DOST Form 2 (for Basic/Applied Research)

DETAILED RESEARCH & DEVELOPMENT PROJECT PROPOSAL

(1) PROJECT PROFILE

Program Title: Local Grant-in-Aid
Project Title: Design and Development of Fuel-Efficient Kiln for salt bed tiles
Project Leader/Sex: Michelle D. Enriquez / Female
Project Duration (number of months): 12 months for project implementation / 24 months for monitoring of outcomes
Project Start Date: October 2024
Project End Date: September 2027
Implementing Agency (Name of University-College-Institute, Department/Organization or Company):
Occidental Mindoro State College-Main Campus
Address/Telephone/Fax/Email (Barangay, Municipality, District, Province, Region):
Barangay Labangan Poblacion, San Jose, Occidental Mindoro

(2) COOPERATING AGENCY/IES (Name/s and Address/es)

Occidental Mindoro State College, San Jose, Occidental Mindoro
Tamaraw Salt Producers Cooperative of Occidental Mindoro

(3) SITE(S) OF IMPLEMENTATION

IMPLEMENTATION SITES NO.	COUNTRY	REGION	PROVINCE	DISTRICT	MUNICIPALITY	BARANGAY
1.	Philippines	MIMAROPA	Occ. Mdo	Lone	San Jose	Mapaya

(4) TYPE OF RESEARCH

____. Basic
__✓__. Applied

(5) R&D PRIORITY AREA & PROGRAM (based on HNRDA 2017-2022)

____ Agriculture, Aquatic and Natural Resources
Commodity: _____
____ Health
Priority Topic: _____
__✓__. Industry, Energy and Emerging Technology
Sector: Agriculture
____ Disaster Risk Reduction and Climate Change Adaptation
____ Basic Research
Sector: _____

Sustainable Development Goal (SDG) Addressed

INDUSTRY INNOVATION AND INFRASTRACTURE

(6) EXECUTIVE SUMMARY (not to exceed 200 words)

This project proposal aims to develop a fuel-efficient gas kiln specifically for fabricating salt bed tiles for salt farmers in Occidental Mindoro. Kilns, which are industrial ovens used to fire clay products, have evolved to enhance material processing, thermal efficiency, and environmental considerations. The project seeks to provide an efficient kiln design that meets the needs of salt farmers, as current kilns in the province offer limited opportunities for mass production due to high energy and material consumption. The proposed cross-draft kiln ensures uniform heat distribution in the cooking chamber while minimizing fuel consumption. The kiln features a rectangular-shaped oven for salt bed tiles, enclosed with metal sheets for heat insulation. The cooking chamber, with a capacity of five layers, can accommodate 550 salt bed tiles per layer, allowing for a total production of 2,500 tiles per batch. Additionally, the kiln is equipped with a programmable unit for automated control of firing operations and an airflow mechanism to ensure safe, efficient, and environmentally friendly operations. This design aims to optimize production capacity while maintaining sustainability and reducing fuel consumption.

(7) INTRODUCTION

(7.1) RATIONALE/SIGNIFICANCE (not to exceed 300 words)

Based on the 2021-2026 Philippine Salt Industry Roadmap, Occidental Mindoro is considered as the largest salt producer in the country contributing to approximately 65, 000 MT for 876 ha annually (Khongun, 2020). But a factor affecting the salt production in the province causes the decline and placed the salt industry in a thriving situation. The changing climate conditions, environmental factors, declining labor workforce and availability of materials for salt beds are considered as the major players

triggering the reputation of the province in salt industry. Most of the salt ponds in the province still uses the traditional evaporation ponds with salt beds made up of tiles laid purposely to store the salt water, and provides an area for crystallization to occur and where harvesting of salt crystals took place. Clay tiles prevent the salt from coming into contact with the soil and avoid the intrusion of impurities in the white crystals. Therefore, salt bed tiles are vital components of salt farms that need to be examined to determine its capability to yield maximum production and good quality. Salt beds tiles or commonly known as "tisa" is a product of an oven-dried or kiln dried clay. At present there are almost 35, 000 salt beds in the province (TAMACO, 2023). Most of the clay tiles were from Ilocos Region but the province is now facing insufficient sources of raw materials: Vigan clay and the woods for kiln and as triggered by the shifting of traditional pottery to plastic technology. These problems were felt by the local salt producers as Vigan tiles are gradually disappearing. At most, 750 kilos of tiles is needed for a new salt bed; and an average of 2-3% for every three years tile replacement. But the availability of the kiln and furnaces are limited in the province and feedback from the users of local tiles stated weak property of the clay tiles to resist the salt intrusion and tend to pulverize in a small period of time. As the salt industry embraces the development of technology to optimize the salt production processes, one possible solution is the development of a fuel-efficient kiln to sustain the needs for salt bed tiles. This prompted the development of the proposed fuel-efficient cross-draft kiln that can offer an automated system considering the uniform heat distribution and optimum production capacity.

(7.2) SCIENTIFIC BASIS/THEORETICAL FRAMEWORK

According to the study that aimed to improve salt production in Occidental Mindoro by profiling local salt farms and identifying production methods and challenges. Findings revealed that all farms use solar evaporation and produce market-driven salt qualities. Effective management ensures good salt quality despite lacking quality assessment facilities, and producers sell their salt immediately due to guaranteed buyers, not the absence of post-harvest facilities. Producers are eager for new technologies to boost production. The study recommends enhancing salt quality for higher market prices, emphasizing collaboration among producers, farmers, and the government for industry prosperity (Mae, et al., 2023).

This study is based on the current issues in salt production of the salt farmers in Occidental Mindoro with the ultimate objective of producing clay tiles for salt bed needs in the province. Driven with the desire to respond to the increasing needs in the salt bed tiles, the proposed design considered existing kilns and the limitation they offer that opted farmers to procure the so-called Vigan clay tiles. As the Vigan clay tiles are becoming obsolete due to the scarcity in the raw materials, salt farmers are starting to look for additional sources of salt bed tiles. A promising opportunity is offered by the abundant source of red clay tiles in the province, however, a sustainable and efficient kiln for mass production is needed to fire up the clay and produce the desired quality of salt bed tiles.

The proposed design of fuel-efficient cross-draft kiln considered existing kilns that use LPG-ignition burner, electrically operated kiln and wood-fired kilns. Eventually, these kilns were not sustained as economic cost hinders the full utilization of the existing kilns. This project proposal is micro-controlled to ensure efficient flow and uniform distribution of heat in the cooking chamber. By utilizing gas as a fuel source, this gas kiln offers higher efficiency compared to traditional kilns that use lumber or wood. It achieves this efficiency by mixing fuel gas with air in the correct proportions to generate a high-temperature flame, ensuring uniform heating within the kiln chamber. Modern gas kiln burners often feature advanced temperature control mechanisms, allowing precise adjustments for specific temperature profiles. The proposed project also has safety features such as flame sensors and automatic shut-off systems to ensure reliable flaming operation. The proposed kiln is equipped with PLC in the control circuits that serve as the brain of the automatic operations and manage the various sensors such as temperature sensors to monitor the internal and external temperature; and the pressure sensors for the monitoring of the combustion and air-flow levels. By continuously analyzing data from these sensors, the PLC will make real-time adjustments to optimize the machine's performance. This results in enhanced firing process efficiency, precise fuel consumption control, and improved product quality. The integration of PLC technology ensures reliable and intelligent automation, streamlining the process and delivering consistent, high-quality results.

(7.3) OBJECTIVES

Generally, the objective of the study is to develop and design fuel-efficient cross-draft kiln for the production of salt bed tiles.

It specifically aims to:

1. Design and fabricate fuel-efficient kiln for salt bed tiles;
2. Evaluate the performance of fuel-efficient kiln in terms of:
    - fuel consumption rate;
    - power consumption rate;

- temperature;
- cooking time of salt bed tiles;
- production capacity
- Quality of the produced salt bed tiles in terms of compressive strength.

3. Provide production cost analysis and selling price of clay tiles per piece.

(8) REVIEW OF LITERATURE

Based on the 2021-2026 Philippine Salt Industry Roadmap by Khonghun (2020) Occidental Mindoro is the largest local salt producer in the Philippines, averaging 65,000 metric tons annually from 876 hectares. In comparison, Pangasinan produces 50,000 metric tons from 800 hectares. Most of the salt ponds in the Philippines uses the traditional evaporation ponds with salt beds made up of clay tiles laid purposely to hold the salt water, and provides an area for crystallization to occur where the salt crystals form. Clay tiles prevented the salt from coming into contact with the soil and avoid the intrusion of impurities in the white crystals. Therefore, salt bed tiles are vital components of salt farms that need to be examined to determine its capability to yield maximum production and good quality. Salt beds tiles or commonly known as "tisa" is a product of an oven-dried or kiln dried clay. Almost all salt production in San Jose, Occidental Mindoro uses solar evaporation and clay tiles are the dominant salt bed material (TAMACO, 2023). Most of the clay tiles were from Ilocos Region but the province is now facing insufficient sources of raw materials as the so-called Vigan clay is triggered by the shifting of traditional pottery to plastic technology. Almost 93.3% of the salt farms in the province of Occidental Mindoro use the Vigan clay (Saulong, et al., 2023). At most, 750 kilos of tiles is needed for a new salt bed; and an average of 2-3% for very three years tile replacement. This requirement for the tile prompted the researchers to develop a technology that can help the salt industry to have available salt tiles bed.

Clay bricks are usually fired in kiln to obtain the maximum strength to hold the brine solution. The presence of firing system is can be classified as intermittent and continuous considering the flow of heat and flue gases up-draught, down-draught and horizontal or cross-draught (Ecosur, 2006; USEPA, 1997; Merschmeyer, 2000. The use of fully or partially enclosed kiln structures allowed the adequate circulation during the cooking process but was describe having low energy efficiencies when compared with continuous kiln (Lopez, et al. 2012). On the other hand, continuous kiln are sophisticated type having suction fan or chimney (RSPCB, 2011; Maithel, et al. 2012). Kiln is usually described as a container where clay or ceramic materials are placed and heated to certain temperature to achieve a desired product (Peterson and Peterson, 2003; Oteng, 2011). Today, kilns can be classified as coal burning kilns, oil fired kilns, electric kilns, firewood and gas kilns. Each of this type had gained popularity with advantages and disadvantages each have. The use of coal burning kilns provided a consisted firing rate but the availability is becoming a problem. The oil fired kilns is complicated and costly and produced fumes increasing the air pollution. The electric kilns are the most convenient but the cost of electricity hindered its acceptance (Oteng, 2011; Nelson, 2002; Chavarria 1993). The firewood kilns constructed with the right type of material can provide a good operating system but produces inevitable smoke contributing to air pollution. Lastly, the gas kilns are inexpensive and can achieve very high temperature and has low maintenance cost (Oteng, 2011; Norton, 1956).

Technologies related to the development of kiln continuously seek improvements as system components and detailed design become a challenging opportunity for inventors and developers. The automatic system of tunnel kiln of Zhang (2010) is characterized by a main kiln, a drying kiln, a kiln head self-acting trailer, a kiln tail self-acting trailer and a turning lane arranged to completely replace the manual operation by adopting a complete automatic process, control system, complete automatic control, to lessen the human efforts and increase the production efficiency. The use of gas or electric kilns also become popular and considered as the most suitable in firing ceramic products. In Ghana, the use of Liquefied petroleum gas (LPG) becomes the most economical method and being promoted by their government. Likewise, an automatic gas tunnel kiln using relay logics and Variable Frequency Drives (VFD's) was produced to cater the needs of the porcelain clay industry in Bengaluru, India (Mahesh, et al, 2020). In the Philippine, the use of gas kilns and wood fired kilns are commonly used by clay and ceramic industry due to resource availability and economy (Casal, 2012).

FPRDI has developed and commercialized 2 kinds of furnace-type kiln dryers. These can be used for drying lumber and non-wood forest products (NWFP) such as rattan, bamboo, woody vines, buri, pandan etc (Cuaresma, 2002). The temperature and relative humidity inside the kiln are determined using dry and wet bulb sensors connected to temperature gauges. These operate within a temperature

range 21oC to 82o C (70oF to 180oF). **Drying Chamber:** The drying chamber measures 3.0 meters (10 feet) in width, 4.2 meters (14 feet) in length, and 2.4 meters (8 feet) in height, providing a total drying area of 9.0 square meters (100 square feet). The structure features a square tube metal frame with double-walled, 6mm thick fire-resistant Hardiflex boards. Between the walls, a 50mm thick layer of styrofoam serves as heat insulation. The inner walls, including exposed metal parts, are coated with "Weatherkote Type 3" to ensure waterproofing and reduce heat loss through the structure. The chamber is designed to be airtight, with a single main door for loading and unloading materials. It includes two air inlet vents on the front wall and two exhaust vents on the back wall. A firewall, constructed of fire-resistant double-walled Hardiflex board with 50mm thick styrofoam in between, separates the heat exchanger from the loading area.

The gasifier-combustors function based on the principle of an open core, batch-type gasifier. The gas produced in the reactor, which has a heating value of 3,900-4,000 kJ/SCM, is either ignited at the gas exit or directed to thermal equipment. Two reactors with internal diameters of 45.72 cm (drum-size) and a larger square unit with dimensions of 105 cm x 105 cm were utilized. The drum-size gasifier-combustors were used to fire clay bricks in a small wood-fired kiln, with four drum-size units also used to fire bricks in a shuttle kiln. Results showed that a temperature of 750 ± 50°C was achieved within the kiln during an 8-hour firing period. Laboratory tests on the fired products indicated that their properties met established standards. Initial tests using the drum-size units in a food dryer (indirect drying) and a grain dryer (direct drying) demonstrated that the gasifier-combustor could maintain the necessary temperature within the drying chamber or plenum. Economic projections indicate that adopting the gasifier-combustor for food and grain drying is financially viable. Additionally, other agro-wastes such as coconut husks, corn cobs, and coffee hulls were successfully tested as fuels in the drum-size units. The large unit, capable of delivering 1 million kJ/hr, will be connected to a 6 cu. m. wood-fired kiln for brick firing. It is anticipated that this type of equipment will be used as a heat source for boilers in power generation and process heating (Vinluan, F.D., et al., 1991).

(9) METHODOLOGY

Kilns have been essential tools for firing ceramics, pottery, and other materials for centuries. It plays a crucial role in transforming raw materials into finished and durable products such as tiles, bricks, pots and other earthen products. The evolution of kiln technology from traditional wood-fired kilns to modern gas kilns has brought significant improvements in efficiency, control, and consistency.

. The proposed machine will be fabricated by a local tinsmith/fabricator in Occidental Mindoro. The performance of the developed kiln will be evaluated using actual field testing considering the heat combustion, fuel consumption, volume of salt bed tiles produces and quality of the product. The fabrication of the proposed kiln will also consider the safety and durability of the machine by selecting the best materials; the performance testing will be validated by the experts in brick production in the province.

Phase 1- Research, Planning and fabrication

The project initiation involves a comprehensive review of related literatures, existing kilns and construction regulations and safety protocols needed for product development. The initial phase includes a careful consideration of the design components, materials specifications and performance operations to ensure that the proposed kiln will adhere to the safety standards and the needs of the salt farmers.

A pivotal aspect of the planning stage is the careful scheduling of meetings, aligning with a predetermined timeline. These meetings facilitate a step-by-step discussion of procedures, promoting a well-organized and seamless planning process from inception through to evaluation. This strategic approach guarantees that the preparatory phase is thoroughly mapped out and executed, laying the groundwork for a secure and effectively managed construction process.

The fabrication begins on the assembly of the frame using high iron steel to sustain its operating temperature. The proposed project is approximately 3mx2mx2m (Length, Width and Height); the body of the machine is covered with 150mm high-grade metal sheet placed on a heat insulation material that

can minimize the heat loss inside the kiln chamber; next is the fabrication of slider and rack with roller. The cooking chamber is designed to have a capacity of five (5) layers designed to accommodate 550pcs salt bed tiles per layer the proposed kiln is designed to produce 2,500pcs salt bed tiles per batch of cooking. The designed temperature of the proposed kiln is 900^0C to 1200^0C. The cooking chamber is covered with fire bricks to provide insulation. The chimney system is designed to discharge the hot gases and fumes during the firing process and designed to control the air circulation and prevent the build-up of harmful substances inside the kiln. Further, the machine is equipped with six (6) gas burners and has a connected air blower with adjustable air vent on the rear part of the gas burner to minimize gas consumption. The installed blower fan is controlled by a VFD or Variable Frequency Drive that adheres to the operation of the six blower fans; this will control the speed by controlling the frequency of the fan that suits to the fuel efficiency of gas kiln. The blowers are designed to open automatically after the ignition cycle of the burner. Each burner is equipped with electronic igniter to automatically fire the gas during the ignition process. The temperature gauge is installed on the top part of the gas level as additional safety features. The high-pressure gas rail line is equipped with a Rail Pressure sensor to ensure the accurate gas pressure gauge, and this is designed to shut-off the solenoid valve to reduce the risks of any explosion caused by gas leaks. This part is controlled by the PLC or Programmable Logic Controller. The machine is also protected with a manual shut-off valve to ensure safety for gas leaks. A thermocouple is also installed to the upper part and bottom part of the kiln connected to the microcontroller to manipulate the initial reading of temperature inside the chamber. The proposed machine is also equipped with control panel placed along with electronic devices intended for various purposes: the VFD/ Variable Frequency Drive, microcontroller, MC/ magnetic contactor, Voltmeter, UI-User Interface or LCD screen, indicator bulbs, and push button switches.

4.1 Phases of Activities

The following are the different phases of activities to be carried out:

Phase 2 – Release of Funds

Once all the documents are submitted and approved, DOST-MIMAROPA, through PSTO-Occidental Mindoro will download/release the approved project funds to the respective builder.

Phase 3 – Training of Technical staff

Training of the technical staff including the members (men and women) of the Team who are involved in the project will be conducted, particularly on the design, fabrication, installation, operation and maintenance, testing and evaluation of gas kiln. This activity basically will give freehand information and understanding on how the project is to be undertaken and how it is to be scaled in relation to its future application.

Phase 4 – Fabrication and Functional Testing

Once the design plan is completed and discussed with the Project Team, listing of the appropriate materials and equipment/tools needed will follows. The project team will then present the design to the selected CF to finally iron out everything before the fabrication process.

Regular monitoring during the fabrication will be conducted to ensure that the unit will be built as per specifications provided by the Designer. Materials to be used will be checked to ensure that they strictly conform to required specifications. In case of unavailability of the specified materials in the drawing, the Team and the Fabricator will discuss the possible alternatives fitted to the material/component requirements.

Components of the gas kiln unit will undergo functional testing and energization before the installation and upon approval of the Team. The components that will be subjected to functional testing will include the burners, temperature gauge, rail pressure sensor, blowers, VFD, MC, pilot thermocouple and other accessories.

Phase 5 – Installation and Preliminary Testing

After ensuring the functionality of the different parts of the Gas Kiln, the unit will be installed at the TAMACO facility. Prior to the installation, the Team will visit the area to ascertain the location and to prepare the necessary pre-constructions activities.

Phase 6 – Operation and Performance Testing and Evaluation

The performance testing and evaluation of gas kiln will be conducted by OMSC together with the consultants from DOST, TAMACO and other concern stakeholders. The initial test will use the pressurize

air tanks to simplify the operation of gas kiln. This will trace any leaks from the gas lines and other pressurizes lines; and it will undergo a thorough inspection for some unintended faults/ asynchronization. A 5-minute interval will be implemented to assure the safety adherence to standard.

From the data gathered, the following parameters will be analyzed: (1) Fuel/Gas consumption rate – will be measure using the installed gas meter and digital logger to ensure the actual gas consumption of gas kiln and record the initial duration (time) per cycle; (2) power consumption rate- will be measure using a digital watt meter by observing the data and compute necessary power consumption per cycle; (3) temperature will be measure using the installed thermocouples and a digital pyrometer to read actual readings from thermocouple; (4) cooking time will be measure by cooking the tiles in 3, 3.5, 4, or 5 hours per cycle at 900 to 1,200 degree Celsius; (5) and the quality of the produced salt bed tiles by performing the compressive strength of the material (clay) and water absorption. During the actual testing of the gas kiln, data sheets will be provided to the Technical staff and salt farmers to fill-out during operation. Data to be recorded in the data sheet include: (a) fuel efficiency; (b) operating period; (c) quality of well-cooked clay tiles; and (d) others.

Test the product with consultation in ITDI for material testing and evaluation. (RTEC Comments)
Conduct comparative analysis on the actual test result of using the proposed machine and compare it to ITDI result of clay tile produce using local raw materials in terms of compressive strength and water absorption rate to determine which factors affects most and which materials are best.

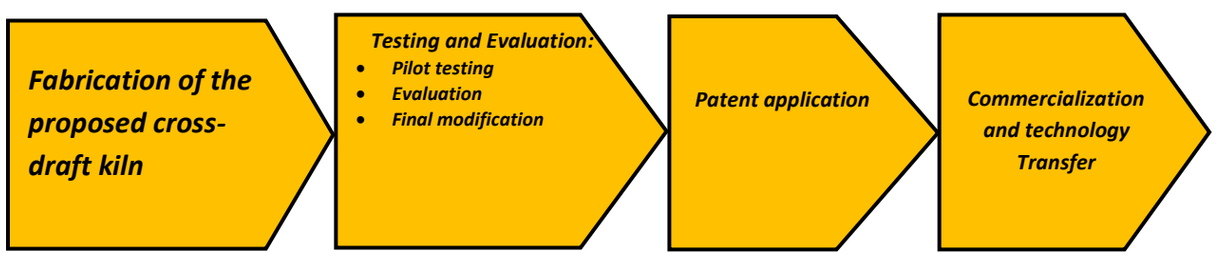
Phase 6 – Socio-Economic and Environmental Impacts Assessment
The following information will be assessed from the project:

(1) Economics - Operating cost of the gas kiln per hour, produce cooked clay tiles per cycle, payback period, Benefit-Cost Ratio (BCR), and Return on Investment (ROI) will be analyzed based on the actual data gathered.
(2) Social Benefits - Information on the social benefits that can be derived from operating the gas kiln development through focus group discussion with the respective officials concerning on the projected ROI. This includes information on the savings derived, added income, labor opportunities, etc.
(3) Environmental Impact - This includes noise pollution, CO and CO2 emission, etc.

Instrumentation
The following instruments will be used during the testing of the engine-gasifier units:

1. Digital Stop Watch – This will be used to record the operating time of the proposed gas kiln.
2. Tachometer – This will be used to measure the speed of the engine shaft as well as of the generator shaft.
3. Digital pyrometer– This will be used to measure the internal and external temperatures and entire parts of the gas kiln.
4. Pressure Gauge - This will be used to determine the pressure required in the gas kiln.
5. Thermo-Anemometer/Data Logger - This will be used to determine the velocity of the gas passing through the gas pipe in order to account for the air or gas flow in the gas kiln.
6. Pressure Manometer – This will be used to determine the air flow of the blower fans.
7. AC Clamp Meter or Ampere Meter – This will be used to measure the current output of solar energy and the consumption of blower fans and other electronic devices connected in gas kiln.
8. Multi-Meter or Volt Meter – This will be used to measure the voltage output of the generator.
9. Hertz Meter – This will be used to measure the output cycle of the blower fan.
10. CO meter - This will be used to determine the amount of carbon dioxide emitted on the surrounding of the gas kiln during testing.
11. CO2 meter – This will be used to measure the amount of carbon dioxide emitted on the surrounding of the engine during testing.

(10) TECHNOLOGY ROADMAP (if applicable) (use the attached sheet)



(11) EXPECTED OUTPUTS (6Ps)
Publication

Out of this project, technical papers will prepare for paper presentation at the Philippine Salt Congress and other presentations related to Industry, Energy, and Emerging Technologies convention. Research paper will also be written and be submitted for publications in journals, or as book chapter. Technical and operation manuals of the gas kiln system will be prepared which can be used as materials for seminars/trainings to be conducted in the future.

Patent/Intellectual Property
The Utility model will be applied for patent for the design and for the operation of the proposed design.

Product
The proposed cross draft kiln is designed to cater the needs of the slat industry for salt bed tiles. The proposed machine is designed to cook the clay tiles placed in the chamber under specified the temperature. The proposed design will be equipped with micro controllers that will act as the brain of the product and control al related system components. The proposed product is designed with Programmable logic circuit that manages the temperature sensors to monitor the internal and external temperature; and the pressure sensors for the monitoring of the combustion and air-flow levels.

People Service
More people will benefit from it for low-cost and readily available clay tiles can be used for minor or major replacement of salt bed tiles. More skilled workers such as welders, mechanics, technical staffs of farmers' cooperatives, engineering students, researchers and developers, etc. will have the opportunity to have hands-on experience, in designing and operating a gas kiln.

Place and Partnership
Fabrication shops/manufacturers, other research institutions, colleges and universities, sales and distributors, etc. will have the prospect to engage in partnership with DOST-MIMAROPA.

Policy
None

(12) POTENTIAL OUTCOMES
This project will lead to the:

a. Development of cross draft kiln for firing/cooking of salt bed tiles;
b. Production of quality salt bed tiles as needed by salt farmers;
c. Optimize the available Mindoro red clay as raw materials in the production of the salt bed tiles;
d. Readily available and low-cost salt bed tiles for repair and replacement needs of the farmers;
e. Long-term impact on women's socioeconomic empowerment.

(13) POTENTIAL IMPACTS (2Is)
Social Impact- The technology can provide salt farmers' cooperatives access to engage in a more profitable business that can provide additional income for their members, and to have accessible locally made available clay tiles in the province.

Economic Impact- Cost reduction on their farming expenses especially in buying of clay tiles from other provinces (field and postharvest processing) operation. Added revenue to both local and national governments can be expected. Minimize the cost of other salt farms owners on importing clay tiles.

(14) TARGET BENEFICIARIES
Name: Tamaraw Salt Producers Cooperative of Occidental Mindoro (TAMACO)
Address: Pag-asa, San Jose, Occidental Mindoro
Date Organized: December 10, 2010
CDA Registration Number: 9520-04017607
Date of Registration: December 10, 2010
Current Membership: 27
Business Activities: Salt production and Aquaculture Production
Successfully-implemented projects:

(15) SUSTAINABILITY PLAN (if applicable**)**

Upon the completion of the project development and ensuring the performance efficiency of the developed cross draft kiln, the DOST PSTO Occidental Mindoro technical team and OMSC team will conduct training with TAMACO and all personnel involved in the operation and maintenance of the machine. The technology developed will be transferred to TAMACO as the main beneficiary and responsible on the commercialization of the end product of the machine. Whereas, the OMSC team will handle all researches, patent application and other activities related to the efficiency of the machine, characteristics of the clay materials and the quality of the end product. Continuous research and development will be laid out during the operational life span of the developed machine.

(16) GENDER AND DEVELOPMENT (GAD) SCORE (refer to the attached GAD checklist)
9.32

(17) LIMITATIONS OF THE PROJECT

The project is limited to the fabrication of fuel-efficient kiln for salt bed tiles using LPG with 6 (six) Forced-Air-Burner with blower controlled by a Variable frequency drive and other related electronic devices. The machine is limited to produce an average of 7, 680 clay tiles. This will provide sufficient supply of clay tiles along the province and other nearby provinces. This also includes performance evaluation of the developed cross-draft gas kiln.

(18) LIST OF RISKS AND ASSUMPTIONS RISK MANAGEMENT PLAN (List possible risks and assumptions in attaining target outputs or objectives.) Please see DOST Form 5C Risks and Assumptions

(19) LITERATURE CITED

Asante-Kyei, K., Asiedu, E., Marfo, S., "Design and Fabrication of Gas Kiln Using Local Materials to Compose Its Refractory Bricks and Mortar." Journal of Arts and Humanities, vol. 8, no. 3, 1 Apr. 2019, pp. 73–84, theartsjournal.org/index.php/site/article/view/1584, https://doi.org/10.18533/journal.v8i3.1584. Accessed 16 Apr. 2024.

Casal, M. (2012). Visiting The Masters of Philippine Pottery: "The Fiery Furnace" (Part 6 of 8)

Chavarria, J. (1993). The Big Book of Ceramics. New York. Watson-Guptill Publication

CUARESMA, C.A. 2002. Rattan Seasoning. Paper presented at the PNOC-EDCTraining/Seminar on Rattan Seasoning and Preservation. PNOC, Ormoc City.

EcoSur (2006) Fired clay bricks. EcoSur Network

Khongun, Gerald C. (2020) 2021-2026 Philippine Salt Industry Roadmap p.9).

Lopez A, Lyoda N, Segal R, Tsai T (2012) Building materials: pathways to efficiency in the South Asia brickmaking industry. The Carbon War Room, school of advanced International studies, Johns Hopkins University.

Maithel S, Lalchandani D, Malhotra G, Bhanware P (2012). A roadmap for cleaner brick production in India. Brick kilns performance assessment, Shakti Sustainable Energy Foundation.

Mahesh, K., Inbasakaran, S., Lithesh, J., & Praveen, S. (2020). Automation Of Gas Tunnel Kiln Using Relay Logics And Variable Frequency Drives. Asian Journal of Current Research, 5(1), 17–24. Retrieved from https://ikprress.org/index.php/AJOCR/article/view/5235

Merschmeyer G (2000) Firing of clay bricks and tiles-wall building. Technical brief, German appropriate technology exchange, Eschborn Germany

Nelson, G. C. (2002) Ceramics: A potter's Handbook. New York. Holt, Rinehart and Winston, Inc.

Norton, F. H. (1956). Ceramics for the Artist Potter, London: Addison Wesley Publishing

Oteng, A .A.(2011). Construction of a Gas-Fired Kiln Using Low-Density Bricks Composed from Mfensi Clay for Schools. K.N.U.S.T. Kumasi: Ghana. Unpublished M.A thesis submitted to the School of Graduate Studies.

Peterson, S. & Peterson, J. (2003). The Craft and Art of Clay: A Complete Potter's Handbook (4th edition). London. Laurence King Publishing Ltd

RSPCB (2011) Environmental guidance manual: Brick kilns. Administrative Staff College Report, Rajasthan State Pollution Control Board, India.

Saulong, V. M. T., Limos-Galay, J. A., & Tampol, R. A. (2023). The salt industry in Occidental Mindoro: Improving the production. International Journal of Research, 11(2), 31-40

Tamaraw Salt Producers Cooperative of Occidental Mindoro, TAMACO (2023). An interview

USEPA (1997) Emission factor documentation for AP-42 Section 11.7, brick and structural clay products manufacturing. Final report, United States Environmental Protection Agency, research triangle, Park North Carolina, USA.

Vinluan, F.D., Jr., A. Santos, L. Pacatang, A. Canayon, M. Valdecanas, W. Balais, E. Sungaben, E. Barnuevo, N. Lontok, R. Padua, J. Aquino, and A. Carandang (1991). Operation and Applicatins of Rice Hull

Gasifier-combustors. Philippine Engineering Journal, XII (3), 49-68. ITDI-DOST, Manila. (1989).

Zhang, M. (2010). Automatic system of tunnel kiln. Google patents

(20) PERSONNEL REQUIREMENT

Position	Percent Time Devoted to the Project	Responsibilities
Fabricator/Supplier	100 %	Fabrication of the Fuel-efficient gas kiln for salt bed tiles
Consultant	75%	Technical aspects of the technology
Researchers	75%	Data gathering and analysis

(21) BUDGET BY IMPLEMENTING AGENCY

IMPLEMENTING AGENCY	PS	MOOE	EO	Total
Year 1		218,068.00	1,350,000.00	1,568,068.00
TOTAL				

(22) OTHER ONGOING PROJECTS BEING HANDLED BY THE PROJECT LEADER: ____ (number)

Title of the Project	Funding Agency	Involvement in the Project
none		

(23) OTHER SUPPORTING DOCUMENTS (Please refer to page 2 for the additional necessary documents.)

I hereby certify the truth of the foregoing and have no pending financial and/or technical obligations from the DOST and its attached Agencies. I further certify that the programs/projects being handled is within the prescribed number as stipulated in the DOST-GIA Guidelines. Any willful omission/false statement shall be a basis of disapproval and cancellation of the project.

	SUBMITTED BY (Project Leader)	ENDORSED BY (Head of the Agency)
Signature		
Printed Name	**MICHELLE D. ENRIQUEZ**	
Designation/Title	Project Leader	
Date	**May 10, 2024**	

Note: See guidelines/definitions at the back.

Prepared by:

MICHELLE D. ENRIQUEZ
Project Leader

Noted by:

VINCENT S. LABINDAO
Supervising Science Research Specialist

Certified Funds Available:

JAY RALPH A. CABIAO
Accountant III

Approved by:

Dr. MA. JOSEFINA P. ABILAY
Regional Director