FISH NEED OXYGEN. WE SUPPLY.

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I. Introduction

In Chisec, Guatemala, aquaculture is a common source of income for the community with an increasing demand for tilapia. This fish is inexpensive and high in nutrients for locals. The limited access to developed technology and power, however, hinders farmer's profitability.

As farmers push for higher yields by increasing fish density, the oxygen available for tilapia is rapidly depleted. To avoid high loss of life, and therefore profit, farmers currently have to limit the biomass in the ponds. If artificial oxygenation is introduced to the ponds, fish yields can double or even triple for the farmers in one harvest season.

Our company, AgInno Institute, is partnering with local Guatemalan farmers and Christian universities to overcome these challenges. Our ONU team was tasked with the implementation of a solar power system to ensure power reliability in addition to optimization and redesign of a paddle aerator to promote longevity and durability.

Previous Olivet teams have designed a preliminary paddle aerator as well as the conceptual design of a solar power system.

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Link to AgInno Institue's website for more information!

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II. Methods

Solar Power System Installation:
- Recalculate system specifications based on peak sun hours, power requirements, and materials available in Guatemala (Table 1)
- Build frame against shed on site to angle solar panels at 15° facing South (Figure 1)

Analyzing longevity and durability:
- 18-HR testing window to analyze hardware, materials, and offset angle
- After passing 18-HR, orientation will be run until failure
- Measuring DO, paddle RPM, and physical observations of quality of aerator

Design concept & testing equipment:
- PVC floating frame, an AC motor, custom designed paddles, a shaft, and a pillow block to prevent shaft vibration
- 1000-gallon testing tub, DO, pH and water temperature sensors, an ESP32 and corresponding wiring

Table 1 – Solar Power System Component Specifications

Component	Quantity	Specification	Other Details
Inverter	1	24V, 1000 W	
Battery	4	12V, 150AH	2S2P connection
Solar Panel	4	33.5V, 9.71A, 330W	Series connection
Charge Controller	1	MPPT ML2430 30A	

III. Results

System Installation in Guatemala:
- Successful installation of the solar power system to power the paddle aerator
- After failure of the paddle aerator, the bubbler was connected to the solar power system
- Existing solar panels can supply power for 3 air pumps for bubblers in ponds

Aerator Optimization
- Necessary hardware includes bolts through the shaft secured by a nut
- Washers help to distribute the load on the paddle material
- 45° angle with 3 and 4 sets of hardware are being compared

Figure 1 – On-site Installation in Guatemala

Table 2 – Longevity and Durability Data

Hardware		Paddle Angle (degrees)	Pass/Fail
Type	Quantity per paddle		
Self-drilling bolt	2	45	Fail
Self-drilling bolt with washers	2	45	Fail
Bolt through shaft with nut and washers	2	0	Fail
Bolt through shaft with nut and washers	3	0	Pass
Bolt through shaft with nut and washers	4	0	Pass
Bolt through shaft with nut and washers	3	45	Fail
Bolt through shaft with nut and washers	4	45	Fail

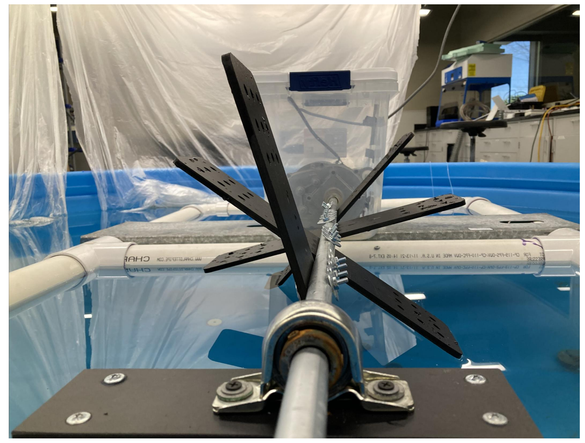

Figure 2 – Setup of 45° Hardware Comparison

IV. Next Steps

- Test durability of reinforced PVC Sintra
- Implement updated aerator design in Guatemala (May 15-20)
- Research motors to improve power efficiency
- Compare paddle aerator and bubbler in a site with oxygen consumption

V. References

[1] "PADDLE WHEEL AERATOR, HS-A120a - Hung Star Enterprise Corp." [Online]. [Accessed: 17-Oct-2019].
[2] "Pond Aeration." [Online]. [Accessed: 24-Oct-2019].
[3] J. W. Jensen, "Paddlewheel aerator design John W. Jensen Extension Fisheries Specialist," *Timely Information Agriculture & Natural Resources*. [Online]. [4] Alam, L. (2017). Risk and Benefits of Tilapia. In B. Richardson (Ed.), Tilapia and trout: Harvesting, prevalence, and benefits. essay, Nova Publishers. Retrieved 2022

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