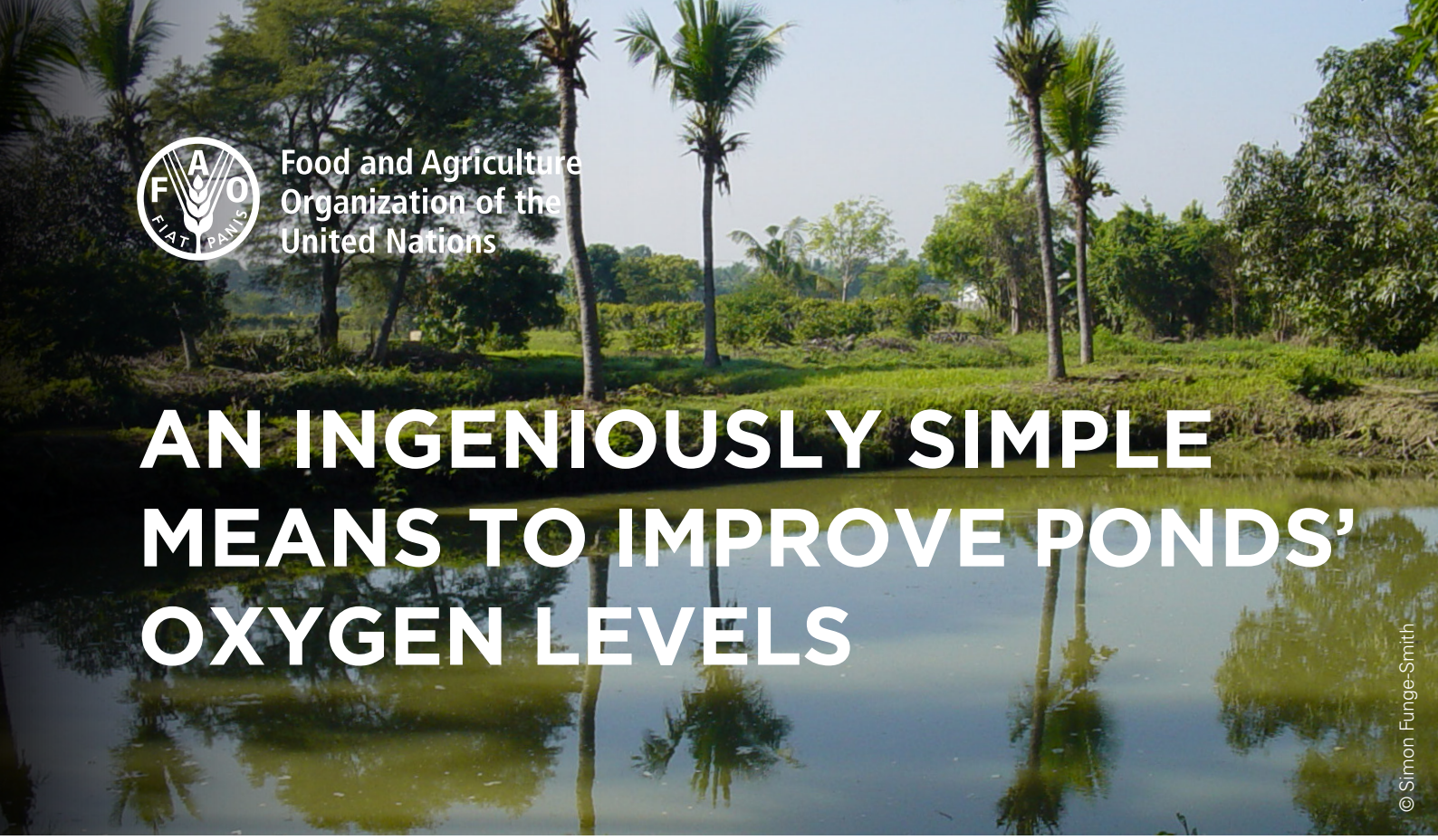


Food and Agriculture Organization of the United Nations

AN INGENIOUSLY SIMPLE MEANS TO IMPROVE PONDS' OXYGEN LEVELS

As trials in the Central Dry Zone of Myanmar suggest, venturi aerators can offer an ingeniously simple and affordable method for farmers to keep their fish healthy, even in the dry season and despite climate change threats.

Climate change is causing extreme weather conditions – including flooding, higher temperatures, drought and forest fires – with the interior zones of large land masses being particularly prone to elevated temperatures and drought. With the prioritization of irrigation water for rice production in most Asian countries, rising temperatures and drought pose particularly severe challenges for farmers operating seasonal aquaculture ponds.

Their inability to pump freshwater into ponds, combined with higher water temperatures, reduces the ponds' dissolved oxygen (DO) levels, which adds to fish stress and can result in mortalities caused by low DO and pathogenic disease outbreaks.

A recent aquaculture development project, AQUADAPT – Myanmar project,[1] has explored ways to mitigate climate change impacts in the Central Dry Zone (CDZ) and in the Ayeyarwady Delta. This involved field trials to investigate the application of a venturi aeration system – named after the eighteenth century Italian physicist Giovanni Battista Venturi – using locally available PVC pipes and portable diesel or petrol water pumps. The pumps can be easily maintained and repaired in local workshops and can provide a means to significantly raise DO levels that is even affordable for small-scale farmers. The project funded and distributed 100 sets of PVC pipework and five petrol-driven pumps to fabricate and demonstrate these venturi aeration systems in applied farmers' field trials in these regions.

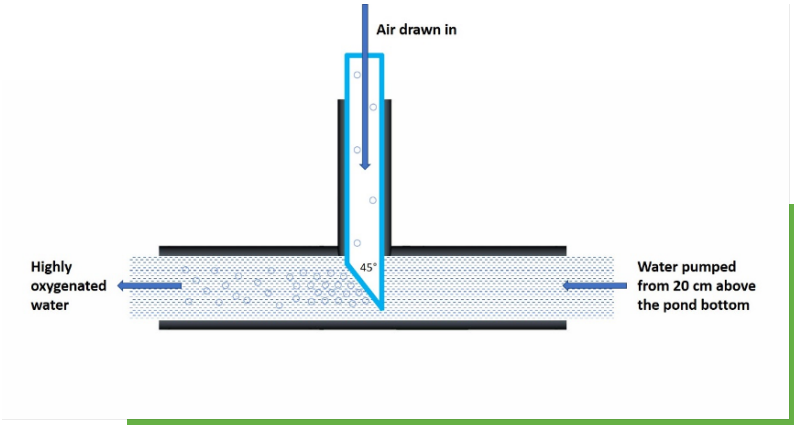
While not a new innovation, the use of venturi aeration in climate-change challenged times is proving a critical tool that is enabling small-scale farmers in the CDZ to continue to cultivate fish, even at the hottest time of the year.

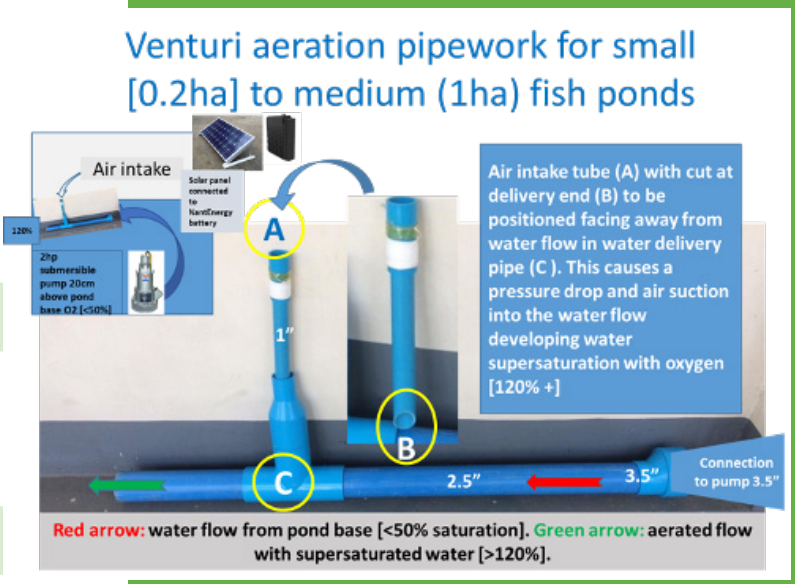
[1] The AQUADAPT – Myanmar project was funded by the United States Agency for International Development and implemented by WorldFish.

TECHNIQUE AND APPROACH USED

The system pumps water up from about 20 cm above the pond bottom, where the DO is lower, through a portable petrol or diesel water pump and along a horizontal PVC pipe, which has a vertical section inserted at a 90° angle (Figure 1). The end of the vertical downpipe section is cut at a 45° angle and is turned so that the angled cut faces downstream. The flow around the cut pipe end causes a drop in water pressure, which draws air down the vertical pipe, oxygenating the water in the horizontal pipe, which is then pumped back into the pond.

Figure 1. The venturi aerator system and pipework





Source: Mike Akester, Khin Maung Soe and Nang Tin May Win, WorldFish Myanmar

Venturi aerator with a single outlet in operation

Venturi aerator with a double outlet in operation

SCOPE AND SCALE OF APPLICATION

The venturi pump system can be used in any country and in most locations, but its promotion has been innovative in Myanmar where it has been applied to small-scale, medium-scale and large-scale farmers.

For small-scale and medium-scale farmers in the CDZ the increased DO and water current created by the venturi aerators elevates and aerates cooler water from the pond bottom and allows farmers to continue to operate in the hot dry season, when previously fish die-offs – due to low DO levels and high water temperatures – were common.

Outside the capital city of Yangon there are many large-scale chicken–fish farms with large ponds (1 ha to 5 ha) that are 2 m to 5 m deep. They also suffer from low DO, which can lead to high fish mortalities when stratified water is overturned, bringing anoxic water up to the surface – usually during storms or on cloudy days during the monsoon as well as higher associated costs, particularly towards the end of production cycles.

ACCESSIBILITY

The project leads had originally intended to deploy submersible pumps with the venturi aeration system, but the imported pumps were relatively expensive, proved a challenge to maintain and repair, and were disabled by the frequent power cuts in rural areas.

Most fish farmers already had either petrol or diesel engine water pumps on farm for general use, which were locally available for as little as USD 150, inclusive of all hoses.

Three different methods for powering the venturi aeration system in Myanmar were costed:

a petrol or diesel water pump

solar panels and a controller system

solar panels, lithium air rechargeable batteries and an inverter system

At an exchange rate of MMK 1 850/USD, the three systems cost approximately USD 150, USD 1 215 and USD 3 180, respectively.

While the petrol- or diesel-powered system was the cheapest, the versions of these pumps available in Myanmar have a short lifespan and require access to fuel, the price of which has increased significantly since a state of emergency was declared in the country on 1 February 2021.

As a result, WorldFish is encouraging better resourced farmers to consider investing in the solar panel and lithium air rechargeable battery system, because it is the most sustainable, lasts for the longest period of time and is the most environmentally friendly option.

THE OUTCOME AND BENEFITS

In trials conducted by AQUADAPT – Myanmar, the base oxygen saturation levels of water from the pond were less than 50 percent, but for water exiting the venturi aeration system the oxygen saturation level was over 120 percent. Water supersaturated with oxygen might be an issue in a closed system – especially in a fish hatchery, where a leaking pump can cause unintentional DO supersaturation and gas embolism in the fish gills. However, it is not normally an issue in an open water pond system, except under exceptional circumstances (Stenberg *et al.*, 2020).

Farmers who routinely observed fish gasping for air at the water surface in the hot season noticed that this stopped when venturi aeration was supplied for an hour or two early each morning.

The effect of the pump with and without the addition of a venturi aeration system can be demonstrated very easily by putting a hand over the air intake of the vertical downpipe.

REFERENCES

Stenberg, S.K., Velle, G., Pulg, U. & Skoglund, H. 2020. Acute effects of gas supersaturation on Atlantic salmon smolt in two Norwegian rivers. *Hydrobiologia*, 849 (527–538). https://doi.org/10.1007/s10750-020-04439-z

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