks in their backyard mainly as a sustenance rather than an additional source of income. (Table 4)

v. Area of SFR and farm

Table 5. Average Farm lot and SFR of respondents

Area Lot	Frequency	Percentage%
SFR		
500 below	435	54.10
501-1000	173	21.52
1,001 above	196	24.38
Farm		
Below 500	42	5.23
500- 10,000	97	12.06
Above 10,000	665	82.71
	804	100

Table 5 shows that most of the SFR farmers own more than 10,000sqm of farmland each and only few own below 500sq.m farmland each. When it comes to the functional SFR, most of the farmers own SFRs with an area of below 500sq.m, followed by more than 1,00sq.m. The farmers also reiterated that they are using their SFRs both as irrigation and fishpond.

vi. Sources of Income

Table 6 Average income in farming and other sources

	Frequency	
Income range	**Farming**	**Other sources**
10,000- and below	543	202
10,001- 20,000	165	75
20,001- 30,000	28	16
30,001- 40,000	17	11
40,001- above	14	5

Almost all of the SFR owners only earn a monthly income of below P10,000 from farming while few have a monthly income of 30,000 and above. The cause of this low income can be traced from their lack of technical, management, and marketing skills. Most of the farmers were dependent mainly on the income from farming.

B. Benefits derived from SFR

Table 7. Perceived benefits from SFR

Benefits	Frequency	Rank
Increased yield	528	2
Increased income	355	3
Deceased production costs	691	1

- *Multiple response*

Most of the SFR farmers experienced a reduction on their production costs after establishing SFR in their farms. This may be attributed to the decrease in the use of gas and labor. Farmers who have acquired knowledge on tilapia production reported an increase in their income.

C. Problems and challenges encountered by SFR farmers

Table 8. Problems and challenges

	Frequency	Rank
Overstocking	202	8
Sudden change in weather	592	3
High cost of inputs	585	4
Natural predators	231	7
Lack of business management skills	760	2
Lack of technical skills	775	1
Limited market	340	6
Limited government support	520	5

- *Multiple response*

Table 8 shows the problems and challenges faced by SFR farmers in Central Luzon. Most mentioned problems in the interview and focus group discussion were the lack of technical and business skills. Most of the respondents only got technical information from neighbors, and local agricultural technicians through verbal communication. This information includes SFR management and tilapia production. The respondents also lack business skills like record keeping, resource and financial management. Most of the SFR farmers do not have formal training in these areas.

Changes in weather pattern is also a concern of the respondents as it affects the quality and quantity of water in the SFR. The reservoir is usually full during the months of June to August, making it ideal for them to grow tilapia during these months. In addition, problems and challenges faced by SFR farmers are high cost of inputs, lack of government support, natural predators, and overstocking.

3. Accomplishments

This table shows the accomplishment report of the project as of August 2022.

No.	Target Activity(ies)	Inclusive Date	Percentage Completed		Remarks
			For the Period	Cumulative (from the start)	
1	**Administrative and Support Activities** -Program/Project meeting -Submission of Monthly, quarterly, annual and terminal report.	August 2021-February 2023	100%	100%	Conducted project meeting. Submitted monthly report.
2	**Identification of areas with SFR and fishpond farmers** -Coordination with PAO, MAOs and DA-RFO 3	August 2021-March 2022	3%	100%	Additional directory of LGU and SFR farmers. Scheduled the conduct of the interview.
3	**Socio-economic profiling of farmers in the SFR areas and fishpond farmers.** -Conduct of Survey to SFR/Fishpond owners (Socio-Economic Profile)	January 2022-February 2023	3%	100%	A total of 804 SFR farmers were interviewed in Zambales, Bulacan , and Nueva Ecija (Table 1)
4	**Preparation of Training Plan** -Consolidation, interpretation and analysis of data gathered -Needs analysis of SFR/fishpond owners	January 2022-February 2023	100%	100%	The Training Plan was prepared based on the needs assessment. IEC materials were prepared. Coordination with LGU and resource person were done .

Percentage of Completion *Completed (add sum of cumulative percentages per activity / total no. of activities)*	100%	February 2022

D. Training and Extension

Based on the data gathered through interview and focus group discussion with the farmers and concerned DA-LGUs, an extension plan was prepared. The needs assessment showed that SFR farmers lack the technical skills in tilapia production and management of SFR. Their present knowledge was only limited to information from neighbors and other farmers. Some of the farmers also sought advice from technicians, but most of the DA_LGU technicians are trained in livestock and crop production.

The training for SFR farmers was divided into 2 categories: technical and business management, as shown in the table below. Technical experts on tilapia production from Roy Pascual, fingerling producer accredited by the Bureau of Fisheries and Aquatic Resources, and fishery expert from the College of Agriculture and Forestry were tapped to be resource person on tilapia and SFR management and care. . The business management training was handled by the College of Business and Management faculty. Entrepreneurial Mind setting is included in the training because most farmers treat tilapia production as a mere sustenance and additional food source rather than as an additional source of income to augment farming income.

The project also sought to strengthen farmers' organization for better access to knowledge, resources from the government, marketing and financial support. It is also an extension goal of the project to help organize at least one cooperative/ farmer organization per province.

Table 10. Intervention of the program based on the needs analysis

Intervention	Activity
1. Capacity- Building	Training on the following areas: Technical Tilapia production SFR Care and Management Business Management Entrepreneurial Mind setting Financial Management Organization management Other Skills Food Processing
2. Monitoring	Training of technicians on monitoring and evaluation

Photo Documentation

Figure 2. Coordination meeting at Municipal Agricultural Office at Aurora

Figure 3. The Conducted Socio profiling of Aurora Province

Figure 4. Coordination meeting at Municipal Agricultural Office at Bulacan

Figure 5. The conducted Socio Profiling at Bulacan Province

Figure 6. Coordination at Municipal Agricultural Office at Zambales

Figure 7. Conducted Interview with SFR Farmers of Zambales

Figure 8. Conducted Interview with SFR Farmers of Pampanga

Figure 9. Coordination meeting with MAO at Nueva Ecija

Figure 10. Conducted Interview with SFR Farmers of Nueva Ecija

Figure 11. Conducted Interview with SFR Farmers of San Jose, Tarlac

Figure 12. Conducted Interview with SFR Farmers of Tarlac Province

DOCUMENTATION ON THE GEOTAGGED EXISTING SMALL FARM RESERVOIR IN SELECTED RAINFED AREAS IN CENTRAL LUZON

A. BASIC INFORMATION

1. **Program Title:** Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon
Project 2 Title: GIS-Based inventories of Existing Small Farm Reservoir in Selected Rainfed Areas of Central Luzon

2. **Researcher(s):** Project Leader - Chelsie C. Pagatpatan (August 2022 – present)
Guiller B. Damian (August 2021 – July 2022)
Project Staff - Jesus A. Tolentino

3. **Implementing Agency/Station**
Lead Agency – Tarlac Agricultural University
Cooperating Agency – Central Luzon State University
Provincial and Local Government Units of Central Luzon (Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)
Project Site(s): Central Luzon
(Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)

4. **Technology Level:** Applied
5. **Sector:** Agriculture
6. **Commodity Classification**: Agriculture
7. **Research Discipline**: Applied
8. **Target Beneficiaries**: 2200 Beneficiaries composed of the following
2100 Small Farm Reservoir farmers
50 Agricultural Technologist/Agriculturist
5 graduate Students
45 undergraduate students
9. **Funding Agency**: CHED-NAFES
10. **Duration**
Date Started: August 2021
Date Ended: January 2023
11. **Financial Reports**
Total Approved Budget: ₱ 9,500,000.00
Actual Released Budget: ₱ 6,142,182.00
Actual Expenditures: ₱ 4,927,658.60.

B. TECHNICAL REPORT

I. Rationale

A small farm reservoir (SFR) can be described as a structure comprising an earthen barrier that is designed to capture, collect, and retain rainwater and surface runoff (BAFS, 2017). In the Philippines, SFR is a technology introduced by the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD) for mitigating drought and irrigation issues brought about by climate change (PCARRD, n.d.). These reservoirs further provide valuable water resources for livestock, and domestic purposes in rural farming communities.

While the Bureau of Soils and Water Management (BSWM) under the Department of Agriculture is mandated to implement small-scale irrigation projects such as SFR, farmers in Central Luzon have developed SFRs indigenously. Farmers in rainfed areas use this to provide additional irrigation water for the cultivation of rice. Small-scale fish production using the SFR is another method that the farmers use to increase the productivity of their farms (Ines, et al., 2017).

Though the SFR technology is widely accepted in a number of areas in the region, there is a lack of information detailing the numbers and extent of these SFRs. Inventory of SFRs can be implemented through the use of geographic information systems (GIS). The GIS integrates spatial data such as reservoir location, size, and attributes. Spatial data can be depicted through maps to show and analyze spatial distributions and relations (Kraak, 2005).

GIS-based inventories play a crucial role in understanding and managing SFRs, which are vital for agricultural water management. These inventories provide valuable insights into the current state of the SFRs. Furthermore, GIS-based inventories contribute to understanding the impacts of climate change and land use dynamics on SFRs, enabling proactive measures to mitigate risks and ensure sustainable water management. The objective of this study then is to locate the spatial distribution of SFR's in rainfed areas of Central Luzon.

II. Objectives

The general objective of the study is to locate the spatial distribution of SFRs in rainfed areas of Central Luzon. Specifically, it aims to: (1) conduct a benchmark survey of the existing SFRs in the rainfed area of Central Luzon and (2) conduct a benchmark survey of SFR's owners.

III. Expected Output:

1. Products
    a. Compilation of SFRs location and other information
2. Places and Partnership
    a. Provincial and Municipal Local Government Units of Central Luzon
3. People Services

a. Agricultural Extension Workers
b. SFR farmers

4. Publication
   a. Production of Maps of Existing SFRs in Central Luzon

IV. **Research Highlights**

Figure 1 shows the conceptual framework of the program. The aim of this study is to conduct GIS Based Analysis in the distribution of SFRs in Central Luzon. Using existing data, site validation, and resources from the internet, GIS based maps of SFRs in Central Luzon were produced.

The methodology for this project is shown in Figure 2. Secondary data was initially acquired from Local Government Units in Central Luzon, particularly in the Municipal Agriculture Office. The secondary data comprises the existing rainfed areas in the municipalities, SFR owners, service area, and number of farmers (see Figure 4 for sample data). The secondary data were collected and utilized as baseline for field validation and geotagging of SFRs. Some SFRs were also identified through Google Maps and a subsequent field validation was conducted to ensure that the identified areas are indeed SFRs.

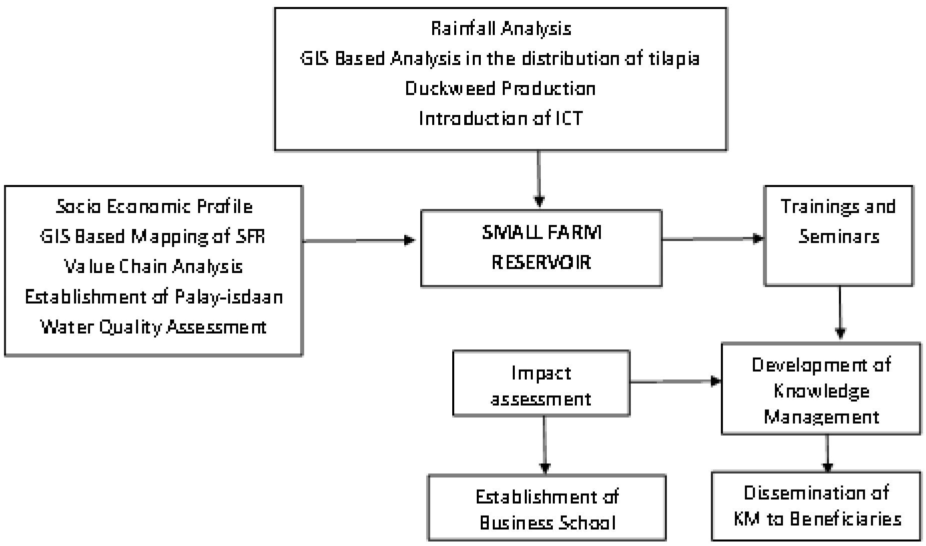


Figure 1. Conceptual Framework of the program

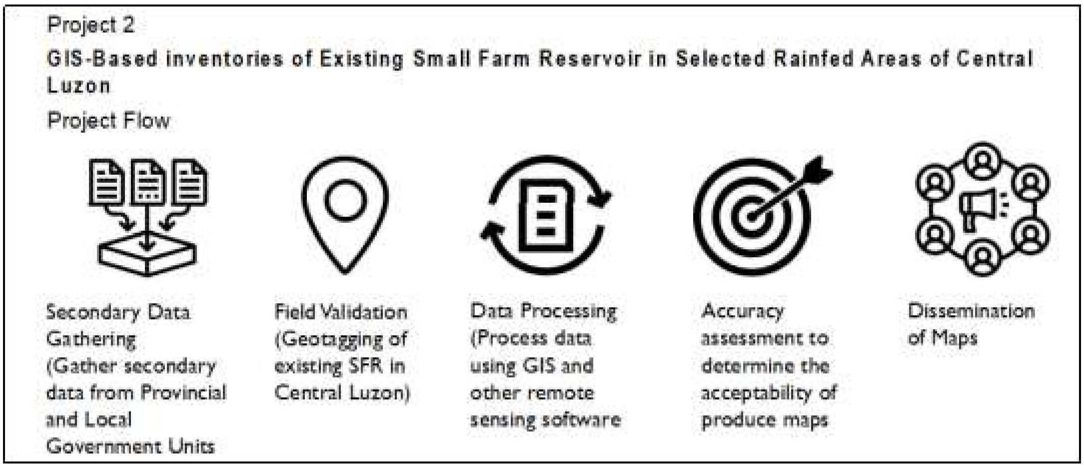


Figure 2. Flow of the Project

Figure 3. Secondary Data Gathering in Provincial and Municipal agricultural offices

Digitizing involves converting raster GIS data into vector data. This can be done through tracing features using the polygon tool in QGIS. The aim is to trace specific plots from the field to extract the desired data (Mabanta, et al., 2018). For this study, SFRs were digitized through Google Earth Pro and QGIS. These digitized SFRs were also used as a reference in field validation.

Geotagging is the process of acquiring the geographic coordinates (longitude and latitude) of a particular area. During field validation, the geographic coordinates of the SFRs were acquired. The geographic coordinates were used to identify the exact location of the SFR and to accurately locate it in the map in QGIS application. For this study, the Survey Cam phone application was used for geotagging (See Figure 4).

The QGIS or Quantum Geographic Information System is a software in which users can make spatial information through editing and analyzing. It has set of tools that are relevant in interpreting and collation of data, calculations and creating graphical map representations. The geographic coordinates of the SFRs were integrated to the QGIS application to validate the digitized SFRs and produce a SFR map per province.

MASTERLIST OF FRESHWATER FISH FARMERS
POND BASED
As of October 18, 2021

REGION	PROVINCE	MUNICIPALITY	BARANGAY	LAST NAME	FIRST NAME	MIDDLE NAME	EXTENSION NAME	POND AREA (Ha)
III	AURORA	MARIA AURORA	BAGTU	DELA CRUZ	LIBERATO	CARINO		0.0100
III	AURORA	MARIA AURORA	BANGCO	ALIBAYA	ARMANDO	NAVILIA		0.3000
III	AURORA	MARIA AURORA	BANGCO	ALIBAYA	LEOPOLDO	NAVILIA		0.6000
III	AURORA	MARIA AURORA	BANGCO	ANCHETA	MYRNA	ANGEL		0.0500
III	AURORA	MARIA AURORA	BANGCO	APOLONIO	JOSELITO	NICER		0.1000
III	AURORA	MARIA AURORA	BANGCO	DUYANEN	ARANCIA			0.1000
III	AURORA	MARIA AURORA	BANGCO	GABRES	AGRIFINA	AGUSTIN		0.8363
III	AURORA	MARIA AURORA	BANGCO	OLEA	NESTOR			0.1500
III	AURORA	MARIA AURORA	BANGCO	QUIBEN	ALBERTO	ALWAG		0.1000
III	AURORA	MARIA AURORA	BANGCO	RIAZA	MAXIE	DELA CRUZ	SR.	0.2500
III	AURORA	MARIA AURORA	BANGCO	VILLANUEVA	ARSENIA	SILVESTRE		0.1000
III	AURORA	MARIA AURORA	BANGCO	DUMPIT	MARIO	ABUAN		0.1000
III	AURORA	MARIA AURORA	BANGCO	PADUA	EDWIN	ABUAN		0.1000
III	AURORA	MARIA AURORA	BANGCO	RANDY	DE LUNA	CASANDIG		0.1000
III	AURORA	MARIA AURORA	BANGCO	ELMER	PADUA	CAMADING		0.1000
III	AURORA	MARIA AURORA	BANGCO	ANGEL	SUSAN	NECESITO		0.1000
III	AURORA	MARIA AURORA	BANGCO	BUCCAT	MARITESS			0.1000
III	AURORA	MARIA AURORA	BANGCO	VALDEZ	ALBERTO	NECESITO		0.1000
III	AURORA	MARIA AURORA	BANNAWAG	ABRERO	NOVELITA	CAPICOY		0.3000
III	AURORA	MARIA AURORA	BANNAWAG	ABRERO	REYNALDO	CAPICOY		0.2000
III	AURORA	MARIA AURORA	BANNAWAG	CAPICOY	MARIVIC			0.1000
III	AURORA	MARIA AURORA	BANNAWAG	ESPIRITU	ARNOLD	IBALE		0.7500
III	AURORA	MARIA AURORA	BANNAWAG	DE GUZMAN	CRISTYLINDA	CAPICOY		0.1000
III	AURORA	MARIA AURORA	BANNAWAG	PICARDAL	JOVENCIO	CANDELARIO		0.1000
III	AURORA	MARIA AURORA	BANNAWAG	RAMIREZ	ROMULO	LEAL		0.1000
III	AURORA	MARIA AURORA	BANNAWAG	RAQUEPO	CESAR	TOLENTINO	SR.	0.5000
III	AURORA	MARIA AURORA	BANNAWAG	SORIA	GERARDO	EVANGELISTA		2.0000
III	AURORA	MARIA AURORA	BANNAWAG	VALENZUELA	CARLITO			0.1000
III	AURORA	MARIA AURORA	BANNAWAG	YAHIN	LORETA	ABRERO		0.3000
III	AURORA	MARIA AURORA	BAUBO	DE VERA	MELANIE	NALUPA		0.4000
III	AURORA	MARIA AURORA	BAUBO	DE VERA	MARIA CARLA	JULIAN		1.0000
III	AURORA	MARIA AURORA	BAUBO	BALINBIN	JANE	MEJICO		0.7500
III	AURORA	MARIA AURORA	BAUBO	DE VERA	ODESSA VICMA	ASCANO		0.5000
III	AURORA	MARIA AURORA	BAUBO	DE VERA	LORENA			0.5000
III	AURORA	MARIA AURORA	BAUBO	BATERINA	PREMIDA			0.2000
III	AURORA	MARIA AURORA	BAUBO	NALUPA	NORBERTO	BALINBIN		0.5000
III	AURORA	MARIA AURORA	BAZAL	ANCHETA	MARIO	LAURIO		0.7500
III	AURORA	MARIA AURORA	BAZAL	GENETA	NERISSA	ASTEJADA		0.2000
III	AURORA	MARIA AURORA	BAZAL	GUTTIEREZ	LUZ	PANLILIO		0.2500
III	AURORA	MARIA AURORA	BAZAL	LAURIO	ROBLEDO	APIGO	JR.	0.2000
III	AURORA	MARIA AURORA	BAZAL	NEYPES	JOSEPH	GENETA		0.1500
III	AURORA	MARIA AURORA	BAZAL	DIRI	VERONICA	JARAVATA		0.0500
III	AURORA	MARIA AURORA	BAZAL	LAURIO	FROILAN	RAMOS		0.3000
III	AURORA	MARIA AURORA	BAZAL	BALAGAT	MARK ANTHONY	FRANKIE		0.1000
III	AURORA	MARIA AURORA	BAZAL	CAMACHO	ROGELIO	ABAWAG		0.3000
III	AURORA	MARIA AURORA	BAZAL	ABUAN	RAMEL	BAMBAO		1.0000
III	AURORA	MARIA AURORA	BAZAL	FERNANDEZ	ELOISA	PACLIBARE		0.5000
III	AURORA	MARIA AURORA	BAZAL	FERNANDEZ	SAMSON	APIGO		0.8000
III	AURORA	MARIA AURORA	BAZAL	AGBAYANI	WILLIAM	RODICOL		
III	AURORA	MARIA AURORA	BAZAL	ANCHETA	EMILY	SAULO		0.2000
III	AURORA	MARIA AURORA	BAZAL	FERMIN	LINA	CAMACHO		0.3000
III	AURORA	MARIA AURORA	BAZAL	ANCHETA	FRANCISCO	CASTILLO	JR.	0.2000
III	AURORA	MARIA AURORA	BAZAL	ANCHETA	AMBROCIO	ORA		0.2000
III	AURORA	MARIA AURORA	BAZAL	MORAL	FEMIA	REYES		0.3000
III	AURORA	MARIA AURORA	BAZAL	ANCHETA	DEMETRIO	SALVADOR		0.2000
III	AURORA	MARIA AURORA	BAZAL	ORA	FLORANTE	APIGO		0.2000
III	AURORA	MARIA AURORA	BAZAL	DE GUZMAN	PHILIP BRYAN	ORA		0.2000
III	AURORA	MARIA AURORA	BAZAL	LAURIO	ROBLEDO	APIGO	JR.	1.0000
III	AURORA	MARIA AURORA	BAZAL	OROGO	ROSEMARIE	APIGO		0.2000
III	AURORA	MARIA AURORA	DEBUCAO	CAMPOS	RODRIGO	NISPEROS		1.0000
SUB-TOTAL								20.1963

Scanned with CamScanner

Figure 4. Sample Secondary Data acquired from DA-Aurora

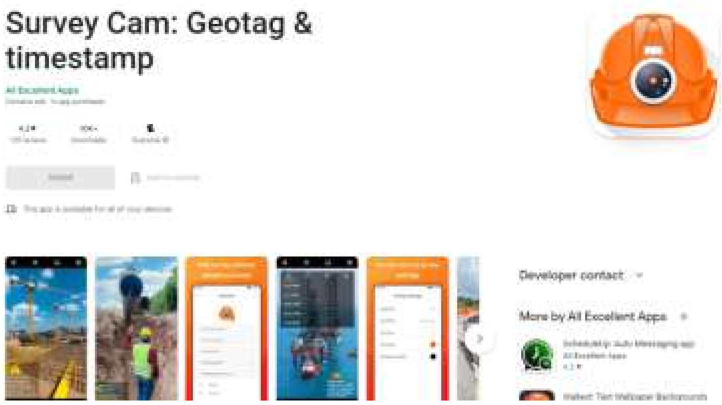


Figure 5. Survey Cam phone application for geotagging

Table 1. Program of Activities

Activities	Months								
	2	4	6	8	10	12	14	16	18
Secondary Data Gathering	■	■	■						
Development of Methodologies		■	■	■					
Data Processing			■	■	■	■	■	■	
Field Validation				■	■	■	■	■	■
Accuracy Assessment							■	■	■
Monthly, Quarterly, Yearly, and Terminal report	■	■	■	■	■	■	■	■	■

2. Accomplishments

The figures in the succeeding pages show the digitized SFRs in Central Luzon. In total, there are 14,761 SFRs that were initially digitized. However, through field validations, there are only 767 SFRs in Central Luzon (excluding Bataan) as of December 2022. In addition to this, 26.47% matched the digitized data. Upon validation, the remaining percentage of the digitized data are mostly grow-out ponds or hatcheries.

There are a total of 644 SFRs that have been geotagged and validated in Tarlac, 53 SFRs have been geotagged and validated in Nueva Ecija, 29 in Aurora, 12 in Pampanga, 10 in Zambales, and 19 in Bulacan. The data that have been gathered was consolidated and were mapped and digitized. The breakdown of this is shown in Table 2. These farmers were also interviewed in coordination of Projects 1 & 9 of the program.

Table 2. Geotagged SFRs in Central Luzon

PROVINCE	MUNICIPALITY	Number of Geotagged SFRs
Tarlac	Anao	13
	Bamban	1
	Camiling	290
	Gerona	51
	Mayantoc	80
	Paniqui	50
	Pura	17
	Ramos	5
	San Clemente	22
	San Jose	7
	Santa Ignacia	108
Nueva Ecija	Cuyapo	3
	Guimba	13
	Lupao	15
	Rizal	8
	San Jose City	14
Aurora	Baler	1
	Dipaculao	10
	Maria Aurora	18
Pampanga	Porac	3
	Sta. Rita	7
	Bacolor	2
Zambales	San Marcelino	7
	Botolan	3
Bulacan	San Ildefonso	1
	San Rafael	5
	San Miguel	13
TOTAL		767

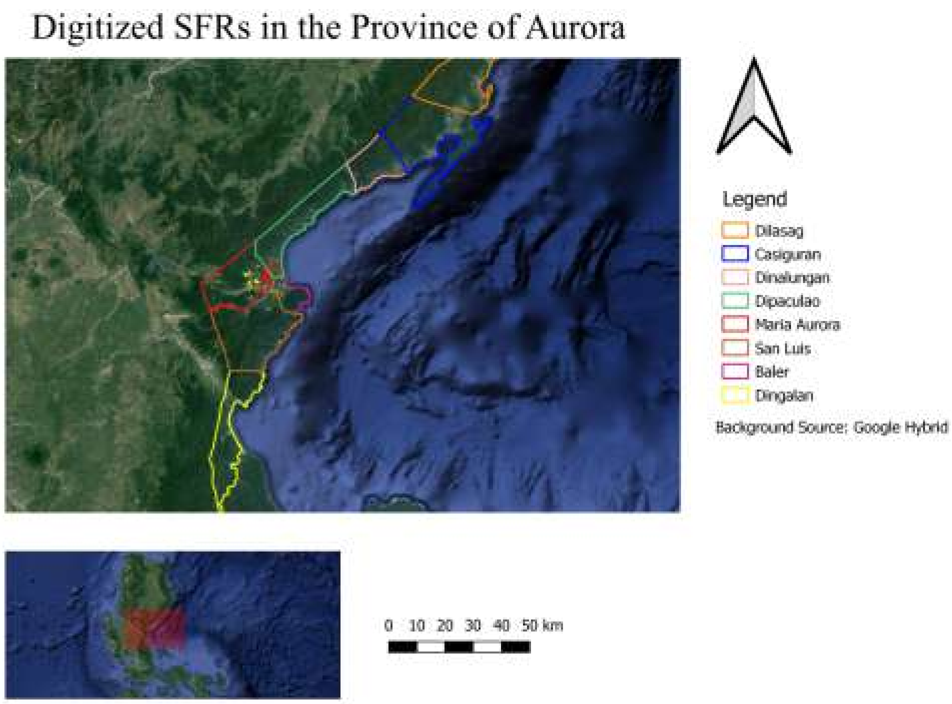


Figure 6. Digitized SFRs in Aurora

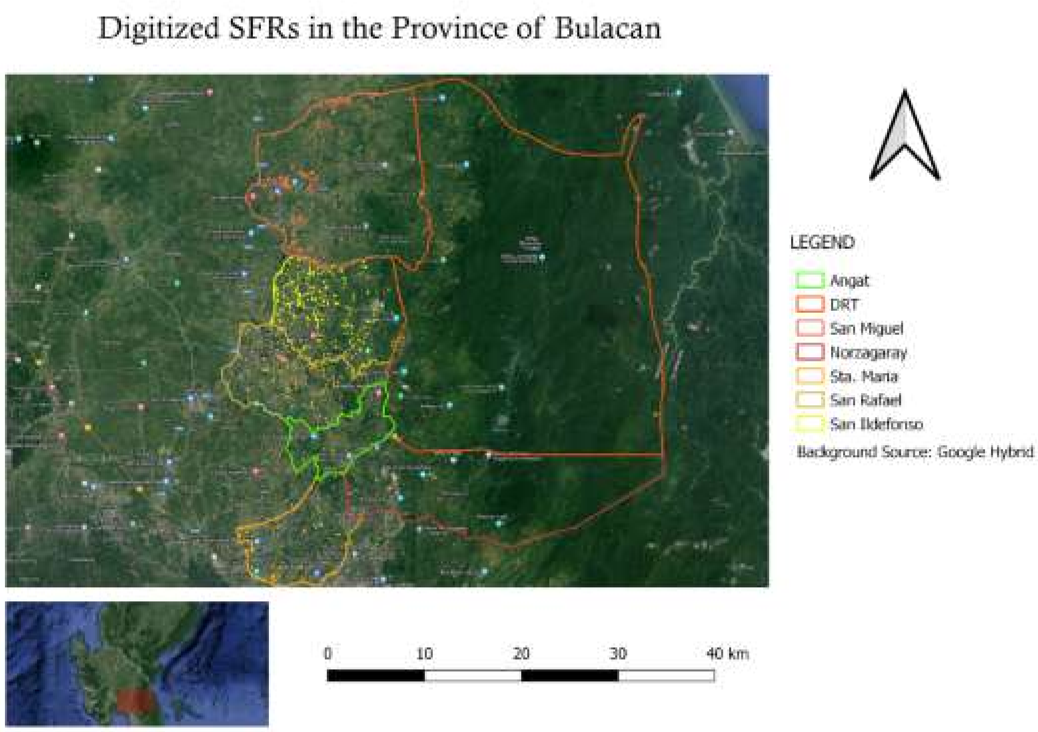


Figure 7. Digitized SFRs in Bulacan

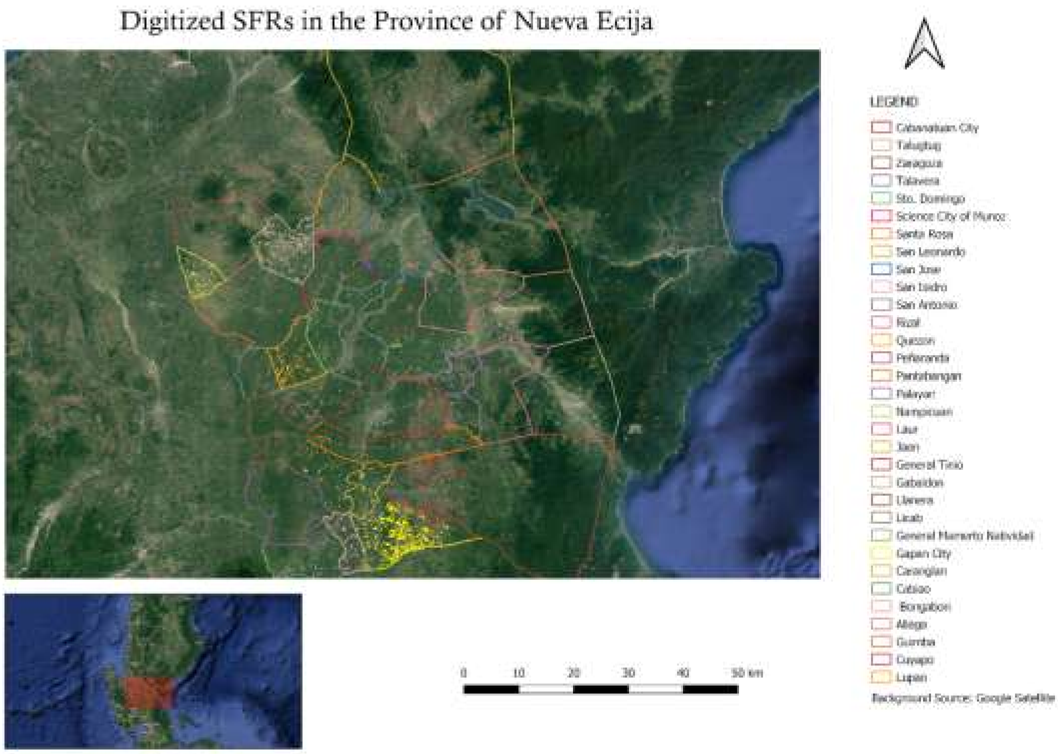


Figure 8. Digitized SFRs in Nueva Ecija

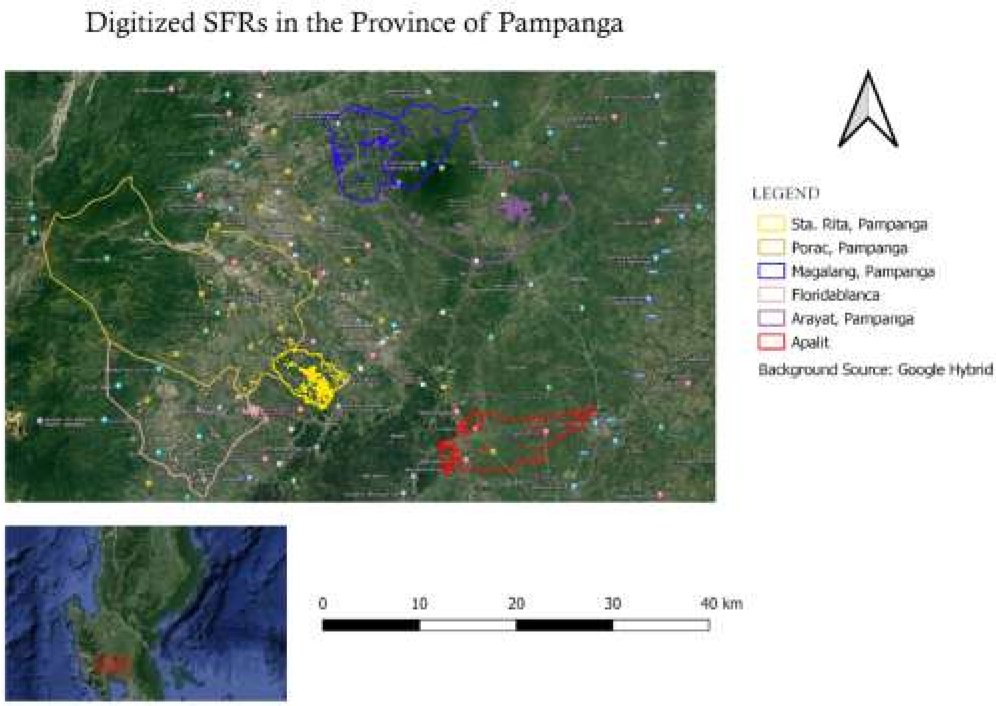


Figure 9. Digitized SFRs in Pampanga

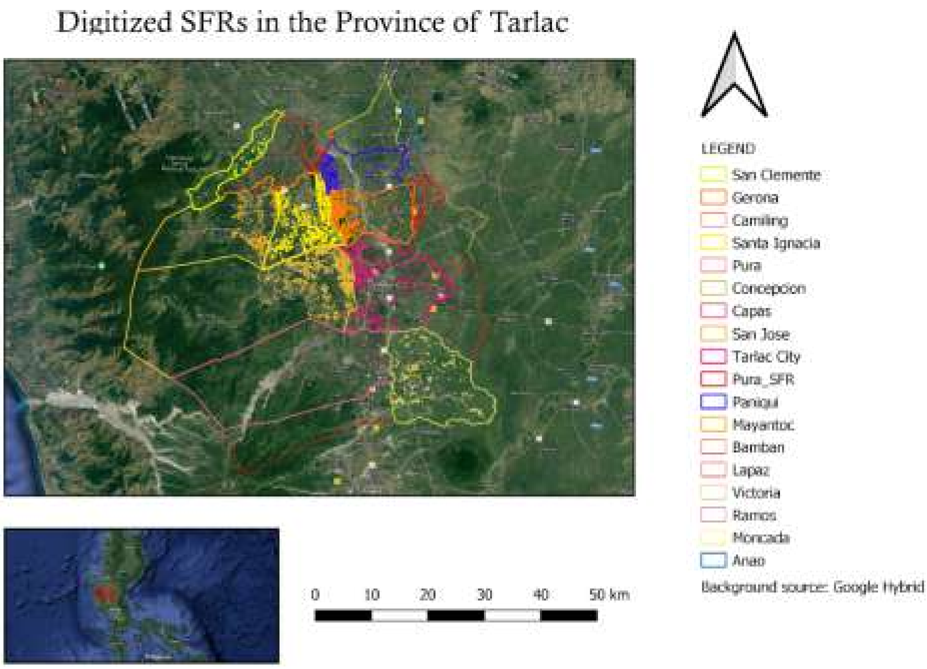


Figure 10. Digitized SFRs in Tarlac

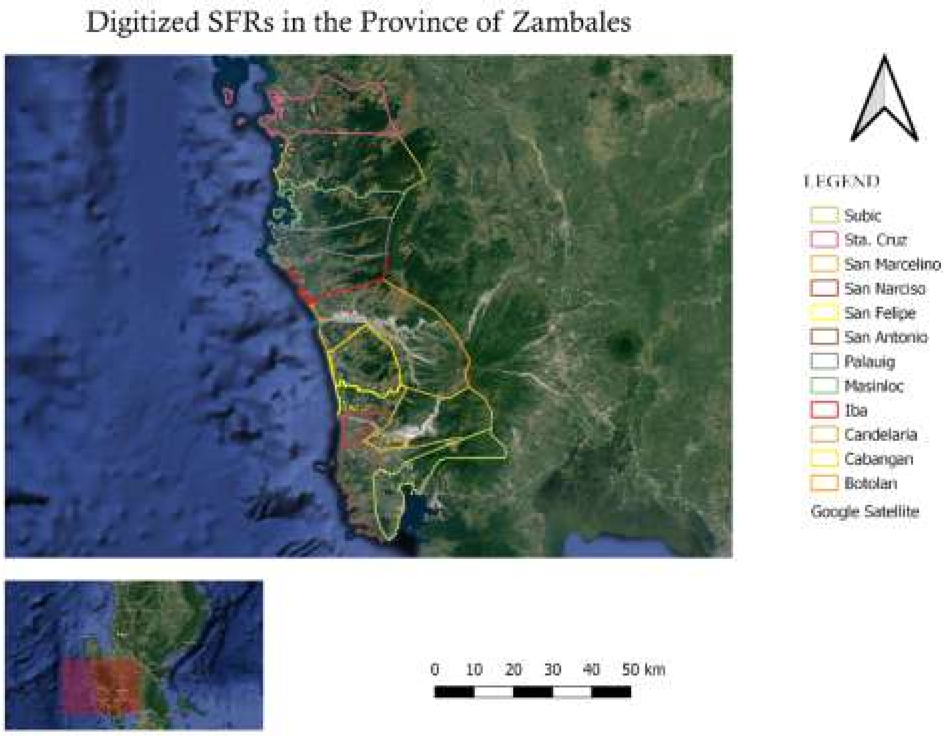


Figure 11. Digitized SFRs in Zambales

The geotagged SFRs are mostly located in or near rice, corn, rootcrops, and vegetable production areas. The farmers use the SFR as an additional source of irrigation water. About 54.10 % of he SFR has a size of <500 sq.m. and about 24.38% has a size above 1,001 sq.m. In terms of the service area, 82.71% of the SFR owners has above 10,000 sq.m. service area and only 5.23% of the owners have below 500 sq.m. service area. For some farmers, the SFR is also used for tilapia production.

From the data gathered, it can be observed that most of the SFRs are located in the western portions of Tarlac particularly in Camiling and Sta. Ignacia, Tarlac. According to Galo (2022), Camiling and Sta. Ignacia, Tarlac are highly suitable areas for SFR. Rainfall, soil texture, slope, land use, irrigation status, groundwater availability, and distance from river were used as suitability factors for the generated suitability map in Tarlac.

Zambales Province has a relatively small number of SFR. During an interview with a DA personnel, it was revealed that some parts of Zambales used to have SFRs in the past, but they are currently non-functional due to the challenge of maintaining an adequate water supply.

Although establishment of small farm reservoirs is part of the Agriculture and Fisheries Modernization Plan, only few SFRs were also identified in Pampanga. Pampanga is known to have an abundant irrigation system brought by the Pampanga River Basin. The Pampanga Delta River Irrigation System (PADRIS) alone has service area of 11,540 ha (Tabios, & de Leon, 2020). This may be a potential reason why there are only few SFRs in the province.

The succeeding maps show the location of the validated SFRs in Central Luzon. The spatial distribution maps are significant as a benchmark for identifying the needs of SFR farmers.

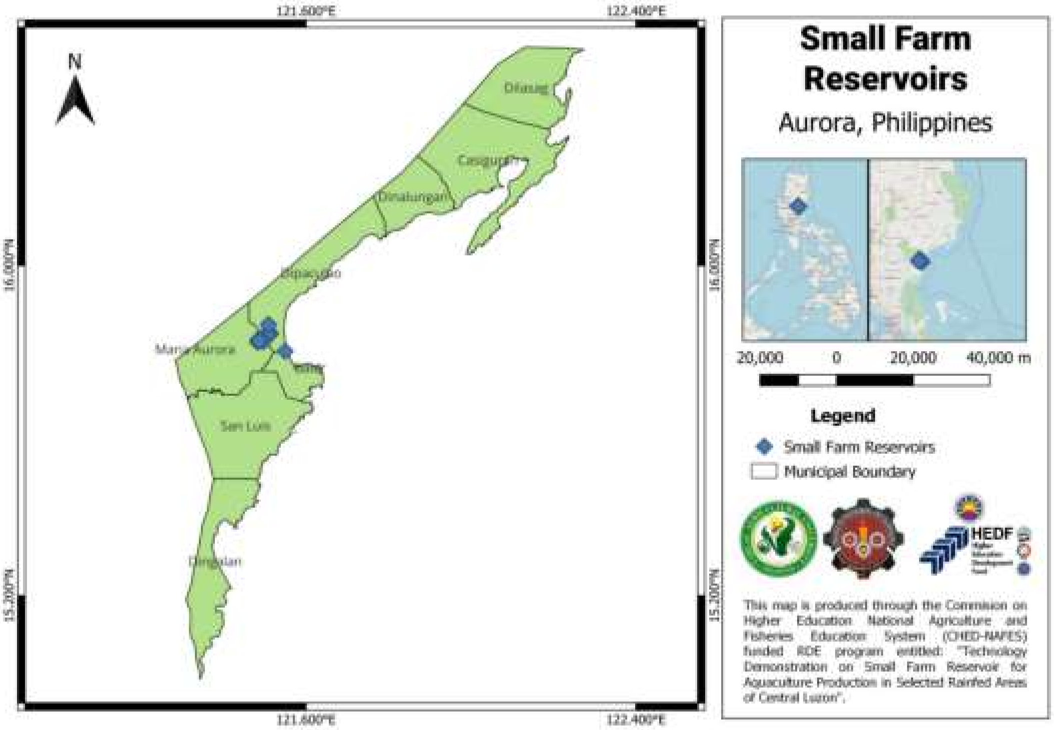


Figure 12. Small Farm Reservoirs in Aurora

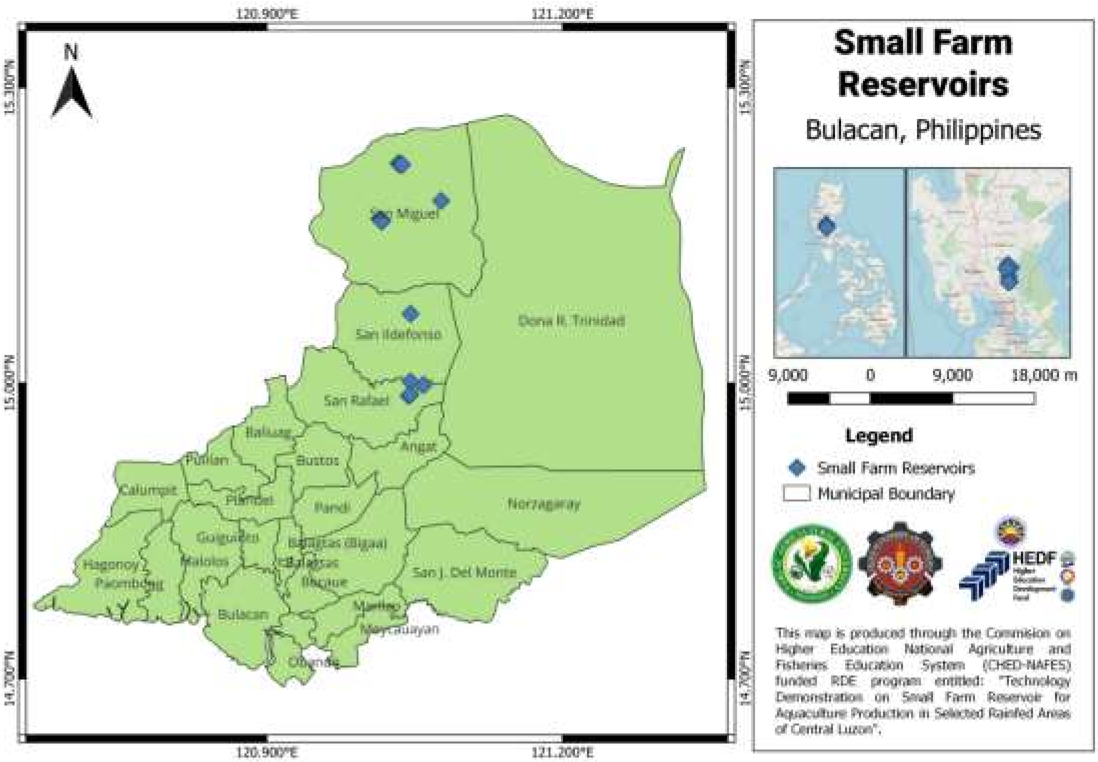


Figure 13. Small Farm Reservoirs in Bulacan

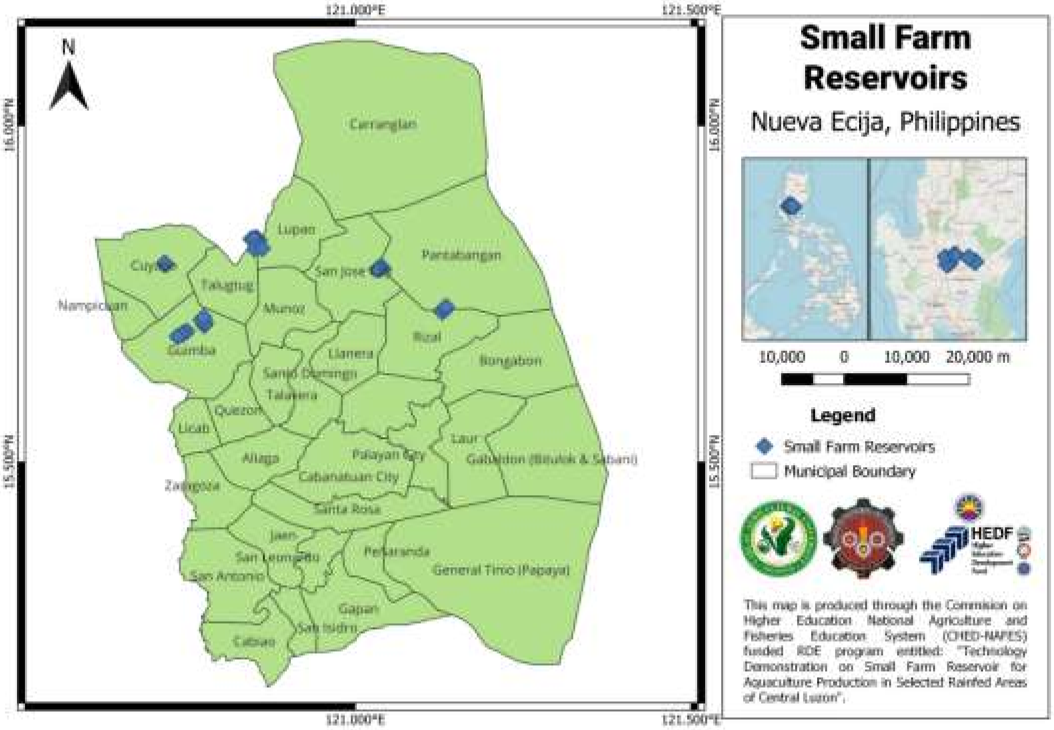


Figure 14. Small Farm Reservoirs in Nueva Ecija

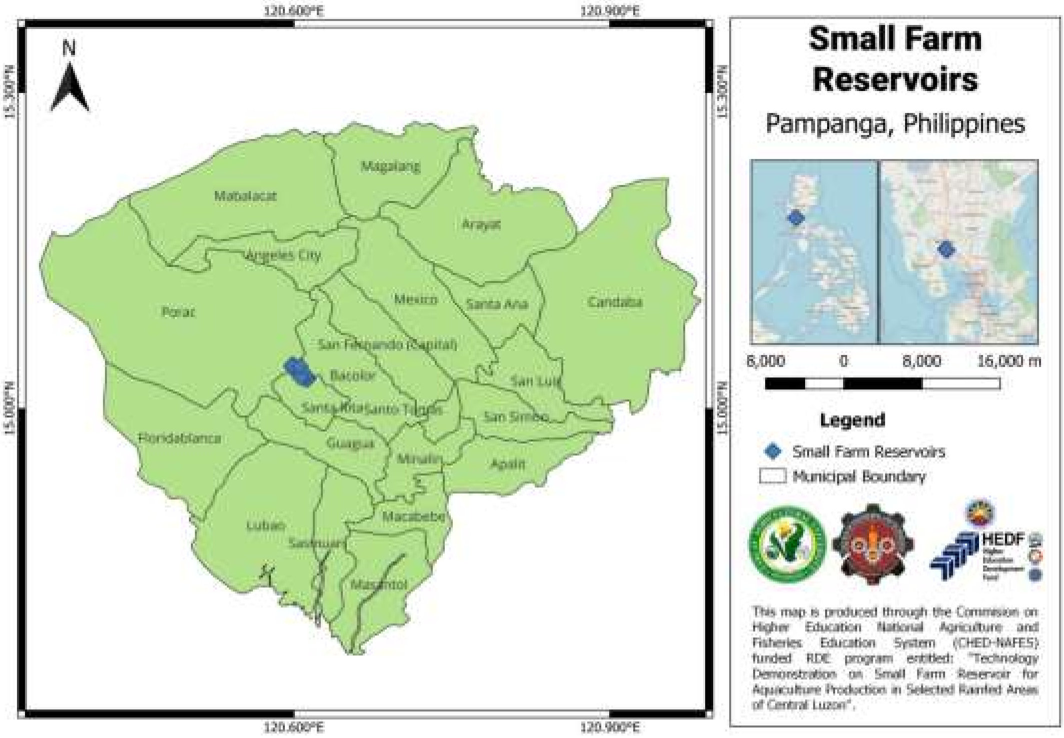


Figure 15. Small Farm Reservoirs in Pampanga

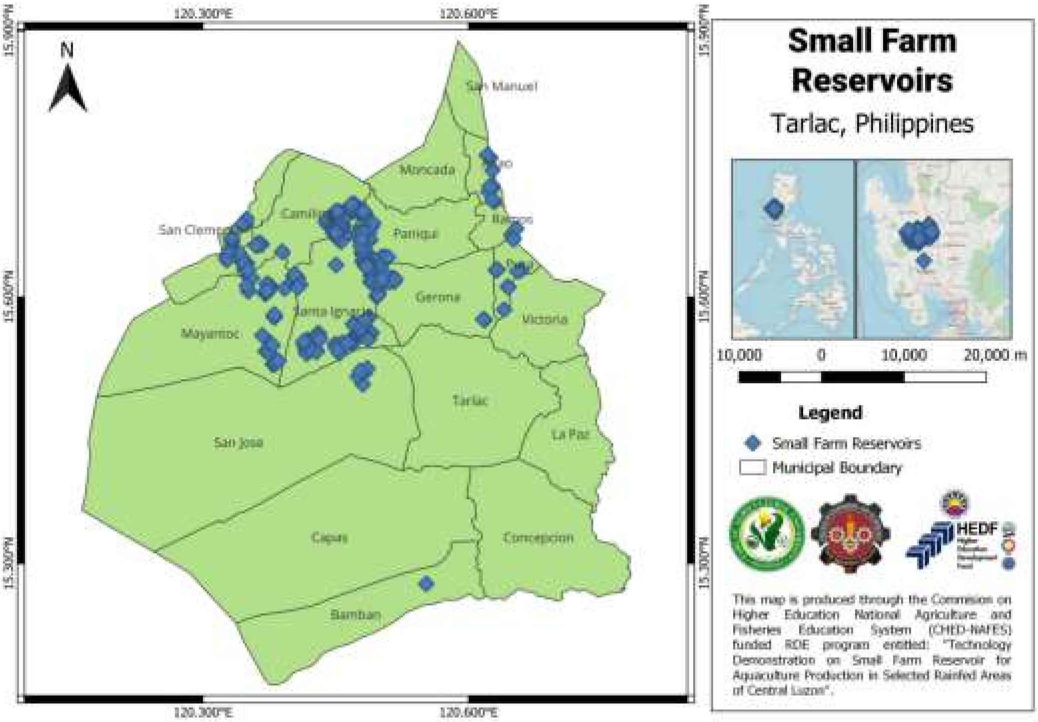


Figure 16. Small Farm Reservoirs in Tarlac

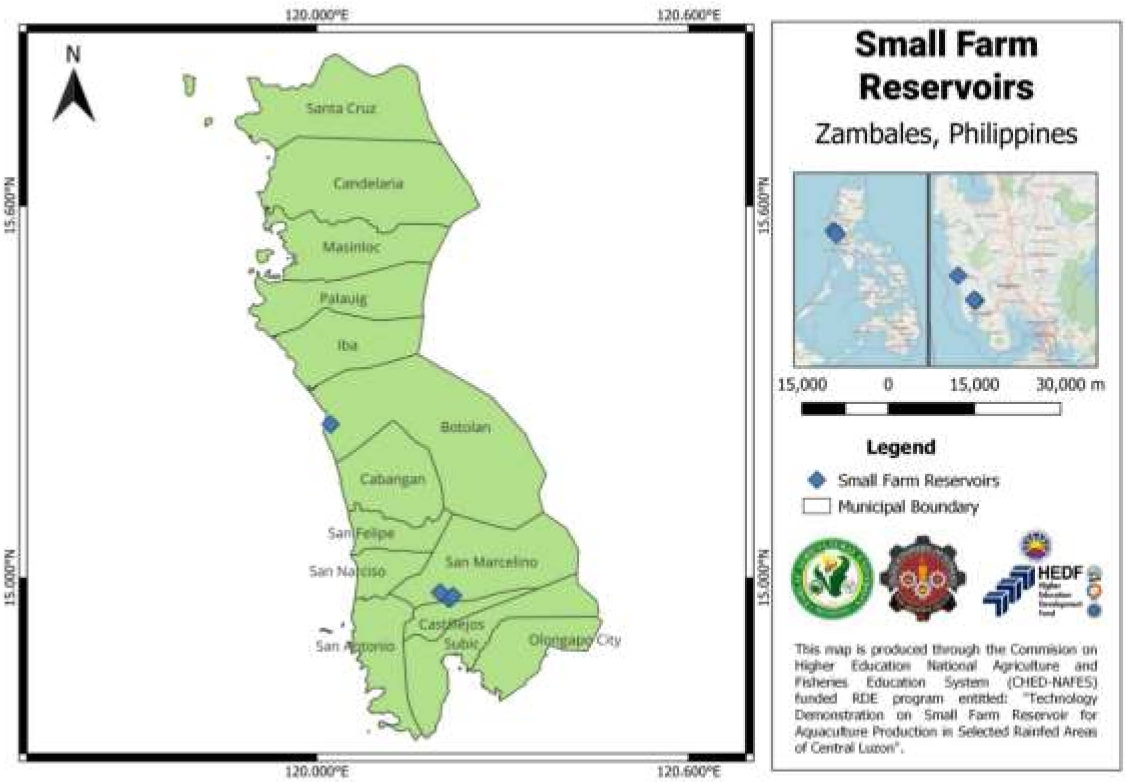


Figure 17. Small Farm Reservoirs in Zambales

Photo Documentation

The following pages show the field validation/geotagging of SFRs and the geotagged SFRs in Central Luzon.

Figure 18. Geotagging of SFR's location in the province of Tarlac

Figure 19. Geotagging of SFR's location in the province of Tarlac

Figure 20. Geotagging of SFR's location in the province of Nueva Ecija

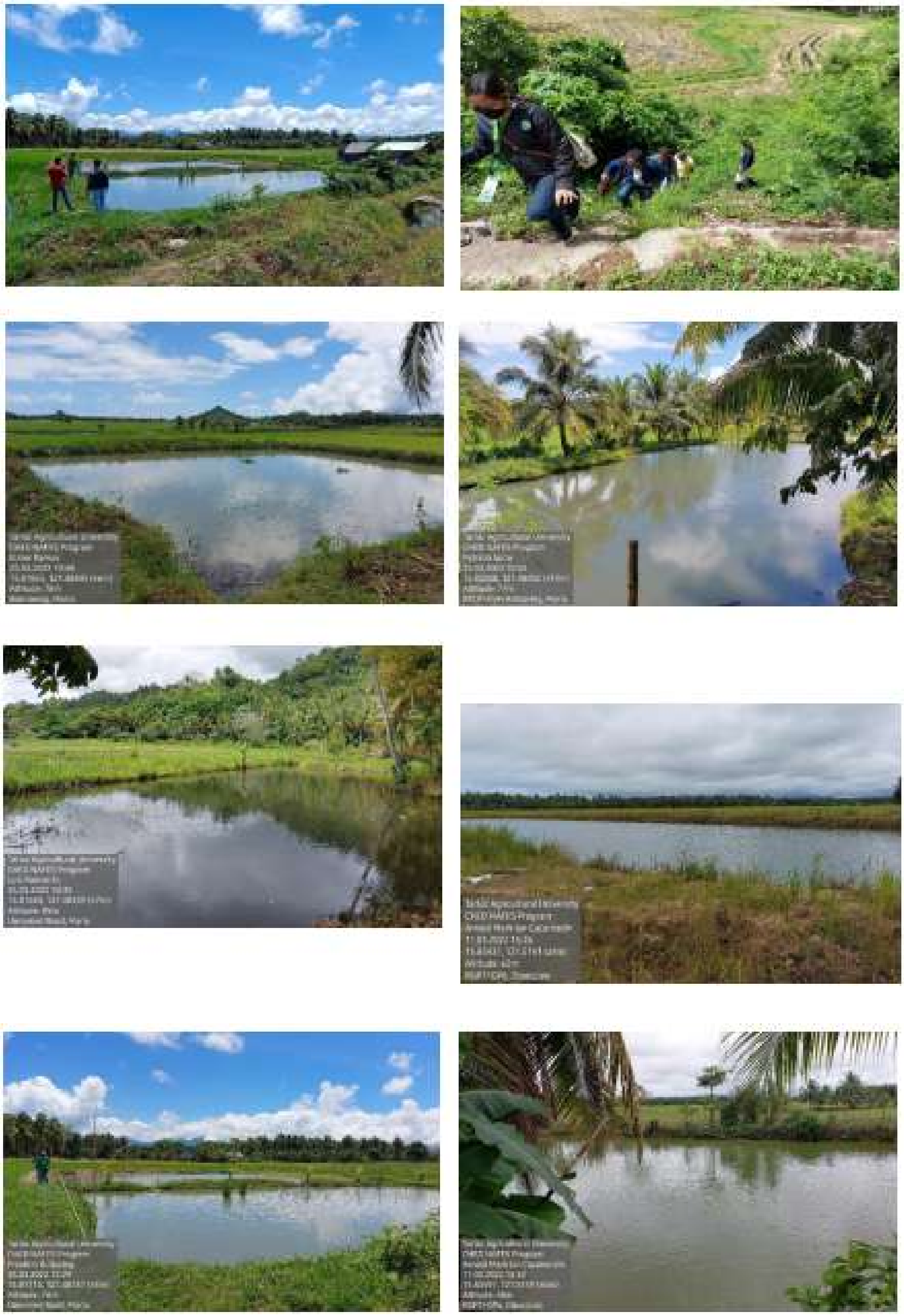


Figure 21. Geotagging of SFR's location in the province of Aurora

Figures 22. Geotagging of SFR's location in the province of Pampanga

Figure 23. Geotagging of SFR's location in the province of Bulacan

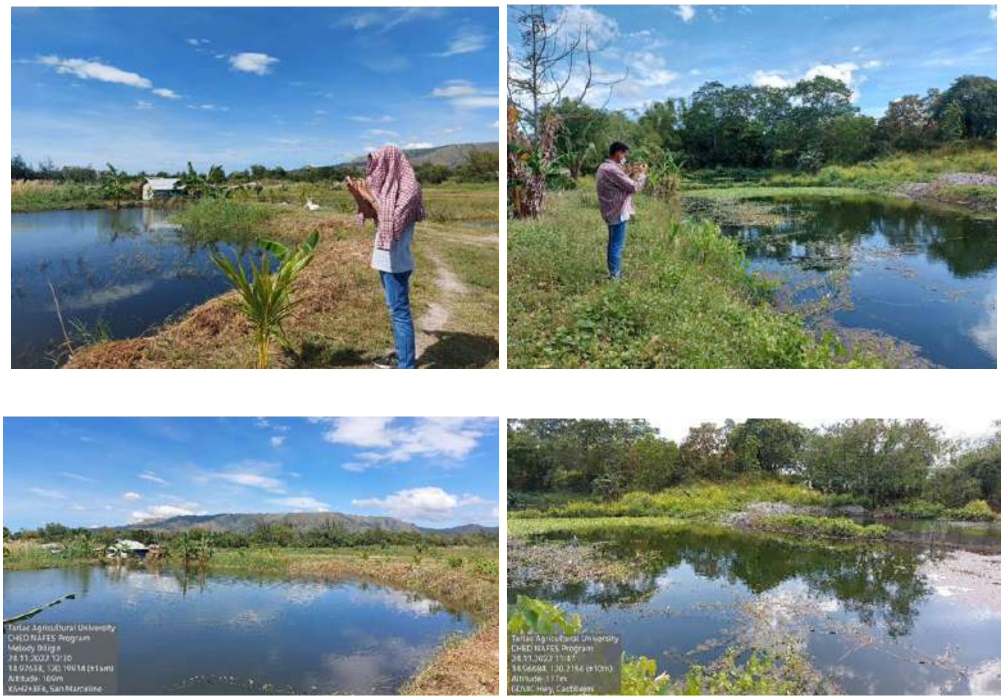


Figure 24. Geotagging of SFR's location in the province of Zambales

IEC Material

The researchers created IEC Material to be use in trainings, seminars, and capability building for students, Agricultural Extension Workers, clientele, stakeholders, and farmers. The researchers will soon produce spatial distribution maps of existing SFRs in Central Luzon that will also be beneficial to farmers, AEW's, students, clientele and stakeholders.

Figure 24. IEC Material

3. **Conclusion**

The research project successfully accomplished its objective of developing GIS-based inventories of existing small farm reservoirs in selected rainfed areas of Central Luzon. Through the collaboration with various government agencies and the valuable contributions of local stakeholders, the researchers were able to identify and map a significant number of small farm reservoirs in the region.

The findings of this study have significant implications for agricultural water management in rainfed areas. By understanding the distribution and status of small farm reservoirs, policymakers and stakeholders can devise more effective strategies to harness and optimize water resources for agricultural purposes. These reservoirs can play a vital role in enhancing water availability, reducing water scarcity, and improving crop yields in rainfed regions, contributing to food security and sustainable agricultural practices.

The GIS-based inventories produced in this research will serve as a valuable resource for future planning and decision-making processes related to agricultural water management in Central Luzon. It is hoped that the information gathered in this project will encourage further research and initiatives to enhance the effectiveness and utilization of small farm reservoirs in rainfed areas, ultimately benefiting farmers and rural communities in the region.

REPORT ON WATER QUALITY EVALUATION OF SMALL FARM RESERVOIR IN SELECTED RAINFED AREAS OF CENTRAL LUZON

A. BASIC INFORMATION

1. **Program Title**: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project Title: Water Quality Evaluation of Small Farm Reservoir in Selected Areas of Central Luzon

2. **Researcher(s):** Ermalyn DG. Galo and Gloria DC. Corpuz
3. **Implementing Agency/Station**

Lead Agency: Tarlac Agricultural University

Cooperating Agency: Provincial and Local Government Units (LGUs) of Central Luzon (Tarlac, Nueva Ecija, Aurora, Bulacan, Zambales)

Project Site(s): Central Luzon (Tarlac, Nueva Ecija, Aurora, Bulacan, Zambales)

4. **Technology Level:** Applied
5. **Sector:** Agriculture
6. **Commodity Classification:** Agriculture
7. **Research Discipline:** Applied
8. **Target Beneficiaries:**

SFR Farmers in Aurora, Bulacan, Nueva Ecija, Tarlac and Zambales
Farmers Association
Agricultural Extension Workers (AEWs)
Policy makers
Students

9. **Funding Agency (ies**): CHED-NAFES
10. **Duration (Definite Dates)**

Date Started: August 2021
Date Ended: February 2023

11. Financial Reports

Total Approved Budget	₱ 9,500,000.00
Actual Released Budget	₱ 6,142,182.00
Actual Expenditures	₱ 2,723,762.50 as of August 2022

I. Rationale

To sustain the ability of SFR's as fishpond, the quality of water is important factor in aquaculture production. The quality of water may be described in terms of the concentration and state (dissolved or particulate) of some or all of the organic and inorganic material present in the water, together with certain physical characteristics of the water. SFRs are utilized for irrigation, but to maximize the purpose of SFR, farmers used as fresh water aquaculture for the increase of income.

The physical characteristics of water can be directly seen, feel, smell and taste such as color, temperature, turbidity while the chemical characteristics composed of dissolved oxygen (DO), ammonia, pH, alkalinity, hardness, carbon dioxide and the living organism present in the water.

The dissolved oxygen (DO) is by far the most important chemical parameter in aquaculture. Low-dissolved oxygen levels are responsible for more fish kills, either directly or indirectly, than all other problems combined. Like humans, fish require oxygen for respiration. The amount of oxygen consumed by the fish is a function of its size, feeding rate, activity level, and temperature. Small fish consume more oxygen than do large fish because of their higher metabolic rate. The amount of oxygen that can be dissolved in water decreases at higher temperatures and decreases with increases in altitudes and salinities. To obtain good growth, fish must be cultured at optimum levels of dissolved oxygen. A good rule of thumb is to maintain DO levels at saturation or at least 5 ppm. After oxygen, water temperature may be the single most important factor affecting the welfare of fish. Fish are cold-blooded organisms and assume approximately the same temperature as their surroundings. The temperature of the water affects the activity, behavior, feeding, growth, and reproduction of all fishes. Temperature also determines the amount of dissolved gases (oxygen, carbon dioxide, nitrogen, etc.) in the water. The cooler the water the more soluble the gas.

The quantity of hydrogen ions (H+) in water will determine if it is acidic or basic. The scale for measuring the degree of acidity is called the pH scale, which ranges from 1 to 14. A value of 7 is considered neutral, neither acidic or basic; values below 7 are considered acidic; above 7, basic. The acceptable range for fish culture is normally between pH 6.5-9.0. Turbidity caused by clay or soil particles, however, can restrict light penetration and limit photosynthesis. Sedimentation of soil particles may also smother fish eggs and destroy beneficial communities of bottom organisms such as bacteria.

Water quality management is crucial for a successful fish farming system. Monitoring water quality in fish culture system is important management tools often overlooked or neglected. This can be detrimental to your bottom line because water quality determine not only how well fish grow on an aquaculture operation but whether or not they survive. Knowledge of testing procedures and interpretation results are important skills knowing the unique water chemistry profile can help avoid or lessen the effects of critical water quality problems this can improve profit potential through increase feed conversion efficiency and reduce aeration expenses.

II. **Objectives**

The general objective of the study is to disseminate information on recommended water quality for tilapia production. Specifically, it aims to: (1) determine the water quality of SFR in terms of pH, dissolved oxygen, (DO) and temperature and maintain the water quality through automated aerators, and (2) disseminate the results of the project through seminars and training of clientele and stakeholders.

III. **Expected Output**

1. Products
   a. Compilation of SFRs location and other information
   b. Compilation of water quality results of SFRs
2. Places and Partnership
   a. Provincial and Municipal LGUs of Central Luzon
3. People Services
   a. SFR farmers
   b. Faculty and students
4. Publication
   a. Production of IEC Materials on SFRs water quality analysis

IV. **Methodology**

Conceptual Framework of the Study

The conceptual framework of the SFRs water quality evaluation from the gathering of secondary data on SFRs followed by the identification of demonstration sites, then collecting of water samples and analysis and lastly to disseminate the information to stakeholders (Figure 1).

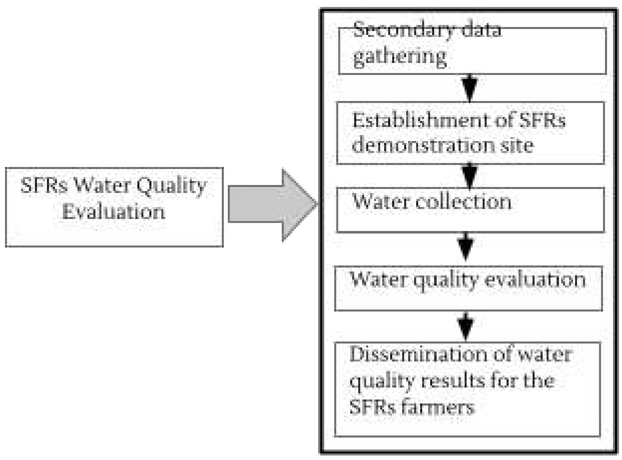


Figure 1. The conceptual framework of the study

Secondary Data Gathering

Inventory of SFRs. The inventory of SFRs in every province was gathered from Provincial and Municipal Agriculture Office in Central Luzon and is validated and was the basis for sampling of the SFRs used for the testing of water quality.

Benchmarking. The water quality parameters are usually monitored in recirculating aquaculture system (RAS) and tilapia production however in SFRs utilized for tilapia production has limited data, therefore, this will be a baseline information for water quality evaluation.

Establishment of SFRs Demonstration Site

There were seven (7) identified demonstration sites for the region. These sites were used for the water quality evaluation.

Water Collection

The major water quality factors most likely to be important to monitored and controlled are dissolved oxygen, temperature, nitrate, ammonia and others such as pH, alkalinity and hardness affect fish but usually are not directly toxic. In this study, the factors to be monitor are the DO, temperature, pH and ammonia.

Water quality testing was done once from the validated SFRs within the provinces in Central Luzon. The water quality parameters will be recorded for the demonstration sites.

Water Quality Evaluation

Table 1 shows the levels acceptable for aquaculture production on water quality parameters. This will be the basis on the analysis of water quality on SFRs.

Table 1. Environmental conditions favorable for tilapia growth

Parameter	Level	Comments
Temperature	25 - 30˚C	Optimum for reproduction and growth
DO (mg/L)	3	Minimum for optimum growth
Salinity (ppt)	10 -15	Favor growth
pH	6.5 - 9	Optimum for primary reproduction
Total ammonia (mg/L)	0.02 – 0.5	
Turbidity	30 – 35	Silt can damage
Water current	20	For intensive culture flow-trough system

Dissemination of Water Quality Results to the SFRs Farmers

Dissemination of the water quality results will be conveyed through seminars and trainings.

Results and Discussion

Validation of SFRs and Water Quality Testing

The list of SFRs were validated and testing was done in the different municipalities in Tarlac, Nueva Ecija, Aurora, Pampanga, Zambales and Bulacan this June to December 2022 with a total of 782 as shown in Table 2. Samples from the validated SFRs were identified using the simple random sampling for the collection and evaluation of the water quality of SFRs wherein the total number of SFRs owner respondents is 53 as shown in Figure 2.

The results of the water quality parameter are shown in Table 3. Dissolved oxygen (DO) are within the minimum acceptable level for the provinces of Tarlac, Aurora and Nueva Ecija has 3.98, 5.79 and 3.20, respectively while 2 provinces of Bulacan and Zambales were below the acceptable level with 2.65 and 2.43, respectively. In terms of temperature the two (2) provinces, Tarlac and Aurora are above the acceptable level of 30.29 ˚C and 30.99 ˚C and the rest is within the acceptable level that ranges of 27.85˚C to 29.93˚C. For the pH level, all the values observed are within the acceptable level which ranges from of 6.50 to 7.77 and the ammonia level generally with the range of the level acceptable for water quality. The water quality parameter observed values were shown in Figures 3 to 6.

In addition, the observed color of the water in the pond are green, dark green and brown. The data was gathered 9:00 – 11:30 am and 1:20 – 5:00 pm and with some vegetation and grasses.

It was observed that the pond with vegetation and grass has low levels of DO and the ammonia with no value because of dissolved substance or colloidal clay particles.

Table 2. Validated small farm reservoir per province

Province	Number of Validated SFRs
Tarlac	644
Nueva Ecija	53
Aurora	43
Pampanga	12
Zambales	11
Bulacan	19
Total	782

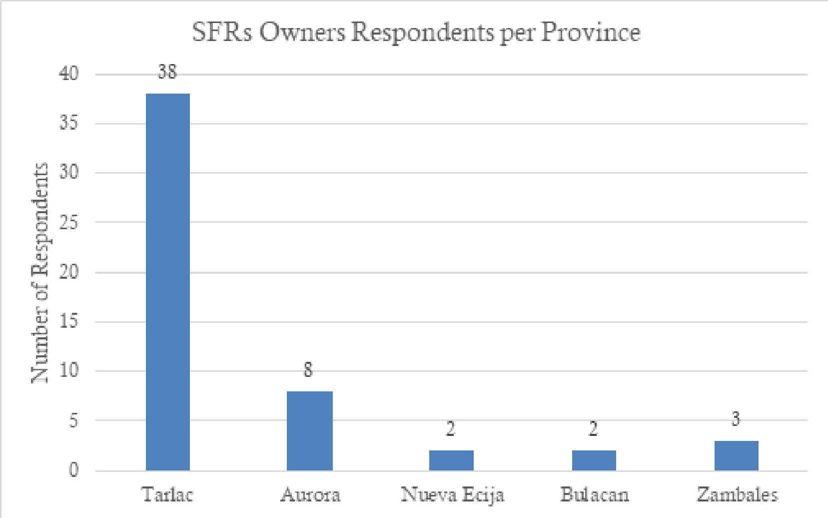


Figure 2. SFRs owners respondents per province

Table 3. Summary of the average values of the water quality parameter per province

Parameters	Province					Level (Acceptable)
	Tarlac	Aurora	Nueva Ecija	Bulacan	Zambales	
Dissolved Oxygen (DO)	3.98	5.79	3.20	2.65	2.43	3
Temperature	30.29	30.99	27.85	29.25	29.93	25-30˚C
pH	7.25	7.39	6.50	7.77	7.72	6.5-9
Ammonia	0.07	0.09	0.50	0.13	0.00	0.02-0.5

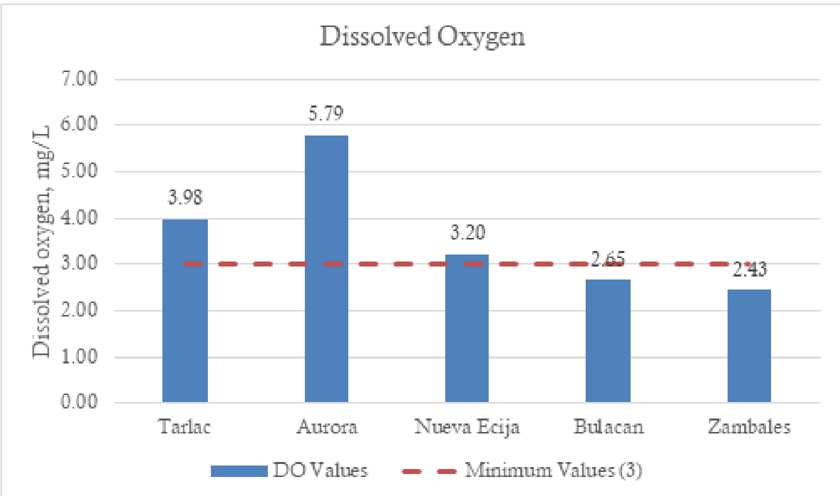


Figure 3. Dissolved oxygen values observed

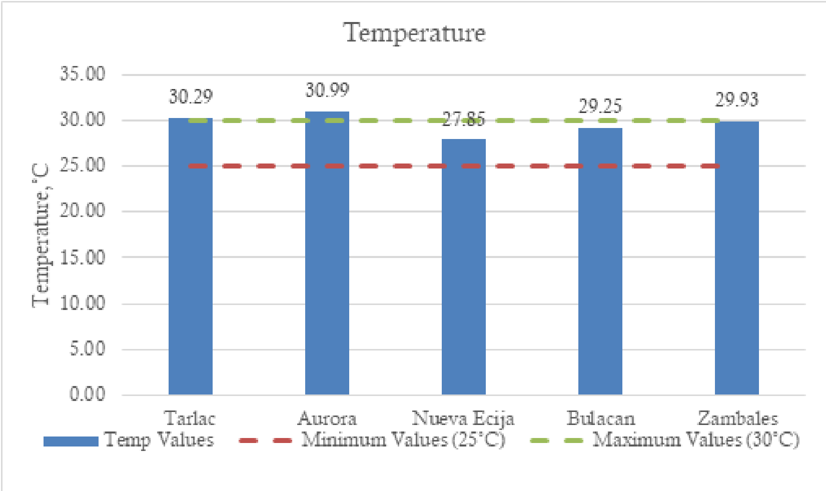


Figure 4. Temperature values observed

Figure 5. pH values observed

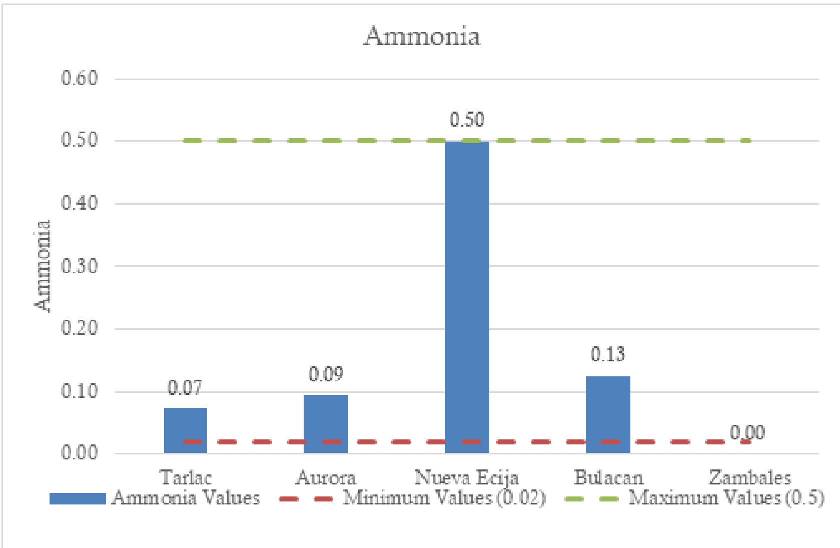


Figure 6. Ammonia values observed

Figure 7 shows the activities done in water quality testing. Coordination within municipalities and barangays by the project staffs were done before the testing and interviews with the SRFs owners were also done.

Figure 7. Activities done for water quality testing

Water Quality Testing Results on Demonstration Site

The list of SFR owner, location of the site, parameter and method used were recorded as shown in Table 4 that were identified as demonstration site.

The results on the analysis of water quality on the different demonstration site on dissolved oxygen (DO), temperature, pH, and ammonia (Table 5). Figure 8 shows the demonstration site on water quality testing. In addition, species being cultured in the SFR is tilapia for the demonstration site at Zambales.

Table 4. SFR owner and SFR location for demonstration site

Province	Name of SFR Owner	Coordinates		Parameter	Method	Level
		Latitude	Longitude			
Tarlac	Crisostomo Galleon	15.512330	120.481130	Dissolved oxygen	Multiparamater	3 mg/L
Aurora	Arnold Mark Ian V. Cacanindin	15.834500	121.514250	Temperatur e	Multiparamater	25-30 ˚C
Nueva Ecija	Anthony Villanueva	-	-	pH	Multiparamater	6.5-9
	Evrod Navarro	15.635470	120.481130	Ammonia	Multiparamater	0.02-0.5
Bulacan	Juanito Iscala	14.998180	121.059240			
	Salvador Estrmadora	15.185160	121.007140			
Zambales	Marlon Ancheta	14.966590	120.21331			

Table 5. Water Quality Results for the SFRs Demonstration Site

Province	Name of SFR Owner	Water Quality Parameter					Species Being Cultured
		Dissolve Oxygen (DO)	Temp	pH	Ammonia	Color	
Tarlac	Crisostomo Galleon	14.20	29.10	8.00	0.25	Brown	None
Aurora	Arnold Mark Ian Cacanindin	5.40	34.30	8.27	0	Green	None
Nueva Ecija	Anthony Villanueva	4.20	27.20	6.00	0	Green	None
	Evrod Navarro	2.20	28.50	7.00	1	Green	None
Bulacan	Juanito Iscala	2.40	28.80	7.57	0	Green	None
	Salvador Estrmadora	2.90	29.70	7.96	0	Green	None
Zambales	Marlon Ancheta	2.10	29.50	7.62	0	Green	Tilapia

Figure 8. Water quality testing on the demonstration site

Seminars Conducted

For the information dissemination, seminars are being conducted. Seminars are conducted in the province of Tarlac, Nueva Ecija and Pampanga.

Other Accomplishments

Benchmarking was done at the DA-BFAR (NFFTC), Nueva Ecija on water quality parameters, timely schedule and the equipment used for the testing and evaluation (Figure 9).

Figure 9. Benchmarking at NFFTC

Procured parameters

Delivered parameters use for water quality evaluation. Ammonia Test Kit and pH Meter (Figure 10 and Figure 11)

Figure 10. Ammonia Test Kit

Figure 11. ph Meter

IEC Materials

The researchers created IEC to be use in dissemination of SFR water quality analysis through trainings and seminars that will also be beneficial to farmers, AEW's, students, clientele and stakeholders (Figure 12).

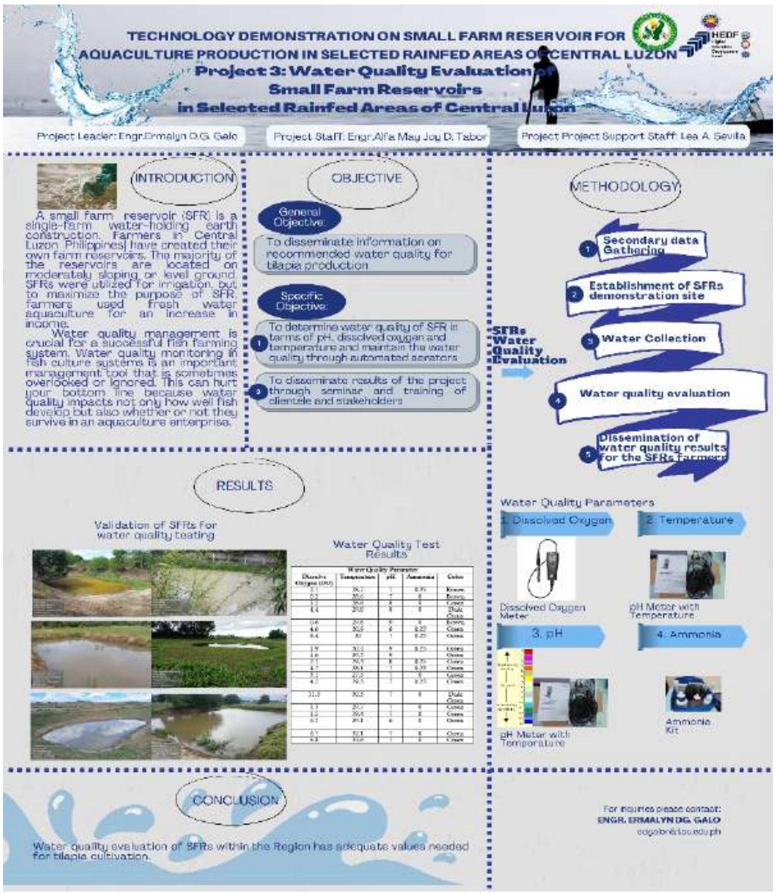


Figure 12. Poster of Water Quality Evaluation

VI. **Summary and Conclusion**

Good water quality is one of the vital activities for an optimum fish production. Thus, this study aims to disseminate information on recommended water quality for tilapia production in SFRs. The water quality parameters on dissolved oxygen (DO), temperature, pH and ammonia are being observed using multiparameter water tester and ammonia kit. The results showed that the dissolved oxygen (DO) are within the minimum acceptable level for the provinces of Tarlac, Aurora and Nueva Ecija has 3.98, 5.79 and 3.20, respectively while 2 provinces of Bulacan and Zambales were below the acceptable level with 2.65 and 2.43, respectively. In terms of temperature the two (2) provinces, Tarlac and Aurora are above the acceptable level of 30.29 °C and 30.99 °C and the rest is within the acceptable level that ranges of 27.85°C to 29.93°C. For the pH level, all the values observed are within the acceptable level which ranges from of 6.50 to 7.77 and the ammonia level generally with the range of the level acceptable for water quality.

The water quality results in terms of dissolved oxygen (DO), temperature, pH and ammonia are mostly within the acceptable values for tilapia production. However, monitoring for dissolved oxygen is recommended to avoid the decline in values for optimum fish growth and production. Seminars are conducted in 3 provinces for information dissemination.

REPORT ON DUCKWEED PRODUCTION FOR AQUACULTURE PRODUCTION

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project Title: Duckweed/Azolla Production for alternative Feeds for Aquaculture Production

2. Researcher(s): Leonell P. Lijauco, Mark Augustine A. Ferrer
3. Implementing Agency/Station: Tarlac Agricultural University
   Lead Agency: Tarlac Agricultural University
   Cooperating Agency: Central Luzon State University
   Project Site(s) : Region III except Bataan

4. Technology Level: Technology Demonstration
5. Sector: Agriculture
6. Commodity Classification: Aquaculture
7. Research Discipline: Applied Research
8. Target Beneficiaries: Small Farm Reservoir owners and farmers in rainfed areas of Central Luzon
9. Funding Agency (ies): Commission on Higher Education under National Agriculture and Fisheries Education System (NAFES)
10. Duration (Definite Dates)
    Date Started: August 2021
    Date Ended: January 2023
11. Financial Reports (whole program as of August 2022)
    Total Approved Budget ₱ 9,500,000.00
    Actual Released Budget ₱ 6,142,182.00
    Actual Expenditures ₱ 2,723,762.50 as of August 2022

B. TECHNICAL REPORT

I. Rationale:

Duckweed is the common name for a small family of aquatic herbs called "Lemnaceae" – The smallest flowering plant on earth and often seen growing in thick, blanket-like mat on still, nutrient rich fresh and moderately saline environment. Duckweeds are small flowering plants with a reported crude protein content of 18 percent to 42 percent. An earlier study made at the bureau's fish farm in Iguig, Cagayan has determined the viability of this rapidly reproducing plant as an alternative diet without adverse effect on the growth of tilapia.

Duckweed plants appear to be a complete nutritional package for tilapia ponds. It is significantly more productive and easier to manage than traditional pond fish culture processes. Its species grow faster in warm weather when fish need more feed and more slowly in cold weather when the fish do not require as much feed. BFAR Researchers found out that tilapia fed with a diet consisting of 50% fresh duckweeds and 50% commercial feed offers the best possible economic return.

Duckweed farming is a continuous process requiring intensive management for optimum production. Duckweed can be farmed using organic and non-organic inputs. Some source of nutrients being supplied from chicken dung, cattle dung, pig waste or any other organic matter in slurry form. To produce duckweeds, seed plants must be transferred to a growing area, which could be tanks, ponds, or any secured body of water.

The project thereby focuses on the potential for duckweed residues in its use as a sole fish feed or a component of fish diets that shows a good source of nutritional value to fish which results that it can be used at the site of production for fish cultivation.

II. Objectives:

General Objective: To give technical assistance on alternative feeding using duckweed.

Specific objectives:

1. To document and assess alternative feeding using duckweed.
2. To assess the viability and acceptability of alternative feeding for aquaculture using duckweed.

3. To disseminate results of the project through seminars and training of
   Clientele and stakeholders.

III. Expected Output:

Activities	Deliverable/ Outputs
Secondary Data Gathering	Gather Data form Provincial and Local Government Units
Duckweed Production	Produce Duckweed
Comparative study of using duckweed and feeds	Conduct series of study for duckweed as alternative feed for aquaculture production
Established of Demonstration Sites	Establish of Demonstration Sites
Pilot testing of using Duckweed as alternative feeds	Established pilot testing sites for duckweed testing
Monthly, Quarterly, Yearly and Terminal report	Delivered project updates and accomplishment.

IV. Research Highlights:

1. Procedure/Methodology

I. Document and assess alternative feeding using duckweed

secondary data gathering

i. identification of duckweed producer in each province
ii. surveys/interviews of duckweed producer

2. Assess the viability and acceptability of alternative feeding for aquaculture using duckweed

duckweed production

i. identification of supplier of tilapia fingerlings
ii. selection and establishment of three areas for production of duckweeds
iii. selection and establishment of areas for tilapia production (experimental ponds for duckweed and commercial feed treatment)
iv. identification and/or procurement of commercial feeds

3. Disseminate results of the project through seminars and training of clientele and stakeholders

establishment of demonstration site and pilot testing of using duckweed as alternative feeds

trainings
paper publication and presentation

Table 1. Schedule of proposed work.

Activities (Program)	Months								
	2	4	6	8	10	12	14	16	18
	AS	ON	DJ	FM	AM	JJ	A S	ON	DJ
Project 4									
1. Secondary Data Gathering									
2. Duckweed production									
3. Comparative study of using duckweed and feeds									
4. Establishment of Demonstration sites									
1. Pilot Testing of using Duckweed as alternative feeds									
1. Monthly, quarterly, annual and terminal report									

Project Timeline: Succeeding Months: Monthly Report:

Attainment of the Project

The Project team conducted secondary data gathering from different Provinces in Central Luzon to acquire data and information of Duckweed Producers by coordinating with the Office of the Provincial and Municipal Agriculturist and to DA-RFO-III. During the project visit to different offices in Central Luzon in similar situations there is no available data of duckweed/azolla producers.

Thus the project team needs to get primary data collection and information directly to the producers through surveys and interviews. The table and Figures 1-42 represents the data gathered and photos from face to face observation and online interview by the researchers.

Table 2. Data gathering of producers of azolla and duckweed at different Provinces of Central Luzon.

Name of Farmer	Provinc e	Farmers Information	Photo Documentation
Myrna M. Fernando	Tarlac	Produced duckweed for her personal used as alternative feeds for her livestocks and tilapia production. -She used duckweed as vegetation to her pond.	
Roy Pascua	Tarlac	Duckweed as alternative feeds to his tilapia production business. Duckweed as business purposes.	
Trisha Balaoing	Tarlac	Used duckweed and Azolla farming for her peckin duck business. Selling Fresh Azolla and Duckweed.	
Khian James Martin	Tarlac	Selling Azolla Online	

Dianne Cabansag Dagdag	Tarlac	Selling Azolla Online	
Maureen Joyce Gadia	Tarlac	Selling Azolla/Duckweed and used for her livestock and poultry.	
Paul Ravenz Abainza	Tarlac	Azolla Production, Selling Online	
Lylanie S. Resos	Tarlac	Selling Azolla online and used it for livestocks	

Atrzibal Dela Cruz	Tarlac	Livestocks alternative feeding Feeding	
Rhonie Jatico Reyes	Camiling, Tarlac	Selling Azolla Online. Producer of Azolla for Business Purposes.	
Almira Ibarra Cabanayan	Camiling, Tarlac	Producer and Selling Azolla Online	
Eya Dela Cruz	Tarlac	Selling Duckweed Online	

Gilbert Ulzame Torres Jr.	Tarlac	Used Azolla for alternative feeding for his poultry business.	
Aldrin Jan Rafael	Tarlac	Selling Azolla Online	
Jerwin G. Mateo	Tarlac	Used Azolla for pond vegetation and used for his livestocks goats and poultry and sometimes selling it online.	
Rogel Ventura	Nueva Ecija	Azolla Seller Online	

Loy Leal	Nueva Ecija	For His Livestocks and Poultry Feeding	
Jeccell Dela Cruz	Nueva Ecija	Azolla Seller	
Dexter Ruiz	Nueva Ecija	Selling Azolla/ Duckweed Online	
Myline S. Hubac	Nueva Ecija	Azolla Seller online	

Fewee Enriquez	Nueva Ecija	Azolla Seller online	
CLSU BFAR	Nueva Ecija	For Dispersal to Farmers	
Aeron John Eugenio	Bulacan	Producer of duckweed for his personal used for his farm animals.	

Restituto Bernardin o	Bulacan	Duckweed Producer for his Farm	
Philip John Pascual	Bulacan	Azolla Producer for personal used for his farm.	
Yolanda Riguer	Bulacan	Farm business school	
Azolla Bulacan Producer s	Baliuag, Bulacan	Online Seller of Azolla	

Merlie Malig	Pampanga	Farm Business School	
Karlo Alvaro	Pampanga	For Tilapia feeding purposes	
Erwin Manalac	Pampanga	Used for poultry feeding	
Boi Ramilo	Pampanga	Producer of duckweed for fish feeding	

Julius Nacu	Pampanga	Producer of Duckweed	
Prince Alwin Doll	Pampanga	Mass Producer of Duckweed	
Bernardino Mejia	Pampanga	Mass Production of Azolla	
Antonio Sabangan	Zambales	Used duckweed for his livestocks and poultry	

Raymond Casticubay	Zambales	Producer of Duckweed for business purposes	
Joey Alvior	Zambales	Duckweed/Azolla Producers for alternative feeding for his chicken business	
Lorenzo Bello	Aurora	Alternative feeding for livestock and fish culture.	
Adriano Necesito	Aurora	Processing Duckweed As alternative feeds for fish culture	

Feriano Constantino	Aurora	Used duckweed for alternative feeds for his poultry and livestocks.	
Marcelo Dusayen	Aurora	For feeding of tilapia production.	
Arnold Mark Ian Cacanindin	Aurora	Azolla Producer and Seller he also used azolla as alternative feeds.	

Primary Accomplishment

DUCKWEED PRODUCTION

Figure. 43-46. Duckweed area selection
Building and construction of duckweed artificial pond.

The pond composed of 29 kilograms of animal manure and contains 3 kilogram of fresh duckweed. Each unit has a production cycle that can produce 0.5 kilos of duckweed every 24 hours a total of 1.5 kilos of duckweed every day. It is based on the data gathered by the researchers from 3 consecutive trials.

Figure. 47-50. Measuring and Data Gathering.

Figure 51. TAU Duckweed Production Site

Site Selection and Establishment of Duckweed Production at Tarlac Agricultural University.

COMPARATIVE STUDY OF DUCKWEED AND COMMERCIAL FEEDS

Preparation for the Establishment of Fish Cages at TAU for Small Farm Reservoir Technology Demonstration Farm.

Constructing a bamboo-framed fish cage using a drum as a floater can be done following these step-by-step instructions:

Materials needed:

1. Bamboo poles
2. Nylon or plastic netting
3. Rope or wire
4. Zip ties or twine
5. A large plastic drum
6. Scissors or a knife
7. Hooks or fasteners

Step 1:

Choose a suitable location Select a suitable location for your fish cage. It should be a calm body of water with good water circulation and appropriate depth for the fish you intend to raise.

Step 2:

Measure and cut bamboo poles Measure and cut bamboo poles to the desired length for the frame of your fish cage. You will need four longer poles for the vertical corners and shorter poles for the horizontal sections.

Step 3:

Construct the frame Arrange the bamboo poles to form a rectangular frame. Use zip ties or twine to securely fasten the joints. Make sure the frame is sturdy and well-supported.

Step 4:

Attach netting to the frame, cut the nylon or plastic netting to match the size of each side of the frame. Attach the netting to the bamboo frame using zip ties or twine. Ensure that the netting is tightly secured and there are no gaps for the fish to escape.

Step 5:

Prepare the drum. Clean the plastic drum thoroughly, removing any residues or contaminants. Ensure the drum is buoyant enough to support the weight of the fish cage.

Step 6:

Attach the drum as a floater Position the drum underneath the fish cage frame. Attach the drum to the frame using ropes or wires. Securely tie the drum to the frame at multiple points to prevent it from moving or detaching.

Step 7:

Place the fish cage in the water carefully, lower the fish cage into the water, ensuring that the drum floats and supports the weight of the cage. Adjust the depth of the fish cage according to the requirements of the fish species you intend to raise.

Step 8:

Secure the fish cage to prevent the fish cage from drifting away, you can attach hooks or fasteners to the sides of the cage and anchor them to the ground using weights or ropes. This will help keep the cage stable in the water.

Figure 51. Fish Cage Floaters (left) and Sewing of Fish Net Size 5m x 5m. (right)

Figure 52. Construction of Bamboo Frames and Assembling the Fish Cage in the pond

Figure 53. Complete work, Four bamboo framed Fish Cages

IEC MATERIALS

The researchers created IEC Material like posters, brochures and pamphlets to be used in Capability Building: Training and Seminars to disseminate the results of the study to students, agricultural technicians, farm worker and clientele. The training modules gives ideas and information to farmers and students a step by step procedures on how to construct, established, and prepare a duckweed pond. Also to provide them a guide on how to manage and maintain their ponds and to use for their everyday life as a business or assets.

Figure 53. Brochure Gabay sa pag paparami ng Duckweed

Figure 54. For poster and Pamphlets Design

V. Conclusion

- There are 42 interviewed and surveyed Duckweed Producers around Central Luzon for primary and secondary data gathering.
- Identification and validation of SFR Techno Demo sites are done for pilot testing and dissemination of the results.
- Establishment of Fish Cages for the comparative study of duckweed and commercial feeds was accomplished.

REPORT ON THE PROTOTYPE OF AUTOMATIC FEEDER FOR AQUACULTURE PRODUCTION AND MOBILE IMAGE PROCESSING SOFTWARE FOR MONITORING OF TILAPIA GROWTH

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in
Selected Rainfed Areas of central Luzon

Project Title: ICT-Based Aquaculture Production in Small Farm Reservoir in Selected
Rainfed Areas of Central Luzon

2. Researcher(s) : Donna Fay N. Labrador and Jayson J. Elenzano

3. Implementing Agency/Station

Lead Agency: Tarlac Agricultural University

Cooperating Agency: Provincial and Local Government Units (LGUs) of Central Luzon (Tarlac, Nueva Ecija, Aurora, Bulacan, Zambales)

Project Site(s): Central Luzon (Tarlac, Bulacan, Nueva Ecija, Aurora, Zambales

4. Technology Level: Applied
5. Sector: Agriculture
6. Commodity Classification: Agriculture
7. Research Discipline: Applied
8. Target Beneficiaries:

SFR Farmers in Aurora, Bulacan, Nueva Ecija, Tarlac and Zambales)
Farmers Association
Agricultural Extension Workers (AEWs)
Policy Makers
Students

9. Funding Agency (ies): CHED-NAFES
10. Duration (Definite Dates)

Date Started
Date Ended

11. Financial Reports

Total Approved Budget	₱ 9,500,000.00
Actual Released Budget	₱ 6,142,182.00
Actual Expenditures	₱ 2,723,762.50 as of August 2022

I. Rationale

Globally, the total production of aquatic food is increasingly coming from the aquaculture. Aquaculture now provides more than half of fish proteins for human consumption. In Central Luzon, a large portion of the region's aquaculture production comes from commercial, municipal, SFR's as fishponds in municipalities of Tarlac, Bulacan, Aurora, Nueva Ecija and Zambales.

Several systems of ponds, tanks or cages are used in farming fish. One of the major problems in order to improve the feeding system and management is to reduce cost of feeding and increase the efficiency of this task at the same time. With the advancement of technology, automatic fish feeder is one of the solutions to help the farmers easily control the feeding of fish.

This study will commence by establishing the recommended feed-ratio of commercial and alternative feed for aquaculture production. The development of an automatic feeder for the feeding of tilapia will be used in the simulation of the feeding ratio. The image processing will be used to monitor the production of tilapia from fingerlings up to harvest. The auto feeder will help the farmers easily control the ponds everywhere. It will be performed regular automatic feeding without disturbing the owner's work. Using the wireless communication, the system can be set to dispatch the feeds to feed the fish at the certain time. Fish feeder will be automized and can be easily controlled from the mobile phone via mobile application anytime and anywhere in just once click user-friendly dashboard.

II. Objectives

The general objective of the study is to demonstrate automated feed-ration of commercial and alternative feeding of tilapia. Specifically, it aims to: (1) document and assess feed-ratio of commercial and alternative feeding of tilapia, (2) apply mobile image processing software in monitoring the growth of tilapia and (3) disseminate results of the project through seminars and training of clientele and stakeholders.

III. Expected Output

1. Developed algorithms for image processing.
2. Established demonstration site.
3. Developed auto feeder for tilapia feeding.
4. Developed mobile application of image processing.
5. Established pilot site.
6. Delivered project updates and accomplishment.

IV. Research Highlights

Methodology

The project commenced by developing algorithms for establishing the recommended feed-ratio of commercial and alternative feed for aquaculture production. This algorithms is used for identifying, selecting and establishing of demonstration site in determining the best feed-ratio that will give high yield in terms of aquaculture production. This led to the development of automatic feeder for the feeding of tilapia that will be used in the simulation of the feeding ratio and the development of image processing software that will be used to monitor the production of tilapia from fingerlings up to harvest. Pilot testing will be done after the 100% completion of the automatic feeder and mobile application software. The results of the project will be disseminated through seminars and training to the target beneficiaries and stakeholders. The figure below shows the flowchart of activities

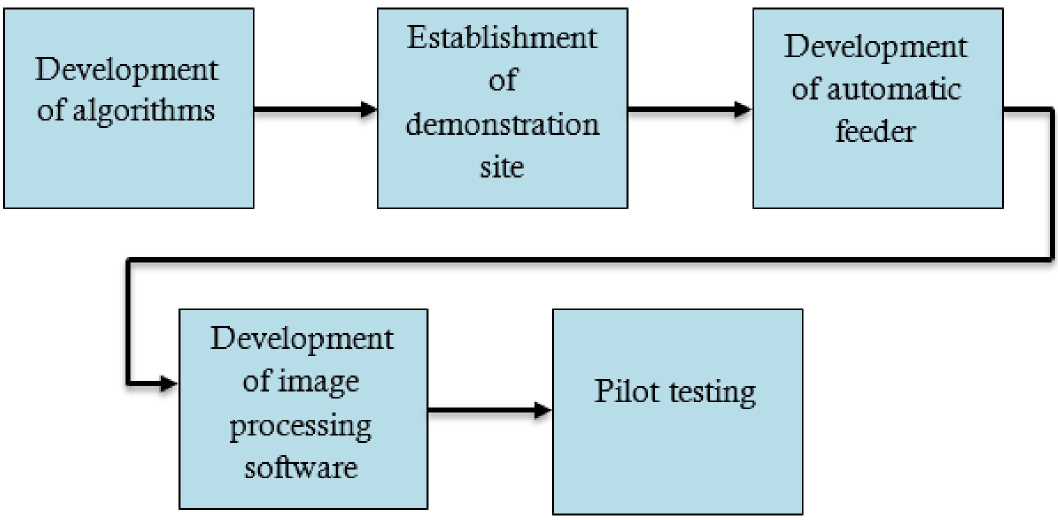


Figure 1. Flowchart of Activities

Development of Algorithms

The project researchers and staff develop algorithms for the automatic feeder with image processing software which includes the design of the automatic tilapia feeder, architecture of the automatic tilapia feeder and the mobile processing application and the activity diagram of the tilapia feeder and mobile application.

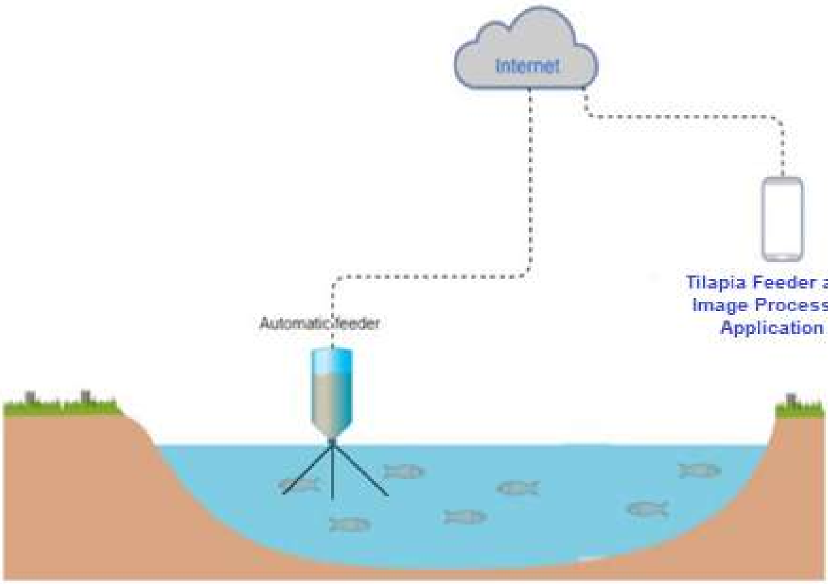


Figure 2. Design of the Automatic Tilapia Feeder

Figure 2 shows the design of the automatic tilapia feeder. It consists of several parts, the hardware and the software. The hardware system consists of Arduino module and automatic feeder and the software includes the android application that can provide feed and simultaneously monitor the growth of tilapia. The design will be integrated with internet of things, which will help the farmers easily control the ponds everywhere as long as they are connected to the internet. It will be performed regular automatic feeding without disturbing the owners work. Using the wireless communication, the automatic feeder can be set to dispatch feeds/pellets to feed the fish at a certain time. The feeder will be automized and can easily controlled from mobile phone via mobile application anytime and anywhere in just one click using the user-friendly dashboard.

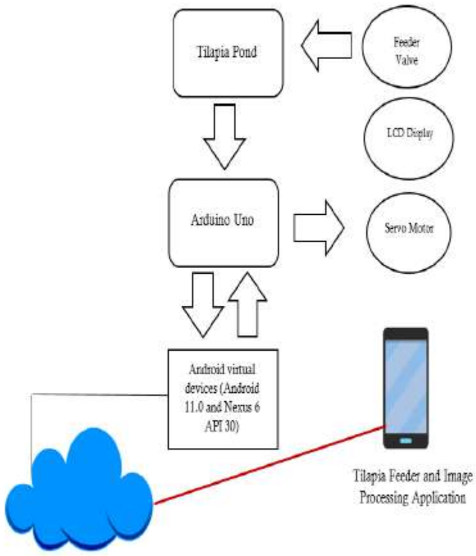


Figure 3. Architecture of the Automatic Tilapia Feeder and Mobile Processing Application

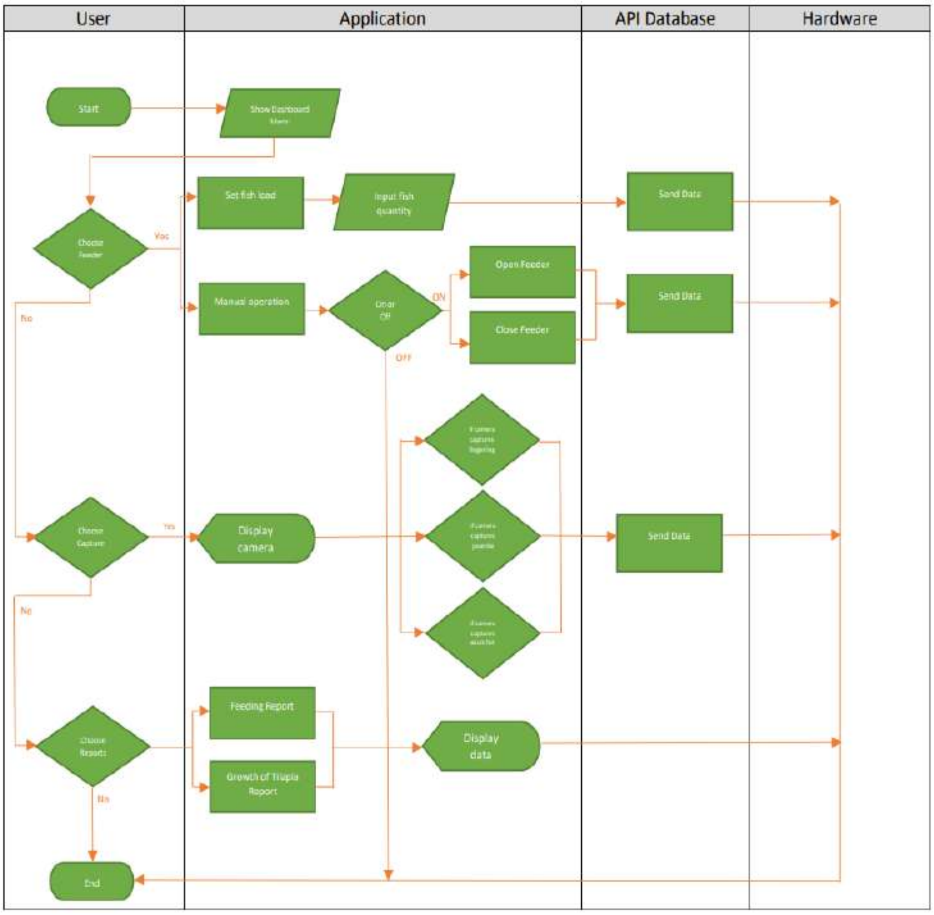


Figure4. Activity Diagram of the Automatic Tilapia Feeder and Mobile Procesing Application

Figure 4 shows the activity diagram of the automatic tilapia feeder and mobile processing application. The user will enter the feeding time schedule using the mobile application. The mobile application will store the schedule input that the user will input. After the input will be stored, the android device will send the user input to be stored in the database on the nodeMCU web browser to receive commands in the database that previously will be sent by system. nodeMCU will execute instructions that will be receive according to the time that will set by the user. The program flow will begin when the user starts running the application on android smartphone. The initial display of the dashboard will be displayed on the user's smartphone screen. Then the options appear for the feeder configuration. If you set the load, you will input the quantity of fish that will send data and will store in the API database. If you set the manual operation, it will open or close the feeder and data will be send and will also be stored in the database. Other option appear will be the capture configuration. It will display the camera and it will monitor the growth of the tilapia from fingerlings to adult fish. The data will be send and will be stored in the database. All the data will be stored in the API database and will be processed by the user interface in the mobile application to be displayed on the user's cellphone. After all configurations have been entered, each time the user will see the feeding report and the growth of tilapia report, the application will immediately retrieve the data in the API database and will send the data directly to the user's smartphone.

Establishment of Demonstration Site

The project researchers and staff visited SFR owners in Central Luzon by coordinating with the Provincial and Municipal Agriculture Office, Department of Agriculture in Central Luzon and Bureau of Fisheries and Aquatic Resources Regional Office No. 3 (BFAR-III) in data gathering and site identification and validation of SFR for the establishment of techno demo site.

Figure 5. Coordination with the municipal agricultural offices in Tarlac

Figure 6. Coordination with the provincial agricultural office in Nueva Ecija

Figure 8. Coordination with DA-RFO III for endorsement to Agricultural Provinces
and gathered data for the list of SFR owners in the Province

Figure 9. Data gathering at BFAR Region III

Figure 10. Data gathering and endorsement to LGUs for site visit at DA-OPA Pampanga

Figure 11. Coordination to DA-OPA Bulacan for data gathering and endorsement to Municipal Agriculture Office in the LGUs of Bulacan Province

Figure 12. Site identification for Techno Demo in Brgy. Tukod, San Rafael, Bulacan in coordination of the Farmers Association of Tukod

Figure 13. Visited the SFR site identified for Techno Demo located in Brgy. Umpucan,San Ildefonso, Bulacan in coordination with the Farmers Association

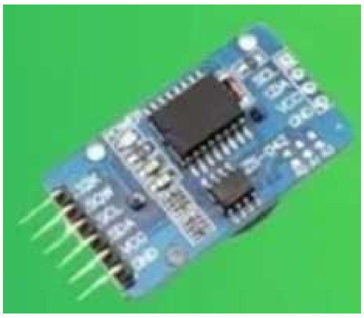
Figure 14. Coordination with the Municipal Agriculturist of San Ildefonso, Bulacan for site validation and visitation

Development of Automatic Feeder

Table 1. Procured of materials needed for the implementation of the project

Materials	Description
For the Food Tank (Floater and food storage)	
Heavy Duty Plastic Container Drum 15 Gal (60 Li) 	This drum serves as the floater of the automatic feeder.
Heavy Duty Plastic Container Drum 10 Gal (45 Li) 	This drum serves as the food tank of the automatic feeder.
For the Food Tank (Braces only)	

Tabular and Angular Metal Bars 	Used for the braces of the automatic feeder
Cutting Disc 	Cutting disc is used to cut the flat and angular metal bars.
Epoxy Gray, Lacquer Thinner and Paint Brush 	Used to coat the metal bars
For the Microcontroller System	

ESP8266 NodeMCU WiFi Module  	NodeMCU Wifi module is used to connect the devices to the internet and serves as the main controller of the system
5V Relay Dual 	5V Relay dual is used to control the servo motor.
Real Time Clock Module DS3231 	Real time clock module keeps the date and time in the feeding of tilapia

<table>
<tr><td>Ultrasonic Sensor 5V
</td><td>Ultrasonic sensor is used to measure the level of feeds in the food tank</td></tr>
<tr><td>Printed Circuit Board (PCB)
64x95 mm
</td><td>PCB is used to connect the electronic components used in the system</td></tr>
<tr><td>Servo Motor 5V
</td><td>The servo motor is responsible to the opening and closing of the pipe where the feeds flows in the food tank. It will work when the time of the real time clock is match on the time set.</td></tr>
</table>

Liquid Crystal Display (LCD) 20x4 and Breadboard 	The LCD displays the output of the food level of the automatic feeder.
Jumper Wires Male to Female 	Jumper wires are used to establish an electrical connection between two points in the circuit.
Power Supply Module 	Power supply module is used to convert AC power from the microcontroller system into usable DC power so that the system to be powered may operate properly

Table 1 shows the procured materials needed in the implementation of the project. These are the materials in developing the automatic feeder.

Design Concept of the Automatic Feeder

Figure 15 and 16 shows the perspective view and isometric view with parts of the automatic tilapia feeder, respectively. The different parts of the auto feeder are the following: the food container serves as the storage of feeds, steel hollow bar serves as the brace of the feeder, the four 60 Li plastic drums serve as the floater of the feeder the 40 Li plastic drum serve as the food tank, solar panel with a backup battery will served as the power source for the microcontroller of the feeder.

Figure 17 shows the different elevations of the automatic tilapia feeder.

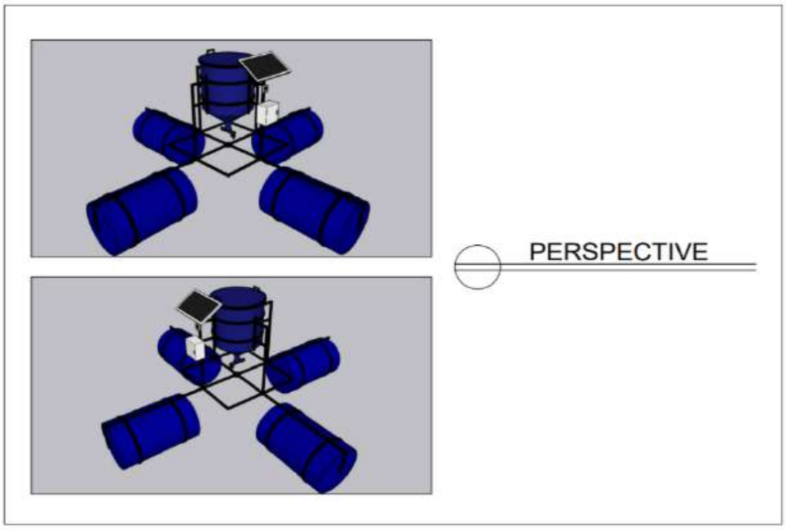


Figure 15. Perspective View of the Automatic Tilapia Feeder

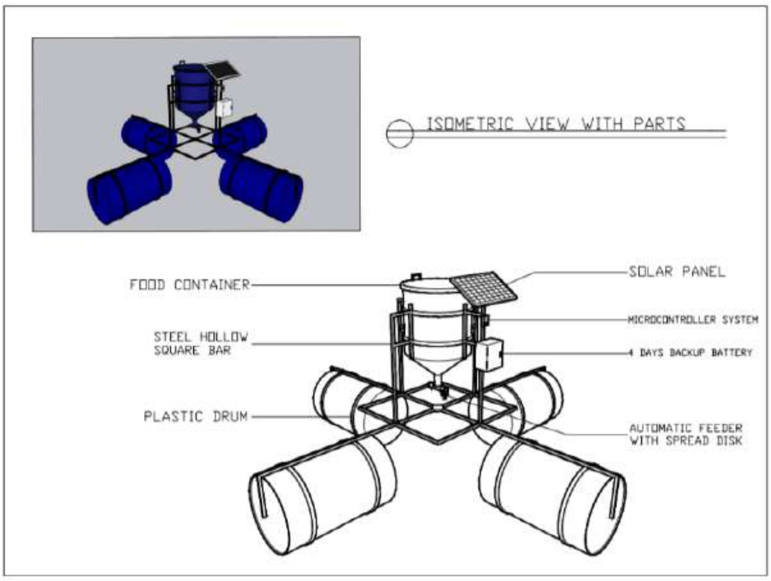


Figure 16. Isometric View with Parts of the Automatic Tilapia Feeder

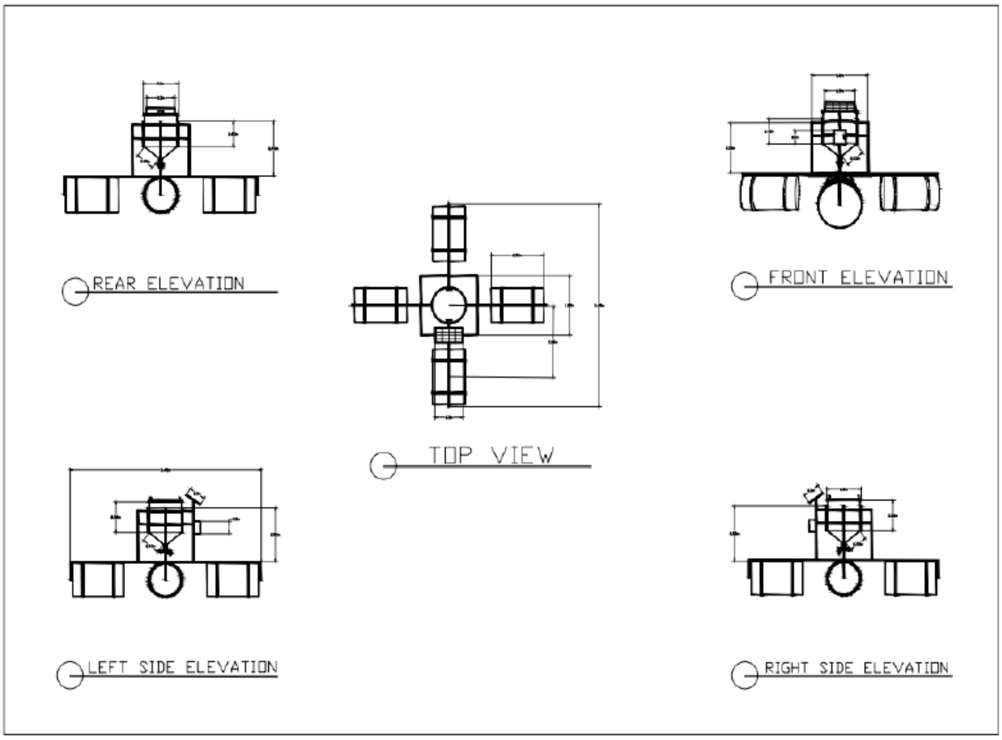


Figure 17. Different Elevation of the Automatic Tilapia Feeder

Figure 18. Fabrication of the Automatic Tilapia Feeder

Figure 18 shows the fabrication of the automatic tilapia feeder. The automatic feeder was constructed based on the design and specifications made.

Development of the Image Processing Software

The development of the image processing software is used to help the SFR owners easily control the ponds everywhere. It perform regular automatic feeding without disturbing the SFR owners work. Using the wireless communication the system can be set to dispatch the feeds to feed the tilapia at the scheduled time of feeding. The automatic feeder is automized and can be easily controlled from the mobile phone via mobile application anytime and anywhere in just one click using the user-friendly dashboard.

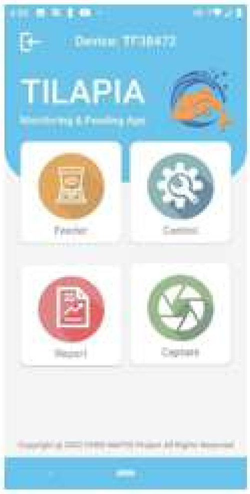


Figure 19. The Mobile Application Dashboard

Figure 19 shows the mobile application dashboard. On the dashboard, there are 4 menus available, the Feeder, Control, Report and Capture.

Feeder Menu button is used to feed the tilapia at the scheduled time and used to monitor the percentage of the remaining feeds in the food tank. It also used to set the feeding if it is automatically or manually delivered.

Control Menu button is used to set the time duration in feeding the tilapia.

Report Menu button is used to monitor the feeding data if it is automatically or manually delivered.

Capture Menu button is used to monitor the growth of tilapia.

Pilot Testing

Pilot testing will be done after the 100% completion of the automatic feeder and mobile application software.

Results and Discussion

Establishment of Demonstration Sites

Six areas in different provinces of Region 3 were identified, selected and established demonstration sites. Two in Tarlac Province located in TAU Campus, Camiling, Tarlac and Brgy. Labney, San Jose, Tarlac, one in San Miguel, Bulacan, one in Bongabon, Nueva Ecija, one in Dipaculao, Aurora and one in San Marcelino, Zambales. Figures 20 – 24 show the six demonstrations sites in Region 3.

There are 2 identified sites from the province of Tarlac Province one is from the Tarlac Agricultural University Malacampa, Camiling, Tarlac. The second site was located at Brgy. Labney, San Jose, Tarlac the SFR has an area of 550 sq. meter owned by the farmer Mr. Crisostomo Gallion (Figure 20).

Figure 20. Demonstration sites in Tarlac Province (TAU Campus, Camiling Tarlac and Brgy. Labney, San Jose, Tarlac)

One identified techno demo site in Bulacan Province. It is located at Brgy.Sibul San Miguel, Bulacan the SFR owner is Mr. Salvador Estremadora (Figure 21).

Figure 21. Demonstration site in San Miguel, Bulacan

One identified and validated technology demonstration site in the province of Nueva Ecija the site was located at Brgy. Magtangol Bongabon, Nueva Ecija the SFR owner is Mr. Evrod Navarro his SFR has a surface area of 400 square meters (Figure 22).

Figure 22. Demonstration site in Bongabon, Nueva Ecija

One identified and validated techno demo site located at Brgy. Salay, Dipaculao, Aurora with an area of 400 square meters the name of the farmer is Mr. Arnold Mark Ian Cacanindin (Figure 23).

Figure 23. Demonstration site in Dipaculao, Aurora

One technology demonstration site from the province of Zambales the SFR owner is Mr. Crisanto Ancheta. It is located at Brgy. Lawin, San Marcelino, Zambales (Figure 24).

Figure 24. Demonstration site in San Marcelino, Zambales

Development of the Automatic Tilapia Feeder

To assess the feed-ratio of commercial and alternative feeding of tilapia, automatic feeder was develop. Figure 25 shows the fabricated automatic tilapia feeder. The solar panel that will serve as the power source and the microcontroller system box that will serve as the controller for the automatic feeding and monitoring the growth of tilapia is not yet installed in the feeder.

Figure 25. The fabricated Automatic Tilapia Feeder

Development of Image Processing Software

The development of the image processing software is thru the use of mobile application. This mobile application contains the information about the feeding schedules, the level percentage of the feeds in the tank, records in the feeding of tilapia and monitoring the growth of tilapia. This application is made to help the SFR owners to provide feed and monitoring.

The circuit diagram in Figure 26 is constructed in a printed circuit board. It is composed of 2 relays with 2 channels. The first relay is for the servo motor and the other is for the fan. The NodeMCU WiFi Module serves as the main controller. The buck converter is used to convert the voltage from 12V to 5V to regulate the output voltage. The LED serves as indicator if the sending of data to the server is successful or not. The first lit of the LED Indicates that it sends data and the second lit indicates that it is successfully sends the data to the server. The servo motor is used for the opening and closing of the pipe where the feeds flows from the food tank. The ultrasonic sensor is used to monitor the level percentage of feeds in the food tank.

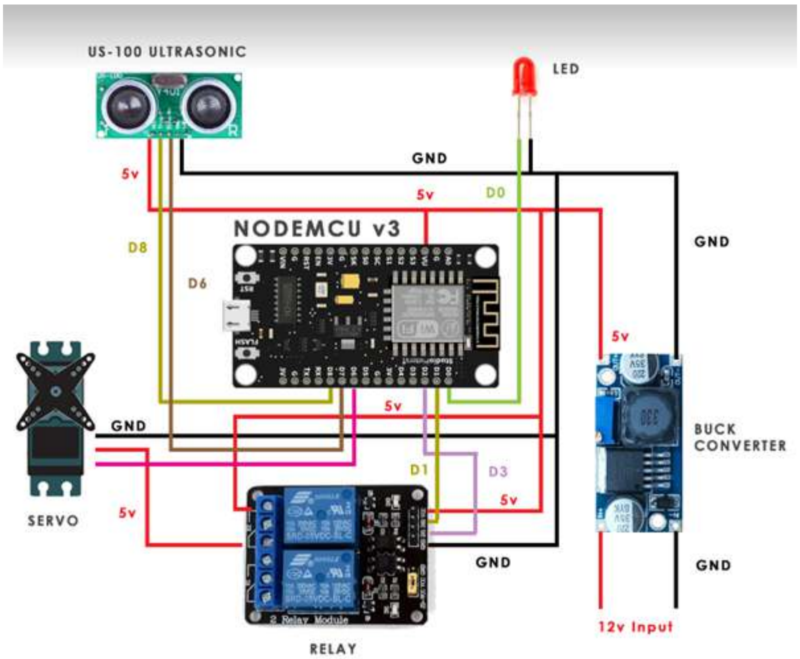


Figure 26. The circuit diagram of the microcontroller system of the automatic tilapia feeder

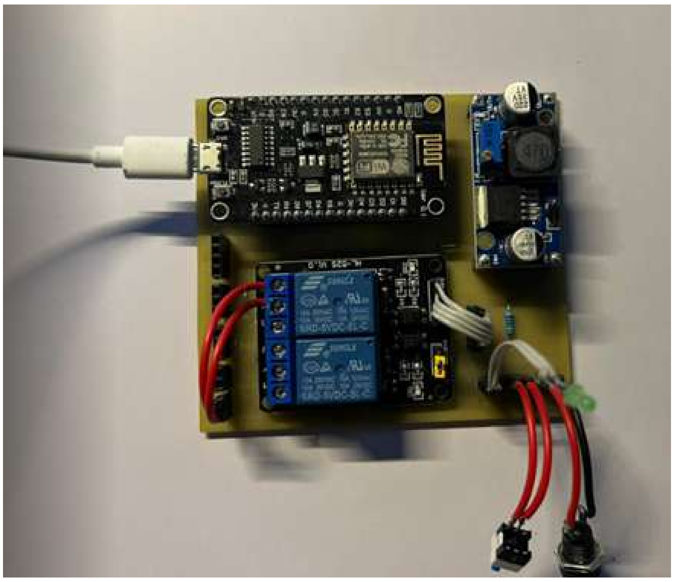


Figure 27. The actual circuit board of the microcontroller system of the automatic tilapia feeder

Figure 27 shows the actual circuit board of the microcontroller system of the automatic tilapia feeder.

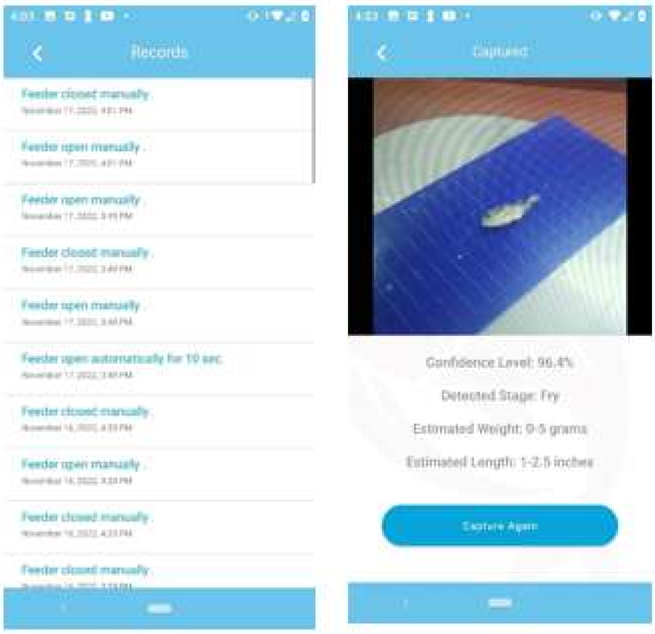


Figure 28. The Dashboard, Feeder Menu, Control Menu, Report Menu and Capture Menu

Figure 28 shows the dashboard of the mobile application. There are 4 menus available namely: Feeder, Control, Report and Capture. The Feeder Menu button is used to feed the tilapia at the scheduled time and used to monitor the percentage of the remaining feeds in the food tank. It also used to set the feeding if it is automatically or manually delivered. The Control Menu button is used to set the time duration in feeding the tilapia. The Report Menu button is used to monitor the feeding data if it is automatically or manually delivered. The Capture Menu button is used to monitor the growth of tilapia.

The SFR owner will regulate the time of feeding the tilapia which is will be adjusted by himself. The system will store the feeding time schedule in the database which will then control the fish feed device according to the time. He can also monitor the level of feeds in the food tank using the system. To SFR owner also easily monitor the growth of tilapia using the system.

IEC Materials

The researchers created IEC material to be use in trainings, seminars, and capability building for students, Agricultural Extension Workers, clientele, stakeholders, and farmers. The researchers will conduct pilot testing of Automatic Fish Feeder that will also be beneficial to farmers, AEW's, students, clientele and stakeholders (Figure 35).

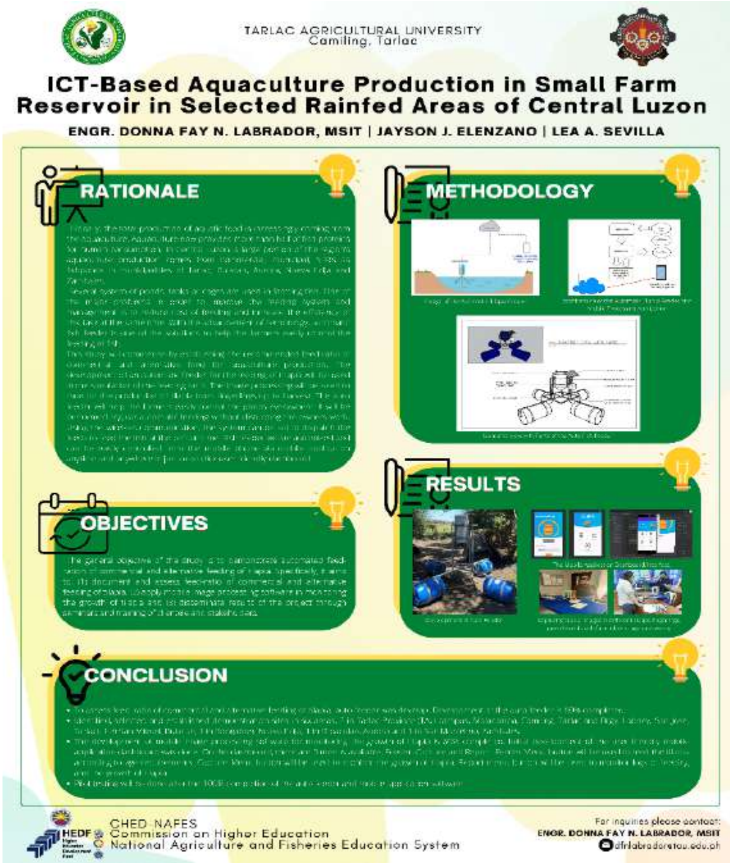


Figure 29. Poster for ICT-Based Aquaculture Production

Conclusion

The project aims to establish the recommended feed-ratio of commercial and alternative feed for tilapia production through the development of automatic tilapia feeder that will be used in the simulation of the feeding ratio. Specifically, it aims to determine the best feed-ratio that will give high yield in terms of tilapia production in the different areas in Central Luzon. It also aims to develop image processing software that will be used to monitor the production of tilapia from fingerlings up to harvest and disseminate the project findings through seminars and training for clients and stakeholders

The project was able to identify, select and establish demonstration site in six areas of Central Luzon: 2 in Tarlac Province, 1 in Bulacan, 1 in Nueva Ecija, 1 in Aurora and 1 in Zambales. The project also develop the automatic tilapia feeder that will be used for the simulation of the feeding ratio of tilapia.

The project was able to develop the automatic tilapia feeder that will be used to assess the feed-ratio of commercial and alternative feeding of tilapia.

The project was also able to develop the image processing software by developing a mobile application. The mobile application is made to help the SFR owners to provide feed and monitor the growth of tilapia.

Bibliography

Chiu, C. C., Liao, T. L., Chen, C. H., & Kao, S. E. (2022). AIoT Precision Feeding Management System. Electronics, 11(20), 3358.

El Shal, A. M., El Sheikh, F. M., & Elsbaay, A. M. (2021). Design and fabrication of an automatic fish feeder prototype suits tilapia tanks. Fishes, 6(4), 74.

Garcia, C., & Tibo, H. (2023). A Solar-Powered Aquaponics with IoT-Based Monitoring and Data Gathering at the Technological University of the Philippines-Taguig.

Hasim, H. N. B., Ramalingam, M., Ernawan, F., & Puviarasi, R. (2017, February). Developing fish feeder system using Raspberry Pi. In 2017 third international conference on advances in electrical, electronics, information, communication and bio-informatics (AEEICB) (pp. 246-250). IEEE.

Kularatne, E. (1997). Information needs and information provision in developing countries. Information.

Ntiri, P., Ragasa, C., Anang, S. A., Kuwornu, J. K., & Torbi, E. N. (2022). Does ICT-based aquaculture extension contribute to greater adoption of good management practices and improved incomes? Evidence from Ghana. Aquaculture, 557, 738350.

Noor, M. Z. H., Hussian, A. K., Saaid, M. F., Ali, M. S. A. M., & Zolkapli, M. (2012, July). The design and development of automatic fish feeder system using PIC microcontroller. In 2012 IEEE control and system graduate research colloquium (pp. 343-347). IEEE.

Ogunlela, A. O. (2014). Development and performance evaluation of an automatic fish feeder. In 2014 Montreal, Quebec Canada July 13–July

16, 2014 (p. 1). American Society of Agricultural and Biological Engineers.

Palconit, M. G. B., Concepcion, R. S., Alejandrino, J. D., Fonseca, V. F., Sybingco, E., Bandala, A. A., ... & Dadios, E. P. (2021, December). IoT-based On-demand Feeding System for Nile Tilapia (Oreochromis niloticus). In TENCON 2021-2021 IEEE Region 10 Conference (TENCON) (pp. 698-702). IEEE.

Perea, R. V., & Cullado, J. P. B. (2022, August). ICT-Assisted Growth Management System for Mud crabs (ICT-AGMAS): Deployment and Evaluation. In 2022 International Conference on Emerging Techniques in Computational Intelligence (ICETCI) (pp. 32-39). IEEE.

Piplani, D., Singh, D. K., Srinivasan, K., Ramesh, N., Kumar, A., & Kumar, V. (2015, December). Digital platform for data driven aquaculture farm management. In Proceedings of the 7th Indian Conference on Human-Computer Interaction (pp. 95-101).

Uddin, M. N., Rashid, M., Mostafa, M. G., Belayet, H., Salam, S. M., Nithe, N., ... & Aziz, A. (2016). Development of automatic fish feeder. Global Journal of Researches in Engineering: A Mechanical and Mechanics Engineering, 16(2), 14-24.

Yasin, H. M., Zeebaree, S. R., Sadeeq, M. A., Ameen, S. Y., Ibrahim, I. M., Zebari, R. R., ... & Sallow, A. B. (2021). IoT and ICT based smart water management, monitoring and controlling system: A review. Asian Journal of Research in Computer Science, 8(2), 42-56.

Yusoff, A. H. M., Salleh, S. M., Abdullah, M. E., Zaman, I., Hani, M. H. M., Siswanto, W. A., & Mahmud, W. A. W. (2018). Experimental evaluation of fish feeder machine controller system. International Journal of Integrated Engineering, 10(8).

DOCUMENTATION OF RAINFALL GAUGING SITES IN SELECTED RAINFED AREAS IN CENTRAL LUZON

A. BASIC INFORMATION

1. **Program Title:** Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project 6 Title: Rainfall Analysis fore Aquaculture Production in Selected Rainfed Areas of Central Luzon

2. **Researcher(s):**
   Project Leader: Mary Grace N. Semilla
   Project Staff: Melanie A. Ferrer

3. **Implementing Agency/Station**
   Lead Agency – Tarlac Agricultural University
   Cooperating Agency – Central Luzon State Univesity, Provincial and Local Government
Units of Central Luzon
Project Site(s): Central Luzon (Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)
4. **Technology Level:** Applied
5. **Sector:** Agriculture
6. **Commodity Classification**: Agriculture
7. **Research Discipline**: Agriculture
8. **Target Beneficiaries**: 2200 Beneficiaries composed of the following
   2100 small farm reservoir farmers
   50 Agricultural Technologist/Agriculturist
5 graduate Students
45 undergraduate students
9. **Funding Agency**: CHED-NAFES
10. **Duration**
   Date Started: August 2021
   Date Ended: February 2023
11. Financial Reports
   Total Approved Budget: P 9,500,000.00
   Actual Released Budget: P 6,142,182.00
   Actual Expenditures: P 2,723,762.50 as of August 2022.

B. Technical Report

I. Rationale

The whole world is experiencing climate change. The World Meteorological Organization (WMO) reported an increasing trend in the global annual mean temperature in the past 45 years. Their recent reports have shown that 2020 was one of the three warmest years (2016 as warmest) on the record which is 1.2 ± 0.1 °C above baseline years of 1850 – 1900 (WMO, 2021). Climate change has been affecting the lives and livelihood of the many (WMO, 2021), especially those in the developing countries (Porio et al., 2018). According to the IPCC (2018), the risk of drought may be higher in some areas with 2°C global warming than with 1.5°C global warming, but it ensures a pattern of flood events. In the Philippines, the agricultural and aquaculture sector could be highly affected.

Changes in rainfall patterns and other forms of precipitation will be one of the most important variables affecting the overall impact of climate change (Yazdi and Shakouri, 2010). Rainfall is significantly harder to forecast than temperature. Changes in rainfall patterns have two obvious impacts on aquaculture productivity and sustainability. A period of increased and little or no rainfall. Potential effects of heavy rains include increased risk of flooding of fish and shrimp ponds and difficulty in catching adequate forage fish, but the effects of drought can lead to mass mortality of fish. It also reduces river flow, impacts habitat quality and the availability of oxygen to freshwater organisms, and increases water temperature and salinity. (Asiedu *et al.,* 2017). In the attempt to at least adopt to this conditions, water impounding can be adopted to ensure continuous supply of water resources.

The small farm reservoir (SFR) is a small water impounding earth dam structure to collect rainfall and runoff, designed for use in a single farm, and typically has an area of about 300-2,000 square meters. The embankment height above ground level is less than 4 meters (Guerra, et al., 1991). The amount of rainfall is an important factor in small farm reservoir, thus is a limiting resource for intensive crop production especially during the dry season. Though, the Philippine average rainfall (2,500 mm) is more than enough to support the annual water requirement of most crops, this rainfall is not uniformly distributed throughout the year in most parts of the country. Because of this, seasons of water excess and deficit occur during the year. Excess water hastens flooding and soil erosion (Baradas, 1979). With this in mind, the aquaculture or tilapia production can be affected too. Thus, the project was initiated.

II. Objectives

This research aims to establish a rainfall-guide for SFR-Based aquaculture production in rainfed areas. Specifically, the study aims to perform the following:

1) document rainfall analysis of SFR and
2) disseminate the four (4) months occurrence of rainfall for SFR. The study though will focus on the tilapia production.

III. Expected Output

The following are the expected deliverable of the project:

1. Aquaculture Calendar
2. IEC Material
3. Paper Presentation
4. Publication

IV. Research Highlights

Methodology

Framework of the Study

The project was anchored on the framework of the whole program. With the rainfall analysis as input the SFR community, training and seminars and impact assessment toward developing a knowledge management system is the direction of the project (Figure 1).

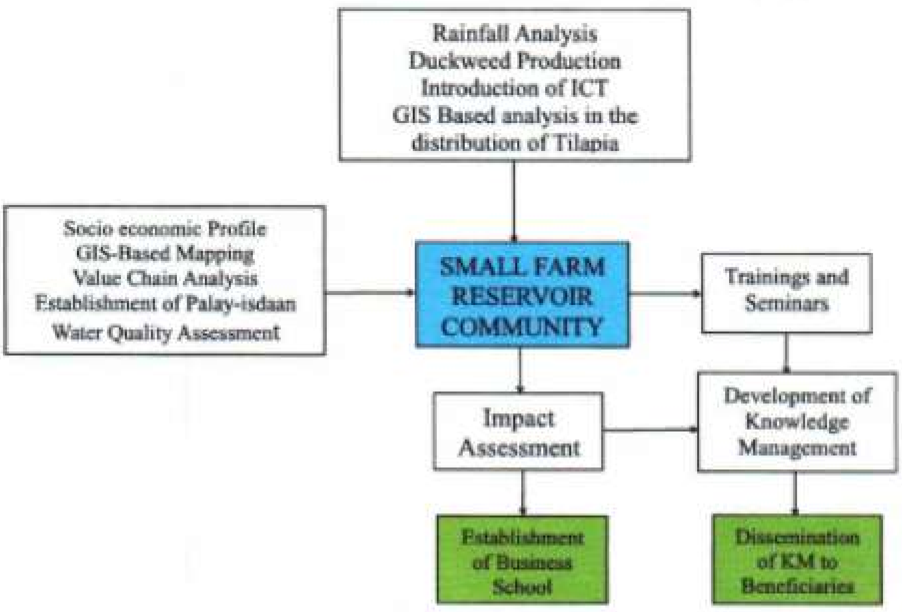


Figure 1. Framework of the Program

Original Procedure/Methodology

The weather stations of the Philippine Atmospheric Geophysical and Astronomical Services Administration were main source of data. Rainfall occurrence was recorded accordingly for the whole project duration. Rain gauges installed in sites that selected for validation of rainfall occurrence in actual condition. Monitoring of rainfall was done regularly. Farmers with SFR located within the 50 km radius was informed through seminars or training which would highlight the results of the project and the impact of rainfall analysis on the capacity of SFRs physical characteristics and impact on aquaculture.

To assure rainfall dependability on the results of the computations, rainfall magnitudes used would be based on eighty percent probability of exceedance (“Hydrology for Engineers”, Linsley Jr. R.K.,et al.). The Hazen logarithmic curve used in the calculation of frequency factor or rainfall has the following formula:

$$X_T = X + SK$$

Where: X_T – magnitude of 10-day rainfall at a given probability of exceedance

X – mean 10-day rainfall

S – standard deviation

K – frequency factor

Cs – Coefficient of skew

Adjusted size of the coefficient of skew:

The calculation of surface inflow normally does not apply except for areas subject to flooding while sub-surface inflow is only of local significance in areas where there is upward movement of water form deep sub-soil caused by seepage form reservoir and canals or may occur locally on or near the toe of sloping lands. Inflow is not considered in this study.

The research design in this study would be a combination of descriptive normative and historical method using documentary and correlation analysis. The research classified under prognosis type of research in which the rainfall based analysis would be based on the rainfall pattern

Change in Procedure/Methodology (Cite Reasons)

There was a slight change in the methodology as stated in the proposal. Apart from the change in leadership of the project, the objectives as seen by the team needs to be directly addressed. And thus, detailed and doable methodology was crafted and followed. Following are some of the procedures involved.

Conceptual Framework

The project would follow the conceptual framework shown in Figure 2.

Data Collection

The weather data such as rainfall, temperature, evaporation and humidity was taken from the PAGASA Synoptic and Agromet Stations. 30-year daily data shall be used. On the other hand, yield data will be taken from Provincial Agriculture Office, or BFAR whichever is available. During the data collection process, not all stations have 30 year data, so adjustments were made such that only the available data were processed. Moreover, yield data for Tilapia production is very limited. Activities regarding data collection and consultations were also conducted (Appendix Figures 1 to 5).

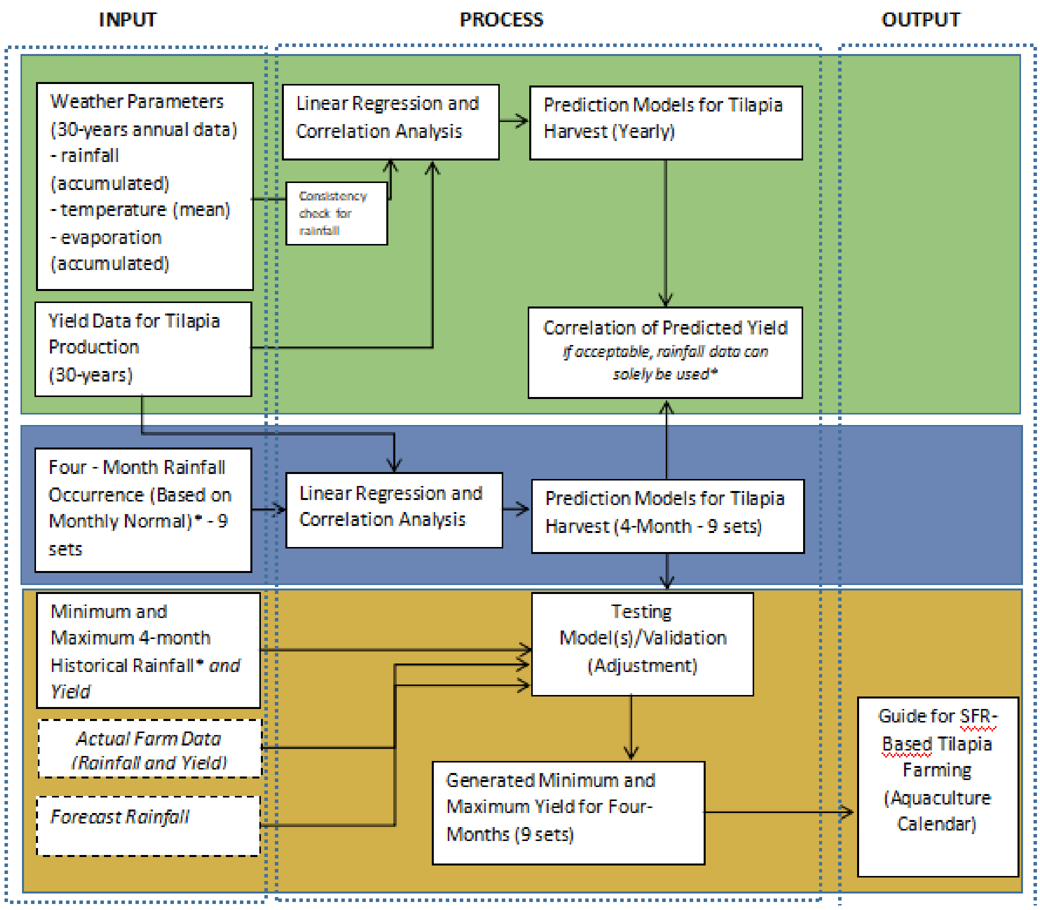


Figure 2. Conceptual framework of the project

Documenting Rainfall Analysis

The collected data from various weather stations were utilized to achieve a documentation of rainfall for the project sites. In this project, rainfall analysis achieved for Nueva Ecija and Tarlac provinces. The following methodologies were employed during upon the processing of data.

Normal Annual Rainfall and Evaporation

Here are the steps in computing for the normal values of rainfall and evaporation in each station.

If there is no missing data:

1. Using the daily data gathered from PAGASA Stations, get the accumulated rainfall and evaporation every year. Starting from 1990 up to 2020. Each year will have an accumulated annual rainfall value and evaporation value in millimeters

2. Once all the annual values have been determined, get the normal value by averaging all the accumulated values computed each year.

If there is missing data:

1. Determine first the normal values of the daily rainfall. For the 30-year data (1990-2020), get the average rainfall in each day. This value will represent the normal daily rainfall.

2. Once all the normal daily rainfall have been determined, get the normal accumulated value by summing up the normal daily rainfall.

Estimated Annual Rainfall

In order to have a data set to be used in linear regression for predicting harvest, missing annual rainfall was determined for each station using the normal ratio method.

Px - missing precipitation at Station x

Nx - normal annual precipitation at Station x

P1, P2, Pm - annual precipitation at surrounding stations 1, 2 and 3

N1, N2, Nm - normal annual precipitation at surrounding stations 1, 2 and 3

This method was based selecting m (m is usually 3) stations that are near and approximately evenly spaced around the station with the missing record.

For Tarlac: Cabanatuan, Botolan and Dagupan Stations

For Nueva Ecija: Cabanatuan, Dagupan and Baler Stations

Checking Consistency

Before further processing of data, checking for consistency should be done first. The consistency of rainfall using the double mass curve method compared the graph of the cumulative data of one station versus the cumulative data of other stations. Cumulative data of other stations is the mean of several neighboring stations. If the curve obtained was a straight line, station X was consistent, and if there was a break in slope, the record at station X was inconsistent and should be corrected. If there were inconsistencies, the data should be adjusted accordingly. Following are the steps used for consistency checking.

1. To draw the curve, a group of station (8) was taken as a base stations in the neighborhood of the station X.
2. The accumulated rainfall of station X ($\sum Px$) and accumulated values of average of group of base station ($\sum P_{AV}$) were calculated starting from the latest record.
3. $\sum Px$ on Y-axis and $\sum P_{AV}$ on X-axis.
4. In the plot, if a break in the slope was observed, it indicated a change in precipitation of station X. The values of precipitation at X beyond the break point should be corrected based on the slope of both the lines.
5. A change in a slope was normally taken as significant only where it persisted for more than 5 years. Inconsistencies of data can be adjusted using correction factor.

Correction Factor= corrected slope / original slope = c / s

Determining Monthly Normal Precipitation

After checking the consistency, the collected data were summarized into monthly normal precipitation. Data should have been a 30-year rainfall record. However, due to unavailability, at least 10 years or more data were utilized. In Nueva Ecija and Tarlac, the data used was from 1995 to 2021, and 2009- 2020, respectively. The accumulated monthly rainfall in each specific month every year was averaged to get the monthly normal rainfall.

Linear Regression Models for Monthly Rainfall

Linear regression models for rainfall were determined to predict monthly accumulated rainfall for the next five years (2022 - 2026). The models were tested by comparing the actual and the predicted monthly rainfall by correlation. After testing, the monthly predictions can then be used as a guide to create a four-month accumulated rainfall for the next five years.

Four-Month Rainfall Occurrence

The four-month rainfall occurrence was determined in the assumption that the tilapia production would last for four months from stocking to harvesting. To test the relationship of tilapia yield to other weather parameters, other than rainfall, the four-month accumulated yield, rainfall, evaporation and mean temperature data using the monthly normal were also computed.

Rainfall, Evaporation, Temperature and Yield Relation

This was done by getting the sum of the monthly means for January-April, February - May, March - June, April - July, May - August, June - September, July - October, August - November until, September-December. There were nine sets of four-month data prepared. Appendix Table 1 shows the four-month accumulated yield, Appendix Table 2 which shows the four-month accumulated rainfall, Appendix Table 3 with the four-month accumulated evaporation and Appendix Table 4 with the four-month mean temperature data were generated. The data generated were used in regression analysis and the results of ANOVA were shown in Appendix Table 5 to Appendix Table 58. Data used here were taken from CLSU Nueva Ecija since yield data is available in BFAR.

Aquaculture Calendar

Determining the calendar would depend on the activities of tilapia pond production. In a rainfed setting, this can highly be dictated by the occurrence of rainfall. The output of the rainfall analysis, would be vital in scheduling the production activities.

The climate types can be considered were Climate Type I (For Nueva Ecija and Tarlac) and Climate Type 2 (For Aurora). However, it was found by other projects (Pagatpatan, et.al., 2022) that there were only few Small Farm Reservoirs in Aurora (Climate Type II). This could be possibly be affected by its rainfall pattern, which has no pronounced dry season. The most common purpose of establishing Small Farm Reservoir is for irrigation, which the farm fields there probably do no need. Moreover, the SFR requires a unimodal pattern of rainfall which has wet and dry months (PAES, 2017).

For Climate I, dry season is from November to April (6 months) and wet season is from May to October (6 months).

Rainfall-Based Tilapia Production Guide

The outputs here would be the monthly five-year predictions, and the schedule of activities based on the monthly rainfall pattern.

Results and Discussion

The rainfall data and other weather parameters were collected from the different PAGASA Stations as shown in Figure 3. These stations are the following:

1. Synoptic Stations

    - Baler, Aurora
    - Cabanatuan, Nueva Ecija
    - Casiguran, Aurora
    - Clark Airport, Pampanga
    - Cubi Point, Subic Bay, Olongapo
    - Dagupan City, Pangasinan
    - Iba, Zambales
    - Science Garden, Quezon City

2. Agromet Stations

    - TAU, Camiling, Tarlac
    - CLSU, Science City of Munoz, Nueva Ecija

Establishment of raingauge sites involved identifying of selected demo sites (Figure 3). The procurement of raingauge was delayed due to inappropriateness of pricing per unit of raingauge. The price in the proposal preparation was already less than the existing price of the raingauge. Nevertheless, the data for each site was taken from the nearest PAGASA Station. Improvised raingauges were installed in the selected site(s) for monitoring. However, the data were not well-taken due to inadequacy of fund and time upon implementation.

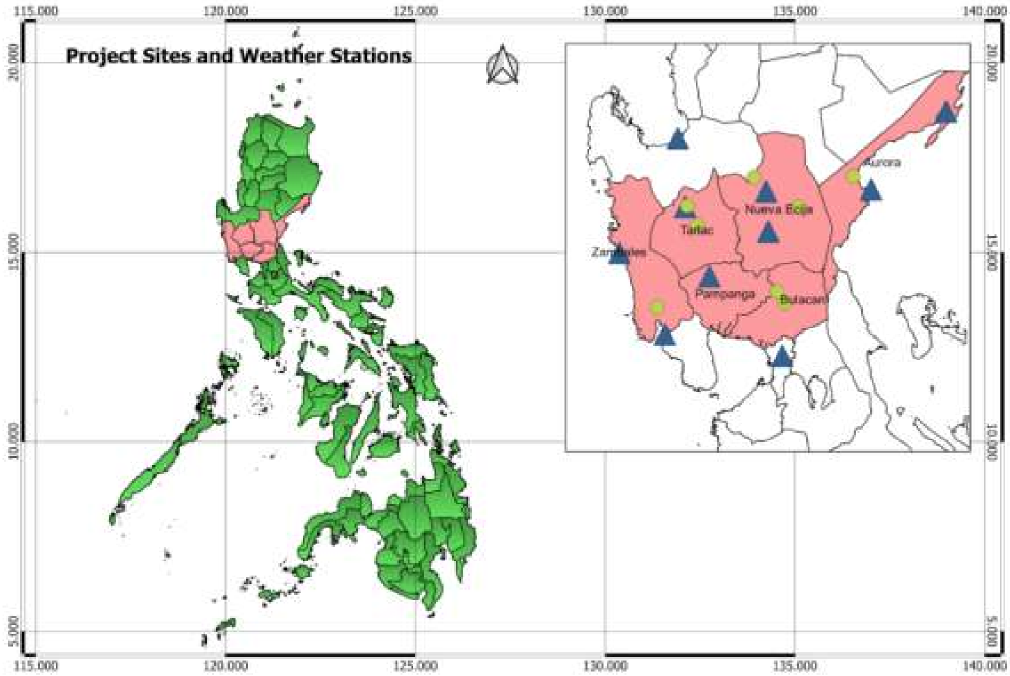


Figure 3. PAGASA weather stations and project sites

Rainfall Analysis

The consistency of the data especially rainfall was checked by using the double-mass curve. As shown in Figure 4. The data for Nueva Ecija (CLSU Munoz Station) was consistent from 1995 to 2020. Thus, these sets of data can be utilized for further processing. Figure 5 shows the monthly normal rainfall of PAGASA CLSU weather station which represents Nueva Ecija Province. This data covers at least around 50 kilometer radius from the station. It can be observed that driest months are observed in January to April. Rainfall occurrence increased by the month of May, June and reached its peak in July. August to October accumulated rainfall were also relatively high. The monthly rainfall then decreased by November to December. This trend is also observed in the predicted rainfall for year 2022 -2026 (Figure 6). The same trend or pattern is also observed in PAGASA- TAU in Tarlac, for both historical and predicted data (Figures 7 and 8).

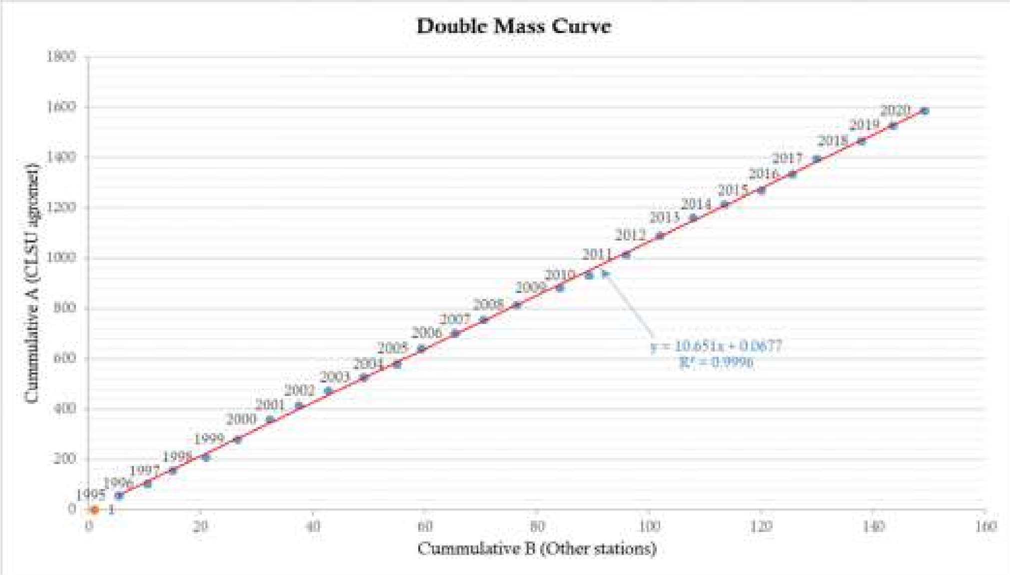


Figure 4. Double mass curve for rainfall data in CLSU and other stations

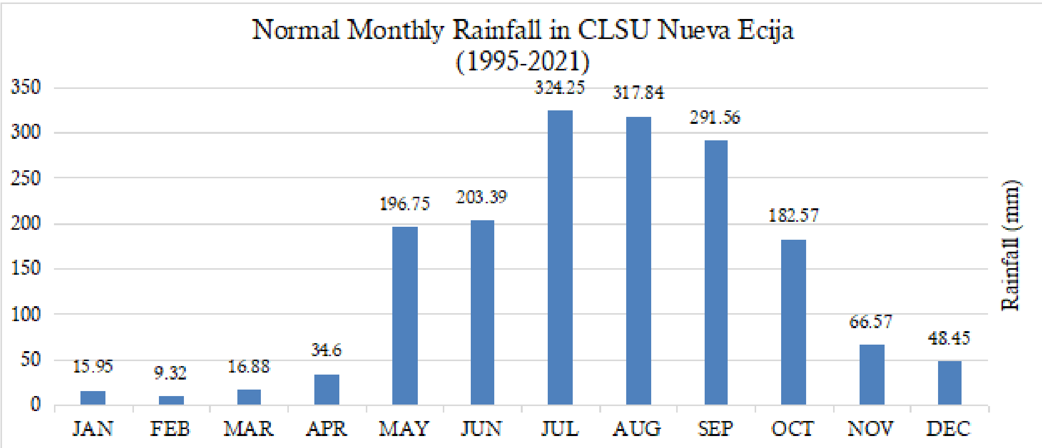


Figure 5. Monthly Normal Rainfall observed at PAGASA-CLSU

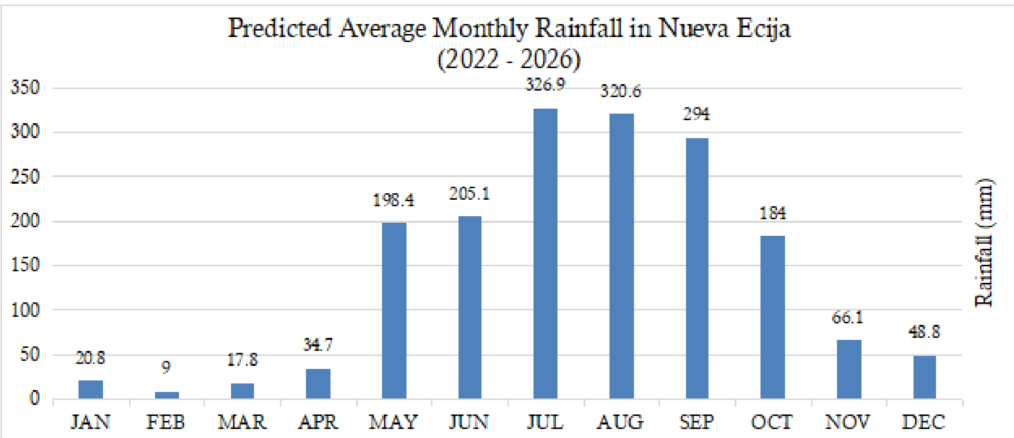


Figure 6. Predicted Monthly Average Rainfall for Nueva Ecija

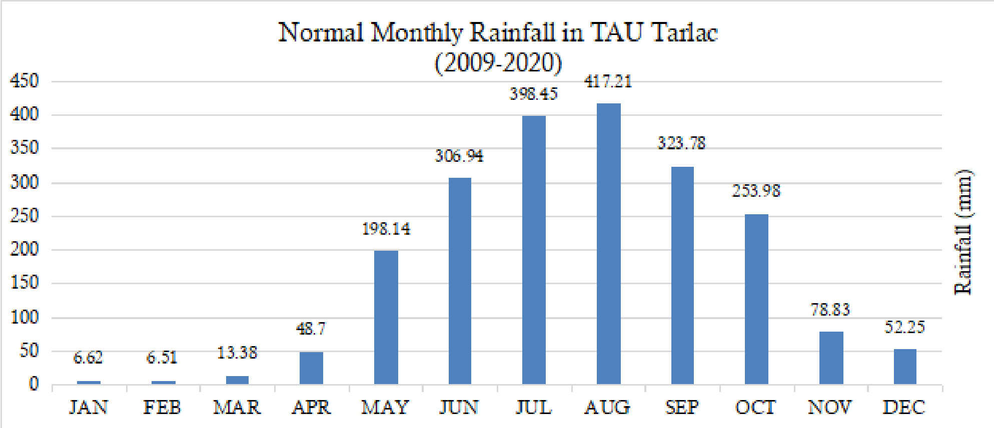


Figure 7. Monthly Normal Rainfall observed at PAGASA-TAU

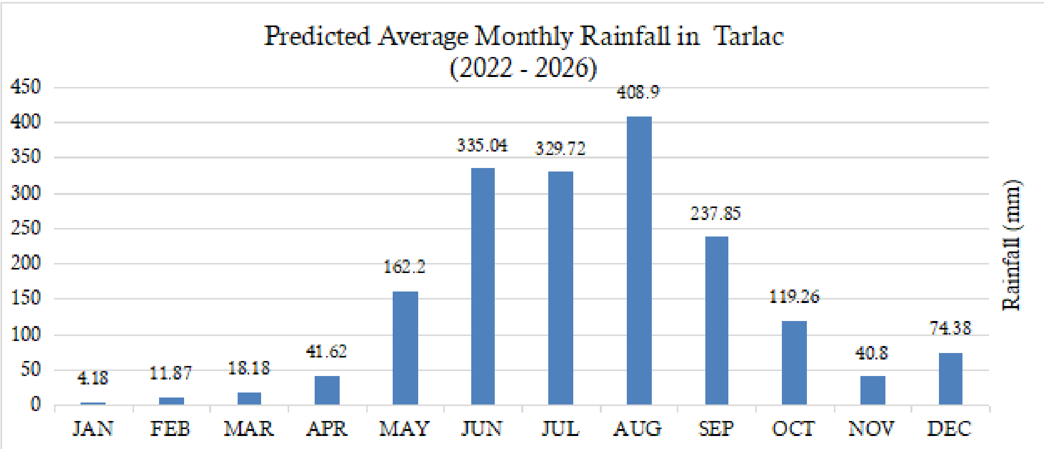


Figure 8. Predicted Monthly Average Rainfall for Tarlac

Four-Month Rainfall Occurence

Rainfall, Tempearature, Evaporation Yield Relations

Table 1 shows that rainfall alone does not affect the yield of tilapia. On the other hand, temperature and evaporation caused significant effect on the yield of tilapia. With this data, a model for rainfall-yield cannot be solely developed and thus, needs further analysis or adjustment. With this, the study or project focused on the rainfall occurrence affecting relevant activities in the pond.

Table 1. Pr value of the regression analysis for rainfall-temperature-evaporation and yield relations

Four-month Occurrence	Rainfall	Temperature	Evaporation	Rainfall, Temperature	Rainfall, Evaporation	Rainfall, Temperature, Evaporation
January - April	0.4118	0.8058	0.3620	0.2877	0.5727	0.2873
February - May	0.7208	0.0019**	0.4479	0.0269*	0.4724	0.0218*
March - June	0.7492	0.9640	0.7802	0.9507	0.9587	0.9950
April – July	0.4867	0.5141	0.7604	0.8223	0.6317	0.8259
May-August	0.6789	0.3850	0.0037**	0.4124	0.0344*	0.2171
June-September	0.1913	0.1182	0.4408	0.2970	0.5147	0.0537
July-October	0.5393	0.1828	0.7604	0.4368	0.4740	0.0328*
August-November	0.4909	0.5050	0.1729	0.5456	0.3625	0.7168
September – December	0.7566	0.2055	0.4875	0.3516	0.8248	0.7009

Linear Regression Models for Monthly Rainfall

The linear regression models for monthly rainfall were tested. Figure 9 shows that there is a strong correlation between actual and predicted monthly rainfall in Tarlac. This means that the linear regression models can be utilized to predict accumulated monthly rainfall for the succeeding years. With this the four-month rainfall occurrence can be reliably developed.

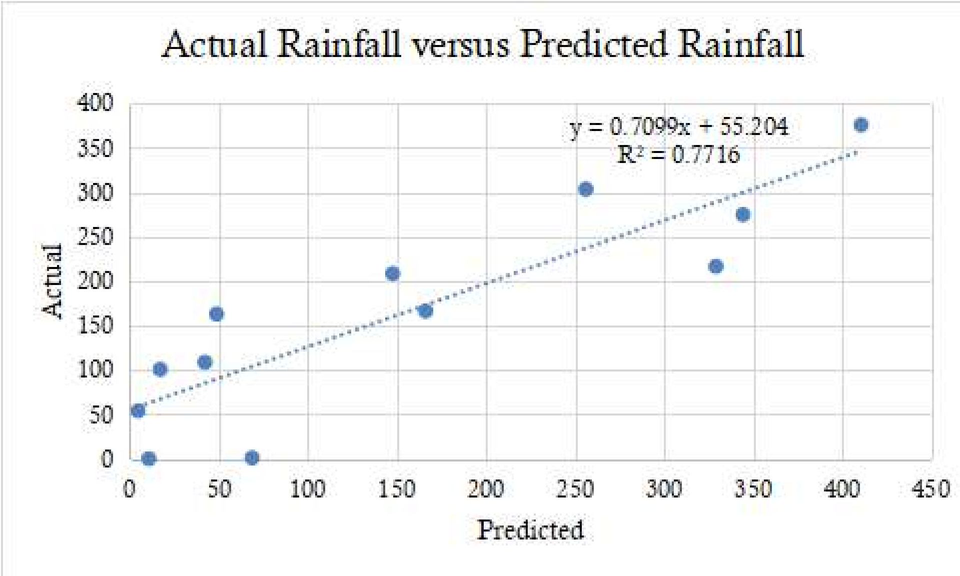


Figure 9. Actual versus predicted rainfall using TAU PAGASA data

For Nueva Ecija and Tarlac, the four-month rainfall for the next five years in shown in Figures 10 and 11, respectively. These data can be used as basis for tilapia pond production and for other crops as well. It can be observed that the peak accumulation of four-month rainfall is from June to September for both provinces. On the other hand the lowest accumulation of four-moth rainfall can be observed on January to April. In rainfed areas, this data can be a basis in planning for cropping systems especially if water requirement is considered.

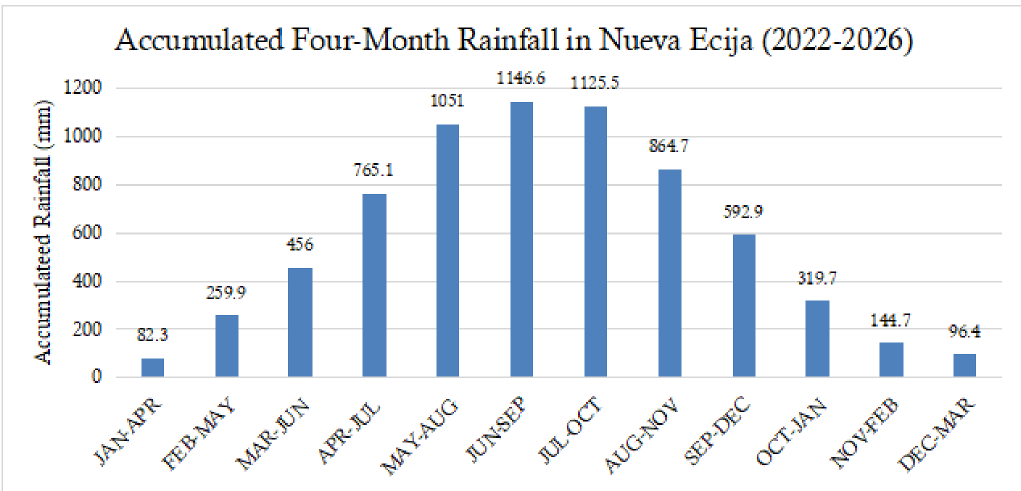


Figure 10. Accumulated Four-Month Rainfall in Nueva Ecija

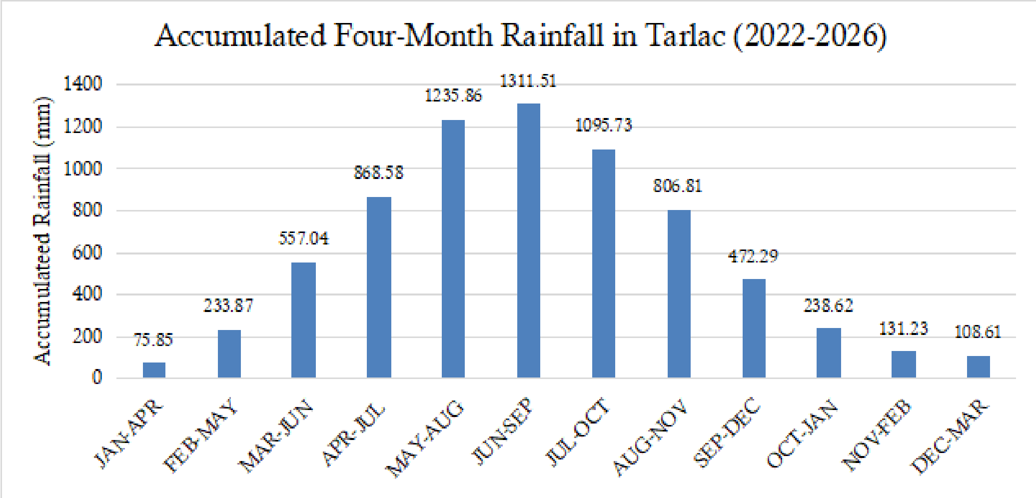


Figure 11. Accumulated Four-Month Rainfall in Tarlac

Aquaculture Calendar

Table 2 shows a management plan with activities involved in tilapia production. Based on the rainfall analysis, the peak of rainfall starts July to August. Thus, this should be the time where tilapia can be released or stocked. This is also the time where the water in the small farm reservoir would not be possibly used for irrigation since there is occurrence of rainfall. In addition, the expected harvest of the tilapia would fall in October to December where rainfall decreased. And thus, favorable for harvest time. This can be applicable for Climate II Type areas in Central Luzon; all provinces except Aurora.

Table 2. Management plan for tilapia production

Management Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
I. Pond Preparation												
a. Draining	■	■										
b. Pond treatment (elimination of predatory fishes and pests)			■									
c. Pond Washing			■									

d. Tilling, Plowing and Levelling of pond bottom												
e. Lime application												
f. Basal Fertilization												
g. Screening of water inlet/outlet												
h.Water filling												
II. Tilapia Stocking												
- Conditioning and stocking												
III. Feeding												
IV. Water qty. monitoring												
V. Monthly Sampling												
VI. Pond maintenance												
- Checking of screens of water inlet and outlet												
- Fertilizer application												
- Maintenance of the surrounding by cutting grasses and weeds for safety and ease of doing activities												
-Good management to prevent												

spread of disease												
VII. Harvesting												

Note: Pond preparation may or may not be applicable depending on the use of SFR. Source of management activities (BFAR, 2019)

Water Level Data of SFR

Installation of staff gauge in techno-demo site inside TAU campus and reading of water level data regularly. Based on the following data, the water level on the month of August is constantly higher than the month of September due to regular heavy rainfall during afternoon. Staff gauge and rain gauge was also installed in the SFR site located in Brgy. Salay Dipaculao, Aurora.

Figure 12. Installation of staff gauge, data gathering and measuring the topography of pond bottom of each point in the pond at TAU Techno demo site.

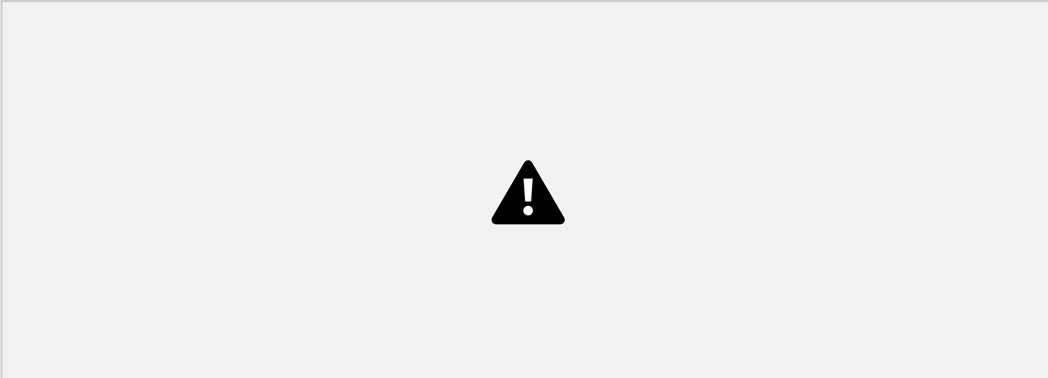


Figure 13. Installation of staff gauge, data gathering and measuring the topography of pond bottom of each point in the pond at Brgy. Salay Dipaculao, Aurora.

Figure 14. Installation and conduct regular reading of raingauge. Brgy. Salay Dipaculao, Aurora.

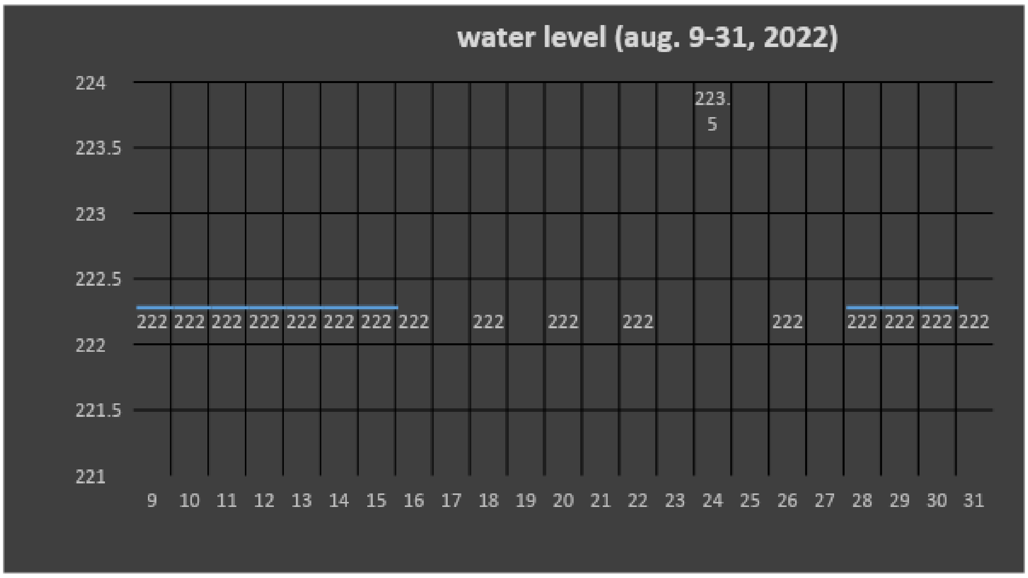


Figure 15. Water level data in the month of August 2022.

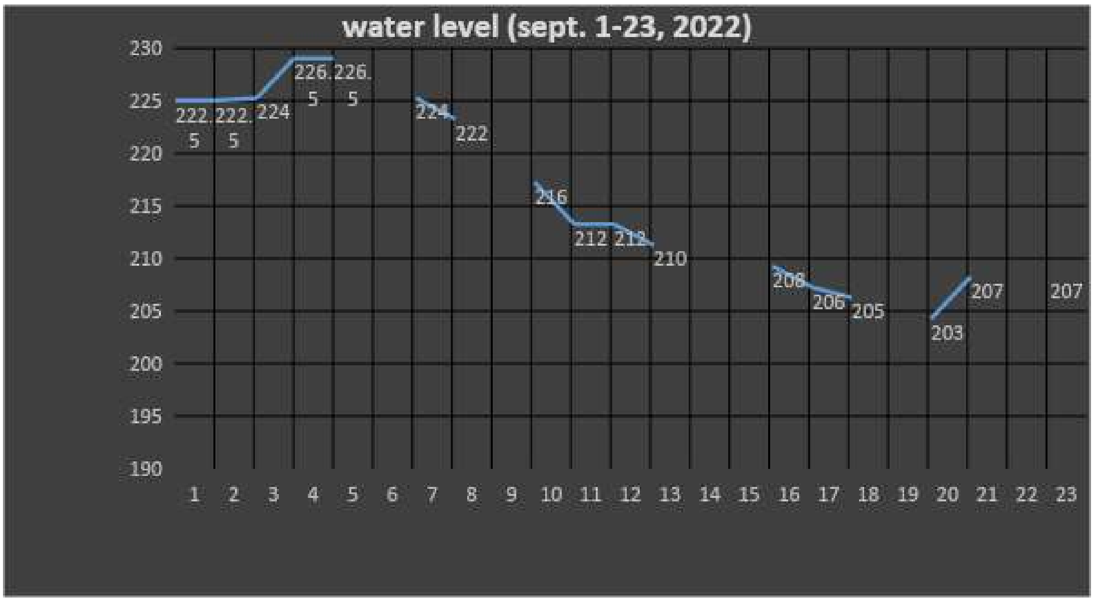


Figure 16. Water level data in the month of September 2022

IEC Materials

The researchers created IEC material to be use in trainings, seminars, and capability building for students, Agricultural Extension Workers, clientele, stakeholders, and farmers.

3. Conclusion

A rainfall-guide was established for Nueva Ecija province using the monthly normal and the predicted monthly rainfall for the next 5 years. Also, a management plan calendar for tilapia farming was also developed as reference for tilapia growers. Rain gauge and Staff gauges were installed in 2 site – TAU techno demo site and in Brgy. Salay Dipaculao, Aurora. An IEC material was developed

A rainfall-guide was established for Nueva Ecija province using the monthly normal and the predicted monthly rainfall for the next 5 years. Moreover, a suggested calendar for tilapia farming was also developed as reference for tilapia growers.

Based on the results of the study/project, the following conclusions can be drawn:

1. Monthly normal precipitation in Nueva Ecija from 1995 - 2021 is highest in July with 324.25 mm, and lowest is on February with 9.32 mm raiinfall. On the other hand, Tarlac had peak monthly normal precipitation of 417.21 mm in August, while the lowest is on February with 6.51mm. Predicted highest monthly rainfall is still observed in July and August with 326.9mm and 417.21mm, for Nueva Ecija and Tarlac, respectively. Actual and predicted

rainfall showed strong correlation in which the models were deemed reliable.

2. The predicted four-month accumulated rainfall for 2022-2026 shows similar trend to the observed and predicted monthly rainfall. Highest accumulated rainfall is observed from June to September with 1146.6mm and 1311.51mm for Nueva Ecija and Tarlac, respectively. January to April has the lowest accumulated rainfall with 82.83mm and 75.85mm, respectively for Nueva Ecija and Tarlac. These accumulated four-month rainfall may also be used for other crop management.

Climate Type II areas in Central Luzon; all provinces except Aurora may utilize the developed aquaculture calendar as a guide. Here, stocking is recommended at peak rainfall which is July to August.

Bibliography

Asiedu, B., Adetola J.O., and Kissi I.O., (2017). Food Science and Technology. Aquaculture in troubled climate: Farmers' perception of climate change and their adaptation. Cogent Food & Agriculture, 3(1296400).

Baradas, M.W., 1979.Harnessing Climate for Optimum Crop Productivity in the Philippines. Paper Presented at the PCARRD Seminar, November 29, 1978.UPLB, Los Banos, Laguna.

BFAR, (2019). Philippine fisheries profile 2018. PCA Compound, Elliptical Road, Quezon City Philippines

Del Jesus M., and Sierra J.D., (2017). A rainfall analysis and forecasting tool. Environmental Modelling and Software 97, 243-258. Available at https://doi.org/10.1016/j.envsoft.2017.08.11

Gao, P., Li, P., Zhao, B., Xu, R., Zhao, G., Sun, W., and Mu, X. (2017). Use of double mass curves in hydrologic benefit evaluations. Hydrological processes, 31(26), 4639-4646.

Guerra, L.C. Watson, P.G. Bhuiyan, S.I. Design, construction, and maintenance of small farm reservoirs 1991. International Rice Research Inst., Los Banos, Laguna (Philippines). Water Management Dept. Retrieved last August 2018 at http://agris.fao.org/agris- search/search.do?recordID=PH9310187

Hossain, P.R., Amjath-Babu, T.S., Krupnik, T.J., Braun, M, Mohammed, E.Y., and Phillips, M. (2021) Developing Climate Information Services for Aquaculture in Bangladesh: A Decision Framework for Managing Temperature and Rainfall Variability-Induced Risks. Front. Sustain. Food Syst. 5(677069). Available at https://doi.org/ 10.3389/fsufs.2021.677069

IPCC (2018). Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty, eds V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield.

Mu, X. M., Zhang, X. Q., Gao, P., and Wang, F. (2010). Theory of double mass curves and its applications in hydrology and meteorology. Journal of China Hydrology, 30(4), 47-51.

Odjugo, P. A. (2005). An analysis of rainfall patterns in Nigeria. Global Journal of Environmental Sciences, 4(2), 139-145.

Philippine National Standard. 2017. Rainwater and Runoff Management - Small Farm Reservoir. PNS/BAFS/PAES 226:2017.

Porio, E., Dator-Bercilla, J., Narisma, G., Cruz, F. and A. Yulo-Loyzaga. (2018). Drought and Urbanization: The case of the Philippines. In: Ray B. Shaw R (eds) Urban Drought. Disaster Risk Reduction (Methods, Approaches and Practices). Springer, Singapore. doi:10.1007/978-981-10-8947-3_12

Prabakaran, S., Kumar, P. N., and Tarun, P. S. M. (2017). Rainfall prediction using modified linear regression. ARPN Journal of Engineering and Applied Sciences, 12(12), 3715-3718.

Searcy, J. K., and Hardinson, C. H. (1960). Double-mass curve. Manual of Hydrology.

Shadeed, S., and Almasri, M. (2007). Statistical analysis of long-term rainfall data for a Mediterranean semi-arid region: a case study from Palestine. In Sustainable Development and Management of Water in Palestine, International Conference on Palestine Water, Amman, Jordan.

World Meteorological Organization (WMO). 2021. State of Global Climate 2020. WMO-No. 1264. ISBN 978-92-63-11264-4

Yazdi, S. K., and Shakouri, B. (2010). The effects of climate change on aquaculture. International Journal of Environmental Science and Development, 1(73), 378–382. Available at https://doi.org/10.7763/IJESD.2010.V1.73

REPORT ON GIS-BASED ANALYSIS IN THE DISTRIBUTION OF TILAPIA FINGERLINGS IN SELECTED RAINFED AREAS OF CENTRAL LUZON

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon
   Project Title: GIS-Based Analysis in the distribution of Tilapia Fingerlings in Selected Rainfed Areas in Central Luzon
2. Researchers:
   Project Leader: John Leonard M. Constantino
   Project Staff: Fatima P. Gumamac (August 2022 – present)
   Chelsie C. Pagatpatan (August 2021 – July 2022)
3. Implementing Agency/Station
   Lead Agency: Tarlac Agricultural University
   Cooperating Agency:
   Provincial Agriculture Office of Aurora
   Provincial Agriculture Office of Bulacan
   Provincial Agriculture Office of Nueva Ecija
   Provincial Agriculture Office of Pampanga
   Provincial Agriculture Office of Tarlac
   Provincial Agriculture Office of Zambales
   Department of Agriculture Regional Office No. 3 (DA-III)
   Bureau of Fisheries and Aquatic Resources Regional Office No. 3 (BFAR-III)
   Bureau of Fisheries and Aquatic Resources – National Freshwater Fisheries Technology Center (BFAR-NFFTC)

   Project Sites:
   Provinces of Aurora
   Province of Bulacan
   Province of Nueva Ecija
   Province of Pampanga
   Province of Tarlac
   Province of Zambales

4. Technology Level: Applied
5. Sector: Agriculture
6. Commodity Classification: Agriculture
7. Research Discipline: Applied
8. Target Beneficiaries: Small-Farm Reservoir Farmers
9. Funding Agency: Commission on Higher Education
10. Duration (Definite Dates)
    a. Date Started: August 2021
    b. Date Ended: January 2023
11. Financial Reports **to follow*
    a. Total Approved Budget ₱ 9,500,000.00
    b. Actual Released Budget ₱ 6,142,182.00
    c. Actual Expenditures ₱ 4,927,658.60

B. TECHNICAL REPORT

I. Rationale

The program is based from the previous project of Dr. Viray entitled “Strength and Needs Assessment of Small Farm Reservoirs in Support of the Aquaculture Industry in Western Tarlac”. Then the project recommended to establish a Small Farm Reservoir based Aquaculture production.

To maximize the potential of SFR’s in rainfed areas of Central Luzon, this program was proposed. The main objective of the program is to establish technology demonstration for Small Farm Reservoir-based (SFR) Tilapia Production in Rainfed Areas of Central Luzon, specifically; it aims to improve the income generating capacity of Small Farm Reservoir through engineered aquaculture production, and to disseminate the results of projects through seminar, training, and hands-on workshop.

For the 7th component of the program entitled “Project 7: GIS-Based Analysis in distribution of Tilapia Fingerlings”, its main goal is to map the most accessible ways to deliver, market, and distribute the Tilapia fingerlings to clientele without impairing the life and quality of the fingerlings. The project will also be beneficial to the SFR owners to locate a different source of fingerlings near their area rather than relying on BFAR dispersal of fingerlings. The result of this project will also be beneficial to the Provincial Agriculture Offices or the Municipal Agriculture Offices in Region III to monitor the aquaculture production in their areas.

II. Objectives

General Objective: To improve the distribution of tilapia fingerlings through mapping.
Specific Objectives:

1. Document and assess the location of SFR owners and fingerling producers.
2. To disseminate results of the project through seminars and training of clientele and stakeholders.

III. Expected Output

The following are the expected outputs of the study:

1. Gathered secondary data from Provincial and Local Government Units
2. Interviewed Fingerlings Distributors
3. Interviewed SFR farmers

4. GIS-based map of tilapia fingerlings distribution
5. Assessed fingerlings distribution from the market up to the farm
6. Established market-based fingerlings distribution from the market up to the farm

IV. Research Highlights

1. Procedure/Methodology

- Framework of the Study

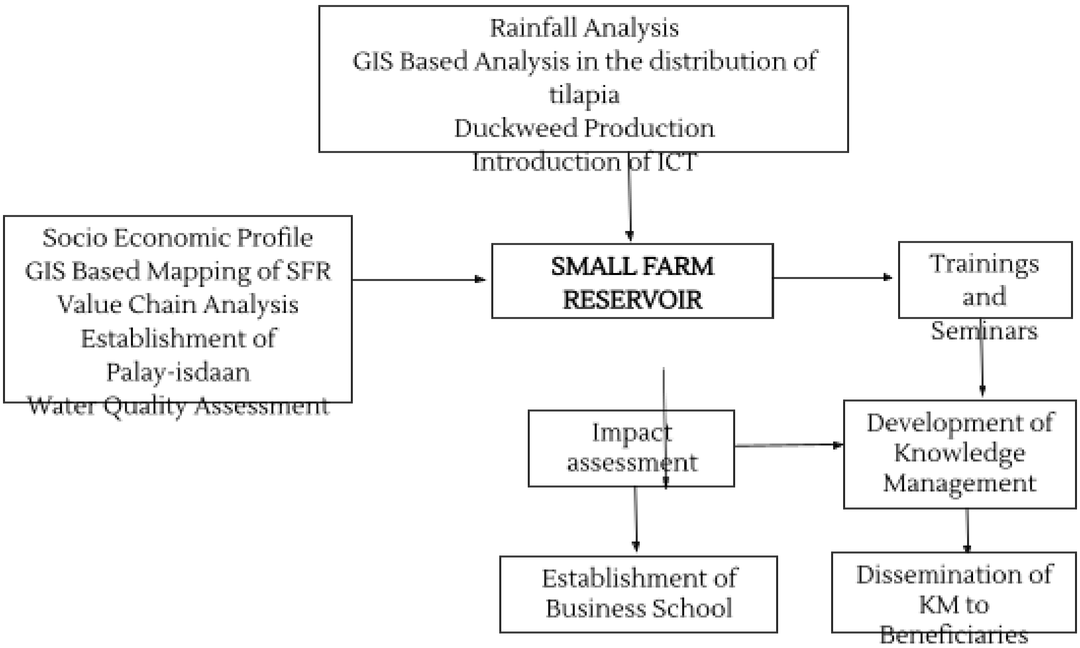


Figure 1. Conceptual Framework of the program

- Methodology

The project will commence by gathering secondary data for fingerlings distribution, markets, and suppliers. The data will be used to map the most accessible ways to deliver, market, and distribute the fingerlings to the clientele without impairing the life and quality of the fingerlings. The results of the project will be disseminated through training and seminar to the beneficiaries and stakeholders of the project. The figure below shows the flow chart of activities:

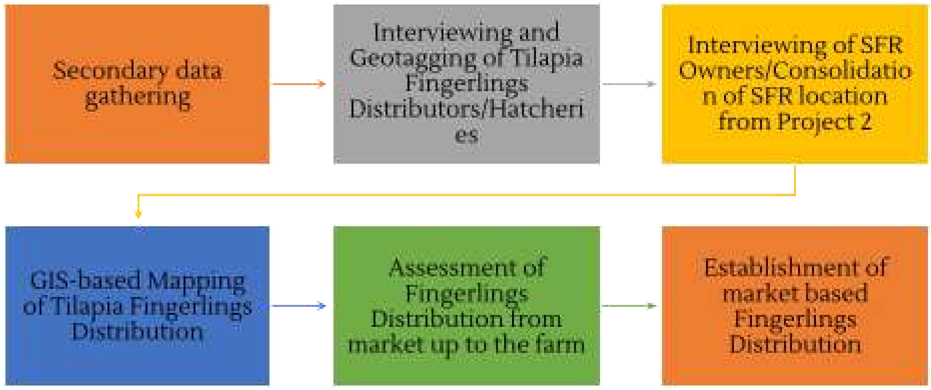


Figure 2. Flow chart of Activities

Table 1. Program of Activities

Activities	Months								
	2	4	6	8	10	12	14	16	18
Secondary Data Gathering									
Interviewing of Tilapia Fingerling Distributors									
Interviewing of SFRs Farmers									
GIS-based Mapping of Tilapia Fingerlings Distribution									
Assessment of Fingerlings Distribution from Market up to the Farm									
Establishment of market-based Fingerlings Distribution									

Monthly, Quarterly, Yearly, and Terminal report									

2. Accomplishments

The project staff and researchers focused primarily on acquiring secondary data on tilapia fingerlings distributors or hatcheries in Central Luzon by coordinating with the Provincial/Municipal Agriculture Office, Department of Agriculture in Central Luzon, and Bureau of Fisheries and Aquatic Resources Regional Office No. 3 (BFAR-III).

From the data of BFAR-III, there are 29 BFAR registered hatcheries and 28 non-registered BFAR Hatcheries in Central Luzon. However, some of the hatcheries on the list stopped their operation due to the pandemic. Furthermore, through coordination with the Provincial/Municipal Agriculture Offices and fieldwork, the researchers and project staff were able to interview tilapia hatcheries that were not on the list provided by the BFAR-III.

Figure 3. Secondary Data Gathering at different agricultural offices in Tarlac

Figure 4. Secondary data gathering at different agricultural offices in Bulacan

Figure 5. Secondary data gathering and benchmarking in Nueva Ecija

Once the list was acquired from the aforementioned agencies, the researchers and project staff were able to conduct geotagging. Geotagging is the process of acquiring the geographic coordinates (longitude and latitude) of a particular area. Geotagging was done by using a phone application (Survey Cam) to determine the exact location and longitude and latitude of the hatcheries.

The tilapia hatchery owners/workers were also interviewed and the following data were acquired:

- Production Area
- Hatchery facility/system used
- Production per hatchery
- Type/Strain of tilapia fingerlings distributed
- No. of years in farming/hatchery
- Amount of fingerlings produced/distributed per month
- Number of breeders
- Distribution Location

Figure 6. Interviewing and geotagging Tilapia Hatcheries in Nueva Ecija

Figure 7. Interviewing and geotagging at the BFAR3 TOS-FD in Brgy. Looc, Castillejos, Zambales

Figure 8. Interviewing and geotagging Tilapia Hatcheries in the Province of Aurora

Figure 9. Interviewing and geotagging Tilapia Hatcheries in the Province of Pampanga

Figure 10. Interviewing and geotagging Tilapia Hatcheries in the Province of Nueva Ecija

Figure 11. Interviewing and geotagging Tilapia Hatcheries in the Province of Tarlac

Central Luzon has a total of 69 geotagged hatcheries, excluding Bataan province. The majority of these hatcheries (34 in total, or 49%) are located in Pampanga. Out of these, thirteen are registered with BFAR while twenty-two are not. Nueva Ecija comes in second with 19 hatcheries, out of which three are BFAR-registered and one is a BFAR outreach station. Tarlac has seven geotagged hatcheries, with four being BFAR-registered and three non-registered. Aurora has five geotagged hatcheries, with three being BFAR-registered and two non-registered. Bulacan has three geotagged hatcheries and Zambales has the least number of geotagged hatcheries with only one BFAR outreach station. Table 1 displays the location of all geotagged hatcheries in Central Luzon

Table 2. Geotagged Hatcheries in Central Luzon

Province	**BFAR Accredited Hatcheries**	**Non-BFAR Accredited Hatcheries**	**BFAR Outreach Station**
Aurora	3	2	-
Bulacan	1	1	1
Nueva Ecija	3	15	1
Pampanga	13	21	-
Tarlac	3	3	-
Zambales	1	-	1
Total	24	42	3

The tilapia hatchery in Central Luzon is dominated by male owners. Ninety-one percent (63 out of 69) of the geotagged hatcheries are owned by men, while only about 8% are operated by women. This is shown in Table 2.

Table 3. Gender of Hatchery Owners

Farm Location/ Province	Male	Female	Total
Aurora	5	-	5
Bulacan	2	1	3
Nueva Ecija	16	3	19
Pampanga	32	2	34
Tarlac	6	-	6
Zambales	2	-	2
Total	63	6	69

The information presented in Table 3 displays the production areas per province. It is noted that approximately 47% of the geotagged hatcheries have a production area ranging from 1 to 3 hectares. Additionally, 23% of the tilapia hatcheries located in Central Luzon possess less than 1 hectare of production area.

Table 4. Production Area

Farm Location/ Province	Less than 1 hectare	1-3 hectares	3.01-6 hectares	6.01-9 hectares	Greater than 9 hectares	Not specified	Total
Aurora	2	2	-	-	-	1	5
Bulacan	-	-	1	-	1	1	3
Nueva Ecija	8	8		1	1	1	19
Pampanga	5	21	6	1	1	-	34
Tarlac	1	2	-	-	1	2	6
Zambales	-	-	-	-	1	1	2
Total	16	33	7	2	5	6	69

In terms of production capacity, 91% (62 out of 69) of the hatcheries in Central Luzon produces less than 5 million tilapia fingerlings. Table 4 shows the production capacity of each province.

Table 5. Production per hatchery

Farm Location/ Province	Small scale (less than 5 million)	Medium Scale (5.1 – 10 million)	Large Scale (greater than 10 million)	Not Specified	Total
Aurora	5	-	-	-	5
Bulacan	2	-	1	-	3
Nueva Ecija	18	-	-	1	19
Pampanga	33	-	1	-	34
Tarlac	4	1	-	1	6
Zambales	-	1	-	1	2
Total	62	2	2	3	69

There are multiple types of Tilapia strains available in Central Luzon, such as GET-EXCEL, IMPROVED EXCEL, Genomar Strain, Nile Tilapia, IDRC, FAST, and Malaysian GIFT. Out of the hatcheries in Central Luzon, 42% of them are growing the IDRC strain, which makes it the most commonly grown strain in the region. The GET-EXCEL strain is the second most popular, with approximately 23% or 16 hatcheries in the region. Table 5 summarizes the tilapia strains grown in the region.

Table 6. Tilapia strains distributed

Farm Location/ Province	GET-EXCEL	IMPROVED EXCEL	Genomar Strain	Nile Tilapia	IDRC	FAST	Malaysian GIFT	Multiple Strain used	Not Specified	Total
Aurora	-	1	-	2	1	-	-	1	-	5
Bulacan	1	-	-	-	-	-	-	2	-	3
Nueva Ecija	1	2	1	-	12	-	-	2	1	19
Pampanga	9	5	-	-	15	1	1	1	2	34
Tarlac	4	-	-	-	1	-	-	1		6
Zambales	1	-	-	-	-	-	-	-	1	2
Total	16	8	1	2	29	1	1	7	4	69

Varied hatchery facilities and systems can be used in raising tilapia. Table 6 shows the hatchery facilities that are commonly used in Central Luzon. About 58% of the farmers use a combination of ponds, nets, and tanks in their farm while 29% of the farmers in the region use ponds and nets.

Table 7. Hatchery facility/System used

Farm Location/ Province	Ponds	Ponds and Nets	Ponds and Tanks	Ponds, Nets, and Tanks	Net and Tanks	Tanks and Hapa	Total
Aurora	-	2	-	2	1		5
Bulacan	-	-	-	1	1	1	3
Nueva Ecija	-	2	-	17	-	-	19
Pampanga	1	15	3	15	-	-	34
Tarlac	1	1	-	4	-	-	6
Zambales	-	-	-	1	1	-	2
Total	2	20	3	40	3	1	69

In terms of the number of years in hatchery operation, 48% of the farmers has 1-10 years of experience. Table 7 summarizes the number of farming years of the hatchery owners from the different provinces.

Table 8. Number of years in Farming/Hatchery

Farm Location/ Province	Less than 1 year	1-10 yrs	11-20 yrs	21-30 yrs	31-40 yrs	Not Specifie d	Total
Aurora	-	4	-	1	-	-	5
Bulacan	-	1	1	-	-	1	3
Nueva Ecija	-	9	5	2	2	1	19
Pampanga	1	17	4	9	1	2	34
Tarlac	-	2	-	1	1	2	6
Zambales	-	-	-	-	-	2	2
Total	1	33	10	13	4	8	69

The GIS-Based mapping of tilapia fingerlings distributors was done using the Quantum Geographic Information System (QGIS) program. The location of the hatcheries was determined on the satellite map in QGIS using the geographic coordinates. The following pages show the GIS-based maps showing the distribution of tilapia hatcheries.

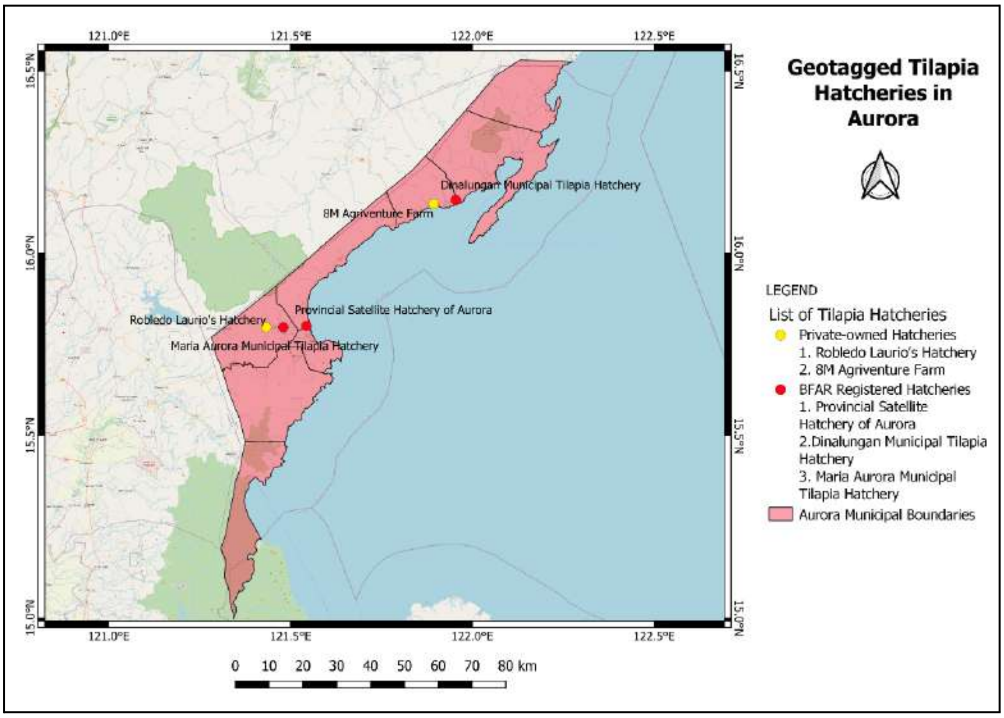


Figure 12. Geotagged Hatcheries in the Province of Aurora

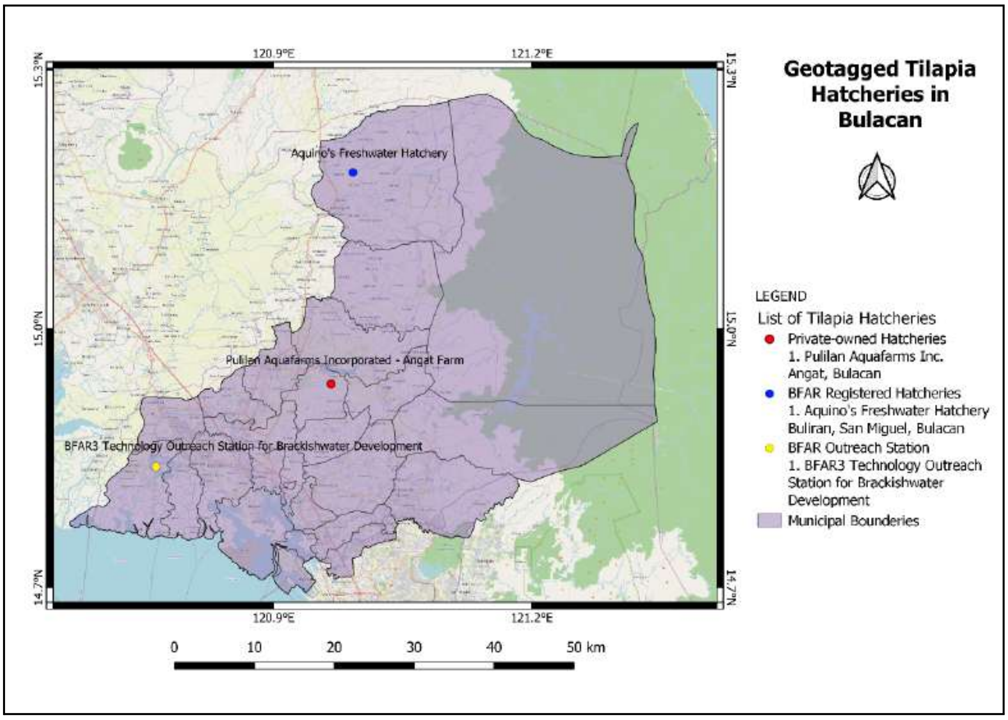


Figure 13. Geotagged Hatcheries in the Province of Bulacan

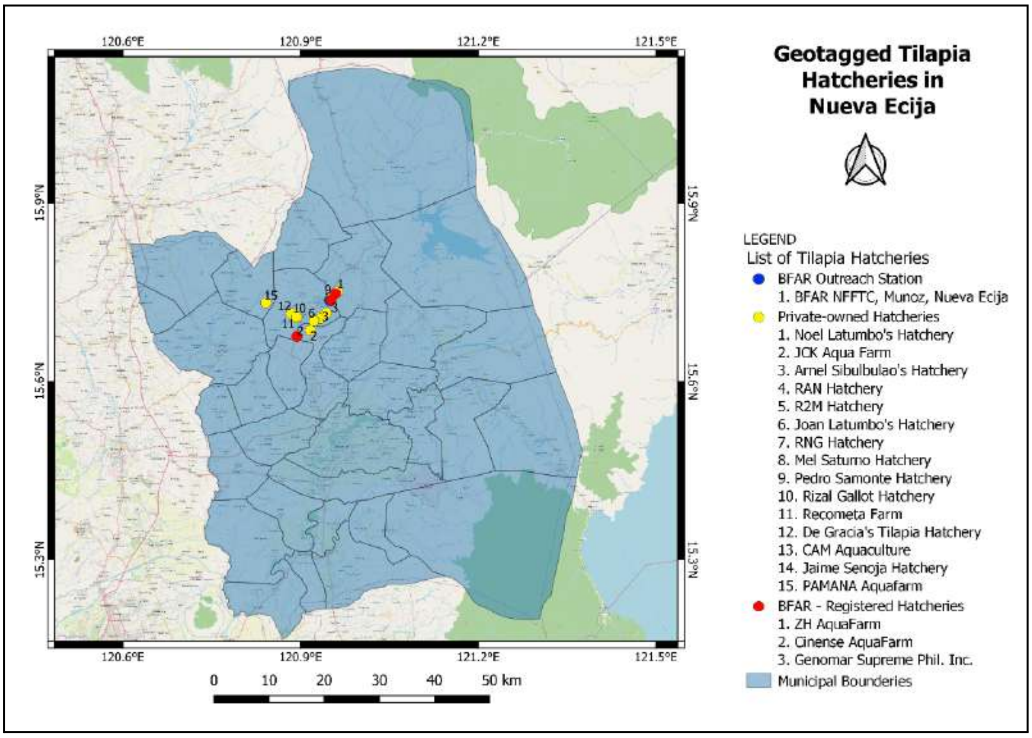


Figure 14. Geotagged Hatcheries in the Province of Nueva Ecija

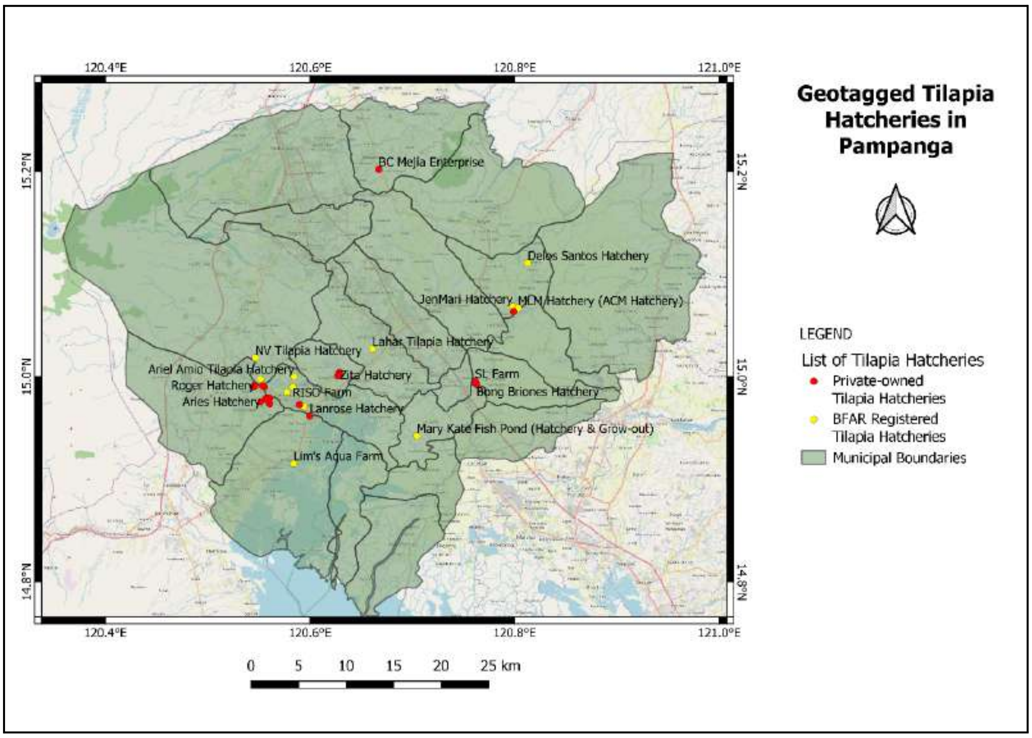


Figure 15. Geotagged Hatcheries in the Province of Pampanga

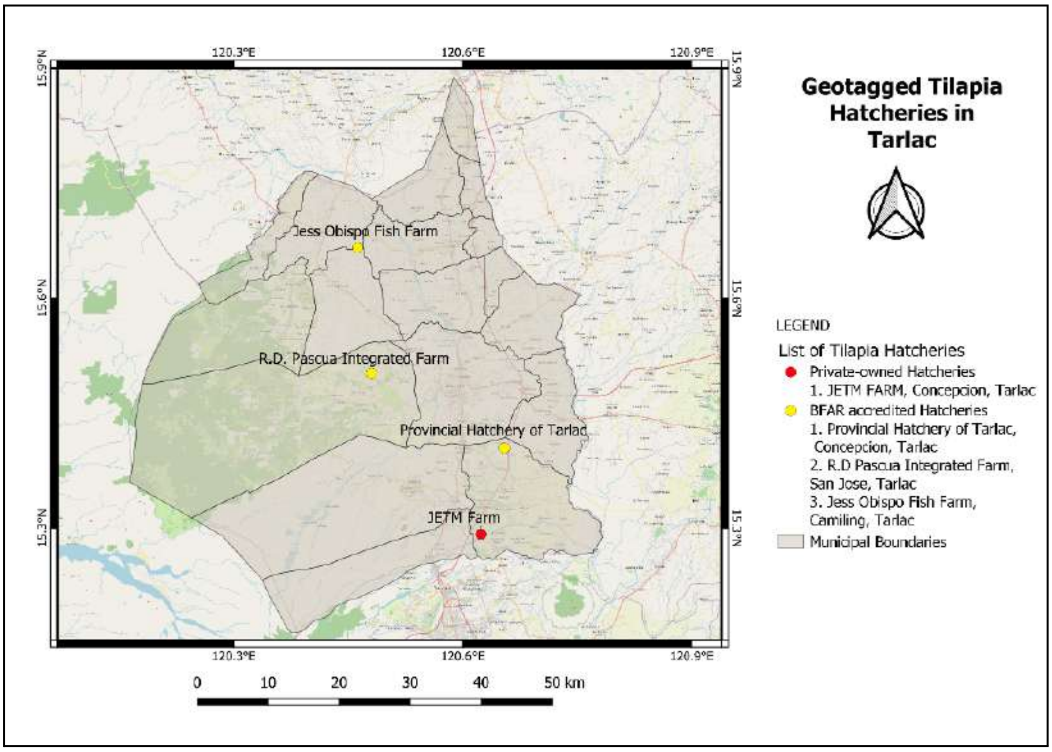


Figure 16. Geotagged Hatcheries in the Province of Tarlac

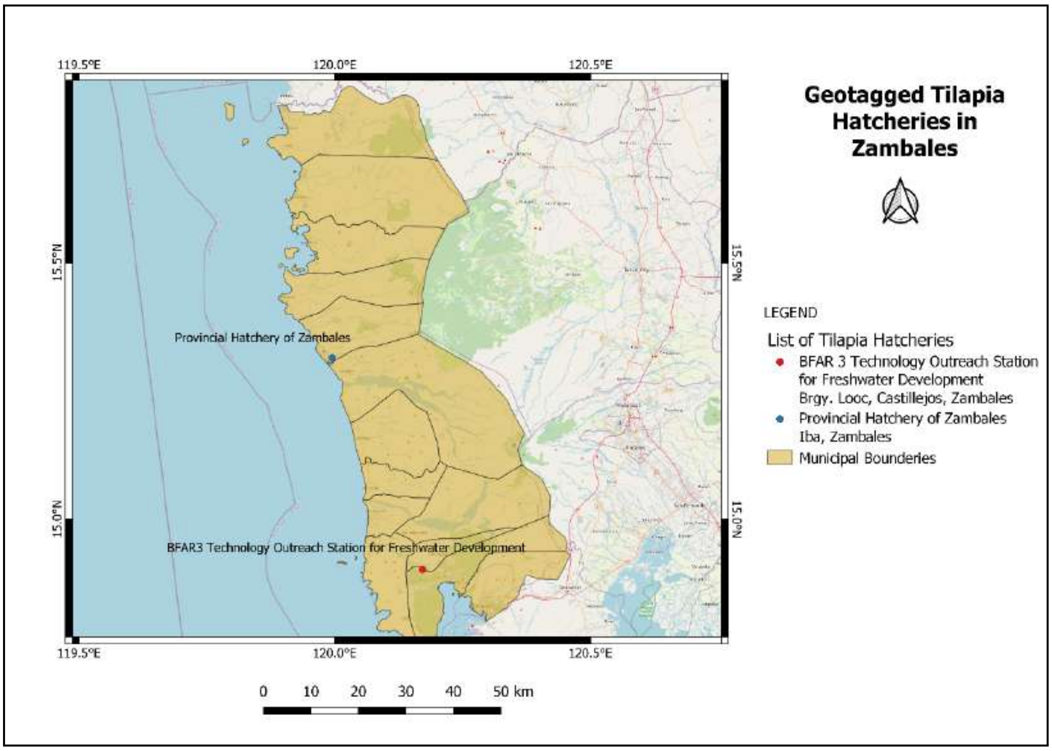
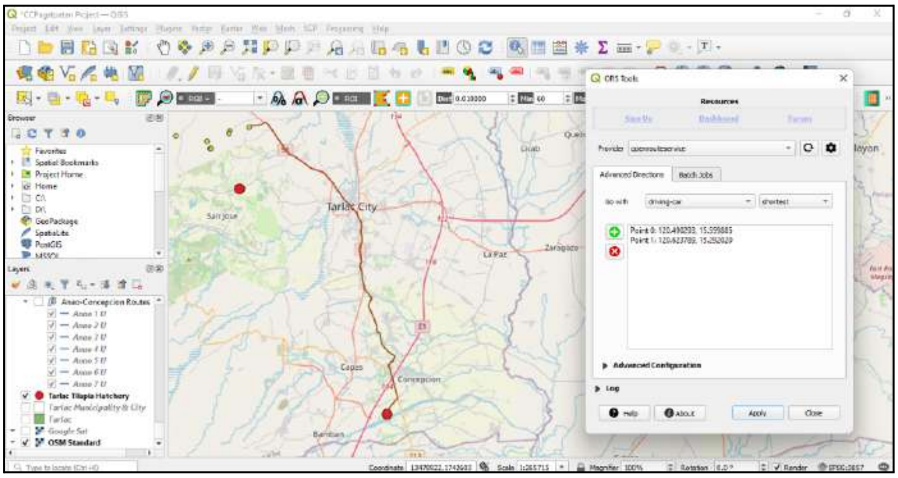


Figure 17. Geotagged Hatcheries in the Province of Zambales

The assessment of fingerlings distribution was done using the Open Route Service (ORS) Tool in QGIS program. The OSR Tool identifies the shortest route from one point to another in different modes of travel. For this project, the shortest route using a driving car was identified from the SFR to the hatchery.



Figures 18. The ORS Tools in QGIS program

The OSR Tool will provide the distance (in kilometers) from the SFR to the hatchery and the travel time (in hours).

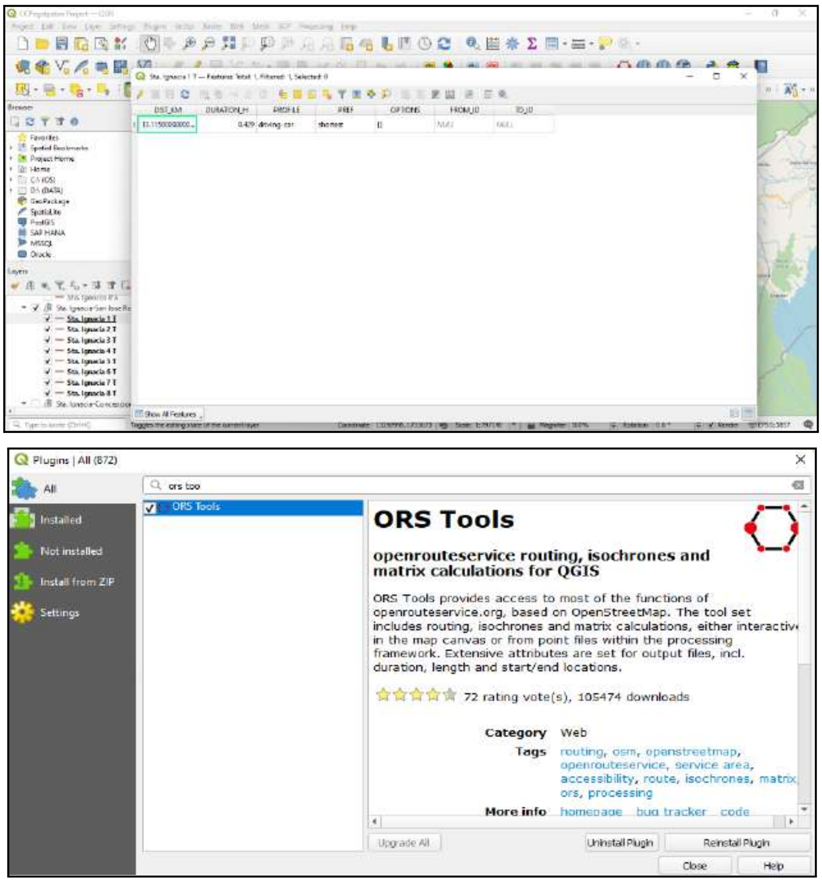


Figure 19. The ORS Tools in Quantum Geographic Information System (QGIS) program

Using the Open Route Service tool, the tilapia fingerling distribution from hatcheries in Tarlac to Camiling and Sta. Ignacia SFRs was assessed.

Table 9 below shows the sample routing results which provide the shortest distance and the corresponding travel time between the SFRs in Brgy. Sinigpit, Paniqui, Tarlac and the nearest hatchery which is in Bangcay 2nd, Camiling, Tarlac. It is crucial to identify the shortest distance for transporting fingerlings to reduce their travel time. Transporting fingerlings can be challenging, as rough handling may cause them stress, weakness, and eventual death. Therefore, it is beneficial to determine the most accessible and safe methods for delivering and distributing fingerlings from the hatchery without compromising their health and quality

Table 9. Routing Result for SFRs of Brgy. Sinigpit, Paniqui, Tarlac

Province	**Municipal**	**Brgy.**	**Surname**	**First Name**	**Name of Route**	**Distance from Hatchery (km)**	**Travel time from Hatchery (hr)**
Tarlac	Paniqui	Sinigpit	Lorzano	Darwin	Sinigpit 1	6.962	0.277
Tarlac	Paniqui	Sinigpit	Lacayanga	Roberto	Sinigpit 2	7.339	0.302
Tarlac	Paniqui	Sinigpit	Tomas	Juspicio	Sinigpit 3	7.022	0.274
Tarlac	Paniqui	Sinigpit	Granita	Marlou	Sinigpit 4	7.203	0.293
Tarlac	Paniqui	Sinigpit	Galapon	Juscoro	Sinigpit 5	11.063	0.275
Tarlac	Paniqui	Sinigpit	Corpuz	John	Sinigpit 6	7.292	0.299
Tarlac	Paniqui	Sinigpit	Roxas	Max	Sinigpit 7	10.76	0.255
Tarlac	Paniqui	Sinigpit	Ordonio	Rolando	Sinigpit 8	7.443	0.309
Tarlac	Paniqui	Sinigpit	Lorzano	Rodel	Sinigpit 9	7.106	0.287

Tarlac	Paniqui	Sinigpit	Temperante	Rolando	Sinigpit 10	7.713	0.327

The routing results were presented as GIS maps to present it in an easier way for the end users. Some sample generated maps of the project showing the shortest routes from the hatchery to the nearest SFRs are shown below. Kindly refer to the appendix for the other maps.

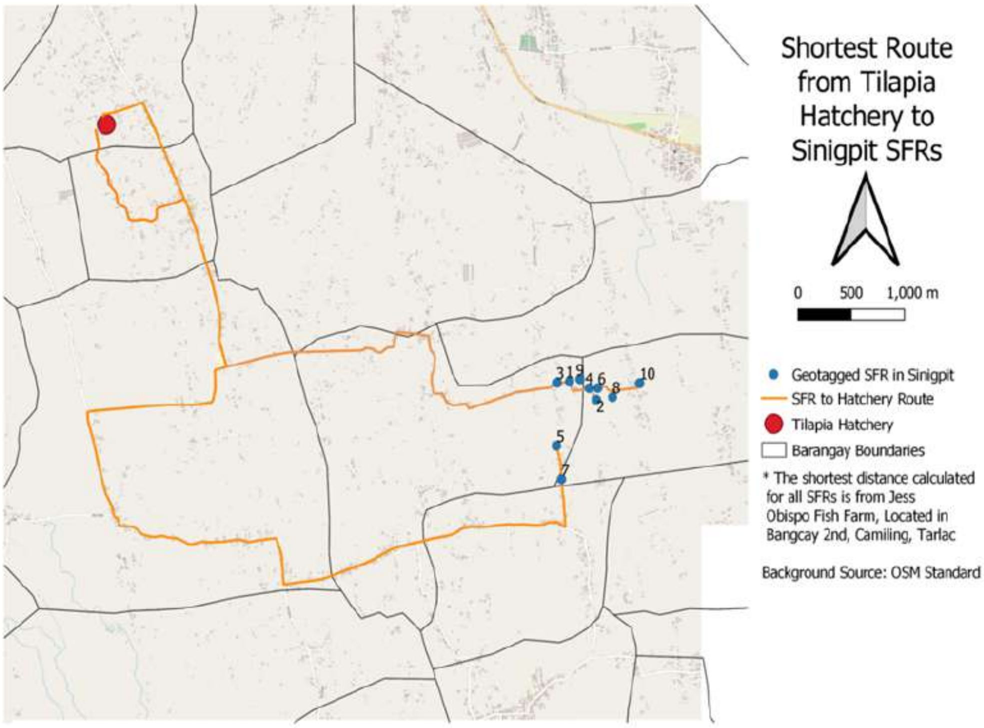


Figure 20. Shortest Route from Tilapia Hatchery to Sinigpit SFRs

Another QGIS tool used to assess the distribution of the tilapia fingerlings is the QGIS Network Analysis Toolbox 3 (QNEAT3). Like the ORS, this tool identifies the shortest route from one point to the other. However, this tool is more time-saving to use since it can simultaneously determine the shortest route from a tilapia hatchery to a number of SFRs. The following figures shows the shortest distance from the tilapia hatcheries and the SFRs in the provinces of Central Luzon.

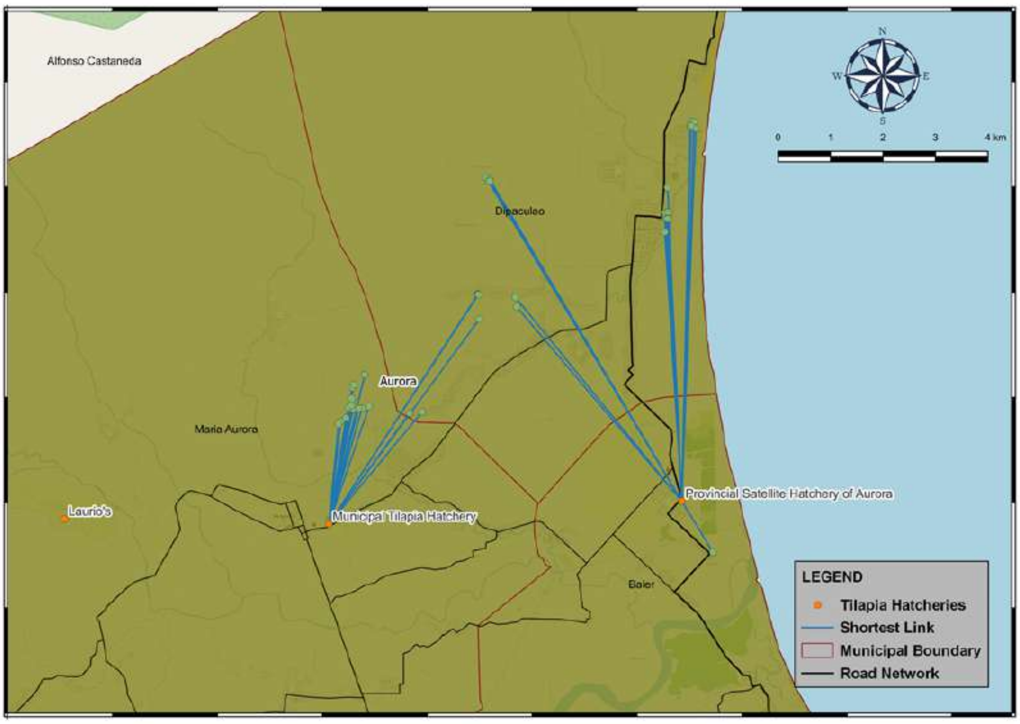


Figure 21. Shortest distance from Hatchery to SFR in Aurora

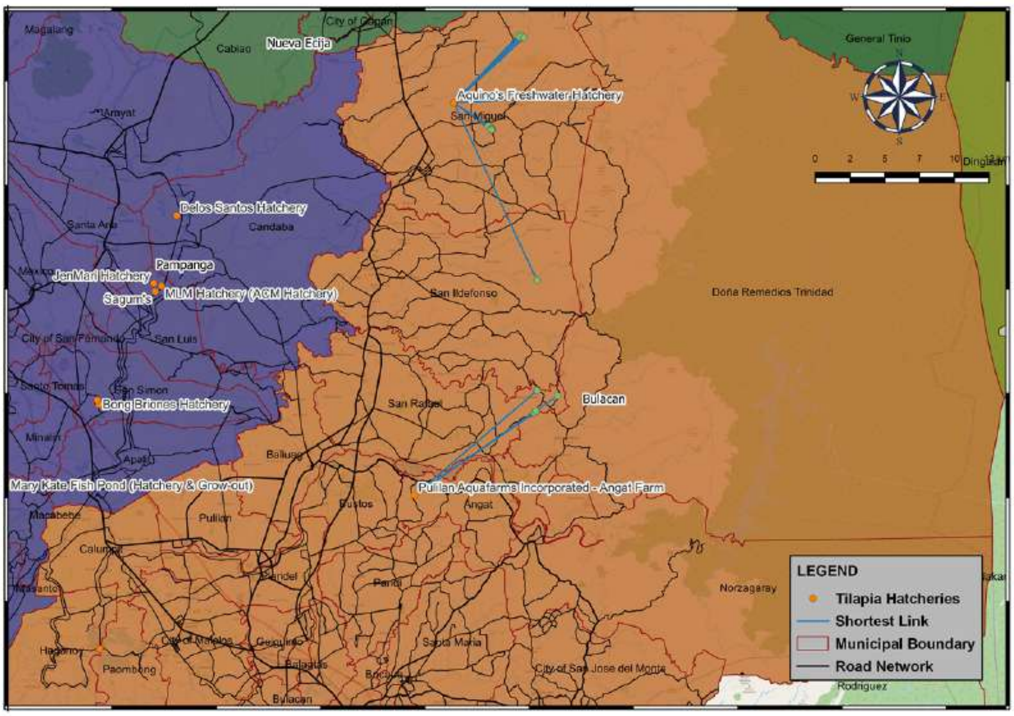


Figure 22. Shortest distance from Hatchery to SFR in Bulacan

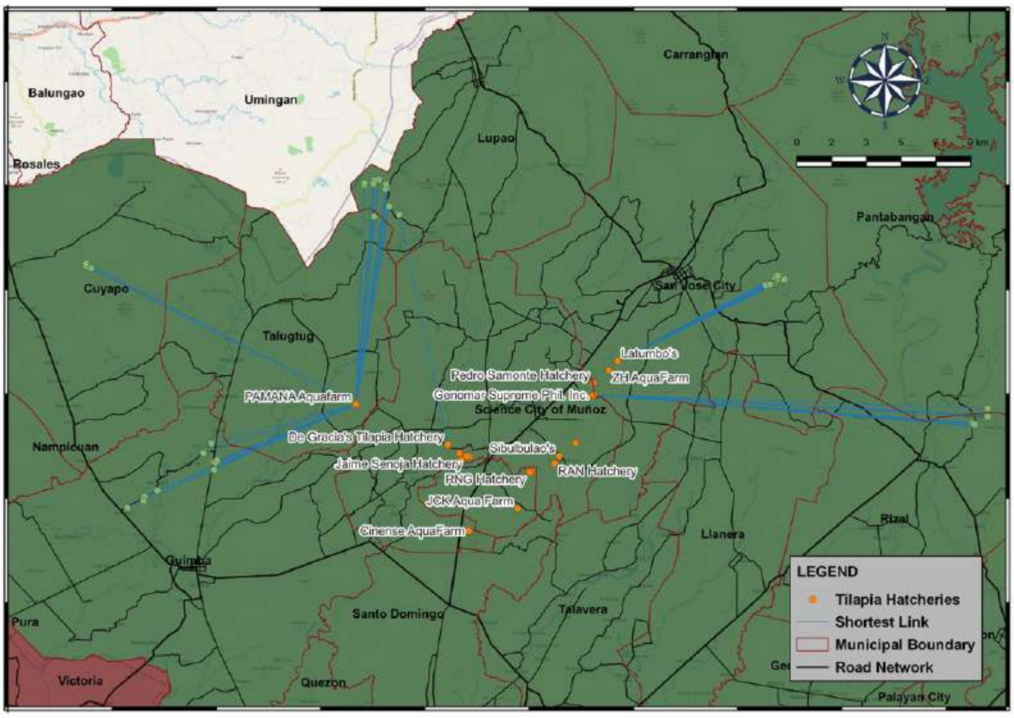


Figure 23. Shortest distance from Hatchery to SFR in Nueva Ecija

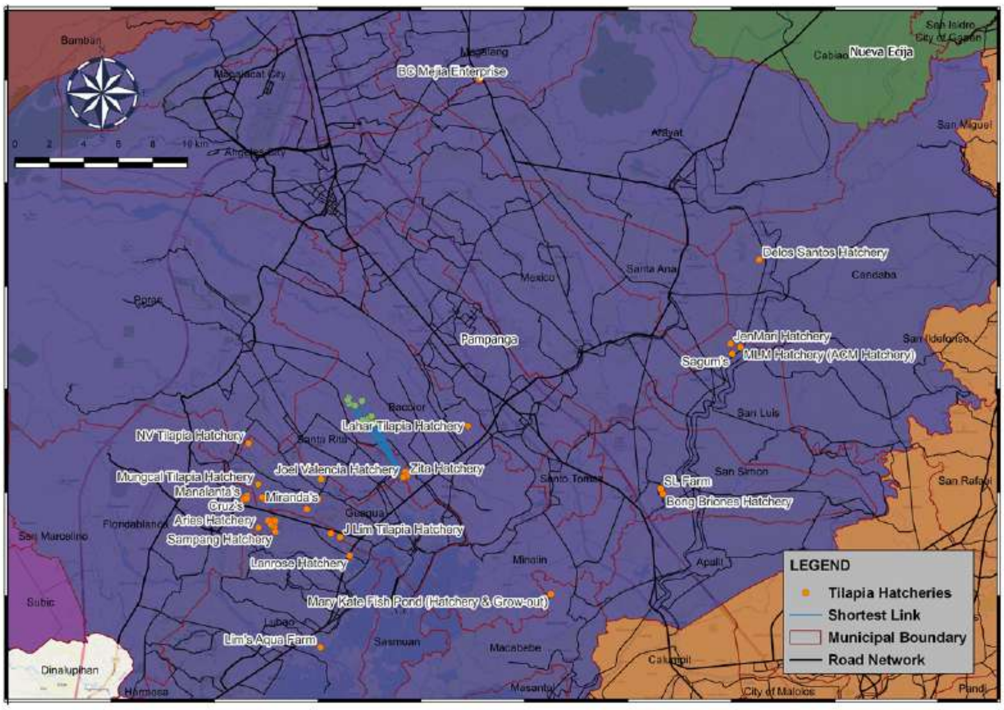


Figure 24. Shortest distance from Hatchery to SFR in Pampanga

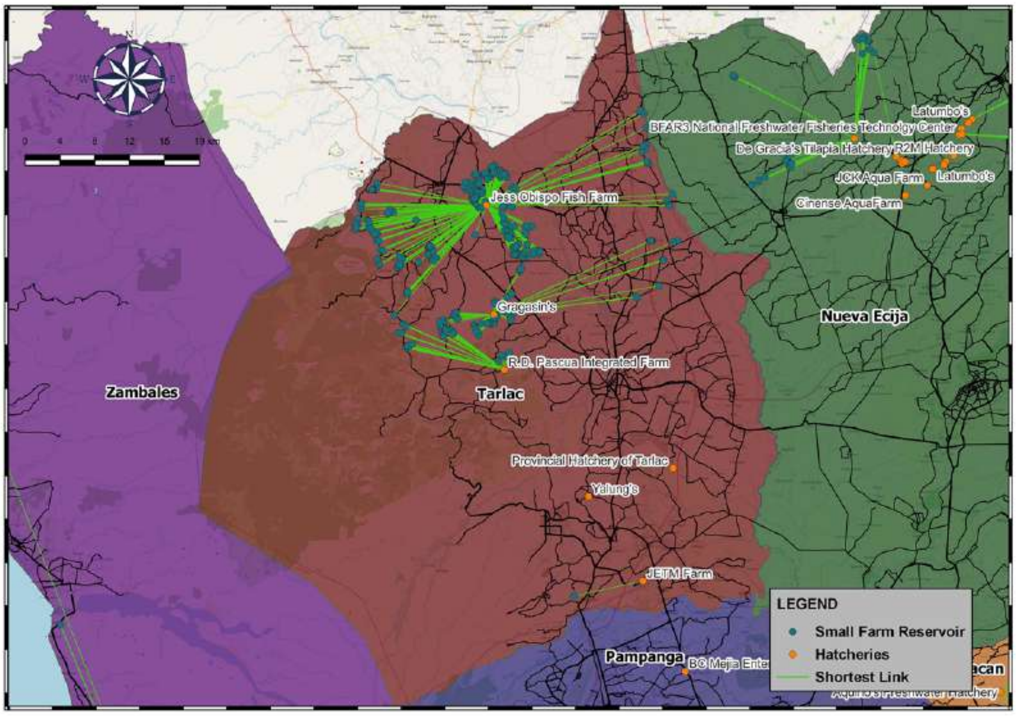


Figure 25. Shortest distance from Hatchery to SFR in Tarlac

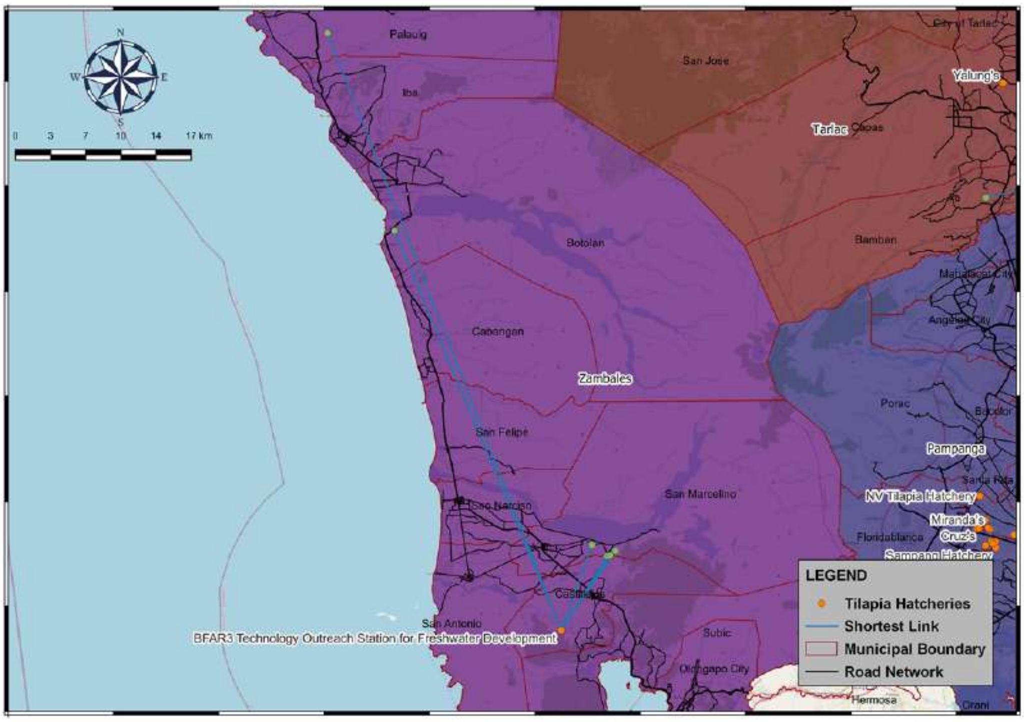


Figure 26. Shortest distance from Hatchery to SFR in Zambales

IEC Materials

The researchers created IEC material to be use in trainings, seminars, and capability building for students, Agricultural Extension Workers, clientele, stakeholders, and farmers.

Figure 27. Project 7 IEC Material

The percentage of completion of the project is 80% as of December 2022. The percentage of completion of each activity is shown in detail in Table 3.

Table 9. Status of Completion of the Project

OBJECTIVE/S STATED IN EXTENSION PROJECT PROPOSAL	EXPECTED DELIVERABLE/ OUTPUT/ OUTCOME/ ACTIVITIES (identify PER objective)	STATUS (% completed) and EXPECTED DATE OF COMPLETION/ SUBMISSION (as of August, 2022)
1. Secondary Data Gathering	Gathered secondary data from Provincial and Local Government Units	100%

2. Interviewing of Tilapia fingerling distributors	Interviewed Fingerlings Distributors	100%
3. Interviewing of SFR's Farmers	Interviewed SFR's farmers	70%
4. GIS-based mapping of Tilapia fingerling distributors	Mapped the fingerling distribution	85%
5. Assessment of fingerlings distribution from market up to the farm	Assessed the fingerling distribution from market up to SFR	45%
6. Establishment of market based fingerlings distribution	Establish market based fingerlings distribution	0%
7. Monthly, quarterly, annual and terminal report	Delivered Project Updates and Accomplishment	95%

3. Conclusion

The project aims to improve the distribution of tilapia fingerlings through mapping. Specifically, it aims to cover all of the tilapia hatcheries in Central Luzon and disseminate the project findings through seminars and training for clients and stakeholders.

The project was able to interview and geotagged 69 tilapia hatcheries in the different provinces of Central Luzon excluding Bataan. The project gathered relevant information about the hatcheries including the production area, tilapia strained distributed, gender of hatchery operators, number of years in farming operation, and hatchery facility used. Using QGIS, the project was also able to generate maps showing the location of the hatcheries in each province. Utilizing the coordinates of the SFRs from Project 2, the distribution of the tilapia fingerlings from the hatcheries was then assessed using the ORS and QNEAT3 tool in QGIS. Maps showing the shortest route from the hatchery to the fingerlings was also generated.

Through GIS-Based mapping, assessment and establishment of market-based fingerlings distribution was conducted. This will help tilapia distributors to improve the marketing of fingerlings and be linked to the SFRs near their area.

REPORT ON THE 1,190 SMALL FARM RESERVOIR FARMERS AND AGRICULTURAL TECHNOLOGIST FOR SFR-BASED AQUACULTURE PRODUCTION FROM THE 8 IDENTIFIED DEMONSTRATION SITES

(Projects 8-10 of the Program)

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of central Luzon

Project Title: Establishment of Palay-Isdaan in Small Farm Reservoir in Selected Rainfed Areas of Central Luzon

2. Researcher(s):

Project Leader: Amy Lizbeth J. Rico, Ph.D.
Project Staff: Engr. Bennidict P. Pueyo
Project Support Staff: Alexander D. Garbin

3. Implementing Agency/Station

Lead Agency: Tarlac Agricultural University

Cooperating Agency: Provincial and Local Government Units (LGUs) of Central Luzon (Tarlac, Nueva Ecija, Aurora, Bulacan, Zambales)

Project Site(s): Central Luzon (Tarlac, Bulacan, Nueva Ecija, Aurora, Zambales

4. Technology Level: Applied
5. Sector: Agriculture
6. Commodity Classification: Agriculture
7. Research Discipline: Applied
8. Target Beneficiaries:

SFR Farmers in Aurora, Bulacan, Nueva Ecija, Tarlac and Zambales)
Farmers Association
Agricultural Extension Workers (AEWs)
Policy Makers
Students

9. Funding Agency (ies): CHED-NAFES
10. Duration (Definite Dates)

Date Started
Date Ended

11. Financial Reports

Total Approved Budget ₱ 9,500,000.00
Actual Released Budget ₱ 6,142,182.00
Actual Expenditures ₱ 2,723,762.50 as of August 2022

B. TECHNICAL REPORT

I. Rationale

To sustain the food production requirement for the ballooning population, intensive crop production is a necessity. The ideal cropping intensity and optimum yield of crops can only be achieved if the required water is available, especially during the plants' critical growth stage. Although the Philippines is blessed with an average of 2,500 mm of rainfall every year, the occurrence and depth cannot be relied on to sustain agricultural production because rainfall is too erratic and unpredictable. Unfortunately, the development costs of new irrigation systems as well as the rehabilitation of existing ones have become prohibitive and they can hardly be afforded by developing countries like the Philippines. The services of the National Irrigation System were fully maximized, especially the irrigation services needed particularly to upland farmers, intensified the construction and utilization of small farm reservoirs (SFR). Purposely, these structures are used to store water during the rainy season and for cropping purposes during the dry season.

The productivity of small farm reservoirs is depending on how the stored water is being used in different agricultural endeavors. Farmers used small farm reservoirs as a source of irrigation for their traditional rice-rice cropping pattern as water yields give minimal income as the land area planted during the dry season. It is dramatically reduced not only due to high storage losses but also to high water requirements of rice.

Studies show that the storage capacity of small farm reservoirs may be improved by reducing losses due to seepage, percolation and evaporation. The utilization of small farm reservoirs depends on the volume of water stored in it, hence, minimizing losses during storage may eventually result in more production and higher income of farmers. Furthermore, small farm reservoir management and farming practices play a vital role in the productive usage of water stored in the reservoir. Packaging technologies to address the low income-generating capacity of small farm reservoirs could somehow alleviate the meager income of upland farmers. Although assessments have been made about the economic importance of SFRs, supplementary information on how farmers manage and utilize their reservoirs may help researchers and technical implementers in packaging appropriate technologies to enhance the utilization of small farm reservoirs.

Detailed information on the density of small farm reservoirs, farmers' management practices and their utilization strategies may help researchers and technical implementers in packaging appropriate technologies for sustained crop production using small farm reservoirs in the rain-fed areas of the Western towns of Tarlac. This project is intended to expound more about small farm reservoirs and results are envisioned to be a part in the strategy for increasing food production and alleviating poverty among upland farmers

II. Objectives

The general objective of the project was to establish palay-isdaan in small farm reservoirs. Specifically, the project aimed to:

a. increase the income generating capacity of Small Farm Reservoir;
b. maximize the use of small farm reservoir; and,
c. disseminate the results of the project through seminars and training of clientele and stakeholders.

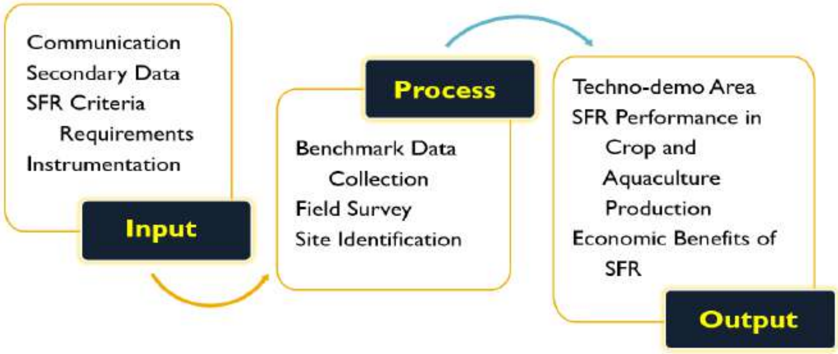
III. Expected Output

a. Establish 12 Demonstration Sites for Palay-isdaan
b. Conduct comparative study of paly-isdaan and not palay-isdaan
c. Seminars and Trainings to clienteles and stakeholders (210)

IV. Research Highlights

1. Procedure/Methodology

Framework of the Study



Methodology

There was a community-based appraisal involving all the stakeholders. Active or receptive farmers or farmer cooperatives were considered with regards to farm diversification and were given priority for technology promotion. Moreover, a site that was nearest to the source of fingerlings and more ideal for tilapia production in terms of marketability of the produce was selected.

Baseline information was gathered from the farmer beneficiaries. Then, the farmers were trained on tilapia production or rice-fish culture including farm record keeping for income determination. Regular monitoring was conducted upon establishment of technology demonstration. Upon harvesting, yield and net income were determined. Observations and learning from farmer beneficiaries were documented for further improvement of the project.

Dissemination of the project results were conducted through seminars and trainings among the selected farmers and other potential areas (which were not yet included in pilot-testing) for tilapia production

2. Accomplishments

Table 1. Status of Technology Demonstration Sites in Five Provinces of Central Luzon

Province	IDENTIFIED SITES	Problems Encountered			Status of Techno Demo Sites
		Site Identification	Establishment of Palayisdaan	Data Gathering (Yield of Tilapia)	
Tarlac	Tarlac Agricultural University		Feeds and water quality test	-no available data on yield of tilapia in most of DA-MAO and DA-OPA of the provinces.	For stocking of fingerlings
	BRGY. LABNEY SAN JOSE TARLAC		Feeds and rain water		Ongoing monitoring
Pampanga	BRGY. PIAS PORAC, PAMPANGA	-No rice field rainfed area, most of the crops in rainfed areas are vegetables and sugarcane.	Rain water	-most of the municipalities in zambales are not producing tilapia specially near in coastal areas.	For stocking of fingerlings

		-Municipalities ricefield are irrigated, coastal area and catch basin of water during rainy season		-other municipalities in Pampanga, they convert to catfish and koi commodity from tilapia farming. -in Porac pampanga, some of the areas are converted back to rice fields from fish ponds due to high inputs, low farm gate price and high supply of tilapia in many parts of Pampanga.	
Zambales	BRGY. LAWIN SAN MARCELINO ZAMBALES	Limited rice field area Many of municipalities are coastal areas The rainfed rice field has no SFR and they are using STW as alternative source of water	Rain water, feeds		On going monitoring
Aurora	BRGY. SALAY DIPACULAO, AURORA	limited ricefield areas and mostly mountain areas and difficulties in finding SFR cooperators.	need to undergo water quality test		Ongoing monitoring

Bulacan	BRGY. TUKOD SAN RAFAEL BULACAN		need to undergo water quality test		for water quality test and waiting of dispersal
	BRGY. SIBUL SAN MIGUEL BULACAN		need to undergo water quality test		for water quality test and waiting of dispersal
Nueva Ecija	BRGY. STO DOMINGO LUPAO NUEVA ECIJA	Most of the part of Nueva Ecija are irrigated area	feeds, and rain water		Ongoing monitorin g
	BRGY. MAGTANGO L BONGABON, NUEVA ECIJA		rain water and feeds		Ongoing monitorin g

a. Establishment of Technology Demonstration Sites

Six provinces in Central Luzon were identified locations in the establishment of technology demonstration. The provinces of Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora were among the cooperators. However, the province of Bataan was not included as a technology demonstration site because of the previous and ongoing projects related to SFR that are implemented in the province.

Two locations from each province of Tarlac, Bulacan, and Nueva Ecija were identified as technology demonstration sites. However, only one technology demonstration site was identified from each province of Aurora, Pampanga and Zambales. Those sites were in Tarlac Agricultural University and Barangay Labney, San Jose for Tarlac Province, Barangay Tukod, San Rafael and Barangay Sibul, San Miguel Bulacan for Bulacan Province, Barangay Santo Domingo, Lupao and Barangay Magtangol, Bongabon for Nueva Ecija Province, Barangay Lawin, San Marcelino for

Zambales Province, Barangay Salay, Dipaculao for Aurora Province and Barangay Pias, Porac for Pampanga Province (Figure1).

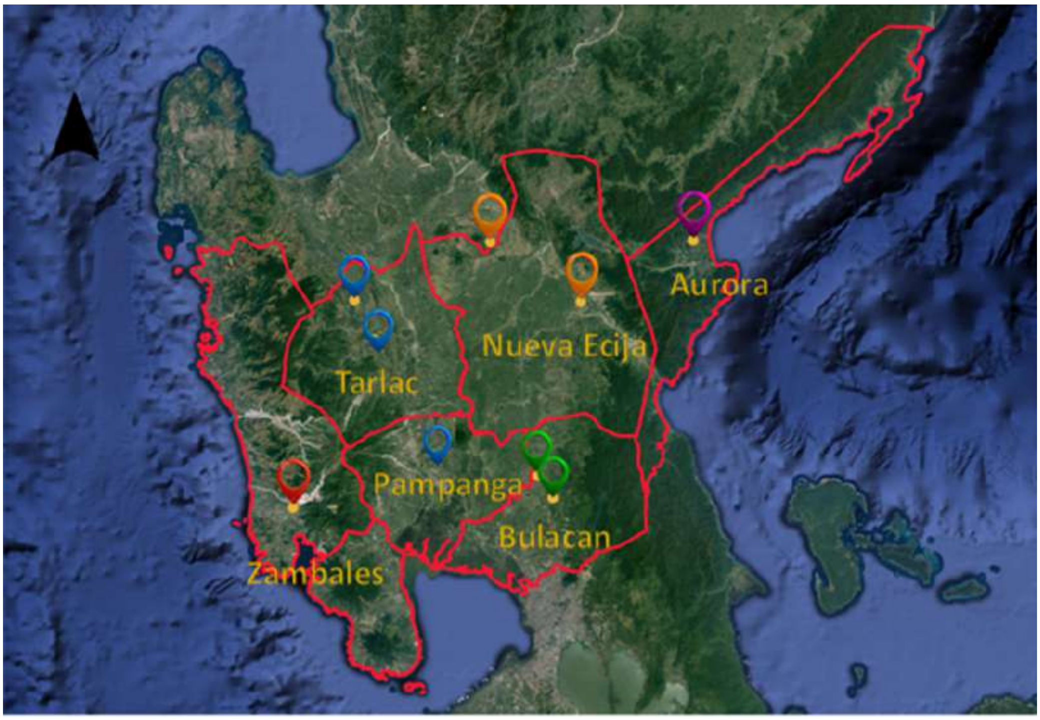


Figure 1. Locations of Technology Demonstration Sites in Central Luzon

b. Pond preparation on the identified techno-demo sites (9)

Good practices in Tilapia production were rigorously implemented in the identified techno-demo sites to attain a good harvest. A proper pond preparation was done before the dispersal of Tilapia Fingerlings. All unnecessary vegetation was removed from the pond to reduce the hiding ground of predators such as frogs and night herons. Also, an organic pesticide was applied to the pond to remove the unwanted fishes from previous culture. Those practices helped to reduce the mortality rate of stock. Chicken manure and inorganic fertilizer were used to fertilize the pond for the production of algae and lablab.

Figure 2. Removal of vegetation on SFR site at Brgy. Labney San Jose, Tarlac

Figure 3. Draining of water for drying of pond in techno-demo at Brgy. Magtangol Bongabon, Nueva Ecija.

In the preparation of pond, the following practices were implemented in TAU technology demonstration site:

- Removal of vegetation around the pond and dike to reduce the hiding ground of natural predators and also for safety purposes for the personnel who manage the pond
- 100% draining of water
- Harvesting the fishes from previous culture.
- Application of teaseeds to eliminate unwanted fishes and reduce the mortality rate of stockings.

- Application of agricultural lime to neutralized the pond bottom.
- Fertilization of pond by applying chicken manure for the production of algae.

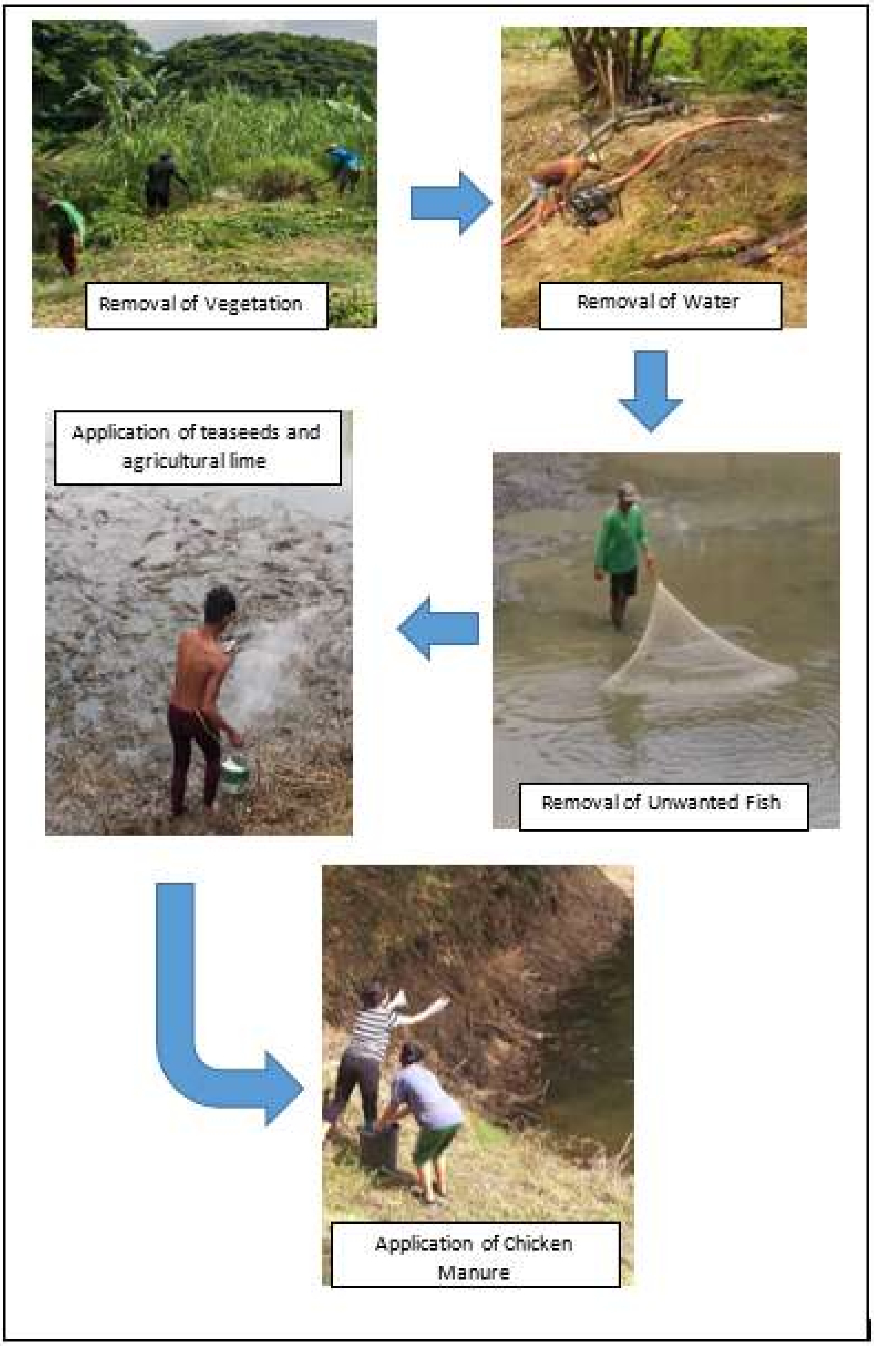


Figure 4. Pond Preparation Activities at TAU Technology Demonstration Site

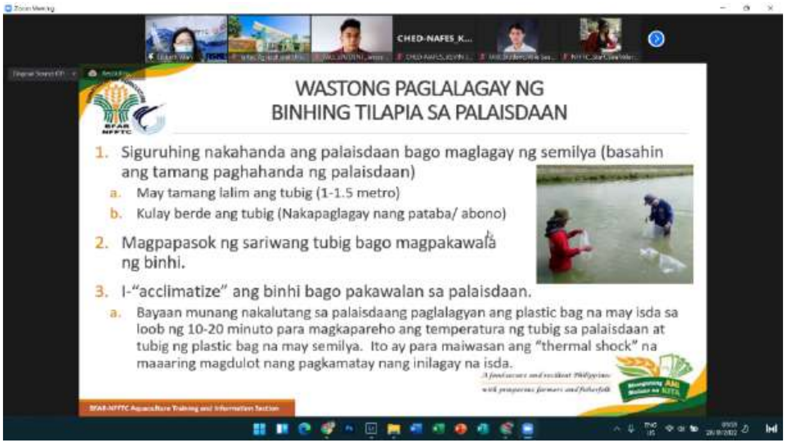
c. Distribution of Tilapia Fingerlings

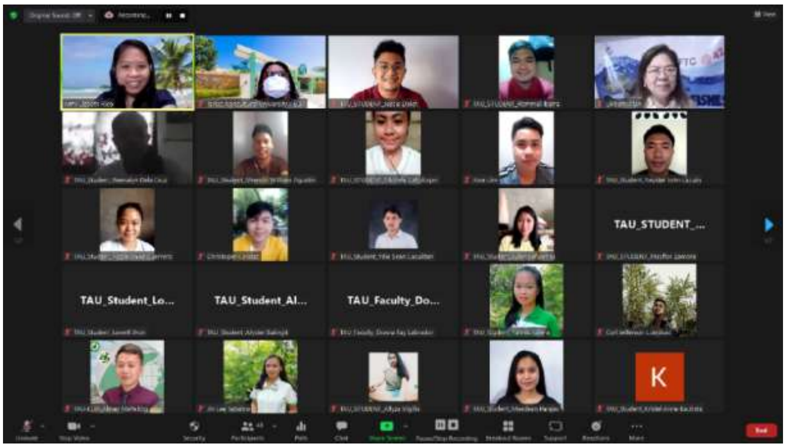
Seven (7) cooperators from the identified technology demonstration sites received initial stock of tilapia fingerlings. Those cooperators received technical assistance and were capable in tilapia production. Also, regular site visitation and monitoring were done to ensure that all procedures in tilapia production were properly implemented.


Figure 5. Distribution of Tilapia fingerlings to Mr. Anthony Villanueva at Brgy. Sto. Domingo Lupao,Nueva Ecija (left) and Mr. Crisostomo Galleon, at Brgy. Labney San Jose, Tarlac (right)

c. Seminars and Trainings to clienteles and stakeholders (210)

Seminar on aquaculture production and site selection was conducted virtually to students and other clienteles on January 28, 2022. Resource speakers of the said seminar were experts from BFAR – NFFTC namely, Dr. Lilibeth Afan and Dr. Lydia M. Morales. Eighty (80) students and other stakeholders joined in the seminar.





3. Conclusion

In view of the looming problem on food sustainability not only in the country but in the world, the availability of fresh water is emerging as one of the primary restrictions in crop production. Although annual rainfall depth is reported to be sufficient, the time and place of rainfall occurrence is very unpredictable requiring crop and livestock endeavors to increase capital allocation on water. The ingenuity of upland farmers to construct small farm reservoirs mainly to store rainfall and support dry land cropping was found to be a breakthrough among water management schemes to conserve and preserve water. Enhancing the utilization of these rain catching structures by providing assistance and guiding the implementation of crop production technologies may not only alleviate the farmers' income but may be of immeasurable help in the nation's quest for food sustainability and sufficiency. Likewise, the undisclosed contribution of small farm reservoirs in reducing the risk of flash floods and increasing groundwater recharge needs to be explored.

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project 9 Title: Value Chain Development for SFR-Based Aquaculture Production in Selected Rainfed Areas of Central Luzon

2. Researcher(s): Project Leader: Maribel C. Ramales
Project Staff: Orlando H. Locading Jr.
Sonny A. Santos
Paul Christian A. Santos

3. Implementing Agency/Station:

Lead Agency: Tarlac Agricultural University

Cooperating Agency: Central Luzon State University, Provincial and Local Government Units of Central Luzon (Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)

Project Site(s): Central Luzon (Tarlac, Nueva Ecija, Bulacan, Zambales, Pampanga and Aurora)

4. Technology Level: Applied

5. Sector: Agriculture

6. Commodity Classification: Agriculture

7. Research Discipline: Applied

8. Target Beneficiaries: 2200 Beneficiaries composed of the following
2100 small farm reservoir owners
50 Agricultural Technologist/Agriculturist
5 graduate students
45 undergraduate students

9. Funding Agency: CHED-NAFES

10. Duration

Date Started: August 2021
Date of Completion: February 2023

11. Financial Reports

Total Approved Budget: P 9,500,000.00
Actual Released Budget:
Actual Expenditures:

B. TECHNICAL REPORT

I. Rationale

For many years, aquaculture production had long been a source of livelihood for farmers especially in the rural communities where vast lands are utilized for agriculture. Many farmers with crops in less irrigated areas use water storage in small farm reservoirs to provide supplemental irrigation during the rainy season and off-season rice production. Aside from irrigation, water in small farm reservoirs is also used for small scale aquaculture production, livestock watering and groundwater recharging. However, it is observed that the aquaculture production does not reach its full potential as a source of income for farmers' households as there are still lots of problems and challenges that are being encountered by the farmers.

The main objective of the program is to establish technology demonstration for Small Farm Reservoir-based Aquaculture Production in Rainfed Areas of Central Luzon, specifically, it aimed to improve the income generating capacity of Small Farm Reservoir farmers through various interventions needed.

The program started with the socio-economic profiling of SFR farmers/owners, needs assessment and gap analysis. Results and information gathered were used to propose interventions and other business development services appropriate to the needs of the farmers. This includes an appreciation course and capacity building through a farm business school that aimed to capacitate the farmers in aquaculture operation and management as a way to develop and improve the aquaculture value chain, thus, increasing the income of farmer- beneficiaries and other actors in the value-chain.

The project is set to benefit a total of 2,100 SFR owners and farmers from Aurora, Bulacan, Nueva Ecija Pampanga, Tarlac and Zambales.

II. Objectives

The general objective of the study is to develop and improve the SFR-based aquaculture value-chain in rainfed areas of Central Luzon.

Specifically, it aims to:

1. provide appropriate business development services to SFR-based farmers;

2. develop partnership to sustain continuing innovation and improvements aquaculture value- chains; and

3. improve market development initiatives by providing updated, validated consumer, market, and industry information.

III. Expected Output:

1. Products

- Lectures (Enterprise Development/Mindset, Marketing, Financial Management, and Recordkeeping)

- Directory of Established Partnership

2. Places and Partnership

- Provincial and Municipal LGUs of Central Luzon

- Consumer and Industrial Market for Aquaculture

3. People Services

- Capacitated Agricultural Extension Workers and SFR farmers

- One organized farmers' association

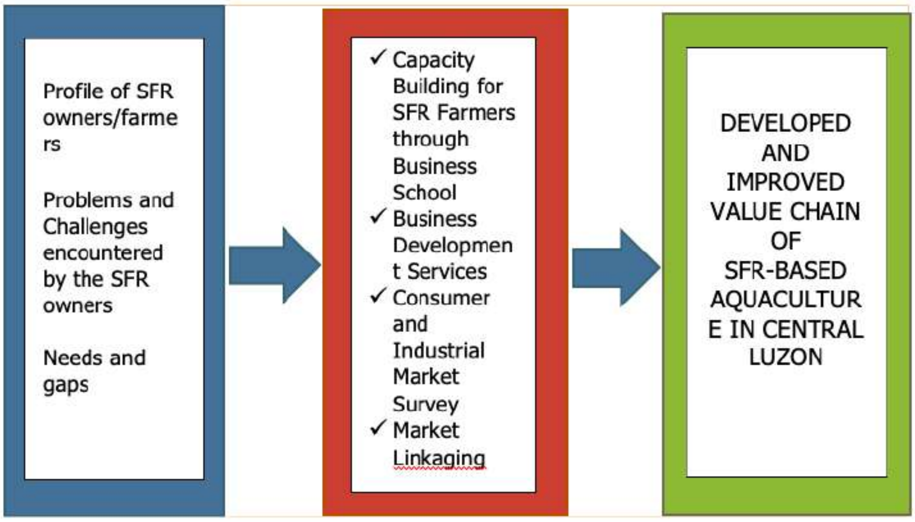
4. Publication

- One publication (national)

IV. Research Highlights

1. Procedure/Methodology

To achieve the objectives of the study, the following methodologies were conducted and facilitated.



1.1 Needs Assessment

This study started with a needs assessment conducted with SFR owners through survey questionnaires and then validated through interviews (KII). Farm ocular inspection was also conducted to further validate the findings from the survey and interviews conducted. The results of the needs assessment and gap analysis were then used as baseline information for the interventions to be carried out for the development of the SFR-based aquaculture value-chain.

1.2 Curriculum Development

The needs of the SFR owners/farmers and the gaps identified in the value chain were also used as basis in the formulation of the curriculum for the farm business school. The curriculum covered various topics that include SFR operations and management, aquaculture (tilapia) production and management, feeding management and alternative feed production, tilapia-based food processing and enterprise development. Enterprise development include entrepreneurial mindsetting, marketing, financial management, record keeping and bookkeeping.

1.3 Capacity Building thru the Farm Business School (FBS)

The SFR owners/farmers were capacitated through the Farm Business School. Trainings were conducted in various provinces of Central Luzon with the assistance of the Provincial Agricultural Offices, Municipal Agricultural Offices, DA-Local Government Units representatives and barangay officials.

Other business development services were also identified for added assistance to SFR owner-beneficiaries. Partnership with the Local Government Units and other government agencies in various provinces of Central Luzon was also facilitated for possible technical assistance, grants and/or donations of equipment and other inputs.

1.4 Market Survey

Consumer and industrial market survey was also conducted through interviews with various actors in the aquaculture value chain and other stakeholders. Data gathered through the surveys were consolidated to have a clear picture of the aquaculture value chain in Central Luzon. This is very vital in helping and assisting the SFR owners in establishing and sustaining the linkages between and among the actors in the aquaculture value chain. Thus, helping them see and have access to a wider and bigger market.

3. Findings

3.1 Results of the gap and needs assessment conducted

The survey conducted through an interview and focused group discussion, from a total of 800 SFR owners from six provinces of Central Luzon gave us the following problems and challenges they encounter in the operation of their SFR and aquaculture production. Most of the SFR owners/farmers claimed that they lack the technical skills necessary in the operation of their SFR and aquaculture production that is why they tend to experience 'fish kills' and 'dwarfed fish' caused by overstocking, and natural predators that tend to kill small fishes. Naturally, these result in little or no harvest at all. Only very few of them have knowledge in aquaculture management. Most of the SFR owners did not undergo formal training on aquaculture production and management, they just relied on their previous experiences and advice from DA-LGU staff and neighbors with existing aquaculture production.

Most of the farmers also do not have the skills or know-how in enterprise development and business management. Most of them lack knowledge in marketing, financial management, bookkeeping, and record keeping as only few of them are college graduates. No formal training was also attended by the farmers on enterprise development and business management.

Table 1. Problems and Challenges encountered by the SFR owners

Problems/Challenges	Frequency	Rank
Overstocking	202	8
Sudden change in weather	592	3
High cost of inputs	585	4
Natural predators	231	7
Lack of business management skills/entrepreneurial mindset	760	**2**
Lack of technical skills	775	**1**
Limited market	340	6
Limited government support	520	5

Other challenges encountered by the farmers are 'limited support from the government' and 'high costs of inputs' in the aquaculture production. (Table 1)

3.1.1 Interventions Conducted

Given the various problems and challenges encountered by the SFR owners, the following interventions were conducted:

1. Capacity Building through the Farm Business School (FBS)

The lack of technical and business management skills of the farmers led the researchers in coming up with a Farm Business School, an avenue where the farmers were capacitated in all areas of aquaculture enterprise operation and management. The Farm Business School (FBS) aimed in capacitating the SFR owners/farmers through training, mentoring, consultancy, and farm demonstration, with the end goal of empowering the farmers with added learnings in operating, managing and sustaining their SFR enterprises thus, increasing their income and making their lives more comfortable.

In answer to the challenges/problems encountered by the SFR owners/farmers an FBS curriculum was prepared. (Table 2)

Table 2. Farmer Business School Curriculum

Topics	Method	No. of Hours
1. Small Farm Reservoir Operations and Management	Lecture-discussion and Farm demo	3 hrs
1.1 Site Preparation		
1.2 Water Quality		
1.3 Aquaculture Production		
1.4 Feed Management		
2. Alternative Feeds	Lecture-discussion	1 hr
2.1 Duckweed Production		
2.2 Feed Management		
3. Palay-Isdaan	Lecture-discussion	1 hr
4. Tilapia Food Processing	Lecture	1 hr
5. Enterprise Development	Lecture-discussion with practice sets for bookkeeping	2 hrs
5.1 Entrepreneurial Mindsetting		
5.2 Marketing		
5.3 Financial Management		
5.4 Simple Record and Bookkeeping		

A total of six (6) training sessions were conducted, attended by a total of 1,145 participants, where 998 of them are SFR owners/farmers, 64 students and 83 DA-LGU technical staffs (Table 3).

A total of six (6) training were conducted, attended by a total of 1,145 participants, where 998 of them are SFR owners/farmers, 64 students and 83 DA-LGU technical staffs (Table 3).

Table 3. Training conducted

Training Date	Venue	No. of Farmers/ SFR owners	No. of ATs/ LGU staffs	No. of students	Total no. of Participants
July 26, 2022	Tarlac	269	31	50	350
July 28, 2022	Nueva Ecija	178	5	12	195
July 29, 2022	Pampanga	187	6	2	195
November 11, 2022	Aurora	93	7	0	100
November 25, 2022	Zambales	93	17	0	110
September 09, 2022	Nueva Ecija	178	17	0	195
TOTAL		998	83	64	1145

Photo Documentation Training Conducted in Tarlac, Pampanga, and Nueva Ecija.

Figure 2. The attendees of conducted training at Sta Ignacia, Taralc

Figure 3. The attendees of conducted training at Bacolor Pampanga

Figure 4. The attendees of conducted training at Munoz, Nueva Ecija

Figure 5. The attendees of conducted training at Bongabon, Nueva Ecija

A. BASIC INFORMATION

1. Program Title: Technology Demonstration on Small Farm Reservoir for Aquaculture Production in Selected Rainfed Areas of Central Luzon

Project Title: Benefit Monitoring and Impact Assessment of SFR based Aquaculture Production in Selected Rainfed Areas of Central Luzon

2. Researcher(s): Catherine DR. Pueyo, Sherwin S. Alar

3. Implementing Agency/Station: Tarlac Agricultural University

Lead Agency: Tarlac Agricultural University

Cooperating Agency: Central Luzon State University

Project Site(s) : Region III except Bataan

4. Technology Level: Technology Demonstration

5. Sector: Agriculture

6. Commodity Classification: Aquaculture

7. Research Discipline: Applied Research

8. Target Beneficiaries: Small Farm Reservoir owners and farmers in rainfed areas of Central Luzon

9. Funding Agency (ies): Commission on Higher Education under National Agriculture and Fisheries Education System (NAFES)

10. Duration (Definite Dates)

Date Started: August 2021
Date Ended: January 2023

11. Financial Reports (whole program as of August 2022)

Total Approved Budget ₱ 6,142,132
Actual Released Budget ₱ 6,142,132
Actual Expenditures ₱ 2,723,762.50

B. TECHNICAL REPORT

1. Rationale:

Small farm reservoirs (SFRs) are water harvesting structures constructed to collect and store rainfall and runoff during the rainy season mainly for irrigation during the dry season. This unique technology has been initiated by upland farmers in areas wherein the government could not extend its assistance due to the prohibitive cost of constructing new irrigation systems and proved to be of unparalleled importance not only in the country's quest for food security but to climate change mitigation as well.

With the decreasing farmers' profit in crop production, particularly rice and increasing cost of farm inputs, many SFR owners/users have considered the raising of fish and other aquaculture ventures in lieu of dry season cropping particularly on areas with sufficient water recharge from irrigation canals. Studies also showed that because many upland farmers are still practicing the traditional rice-rice cropping pattern, many SFRs are not fully utilized as they are inclined to sacrifice either crop production (no 2^{nd} cropping) or fish production (harvesting early) as the stored water in the SFR is very limited. Technology packaging focused on the conjunctive utilization of water stored in the reservoir for 2^{nd} cropping and aquaculture may boost the morale of upland farmers to endeavor on both ventures.

Recent study conducted on the inventory and characterization of small farm reservoirs in the four western towns of Tarlac (Camiling, Sta. Ignacia, Mayantoc, San clement) tallied a total of 2,264 SFRs with an average depth of 3.20 m. and an average surface area of 1,205 sq. m. On the other hand, reported utilization for fish production is minimal due to the following reported and observed problems; lack of fingerlings for early stocking (61.71%), poor storage capacity of SFRs (19.66%) and lack of capital (64.34%). It was also noted that most SFRs are not properly maintained and no specific package of available technologies for aquaculture ventures using SFRs in conjunction with crop production is practiced and recommendable for farmers' adoption.

A project entitled "Strength and Needs Assessment of Small Farm Reservoirs in Support of the Aquaculture Industry in Western Tarlac", funded by the Department of Agriculture- Bureau of Agricultural Research was commenced last 2014 which aims to improve the income-generating capacity of small farm reservoirs through sustained aquaculture ventures without impairing crop production. The project recommended to establish Small Farm Reservoir-based aquaculture production which was undertaken by the program.

The project thereby focuses on profiling the farmer beneficiaries and monitor the benefits of employing SFR based Aquaculture Production in Selected rainfed areas of Central Luzon based from the identified SFR farmers from the previous project. Also, initial assessment on the farmer's aquaculture ventures using small farm reservoir was undertaken.

2. Objectives:

General Objective: To assess the impact of establishing SFR-based aquaculture production.

Specific Objectives:

1. To conduct initial profiling of the identified famer beneficiaries of the program;
2. To monitor the benefits of employing SFR based- Aquaculture production in selected rainfed areas of Central Luzon; and,

3. Expected Output:

Activities	**Deliverable/ Outputs**
Consolidation of SFR farmer interviewed by Project 1.	Consolidated SFR farmer interviewed by Project 1.
Interview of identified SFR farmer employing SFR based- Aquaculture production	Interviewed selected SFR Farmers.
Analysis of Data	Analyzed survey data.

Monthly, Quarterly, Yearly and Terminal report	Delivered project updates and accomplishment.

4. Research Highlights:

1. Procedure/Methodology

The project will commence by field survey visit to the SFR's farmers to assess the benefit and potential impact of employing aquaculture production. The methods to be used in collecting information will be questionnaires, actual observation, interview, and documentary analysis.

Data will be organized and presented using frequency distribution tables. The data will be analyzed using frequency counts and percentages. Ranking will also be used in presenting the problems encountered by SFR and fishpond farmers.

The results of socio-economic survey will be used to gauge the impact of aquaculture production to the farmers under survey. Comparison of means of socio-economic profile before and after employing the engineered SFR-based aquaculture production will be analyzed using T-test.

2. Accomplishments

Initial Profile of Selected Project Beneficiaries in Selected Areas of Central Luzon

As per program, 12 techno demo sites will be established to further evaluate the benefits of employing SFR-based aquaculture production in Region III except Bataan. To be able to qualify as techno demo sites, the location must have at least 400 to 600 square meters SFR and the water collected was also used for irrigating rice and other crops. As of present, there were already nine (9) identified techno demo sites for the program. The farmer beneficiaries were interviewed and profiled. See Figure 1-9. The Techno-demo site in different provinces in Central Luzon.

a) Techno Demo Site in Bulacan

Figure 1. San Rafael Bulacan

Coordinates: 14.99848, 121.0591

There are two (2) identified techno demo sites in the province of Bulacan. The first site is located at Brgy. Tukod, San Rafael, Bulacan in the name of the farmer Mr. Juanito Iscala He's Small Farm Reservoir has a surface area of 301 square meter with initial depth of 2 meters and involved in farming for almost 10 years. He is currently a member of Farmers Association of Brgy. Tukod the "SAMAHAN NG MAGSASAKA AT MAG GUGULAY NG TUKOD".

The primary source of his income came from farming palay and vegetables and his average household monthly income range from 10,000 to 20,000 monthly. Some of the challenges and problems encountered from his fish farming was lack of technical skills, limited support from the government, limited market and lack of finances and financial management.

The second site located at Brgy.Sibul San Miguel, Bulacan in the name of Mr. Salvador Estremadora a 51-year-old farmer who's involved in farming for almost 21 years and a member of a cooperative group at Brgy. Sibul the name of the cooperative was the FFS PALAY FARMERS PRODUCERS.

He has a Small Farm Reservoir that he used to irrigate his crops and has a surface area of 500 sq. meters the primary source of his income came from farming, and takes 2 cropping per year and has an average net income of 20,000 each per cropping in his rice production.

Figure 2. San Miguel Bulacan

b. **Techno Demo Site in the Province of Nueva Ecija**

There are two (2) identified and validated technology demonstration sites in the province of Nueva Ecija the first site was located at Brgy. Bongabon, Nueva Ecija in the name of Mr. Evrod Navarro his SFR has a surface area of 400 square meters.

The primary source of his income come from farming and livestock production and has a monthly household income range from 10,000 up to 20,000 per month and a farmer for almost 10 years. He's concern was to get more knowledge in SFR Management from preparation up to harvest and marketing to increase his income and to decrease the production cost.

The second site was located at Brgy. Sto. Domingo, Lupao, Nueva Ecija in the name of farmer Mr. Anthony Villanueva and his SFR has a surface area of 400 square meters with a depth of 1.5 meters. His average income ranges from 10,000 to 20,000 monthly the primary source of his income came from rice, livestock production and fish farming.

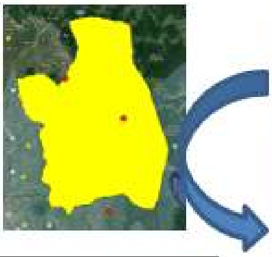


Figure 3. Bongabon, Nueva Ecija

Figure 4. Brgy. Santo Domingo, Lupao, Nueva Ecija

c. Techno Demo Site in the Province of Tarlac

There are 2 validated sites from the province of Tarlac one is from the Tarlac Agricultural University Malacampa, Tarlac with an average surface area of 600 square meter with a depth of 2.5 meters and a service area of 3000 square meters rice field.

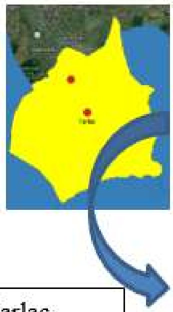


Figure 5. Tarlac Agricultural University Malacampa, Camiling, Tarlac

Coordinates: 15.6404773,120.4151918

The second site was located at Brgy. Labney, San Jose, Tarlac the SFR has an area of 550 sq. meter owned by the farmer Mr. Crisostomo Gallion he is a farmers for 10 years and currently a member of Cooperative in Brgy. Labney and adopting SFR farming for almost 9 years his primary source of income came from farming rice, vegetables, livestocks animals and fish farming his average income range from 10,000 to 20,000 per month. His concerns was he was low in marketing skills, lack of technological skills and financial management skill.

Figure 6. Brgy. Labney, San Jose, Tarlac

Coordinates: 15.51233, 120.48113

d. **Techno Demo Site in the Province of Zambales**

Figure 7. San Marcelino, Zambales

Coordinates: 15.8345, 121.51425

There is one technology demonstration site from the province of Zambales in the name of Mr. Crisanto Ancheta at Brgy. Lawin, San Marcelino, Zambales he is currently a member of Farmers Association named Lawin Farmers Irrigation Association his SFR has a measurement of 600 square meters with an average household income of 10,000 to 20,000 per month to source of income from farming and cattle and goat raising. Some of his concerns is the equipment he used high farm inputs and limited support from the government.

e. Techno Demo Site in Pampanga

There is one identified technology site from the province of Pampanga located at Brgy. Pias Porac Pampanga with an average surface area of 400 square meters SFR in the name of Mr. Jay ar Carpio, a 20 years farmer from Pampanga he used his SFR to irrigate his vegetables crops and rice, He's concerns was he wants to engage more in technology used in fish farming and enhance his skills in fish culture, sustainability of the pond and good management.

Figure 8. Brgy. Pias Porac Pampanga

f. Techno Demo Site in the Province of Aurora

One identified and validated techno demo site located at Brgy. Salay, Dipaculao, Aurora with an area of 400 square meters with the name of the farmer Mr. Arnold Mark Ian Cacanindin 27 years old Farmer from aurora. He's primary concern is to develop more on his technical skills, business, and financial skills.

Benefit monitoring and impact assessment has not commenced prior to the termination of the project. Only nine (9) project beneficiaries were identified and profiled. As per the benefits, data was not yet gathered and recorded to determine the benefit of the program.

Figure 9. Brgy. Salay Dipaculao, Aurora

g. Project Accomplishments

This table shows the status of the project as of December 2022.

No.	Target Activity(ies)	Inclusive Date	Percentage Completed	Remarks
			Cumulative (from the start)	
1	Hiring of Project Support Staff	December 2022	100%	Completed
2	Procurement of Supplies and Materials	December 2022	90%	On going
3	Conduct monthly meeting with the project leader	December 2022	75%	On going
4	Capability building of SFR farmers and agricultural technologies	December 2022	80%	On going
5	Consolidation of SFR farmers interviewed by Project 1	December 2022	35%	On going
6	Interview of selected SFR farmers involved in socio economic profiling	December 2022	84%	On going
7	Analysis of data	July 2022	35%	
8	Monthly, quarterly, annual and terminal report	July 2022	84%	

Percentage of Completion	*Completed (add sum of cumulative percentages per activity / total no. of activities)*		77.375 %	December 2022

h. Highlights of the Accomplishments

GOALS/ OBJECTIVES *(Objectives clearly define specific, measurable, actionable, realistic and time-bounded conditions that must be attained in order to accomplish a particular goal)*	**ACTIVITIES UNDERTAKEN** *(List of activities undertaken to meet a particular objective)*	**VERIFIABLE OUTPUTS** *(Physical outputs such as Product, Process, Publication, People, Services, Policy, Patents)*
General Objective: To assess the impact of establishing SFR based aquaculture production.	1. Joined in "33rd In-House Review of Completed and on-going research and development Projects". 2. Regular program and project meetings. 3. Identification of potential project beneficiaries.	1. Reporting of Project Accomplishments
1. To monitor the benefits of employing SFR based-Aquaculture production	2. Consolidation of SFR farmer's data for Benefit monitoring from eight technology demonstration site.	2. Socio-Profiling and analysis of data for the beneficiaries of tilapia production and technology demonstration in different provinces of central luzon

2 To document and assess the farmer's aquaculture ventures using small farm reservoir	3. Capacity Building Training and seminar for SFR based Tilapia Production	Conduct Capacity Building of SFR Based Tilapia Production for SFR farmers in the provinces of Tarlac, Nueva Ecija and Pampanga.
3 To disseminate results of the project through seminars and training of clientele and stakeholders	4. Monthly, Quarterly, Annual and Terminal Report	5. Deliver Project Upadates and Accomplisments

Table 1. Project Milestone

Activities (Program)	Months								
	2	4	6	8	10	12	14	16	18
Project 10									
1. Interview of identified SFR farmer employing SFR based-Aquaculture production									
2. Analysis of Data									
3. Monthly, Quarterly, Yearly and Terminal Report									

Project Timeline: **Actual Accomplishment:**

3. Conclusion

- The project already identified and profiled nine (9) techno demo sites for the project.
- Identification and profiling of other techno-demo sites are still ongoing.
- Benefit monitoring and impact assessment was not commenced. Hence, it will be proposed as another project in the near future.

APPENDICES

Appendix Figure 1. Program Meeting

Appendix Figure 2. Program Assessment Meeting, Monitoring and Evaluation of CHED-RDE Program at Tarlac Agricultural University last May 5, 2022.

Appendix Figure 3. Program Training and Seminar on SFR-based Tilapia Production for Farmers, AEWs, and Students in the province of Tarlac, held at Santa Ignacia Auditorium last July 26, 2022

Appendix Figure 4. Program Training and Seminar on SFR-based Tilapia Production for Farmers, AEWs, and Students in the province of Nueva Ecija, held at PhilSCAT, Science City of Muñoz, Nueva Ecija last July 28, 2022

Appendix Figure 5. Program Training and Seminar on SFR-based Tilapia Production for Farmers, AEWs, and Students in the province of Pampanga, held at V. Angeles Resort, Bacolor, Pampanga last July 29, 2022

Appendix Figure 6. Program Training and Seminar on SFR-based Tilapia Production for Farmers, AEWs, and Students in the province of Nueva Ecija, held at Bongabon, Nueva Ecija last September 9, 2022