14.2.1. Batangas State University – The National Engineering University offers educational programmes on fresh-water ecosystems (water irrigation practices, water management/conservation) for local or national communities.

Backyard Tilapia Farming (Extension from LSPU)

Miguel Enrique Ma. A. Azcuna and Jonel M. Corral

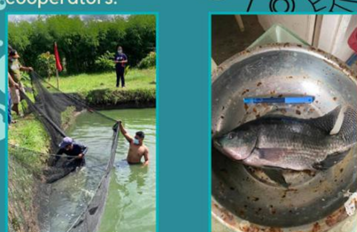
Objectives

The project aims to increase the disposable income of poor household families in Batangas during the post-lockdown period for COVID-19 affected areas.

Accomplishments

Delivery of Tilapia fingerlings to cooperators.

Monitoring of tilapia from growth and feed adjustment, up to the readiness for harvest.



Tilapia was harvested from the ponds of cooperators.

Tilanggit making workshop was conducted at Balayan, Batangas.

Monitoring of hatcheries at Los Baños, Laguna and Balayan, Batangas.

Contact us:
Website: http://vipcorals.batstate-u.edu.ph/
vipcorals@g.batstate-u.edu.ph

BACKYARD TILAPIA FARMING IN BATANGAS IN RESPONSE TO THE COVID-19 PANDEMIC

Objectives

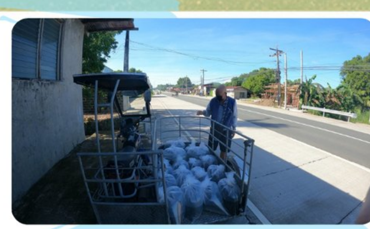
To provide immediate fish supply to poor households in Nasugbu, Batangas and increase the household disposable income. It includes development of 20 fishponds, training 20 fish farmer-household cooperators, conduct a training workshop on backyard tilapia culture, and establish partnerships with LGUs to support tilapia farming and processing in targeted communities.

Miguel Enrique Ma. A. Azcuna, Jonel M. Corral

Accomplishments

Dr. Azcuna and Dr. Corral together with the representatives of DOST-PCAARRD (Dr. Adelaida Calpe, Dr. Wilfredo Ibarra, and Dr. Cynthia Almazan) met the beneficiaries and inspected the ponds for approval.

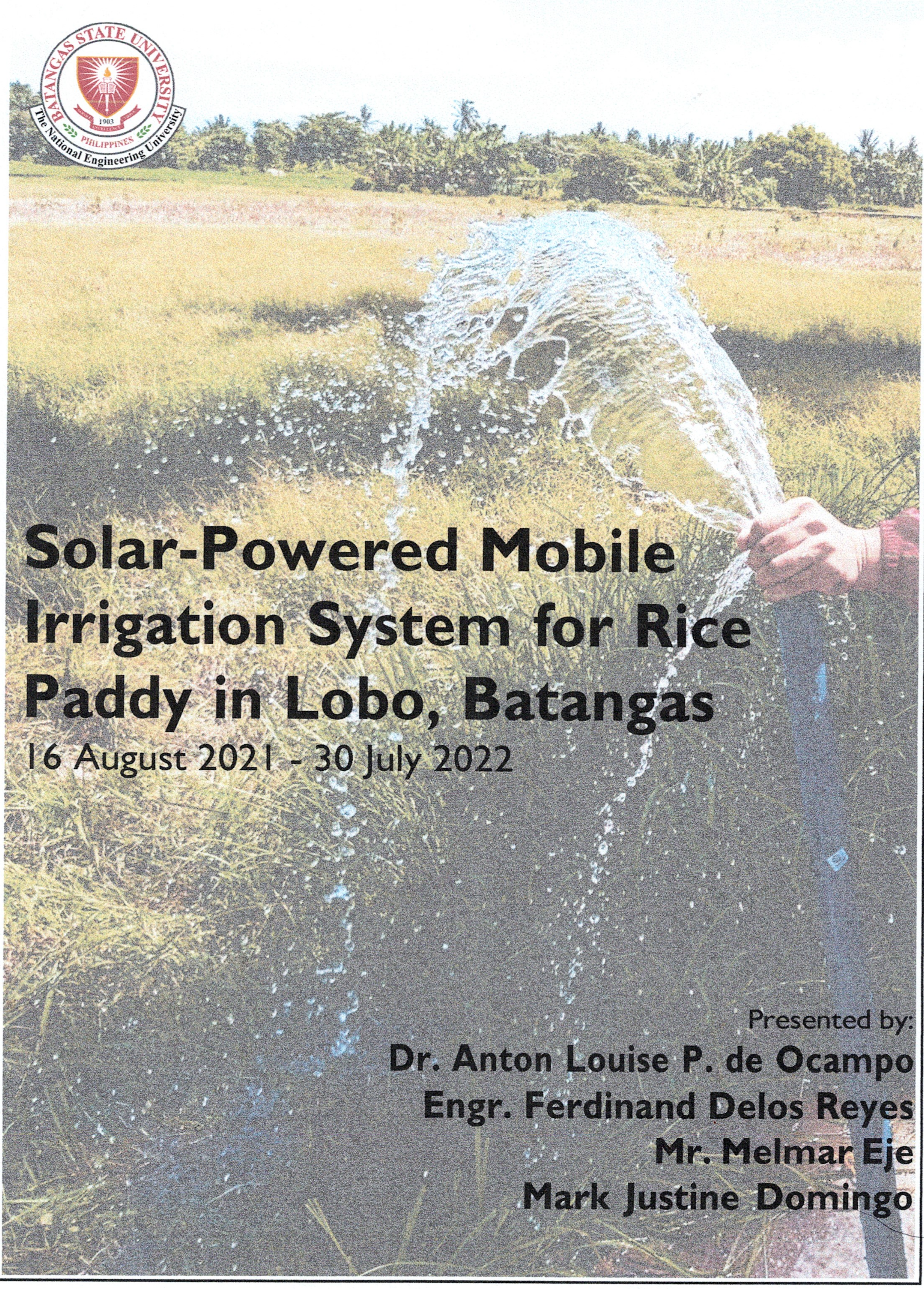
A virtual Memorandum of Understanding (MOU) Signing was held with President Tirso Ronquillo and Chancellor Enrico Dalangin giving the welcome remarks in attendance of the beneficiaries and project staff for the details of the MOU.



Delivery of tilapia fingerlings and feeds to Melecio Bo in Lian.

Contact us:
Website: http://vipcorals.batstate-u.edu.ph/
vipcorals@g.batstate-u.edu.ph

I. **Cover Page**



Solar-Powered Mobile Irrigation System for Rice Paddy in Lobo, Batangas

16 August 2021 - 30 July 2022

Presented by:

Dr. Anton Louise P. de Ocampo

Engr. Ferdinand Delos Reyes

Mr. Melmar Eje

Mark Justine Domingo

II. **Project Details**

Title: "Solar-Powered Mobile Irrigation System for Rice Paddy in Lobo, Batangas"

Author/s:
Project Leader: Dr. Anton Louise P. de Ocampo, Electronic Systems Research Center Head, BatStateU Pablo Bobon Campus
Project Staff (s): Engr. Ferdinand Delos Reyes, Guest Lecturer, BatStateU Alangilan, CEAFA
Project Staff (s): Mr. Melmar Eje, Faculty, Lobo Campus, College of Agriculture and Forestry

Duration
- Approved: August 16, 2021 – July 30, 2022,
- Actual: August 16, 2021 – July 26, 2022,

Budget/Funding
- Approved Budget: Php 298, 500.00
- Total Expenditure: Php 221, 174.50
- Percent Utilization: 74.0953%

Collaborating Agency (If any):

III. **Summary of Accomplishment**

Objectives	Target Accomplishments	Actual Accomplishments
General objective: To develop a solar-powered mobile irrigation system for rice paddy in Lobo, Batangas	To provide a solar-powered mobile irrigation system for rice paddy in Lobo, Batangas chosen by the municipal agriculture office of Lobo.	A constructed and tested solar solar-powered mobile irrigation system for rice paddy was handed over to the beneficiary.
1. To perform a technical site assessment of rice farms in Lobo, Batangas;	To choose a site applicable to the project in partnership and collaboration with the local government unit and important organizations in the municipality.	A technical site assessment was done on the municipality and an area was chosen in agreement with all the involved parties.
2. To design and develop a solar-powered pumping system for irrigation; and,	To deliver a functional solar-powered pumping system to be used for the irrigation of the chosen area.	A working and tested functional unit were given to the beneficiary.
3. To transfer the technology to rice farmers in Lobo, Batangas.	To conduct training and demonstration on how to utilize and maintain the technology developed.	Actual training for the beneficiary and his fellow farmers was done and all the inquiries were answered.

IV. **Abstract (200-250 words)**

The Philippines is annually devastated by typhoons resulting in property and infrastructure damages, one of which is the irrigation system. According to National Irrigation Authority, many irrigation facilities has been established in 1963, and currently, most farmers are adapting the pump irrigation system as an alternative because of the accumulated damages from natural calamities. Currently, 47% or 215 rice farmers are stopped their rice production due to a lack of water supply. This is after the devastation of Typhoon Salome in Lobo year 2017 which leads to the destruction of water intake of irrigation facilities in the lowland. This results to declining in rice production and the shifting of farmers from rice to livestock farming and outside farm jobs. A total of 128.1072 hectares are unproductive due to a lack of water supply. This document presents the design and development of a solar-powered mobile irrigation system to provide an alternative but reliable solution for irrigation.

V. **Introduction (Brief with rationale), Review of Literature and Objectives**

Rationale

The United Nations Conference held in Rio de Janeiro in 2012 gave birth to the Sustainable Development Goals (SDG) which is a set of universal goals to address the urgent challenges facing our world in the environmental, political, and economic aspects. In 2015, the Philippines, as a member state of the United Nations, adopted the call to end poverty, protect the planet, and ensure that all people live in peace and prosperity by 2030.

There are 17 goals encapsulated in SDG (Figure 1) which is the benchmark of the Philippine Development Plan (PDP 2017-2022) and the AmBisyon Natin 2040 (AN2040). SDG 2 is "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". To achieve this goal, two of the five targets are focused on doubling the agricultural productivity and incomes of small-scale food producers, ensuring sustainable food production systems, and implementing resilient agricultural practices that increase productivity and production, help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters and that progressively improve land and soil quality. These are the exact benefits that can be obtained in the adaptation of smart farming or precision agriculture. The transformation of traditional farming practices to smarter ways to manage farm inputs and improve productivity is necessary to achieve the targets inclusive of SDG 2.

Figure 1. United Nations Sustainable Development Goals

Lobo is basically an Agricultural Municipality. Of the total 19,268 hectares of the land area of the municipality, 14,933.4782 hectares are agricultural. A total of 3,570.14 hectares or 23.91% of agricultural lands are devoted to different crop production activities. Mono cropping and mixed cropping systems are being adopted by farmers. Rice farming is a minor agricultural crop in Lobo, Batangas. Of the total 14,933.4782 hectares of agricultural land, 236.2653 hectares are devoted to rice production. Mono cropping is the majority pattern adopted by farmers. There are 457 farmers engaged in rice cropping in both lowland and upland. The water supply came from irrigation facilities constructed by the National Irrigation Administration (NIA) that utilized a sufficient flow of water in the Lobo river. The intake level of water is sufficient in rice production with the proper intervention of the Rice Farmers Association. Also, some farmers constructed their Swallow Tube well (STW) to irrigate highly elevated areas during summer. In upland areas, they are rich in springs (bukal) used for home consumption and for irrigation.

Currently, **47% or 215 rice farmers are stopped their rice production due to a lack of water supply.** This is after the devastation of Typhoon Salome in Lobo year 2017 which leads to the destruction of water intake of irrigation facilities in the lowland. This results to declining in rice production and the shifting of farmers from rice to livestock farming and outside farm jobs. A total of 128.1072 hectares are unproductive due to a lack of water supply.

Objectives
General objective:
To develop a sustainable smart irrigation system for the rice farmers in Lobo (low-land)

Specific Objectives:
1. To perform a technical site assessment of rice farms in Lobo, Batangas;
2. To perform a technical site assessment of rice farms in Lobo, Batangas which includes solar energy availability and water requirement;
3. To transfer the technology to rice farmers in Lobo, Batangas.

Review of Related Literature

BACKGROUND OF LOBO, BATANGAS

Lobo is a hilly mountainous municipality of Batangas which is located on the Southern coast. It is bounded by Batangas City on the West, the Municipality of Taysan and Rosario on the North, San Juan on the east, and the Verde Island Passage on the South. Approximately 148 km from Manila and 36 km away from Batangas City, the Provincial Capital. The municipality is divided into twenty-six (26) component barangays. Of the twenty-six (26) barangays, ten (10) barangays are in the coastal area, and the rests are both hilly and mountainous. The general land use of Lobo comprises 250 hectares of built-up, 14, 933.4782 hectares of agricultural areas, 2, 100 forests, 1,885.6735 pasture lands or open grassland, 53.5593 tourism, 41.2890 roads, and 4.0 hectares of waterways. The municipality lies between 13°38"8'N latitude and 121°12"6'E longitude.

Lobo is basically an Agricultural Municipality. Of the total 19,268 hectares of the land area of the municipality, 14,933.4782 hectares are agricultural. A total of 3,570.14 hectares or 23.91% of agricultural lands are devoted to different crop production activities. Mono cropping and mixed cropping systems are being adopted by farmers. Land utilization has yet to be maximized to improve the municipality's agricultural output. The livestock and poultry industry in the locality is predominantly a backyard enterprise. The integration into the farming systems enhances productivity and improves the income of poor households. The growing meat market has encouraged the development of the sub-sectors. Moreover, the vast grasslands in the uplands provide grazing areas for cattle and goats.

There are two pronounced seasons in the locality, wet and dry. The dry season is prevalent from November to April, while the wet season occurs from June to October. Temperature ranges from 24 °C to 31 °C. Low rainfall distribution is recorded at 30 mm, while high distribution was noted in August at 80 mm (Lobo-CLUP2012-2022).

RICE PRODUCTION STATUS IN LOBO, BATANGAS

Rice farming is a minor agricultural crop in Lobo, Batangas. Of the total 14,933.4782 hectares of agricultural land, 236.2653 hectares are devoted to rice production. Mono cropping is the majority pattern adopted by farmers. There are 457 farmers engaged in rice cropping in both lowland and upland. The water supply came from irrigation facilities constructed by the National Irrigation Administration (NIA) that utilized a sufficient flow of water in the Lobo river. The intake level of water is sufficient in rice production with the proper intervention of the Rice Farmers Association. Also, some farmers constructed their Swallow Tube well (STW) to irrigate highly elevated areas during summer. In upland areas, they are rich in springs (bukal) used for home consumption and for irrigation.

SMART IRRIGATION

Issues in the agricultural sector of a developing country hinder growth. Smart agriculture manifested in the modernization of current traditional methods of agriculture is the only solution to this problem (Nagesrao et al., 2018). Automation and IoT solutions proved to improve crop growth and irrigation decision-making more manageable. It was proven in this study that implementing smart irrigation systems optimized water management through the real-time analysis of the conditions in the field resulted in better crop yields (Namala KK et al. 2016; Sahu CK and Behera P 2015; Zhao W et al. 2017; de Ocampo ALP and Dadios EP 2017).

In the study of N. Sarkar et al., (2015), it was stated that the "use of diesel-run pumping system is neither cost-effective nor environmentally friendly." The paper modeled and analyzed the feasibility of replacing diesel irrigation pumps with solar PV-powered motor-pump systems. The results of this paper showed that the use of a diesel generator is not ideal for irrigation purposes due to its cost and should be replaced by PV-powered motor-pump systems. The use of a storage tank should be employed after the PV-powered motor pump was also emphasized to compensate for excess electricity fractions.

A. Waleed et al. (2019) studied the use of solar-powered water irrigation with wireless control, the paper presented that "advancements in renewable energy can be effectively employed in the agriculture sector to reduce dependency on conventional crops irrigation techniques and fossil fuels." The study exhibits a design of a solar-powered water pumping system with irrigation control features, this includes automation functions and wireless control of irrigation through sensors and a global system for the mobile module.

VI. Materials and Methods (for science and technology research)/ Methodology (for educational & social science research to include research design, data gathering instrument, sampling method, statistical tests used)

1. Site Assessment

The project implementation site at Brgy. Olo-olo was visited on January 26 in order to determine the irrigation requirements of the rice field. The site was assessed in terms of:

- presence of water source and its location and surface level relative to the rice paddy
- presence of tall trees or structures that may overshadow the solar panels
- quality of soil
- size of the farm area
- presence of nearby farms which may also use the water source

2. Calculation of Water Requirements

The water requirements of the farm was calculated based on the procedures provided in the Philippine National Standards on Determination of Irrigation Water Requirements (PNS/BAFS/PAES 217:2017). The following are the formulas used for the calculation of the Farm Water Requirement:

Required Data	Relevance	Lowland	Upland
		CROP WATER REQUIREMENT	
type of crop	planning the cropping calendar and crop coefficient		
evapotranspiration and other meteorological data	determination of actual evapotranspiration (ET_a)	$CWR = ET_a + (S\&P)_{field}$	$CWR = ET_a + (S\&P)_{field}$
type of soil	determination of seepage and percolation rate in the field $(S \& P)_{field}$		

		FARM WATER REQUIREMENT	
depth of root zone	determination of land soaking and land preparation water requirement (LPWR)		
soil physical properties			
residual moisture content			
service area			
required standing water	determination of effective rainfall (ER)	FWR = CWR - ER + LPWR + farm ditch losses or $FWR = (CWR-ER+LPWR)/E_a$	FWR = CWR - ER + farm ditch losses or $FWR = (CWR-ER)/E_a$
service area			
rainfall data			
type of soil	determination of farm ditch losses		
wetted perimeter and length of farm ditches			
type of field application system	determination of application efficiency		

Table 1. Procedure for Calculation of the Water Requirements

For the evapotranspiration rate in Lobo, Batangas,

$$ETo = p(0.46T_{mean} + 8)$$

where p is the Mean daily percentage (p) of annual daytime hours, and Tmean is the daily mean temperature.

Tables in the PNS/BAFS/PAES were used corresponding to the crop coefficient (Table 4) percolation (Table 5), application efficiency (Table 6), conveyance efficiency (Table 7), and mean daily percentage of annual daytime hours (Table B14) parameters.

Meanwhile, the mean daily temperature was obtained by getting the average between the monthly maximum and minimum temperatures in Lobo as recorded in WeatherSpark.com. Effective Rainfall was also calculated from data obtained from the same website.

3. Design and Development

The entire system was made primarily of two parts: an electrical system that will provide power to an irrigation pump, and a cart mechanism that will allow easy set up, disassembly, and transfer of the irrigation system.

After the water requirement calculation, the calculated requirements were used to find the right size of pump that will draw water from the water source and transfer it to the rice paddy. This pump size was then used to find the size of the solar panels and current capacity of the other electrical components. These sizes then dictated the final dimensions of the mechanism that was to be used to make the system movable. Other observations during the site assessment were also set as additional constraints during development.

4. Technology Transfer

Partnerships were established with the Municipal Agricultural Office of Lobo and Lobo Irrigators Services Association (LISA) through a memorandum of understanding. Together, they determined the beneficiaries of the project.

Based on their recommendation, the water source in the implementation site was reinforced and then the system was installed; a training workshop was then conducted to teach the users how to operate, troubleshoot, and maintain the system. Educational materials were also distributed for this purpose.

VII. Results and Discussion (Include tables)

1. Results of site assessment and water requirement calculations

<u>Site Assessment</u>

The technical assessment revealed that there was a spring (Figure 2) immediately north of the site, which was estimated by a representative from the Lobo Municipal Agricultural Office to be 20 ft deep. The surface level of the water in the spring is approximately level to the paddy. No nearby farms are sourcing irrigation from the spring.

On the other hand, the rice paddy had an area of 1000 square meters. Tree cover was present immediately north and east of the rice paddy, which could potentially overshadow the solar panels if deployed near the water source.

The soil in the implementation site was generally loam, and was covered by grass. Nearby plots were either empty or farming *munggo*, which are only dependent on rain for irrigation.

The rice paddy was also just beside a rough road which could be used by the irrigation cart.

Figure 2. Site Visit and spring found in the implementation site

<u>Farm Water Requirements</u>

The table below summarizes the results of the calculations for the Farm Water Requirements (FWR) based on the procedures provided in the Philippine National Standards on Determination of Irrigation Water Requirements (PNS/BAFS/PAES 217:2017).

Units	Symbols	Description	Land Soaking/Prep	Transplant	Growing stage			Harvest
			December	January	February	March	April	May
mm/day	*FWR*	Farm Water Requirement	**36.09**	11.55	16.39	19.28	19.55	6.61
mm/day	*CWR*	Crop Water Requirement	1.75	6.68	7.30	7.88	8.27	5.48
mm/day	*Eta*	Actual Evapotranspiration	0.00	4.93	5.55	6.13	6.52	3.73
	Kc	Crop Coefficient	0.00	0.95	1.05	1.10	1.10	0.61
mm/day	*ER*	Effective Rainfall	6.46	2.98	2.06	1.71	2.01	3.37
	Ea	Application Efficiency	0.32	0.32	0.32	0.32	0.32	0.32

mm	*LPWR*	land preparation water requirement	16.26	0.00	0.00	0.00	0.00	0.00
mm	*LSR*	land soaking requirement	1.20	1.20	1.20	1.20	1.20	1.20
%	*n*	soil porosity	0.47	0.47	0.47	0.47	0.47	0.47
	RMC	residual moisture content	0.05	0.05	0.05	0.05	0.05	0.05
	As	apparent specific gravity	1.40	1.40	1.40	1.40	1.40	1.40
mm	*Drz*	depth of root zone	300.00	300.00	300.00	300.00	300.00	300.00
mm	*SW*	standing water	10.00	10.00	10.00	10.00	10.00	10.00
mm	*ETo*	Reference evapotranspiration	5.06	5.19	5.29	5.58	5.93	6.12
mm/day	*SP*	Seepage and Percolation Rate	1.75	1.75	1.75	1.75	1.75	1.75
m	*P*	wetted perimeter	0.50	0.50	0.50	0.50	0.50	0.50
m	*L*	Length of farm ditch	400.00	400.00	400.00	400.00	400.00	400.00
mm	*DWR*	Diversion Water Requirements	51.56	16.49	23.41	27.54	27.93	9.45
	Ec	conveyance efficiency	0.70	0.70	0.70	0.70	0.70	0.70

Table 2. Summary of Calculation of Farm Water Requirements

The highest requirement in the presented planting cycle is in the month of December or the Land Soaking and Preparation period which is 36.09 mm/day. The shortest photoperiod (time with sunlight) in Lobo is about 11 hours. Only 62% of the total photoperiod was set as the average sunlight hours; this is within the safe side of the default value of 75% used by many online references.

Meanwhile, the values obtained in Table 2 are further explained in the following subsections:

Mean Daily Percentage

Lobo is located at 13.6750° N, 121.2401° E. The table below summarizes the mean daily percentage (p) as interpolated from the values of 10° N and 15°N in Table B14 of PNS/BAFS/PAES.

Mean daily percentage (p) of annual daytime hours for different latitudes												
Lat in Deg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.0000	0.2700	0.2700	0.2700	0.2800	0.2800	0.2900	0.2900	0.2800	0.2800	0.2700	0.2600	0.2600
15.0000	0.2600	0.2600	0.2700	0.2800	0.2900	0.2900	0.2900	0.2800	0.2800	0.2700	0.2600	0.2500
13.6750	0.2627	0.2627	0.2700	0.2800	0.2874	0.2900	0.2900	0.2800	0.2800	0.2700	0.2600	0.2527

Table 3. Mean daily percentage (p)

Temperature

The collected maximum and minimum temperatures are in the table below:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (F)	82	85	87	90	90	88	87	87	87	86	85	83
Tmin (F)	74	74	76	77	78	77	77	77	76	76	76	75
Tmean (F)	78	79.5	81.5	83.5	84	82.5	82	82	81.5	81	80.5	79
Tmean (C)	25.56	26.39	27.50	28.61	28.89	28.06	27.78	27.78	27.50	27.22	26.94	26.11

Table 4. Temperatures

Evapotranspiration Rate

The calculated evapotranspiration rates are in the table below:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eto	5.19	5.29	5.58	5.93	6.12	6.06	6.03	5.82	5.78	5.54	5.30	5.06

Table 5. Evapotranspiration Rates the following crop coefficients:

Table 4. Crop coefficient for various crops

Crop	Growth Stage in Percent of Total Growth Duration				
	0-20	20-40	40-70	70-90	Harvest
Lowland rice	0.95	1.05	1.10	1.10	0.61

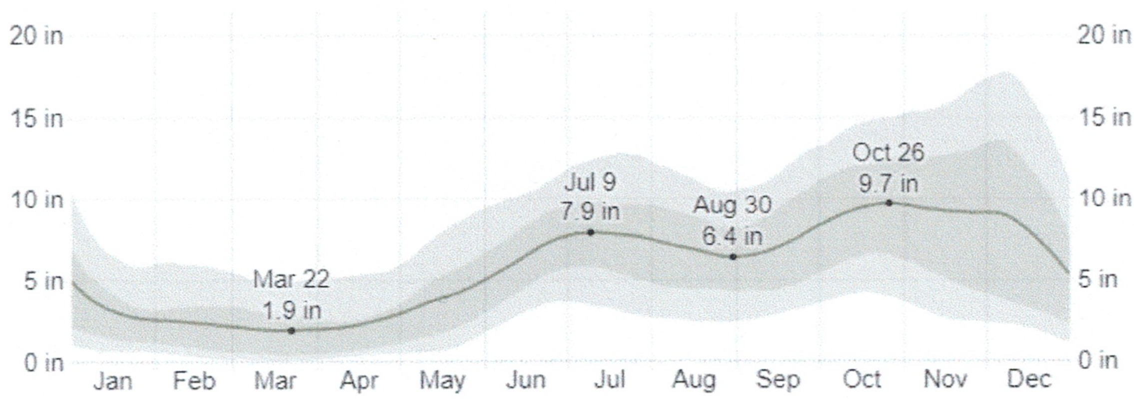
Figure 3. Crop coefficients in PNS/BAFS/PAES

Effective Rainfall

The data for Effective Rainfall is summarized in the following graph:

Crop Coefficient

The target implementation sites are in lowland Lobo, which corresponds to



Effective Rainfall or precipitation												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
inches	3.53	2.43	2.03	2.38	3.98	6.48	7.73	6.93	7.25	9.10	9.30	7.63
mm	89.54	61.81	51.44	60.33	100.97	164.47	196.22	175.90	184.15	231.14	236.22	193.68
mm/day	2.98	2.06	1.71	2.01	3.37	5.48	6.54	5.86	6.14	7.70	7.87	6.46

Figure 4. Effective Rainfall obtained from WeatherSpark.com

Soil Percolation Value

Because the implementation site is generally loam, 1.75 mm/day was set as the percolation value as per Table 5 of the PNS/BAFS/PAES.

Field Application Efficiency

0.32 was the factor used for application efficiency, which corresponds to Rice in Table 6 of the PNS/BAFS/PAES.

Conveyance Efficiency

Because the irrigation system that would be developed had a set schedule, i.e. it would only work during the day when there is sunlight, 0.70 was used as the factor for conveyance efficiency. This corresponds to Table 7 of the PNS/BAFS/PAES.

2. Results of Mobile Irrigation System Development

Pump Selection

As determined in the technical site assessment conducted, a pump capable of delivering at least 4 cubic meters per hour of flow at 10 meters head was required. Considering that the water would be sourced from a deep well and that the pump would be powered using solar power, it was also necessary for the pump to be of submersible construction and for increased efficiency, be operated by DC power.

For these reasons, a 400W DC submersible pump with a nominal input voltage of 48V was selected. Figure 5 shows the characteristic curves of the pump.

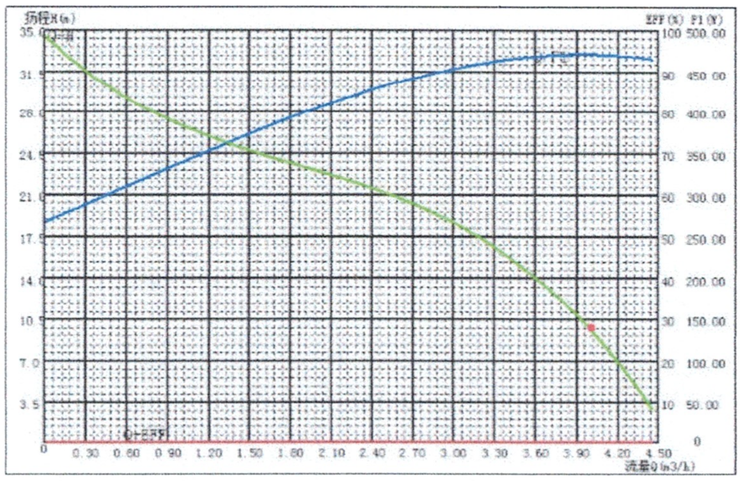


Figure 5. Pump Curves

Design of Photovoltaic System

Because the pump had a nominal power of 400W, the photovoltaic system was sized to be capable of delivering 600W to compensate for efficiency losses and days with less sunlight. Figure 3 shows the parts and connections of the designed electrical system.

Three 18V 100W panels were connected in series to have a total output voltage of 54V, thus exceeding the 48V requirement; these were then paralleled to another set of in-series 18V 100W panels to meet the target nominal power of 600W. A linear current booster/pump controller was then connected to the output of the PV array; this would have the purpose of decreasing the voltage to 48V while increasing the output current of the array (hence, increased motor torque) to prevent the impeller from getting stuck during low sunlight hours.

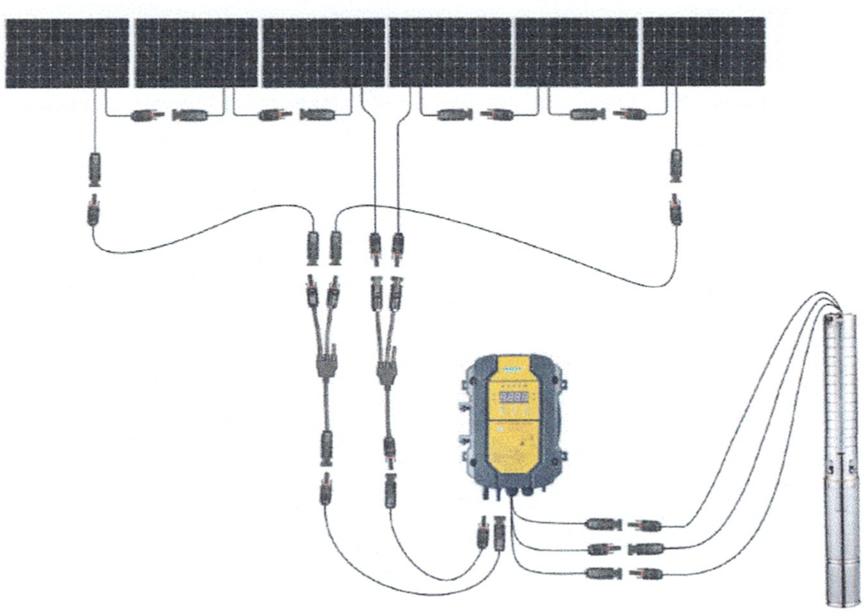


Figure 6. Electrical Design

Design of Linear Current Booster

To convert the high voltage, low current power from the panels to low voltage, high current power, a synchronous buck converter circuit was utilized. By varying the duty cycle of the input, the voltage would be stepped down to the desired level with a proportional increase in current. This was done by controlling the conduction states of two switching transistors using a high and low-side driver IC.

Meanwhile, a feedback signal from the output of the buck converter was hooked to the inverting input of a differential opamp; a voltage reference created by using a programmable reference IC was also connected to the non-inverting input. This way, an amplified error signal was produced at the output of the opamp. This error was then connected as an input to a comparator with a timer IIC-generated ramp signal as a reference to produce a Pulse Width Modulated (PWM) waveform whose duty cycle corresponds to the voltage level of the error. The larger the error, the larger the duty cycle, and vice-versa. This PWM output was the input to the high-and-low side driver IC. As a result, the voltage output of the Linear Current Booster was regulated in a closed-loop manner.

Figure 7 shows the electronic schematic of the circuit.

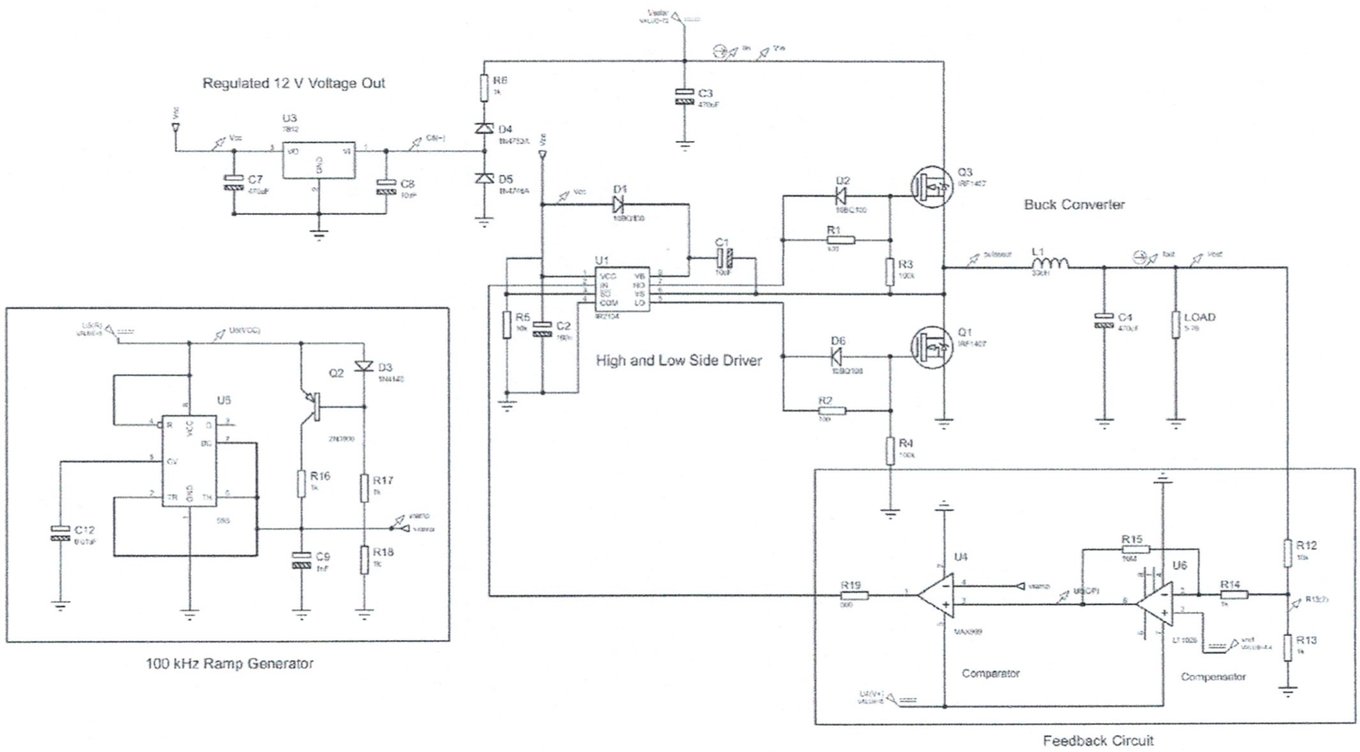


Figure 7. Schematic of the LCB

Design of Cart and Solar Panel Stands

A cart that would be used to transfer the irrigation system was designed considering the dimensions of the selected solar panels. To lessen the costs, market-available black iron was used and finished with waterproof paint. Figure 8 shows the design of the movable frame for the solar power station.

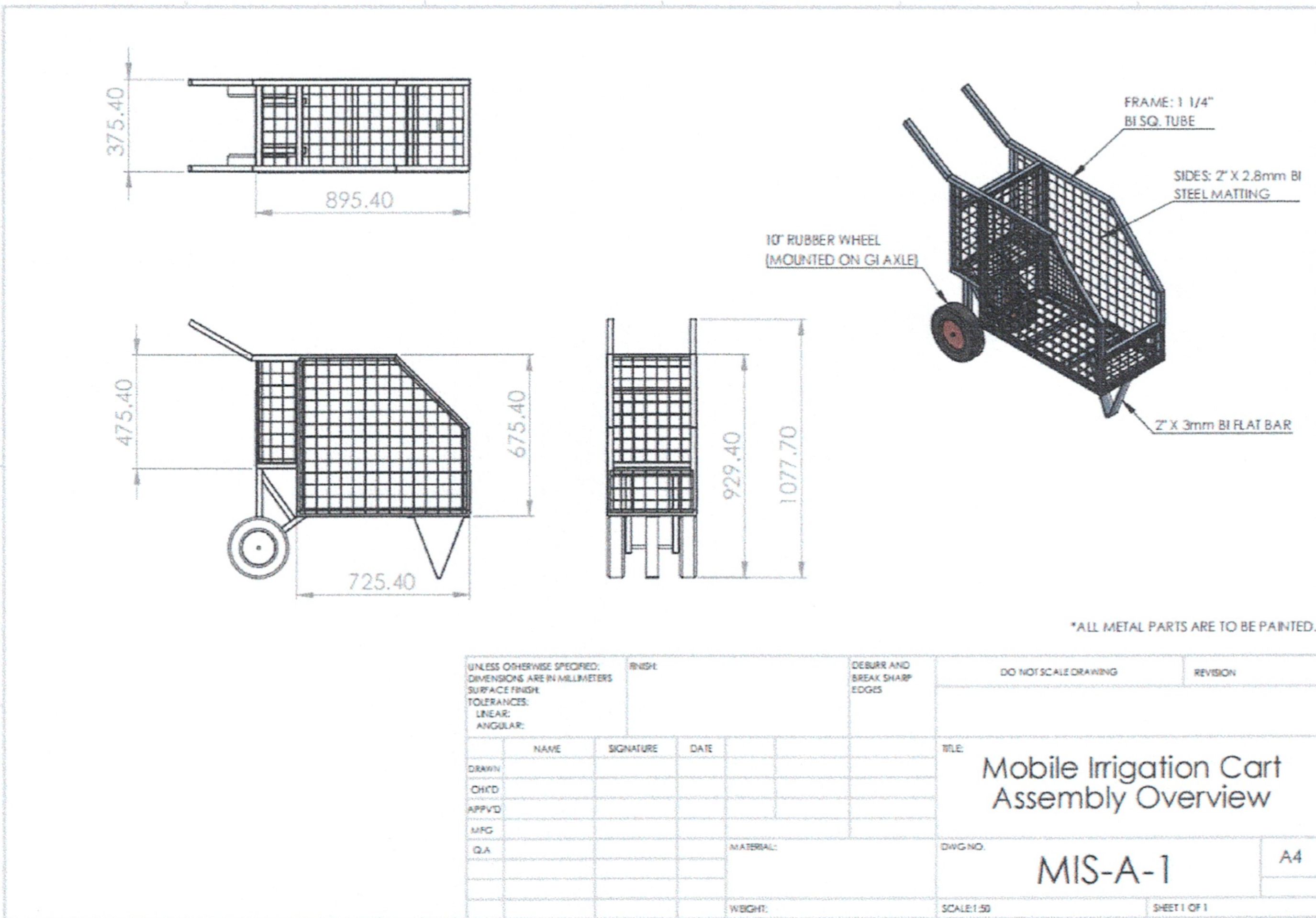


Figure 8. Design of Cart

Frames that were used to deploy the solar panels were also designed. To lessen costs, a simple collapsible mechanism was adopted as shown in Figure 9.

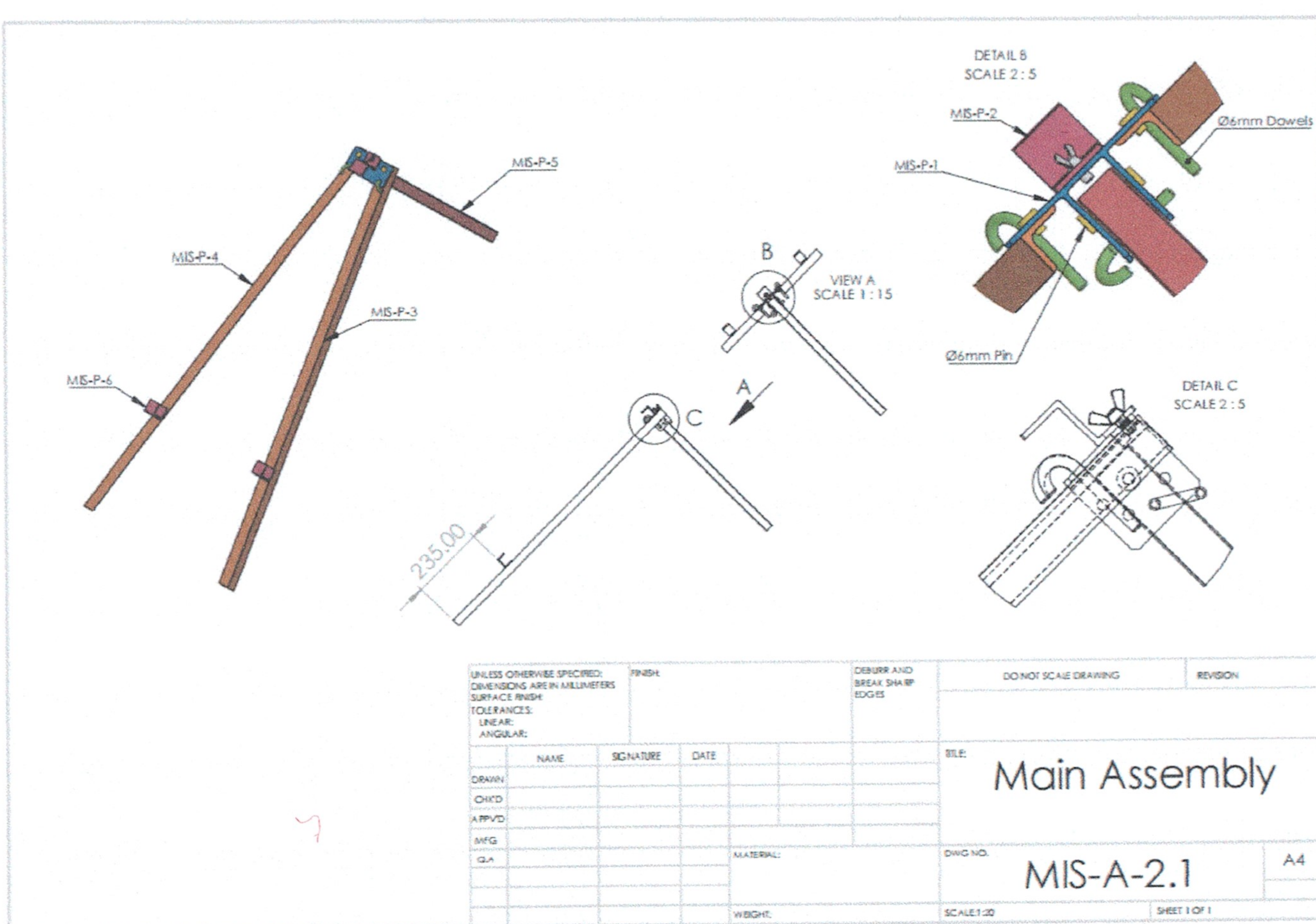


Figure 9. Design of Solar Panel Stands

The LCB circuit shown in Figure 4 was simulated using LTSpice. The inductor and capacitor values were adjusted until the desired transient response was achieved. The simulation is shown in Figure 7.

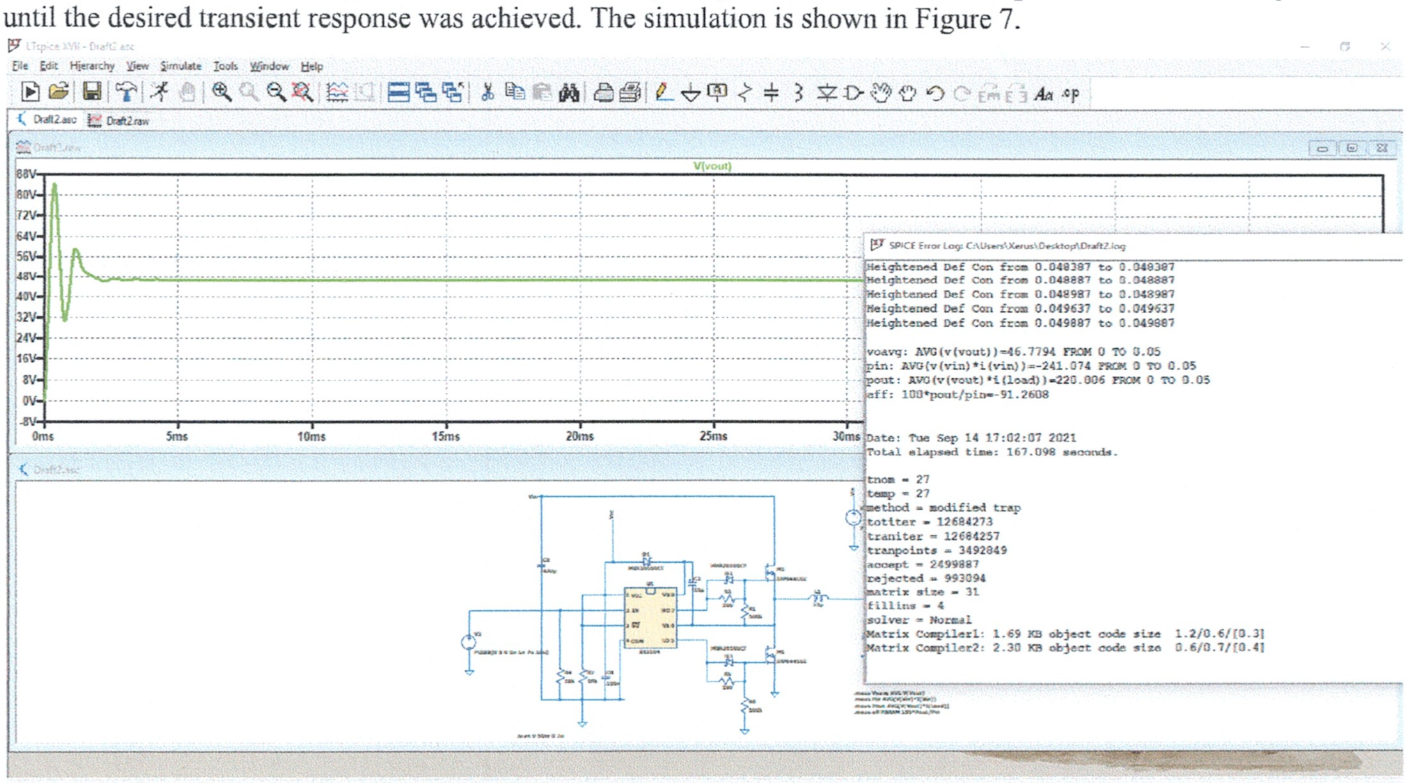


Figure 10. Simulation of LCB

<u>Assembly</u>

The pictures below show the assembly process of the irrigation cart, panel stands, and photovoltaic system.

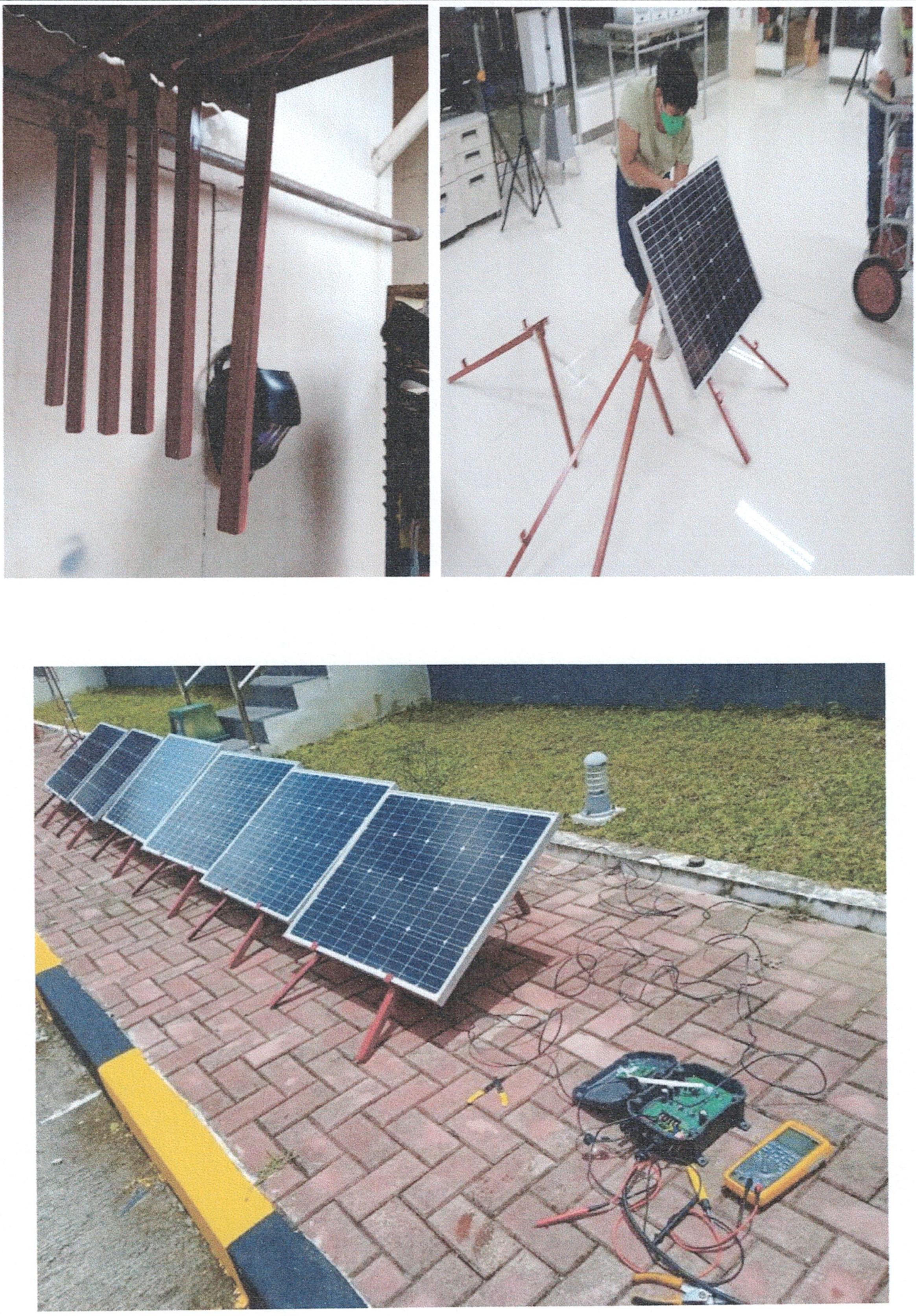


Figure 11. Assembly

3. Installation, Technology Transfer and Evaluation

Construction of Deep Well and Clearing of Trees

Installation of the pump in the spring necessitated that the spring was developed into a deep well to avoid its collapse when . Additionally, a separate hole was bored for the inlet of a gasoline pump which would aid the solar pump in cases of low water output.

Some coconut trees were also cut by the owner to avoid overshadowing the solar panels.

Figure 12. Construction of Deep Well

Testing and Technology Transfer

On July 14, 2022, the system was tested in the project implementation site and was found to be working as expected.

Figure 13. Site Testing

On July 26, 2022, the system was transferred to the beneficiaries. Training in the use and maintenance of the technology was also conducted; the event was attended by representatives from Lobo Municipal Agricultural Office, Lobo Irrigation Services Association, and Batangas State University. Operational Manuals were also distributed among the participants. Figure 14 shows the photos taken during the event while Figure 15 shows a portion of the distributed manuals.

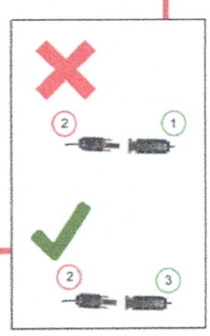
Figure 14. Technology Transfer

II. ELEKTRIKAL NA KONEKSYON

BABALA:* *Huwag pagdudugtungin ang mga kableng may kulay pulang label sa mga kableng may kulay berdeng label.Ito ay magiging sanhi ng short circuit.

HINDI kabilang dito ang mga sumusunod:

Kable #2 at #3
Kable #4 at #5
Kable #6 at #7
Kable #8 at #9



Mga Hakbang sa pagkonekta ng irrigation system:

1. I-off ang switch ng Pump Controller.
2. Ikonekta ang mga Kable #2 at #3.
3. Ikonekta ang mga Kable #4 at #5.
4. Ikonekta ang mga Kable #6 at #7.
5. Ikonekta ang mga Kable #8 at #9.
6. Ikonekta ang mga Kable #1 at #18.
7. Ikonekta ang mga Kable #10 at #11.
8. Ikonekta ang mga Kable #18 at #17.
9. Ikonekta ang mga Kable #11 at #16.
10. Ikonekta ang mga Kable #19 at Kable A.
11. Ikonekta ang Kable A sa Pump Controller.
12. Ikonekta ang mga Kable #14 at #15.
13. Ikonekta ang mga Kable #13 at #12.
14. Ikonekta ang mga Kable #12 at Kable B.
15. Ikonekta ang Kable B sa Pump Controller.
16. I-check muna kung naka-off pa rin ang switch ng Pump Controller dahil baka ito ay nasasagi.
17. Ikonekta ang Kable C ng Pump Controller sa Kable #21 ng Pump.
18. Ikonekta ang Kable D ng Pump Controller sa Kable #22 ng Pump.
19. Ikonekta ang Kable E ng Pump Controller sa Kable #23 ng Pump.
20. Para mabuhay ang pump, I-on ang switch ng Pump Controller.

Maaaring gamiting gabay ang Dayagram 1 sa ibaba at Dayagram 2 sa susunod na pahina sa pagkakabit ng mga kable.

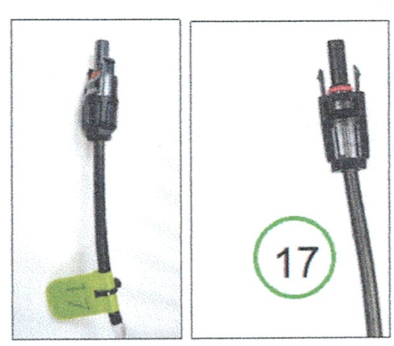


Figure 15. Portion of Distributed Manual

VIII. Conclusions

The project successfully transferred to a farmer beneficiary an irrigation system that is mobile, solar-powered, and battery-less.

A technical site assessment conducted on the municipality is necessary to create the model for evapotranspiration in the target site. Soil type, effective rainfall, site elevation and geodata, type of crops, and amount of solar radiance were used to calculate the farm water requirement of the selected site which is 36mm/day. To provide this, a 400-W submersible pump was selected powered by six 100W solar panels.

In conclusion, the project met all its targets and objectives.

IX. Recommendations

It is recommended that weather-proof materials are used to extend the life of the system. This may entail a larger initial cost but can provide a long-term benefit. The impact analysis should be done after 2-3 years of operation using the developed system to quantify the benefits provided by having such technology.

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Project Title: Solar-Powered Mobile Irrigation System for Rice Paddy in Lobo, Batangas

Project Leader: Dr. Anton Louise P. De Ocampo

Project Staff: Mr. Melmar Eje

Duration: 16 August 2021 to 30 July 2022

Approved Budget: PHP 298,500.00

Expected Output		Delivered Output
Indicators (6Ps & 2Is)	**Target**	
People Trained (Faculty, Students and External Clients)	The beneficiaries from Lobo, Batangas are trained in the use and maintenance of the developed solar irrigation system.	The beneficiaries from Lobo, Batangas were trained in the use and maintenance of the developed solar irrigation system, which is now being used in the implementation site.
Products Developed	An irrigation system powered by a photovoltaic array is developed along with a mechanism that makes the system easy to deploy and disassemble	An irrigation system powered by a photovoltaic arraywas developed along with a cart and solar panel stand mechanism that makes the system easy to deploy and disassemble.
Patents (IPs filed)	Intellectual property protection applications is applied for the design of the mobile irrigation system.	Intellectual property protection applications were applied for the design of the mobile irrigation system and Linear Current Booster.
Publications (published)	A scientific paper is submitted for publication.	A scientific paper was submitted for publication.
Partnerships	A partnership was established with the Municipal Agricultural Office of Lobo.	A partnership was established with the Municipal Agricultural Office of Lobo and Lobo Irrigators Services Association.
Programs / Projects Implemented	The project "Solar-Powered Mobile Irrigation System for Rice Paddy in Lobo, Batangas" is implemented.	The project "Solar-Powered Mobile Irrigation System for Rice Paddy in Lobo, Batangas" was implemented
Number of Clients Served	At least 1 farmer beneficiary is served.	Farmer-members of Lobo Irrigators Services Association were served.