JOURNAL OF THE NACAA

ISSN 2158-9429

VOLUME 17, ISSUE 1 – JUNE, 2024

Editor: Linda Chalker-Scott

Quintero Fonseca, H.[1], Roy, L.[2], Pena Morales, M.[3]

[1]Program Director for Aquaculture Extension, The Ohio State University, Delaware, Ohio, 43015
[2]Extension Professor, Assistant School Director of AFFC Operations, Auburn University, Greensboro, Alabama, 36744
[3]Assistant Professor , Universidad Surcolombiana, Neiva (Huila, Colombia)

Engaging Aquaculture Farmers in Participatory Research

Abstract

A participatory research study involving aquaculture farmers was conducted in Arkansas to develop a warning system for carbon dioxide (CO_2) present in fresh groundwater. The participatory study involved nine commercial farms representing baitfish, sportfish, ornamental fish, and catfish production, and one research facility. The participatory study was conducted over 52 weeks and had an average responsiveness of 34.2% based on the weekly reporting of water quality data (temperature, pH, alkalinity, hardness, carbon dioxide, and iron content). Actions of commercial producers derived from this study included increasing capacity of aeration tower units, cleaning, and removal of sediments, and improving facility maintenance protocols.

Keywords: aquaculture, participatory research study, water quality monitoring, well water.

Introduction

Extension programs are intended to link researchers and producers in two ways, as facilitators of research that improves production practices, and as communicators of producers' research needs. Nicholas and Hinckley (2011) highlighted the importance of researchers partnering with farmers "to integrate their findings with management decision making, foster collaborative problem solving, and perform successful strategic planning." Aquaculture extension programs have used on-farm demonstrations and research verification programs for engaging with commercial aquaculture farmers and evaluating effectiveness of research-based recommendations (Bott et al., 2015; Hanson et al., 2020; Roy et al., 2020), in what is known as "cooperative research" (Salmon et al., 2008).

Another tool that has been used recently is participatory research. Participatory research is a type of collaborative or cooperative research that allows the collection of "real-time" data as farmers and technical specialists partner together, to solve current problems and/or to strengthen their capabilities to solve challenges in the future (Brummett et al., 2004; Lundeba et al., 2022; Mackinson et al., 2015). Tritz (2014) highlights that participatory research involves building trust, a sense of shared power between the researcher and participants, shared responsibility, and commitment of resources including participants' time. Individual and collective learning, based on respectful and engaging dialogue foster the production of new knowledge which is also a key aspect of participatory research (Mackinson et al., 2015; Tritz, 2014).

Cooperative research in general has some advantages related to the efficiency of using local farmer's facilities, and accomplishing research goals with reduced budgets (Cuthill, 2000; Strieter and Blalock, 2006). However, some authors consider this type of research risky because of its nontraditional nature, which could lead to the loss of scientific rigor (Fore et al., 1995; Salmon et al., 2008).

Some factors that have been identified related to the success of projects involving industry members as citizen scientists include willingness to engage, industry inclusion, planning, training, assisting with protocols, equipment and materials, coordination, good and continuous communication, role clarification, responsibilities, and expectations, among others (Mackinson et al., 2015; Skinkis, 2019).

Study Objectives

In the summer of 2019, several aquaculture farmers in Lonoke County, Arkansas, started experiencing fish losses in hatcheries, holding tanks, and packing and shipping units that caused direct losses estimated at over $200,000. An assessment of the mortality events found that those losses were linked to abnormally sudden increases in the carbon dioxide concentration in underground water used in their facilities.

This situation provided a good opportunity to formulate a participatory research study in which farmers themselves could track water quality parameters as proactive measurement, thus reducing the risk of introducing water that threatened fish health conditions, and potential loses. Also, the approach of participatory research was considered for collecting basic data over a considerable geographic area, by training cooperators from different regions.

Methods

Conditions considered when setting up this participatory research project included:

- Willingness to participate: a letter of invitation to participate in a pilot project on water quality monitoring was sent to fifteen producers of baitfish, sportfish, ornamental fish and catfish in Arkansas, including facilities that did not report fish health or water quality issues.
- Standardization of a protocol for measuring water quality parameters based on practicality and low cost. Equipment for water quality measurements was supplied to each participating farm.
- Monitoring locations were established in consultation with the farmers and data tracking forms were provided.

- On-site training was offered to participants.
- Commitment to the project by designation of an employee(s) to do the monitoring on a weekly basis for a minimum of a year.
- Continuous communication and follow up opportunities were available to the trainees, including on-site visits, email, cellphone texts, and WhatsApp messages.

The equipment to do the water quality monitoring was selected based on ease of use for measuring, practicality, and cost, and was supplied to each participant farm. The variables that were monitored included temperature, pH, alkalinity, and hardness. These variables were measured using a Hach Fish Farming Water Quality Test Kit FF-1A (243002; Loveland, CO). The presence of carbon dioxide in groundwater was calculated using an indirect method (pH, temperature, and alkalinity) in which a factor that considered pH and temperature was multiplied by total alkalinity (mg/L) to obtain carbon dioxide (mg/L) (Tucker, 1984; Wurts and Durborow, 1992). In addition, it was decided to monitor iron concentrations in the water. This was related to the fact that in a couple of farms, the producers started using aeration in the sedimentation tanks for stripping carbon dioxide, which in turn caused precipitated iron to go back into solution.

Results and Discussion

A total of nine commercial farms and one research facility were involved in the participatory water quality monitoring project. Five aquaculture farms were in Lonoke County, two in Monroe County, one in Prairie County, one in Benton County, and the research facility was in Jefferson County. Designated employees from each farm were trained on-site (Figure 1). The average training took two-hours per farm, with a couple of farms having an additional hour for follow up.

Sampling locations included the well, and the vats where fish were held prior to shipping. In some instances, the aeration tower (pit) or sedimentation tank were also selected for monitoring (Figure 2).

Figure 1 (left). Training session at one commercial farm.
Figure 2 (right). Aeration tower for stripping carbon dioxide from underground water.

Training was delivered in a two-hour session, over a two months-period since each training was conducted separately for each farm. The instruction was delivered in English (60% of the participants) and in Spanish (40% of the participants), with water quality kits being delivered at the end of the training session. The monitoring period, including the training period went from September 2019 to October 2020, and during the mid-part of this process, on March 11th, the World Health Organization (WHO) declared the COVID-19 pandemic.

The communication channels that were established at the beginning of the participatory research were maintained and the communication process allowed continued reporting/collection of data (Figure 3). However, we are not sure about the impact of the pandemic on the level of response of the different participants, but it is worth noting that three to four farms were reporting on a weekly basis until that week, and afterwards, only one or two farms were reporting on a constant basis.

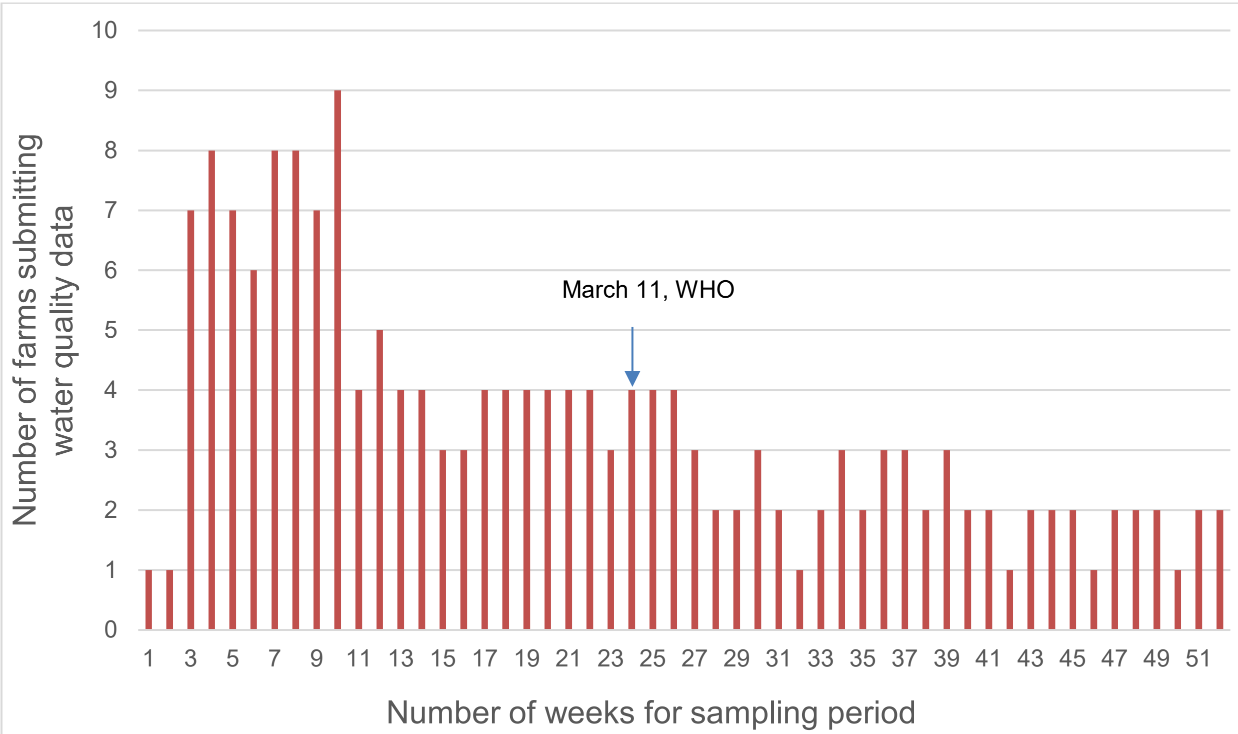

Figure 3. Number of farms submitting water quality data during the training/sampling period.

Data reporting responsiveness of the farms ranged from 7.7% to 88.5% considering the number of weeks reported in a year period (52 weeks) with an average responsiveness of 34.2% (Figure 4). There are several factors that may have affected the level of response, including the size of the farm which relates to who was responsible for doing the monitoring, personnel availability, degree of water quality impact (some areas did not evidence changes in CO_2 concentration), and potentially losing interest after identifying the problem and taking corrective measurements that solve the problem. Finally, it was observed that larger, well-established commercial farms devoted personnel to follow up and measure on a more continuous basis, compared to farms that were smaller in size and where only few people were responsible for the whole operation.

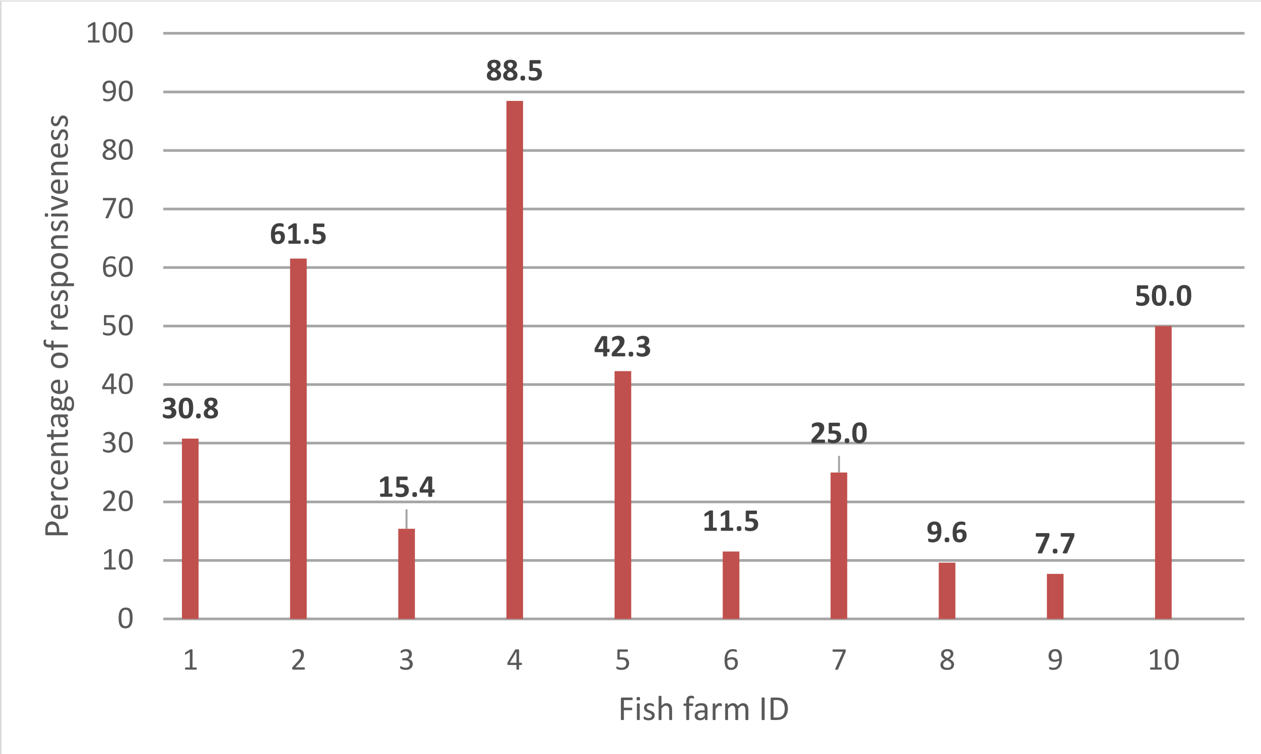

Figure 4. Aquaculture commercial farms' responsiveness

Conclusions

Standard operating procedures and best management practices related to water quality monitoring and facilities maintenance (aeration towers, sedimentation tanks, etc.) were reviewed by the participating fish farmers producers, which might have a greater impact for future production practices in baitfish and sportfish production. Data reporting responsiveness was in average 34.2%. We suggest farms continue to monitor these parameters to gain a deeper knowledge of these variables not only by farmers themselves, but by a faculty research team.

The water quality monitoring program allowed fish farmers to identify issues related to the aeration tower and/or sedimentation tanks. Some of the actions that farmers took shortly after identifying the problem through this participatory water quality monitoring program included:

- Installation of additional aeration tower units.
- Modification of a production pond to a reservoir to aerate the well water.
- Cleaning of the sedimentation tanks to extract the iron compounds (Figures 5-6).

Allowing farmers to participate in the project led them to take ownership of the problem and implement corrective actions accordingly to their own needs. The responsiveness of producers evidenced their willingness to engage in a research project. The impact of the project was evidenced in upgrades that were performed in their facilities (cleaning and/or increasing sedimentation tanks, and degasification units) in five of the participant farms. Action of these farmers regarding spreading this information to other producers was not evaluated.

Figure 5. Extraction of sediment and iron compounds from a sedimentation tank on a commercial farm.

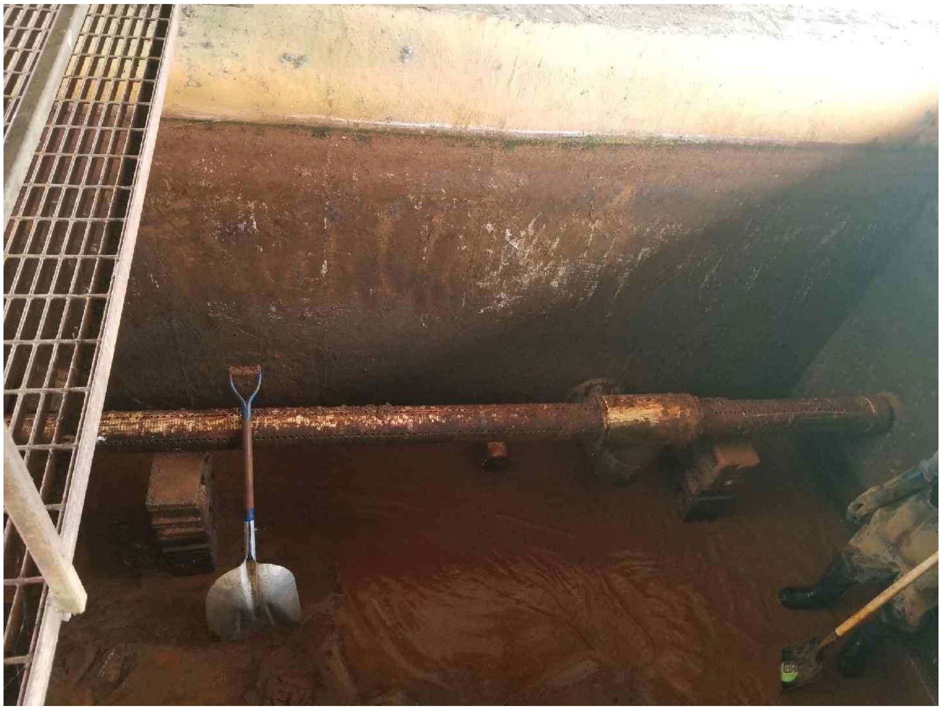

Figure 6. Residue from cleaning a sedimentation tank on a commercial farm.

Acknowledgments

The authors acknowledge the University of Arkansas at Pine Bluff Cooperative Extension Service for supporting our participatory research study, as well as Arkansas commercial baitfish and sportfish producers who opened their farms for this study.

Literature Cited

Bott, L.B., L.A. Roy, T.R. Hanson, J.A. Chappell, and G.N. Whitis. 2015. Research verification of production practices at an intensively aerated hybrid catfish operation in west Alabama. *North American Journal of Aquaculture 77*(4): 460-470. https://doi.org/10.1080/15222055.2015.1047543

Brummett, R., D. Jamu, and V. Pouomogne. 2004. A farmer-participatory approach to aquaculture technology development and dissemination. *Uganda Journal of Agricultural Sciences* 9: 530–536.

Cuthill, M. 2000. An interpretive approach to developing volunteer-based coastal monitoring programs. *Local Environment* 5: 127-137.

Fore, L.S., K. Paulsen, and K. O'Laughlin. 2001. Assessing the performance of volunteers in monitoring streams. *Freshwater Biology* 46: 109-123.

Lundeba, M., S.M. Cole, W. Mekkawy, R. Yossa, R.K. Basiita, M. Nyirenda, N. Muyuni, and J.A.H. Benzie. 2022. On-farm participatory evaluation of feeding approaches used by farmers for tilapia (*Oreochromis macrochir*) production in northern Zambia. *Aquaculture* 54: 737747 https://doi.org/10.1016/j.aquaculture.2021.737747

Hanson, T.R., L.B. Bott, G.N. Whitis, J.A. Chappell, A.M. Kelly, and Roy, L.A. 2020. Research verification of single- and multiple-batch production practices at two channel catfish *Ictalurus punctatus* farms in west Alabama. *North American Journal of Aquaculture* 82(4): 377-386. https://doi.org/10.1002/naaq.10159

Mackinson, S., S. Raicevich, M. Kraan, M., R. Magudia, and K. Borrow. 2015. *Good Practice Guide: Participatory Research in Fisheries Science*. https://www.researchgate.net/publication/330577164_Good_Practice_Guide_Participatory_Research_in_Fisheries_Science

Nicholas, K.A., and E.S. Hinckley. 2011. Conducting research on private farms and ranches: approaches, issues, and tips. *The Journal of Extension* 49(6): 28. https://tigerprints.clemson.edu/joe/vol49/iss6/28

Roy, L.A., and D.A. Davis. 2020. Tank systems on shrimp farms are effective for Extension demonstrations in aquaculture. *Journal of Extension* 58(6): 58-66. Available at https://tigerprints.clemson.edu/joe/vol58/iss6/29/

Salmon, T.P., B. Faber, G. Bender, D., Shaw, V.J. Kowalski, and A. Berentsen. 2008. Volunteer researchers: moving beyond cooperators. *Journal of Extension* 46(2): 9. https://tigerprints.clemson.edu/cgi/viewcontent.cgi?article=3964&context=joe

Skinkis, P.A. 2019. Participatory research engages industry and leads to adoption of methods that cchallenge long-held production standards. *Journal of Extension* 57(4). Retrieved from https://tigerprints.clemson.edu/joe/vol57/iss4/20

Strieter, L., and L.D. Blalock. 2006. Journey to successful collaborations. *Journal of Extension* 44(1): 1TOT4.

Tritz, J. 2014. Participatory research: a tool for extension educators. *The Journal of Extension* 52(4): 31. https://tigerprints.clemson.edu/joe/vol52/iss4/31

Tucker, C.S. 1984. Carbon dioxide. In: (T.L. Wellborn, Jr., and J.R. MacMillan, eds.), *For Fish Farmers* 84-2. *Mississippi Cooperative Extension Service*.

Wurts, W.A., and R.M. Durborow. 1992. Interactions of pH, carbon dioxide, alkalinity, and hardness in fishponds. *Southern Regional Aquaculture Center*, Pub. 464.