Fish cage culture in small water bodies in North East Region of Ghana: Technical and institutional guiding principles for sustainable and inclusive uptake

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A youth group on their boat and fish cages behind them *(photo:* Lawrence Armah Ahiah, FC Ghana).

Rationale and context

Northern Ghana is primarily characterized by rainfed agriculture with low groundwater irrigation development, low agricultural productivity, and high poverty rates. Climate change-induced uncertainty in rainfall intensity and timing is likely to worsen the situation in the region. In this context, in 2017 the Government of Ghana started constructing small earth dams in five deprived regions of northern Ghana under the 'One Village, One Dam' (1V1D) Program with a target of 570 dams in total. The objective of the 1V1D Program is to provide water access by building dams for rural communities all year round to enable dry-season irrigation and other uses including for livestock and domestic use. These reservoirs also create a unique opportunity for enhancing the multipurpose use of water infrastructures by introducing aquatic food production. Fish production in these reservoirs can benefit communities nearby through increased income, improved nutrition, employment generation, and empowerment of marginalized groups (youth, women, and small-scale farmers).

The CGIAR Initiative on Aquatic Foods partnered with the Council for Scientific and Industrial Research's Water Research Institute (CSIR-WRI), the Fisheries Commission, and collaborated with local government departments and local communities to implement fish cage culture in selected small reservoirs in Ghana. This brief highlights the technical and institutional principles that were applied in these sites for inclusive and sustainable aquatic food production in the year 2023. These principles, synthesize in Figure 1, are aimed at informing the designs of potential replications, including the next phase of the 1V1D program, in other suitable sites with the support of their respective communities.

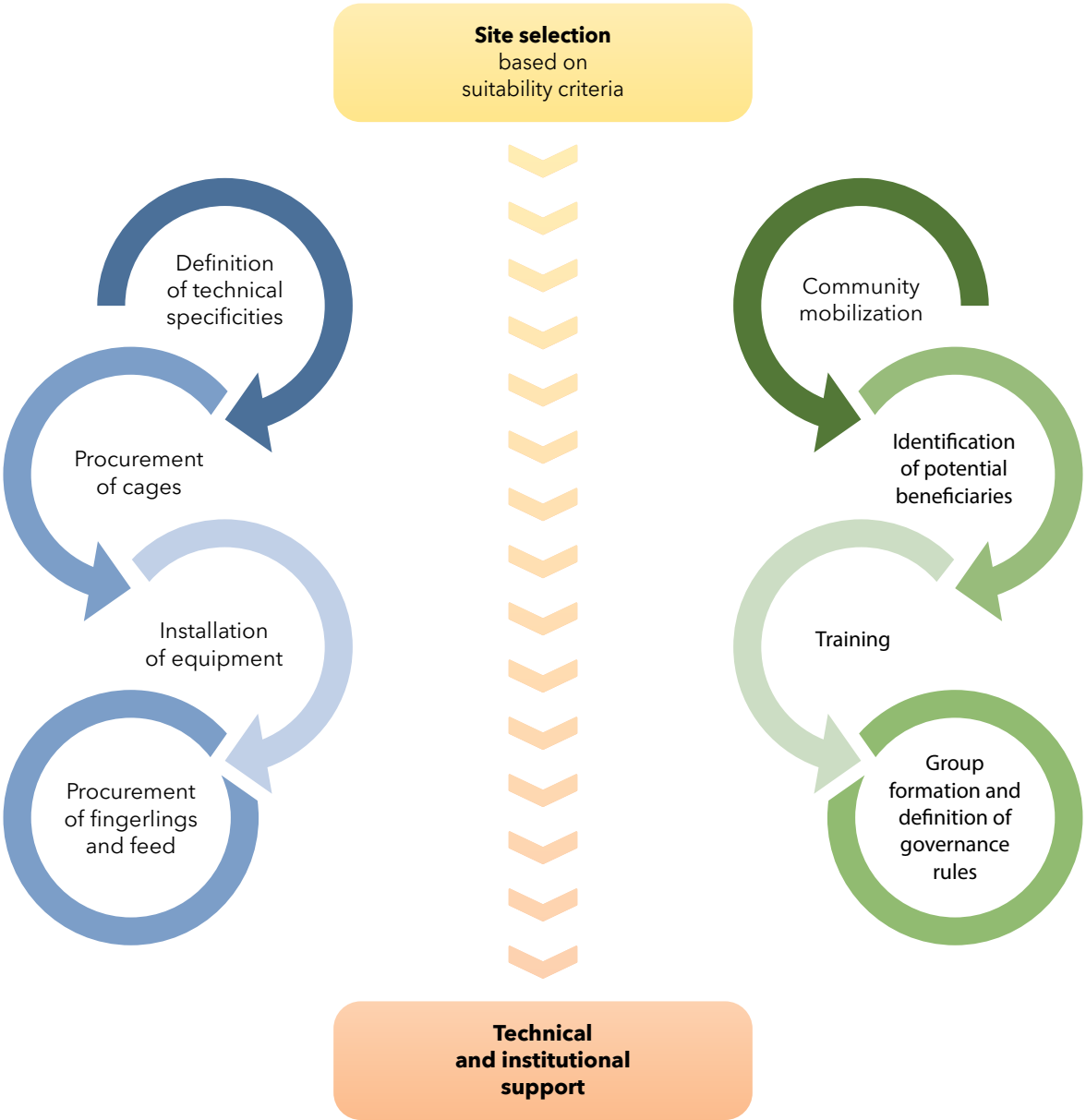

Figure 1. Technical and institutional processes for the establishment of fish cage cultivation in small reservoirs.

Site selection

A reservoir must satisfy some physical and chemical requirements in order to be considered suitable for aquaculture. It needs to be large enough to support fish production along with its other uses, it needs sufficient depth, and importantly, it needs to have suitable water quality all year round including during the dry season.

In this project, the site selection followed a phased approach. First, extension officers from the Fisheries Commission identified 17 reservoirs in the North East region, which seemed suitable for aquaculture development according to their local knowledge. Second, water availability all year round, especially during the dry season (November to April), was assessed using Sentinel-2 satellite imagery in the Google Earth Engine Environment. As a result, eight reservoirs that did not dry up during 2021-2022 and had a minimum surface area of 2 hectares during the drier months of the year were selected. Finally, field visits were conducted to collect information on the characteristics of the reservoirs (size, depth, shape, and its location in the watershed), the reservoir uses and its users, the water quality, and some socioeconomic and institutional characteristics of the neighboring communities. The field visit also included consultations with traditional leaders and stakeholders at the community and district levels in various areas to assess their interest and obtain buy-in. On this basis, the four sites with the highest potential and whose leaders embraced the initiative were selected. The selected communities in the North East region of Ghana are Langbinsi, Nalerigu, Nansoni, and Tombu (Figure 2).

Fish cage installed in a small reservoir *(photo:* IWMI).

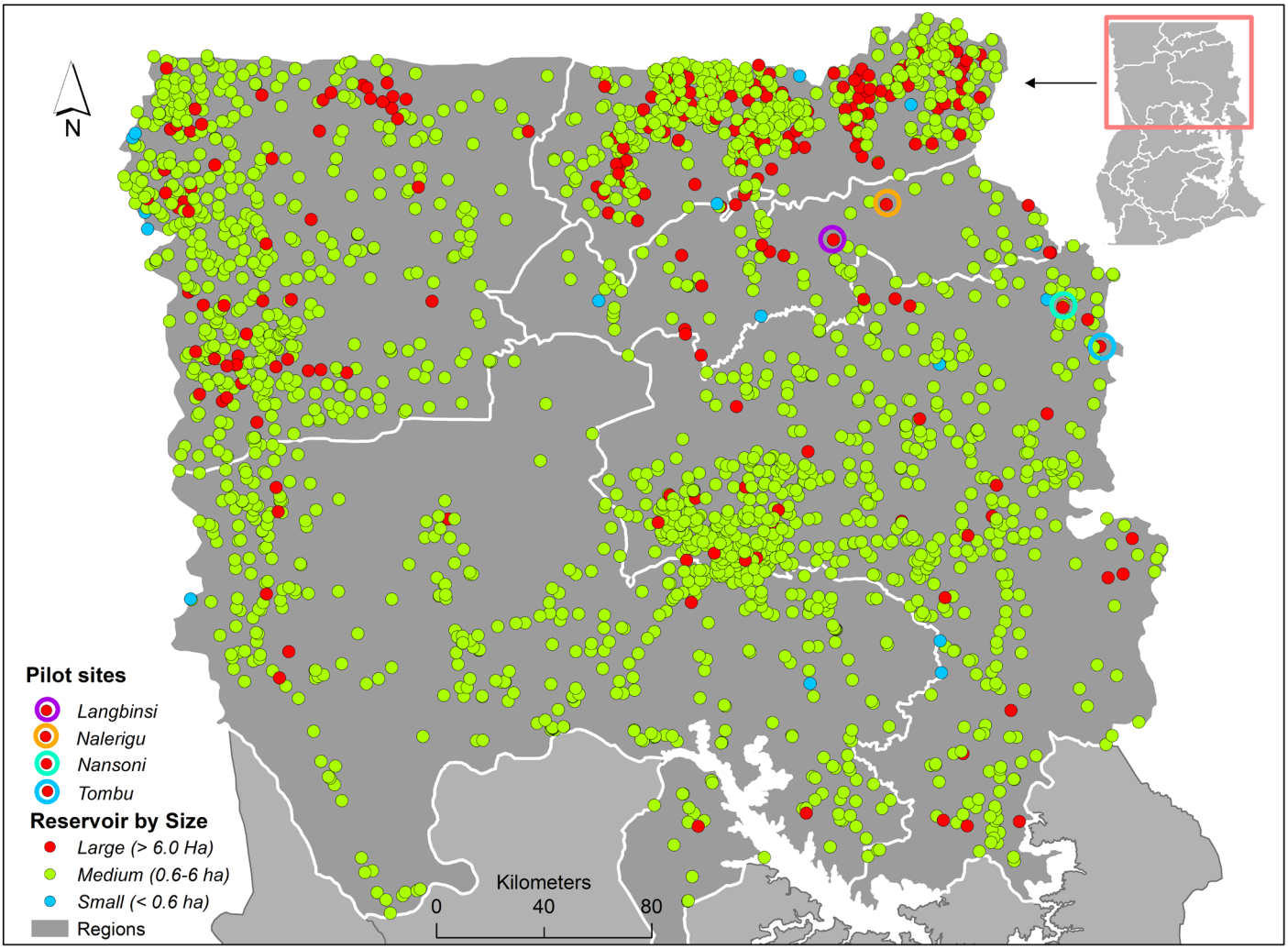

Figure 2. Reservoirs in Northern Ghana in 2023 and selected pilot sites (*source:* Komlavi Akpoti, IWMI, Ghana).

Technical principles for fish cage culture

First, support was provided to obtain the necessary permits to conduct aquaculture in Ghana. The environmental and water use permits from the Environmental Protection Agency (EPA) and Water Resources Commission of Ghana have been obtained respectively.

Second, two cages (5m x 5m x 3m) with inner production nets and outer protection nets have been installed in each reservoir. The project also provided one planked canoe per reservoir and life jackets for the safety of the beneficiaries.

Beneficiaries received fingerlings and feed to start aquaculture production: 4,000 tilapia *(Oreochromis niloticus)* fingerlings per cage, with a 10 percent expected mortality rate, and enough feed to cover the entire production period (Rannaan extruded tilapia starter and grower feed).

The culture period after stocking is estimated to last from five to six months after which the expected harvest should be at least 2.4 metric tons of fish per cage. During this period, the beneficiaries will collect data on basic water quality daily. The technical partners will conduct monthly fish sampling to assess growth performance and monitor water quality. The beneficiaries received technical training on aquaculture and will be supported throughout the production period with additional training on production, postharvest handling, and capacity building.

Institutional principle for governance and inclusion

The technical principles described above are accompanied by developing institutions that will collectively manage aquaculture activities.

A key feature of this project is that fish cage culture takes place in water bodies (small reservoirs) that belong to the community. Therefore, the project needs to benefit the community, directly or indirectly, even if involving the entire community is neither realistic nor practical. Instead, the project is run by a group of direct beneficiaries (hereafter named 'aquaculture group'), selected according to inclusive criteria, and only benefits the broader community indirectly. The indirect benefits to the community include generating additional income, and an increased availability of affordable and nutritious food locally.

Aquaculture groups of 10 to 15 direct beneficiaries were formed for each reservoir. Group formation was done jointly with community leaders, assemblymen, and traditional leaders while encouraging the inclusion of youth and women. Specifically, an indicative list of criteria was provided to the community to identify eligible individuals (see Box 1).

Box 1. List of criteria for selecting members of the groups

Members of the group should: (i) be aged between 18 and 35, (ii) be willing to volunteer their time for the project without receiving any compensation for at least six months, (iii) have another income-generating activity (fishing/farming/trading, etc.), (iv) be a permanent resident of the community for at least five years, (v) not be already engaged in commercial fish farming; (vi) not have tertiary education, (vii) be residing in proximity to the water body, and (viii) be willing to participate in a three-day initial technical training followed by other training and meetings in due course.

Delivery of boats to the community (*photo:* Lawrence Armah Ahiah, FC Ghana).

In addition to the criteria provided by the project, it was also recommended that at least 30 percent of the group members be women. Community leaders also ensured that the selected beneficiaries represented the different villages using the water from the reservoirs. Also, it was proposed to include some older members in the group who could serve as advisors.

The fact that the project benefits a group instead of a single individual has several advantages. First, the workload can be shared among the members. Second, while the high initial capital and skills required would make it hard for a single individual to invest, the project provides the group with the initial capital for one season and allows them to gradually acquire technical skills and build capacity, ensuring that the proceeds from the first cycle will be reinvested in the second cycle. Third, through the group approach, the direct benefits and capacity building are widely shared among the community members and indirectly impact the entire community.

Training programs on group dynamics and functionalities are essential and have to be provided both during and after the introduction of the project. Aquaculture groups are accompanied to maturity following Ostrom's (1990) principle for collective action in natural resources governance (see Box 2).

Box 2. Ostrom's (1990) principle for collective action-based projects applied to fish cage culture in small water bodies.

- **Clearly defined boundaries:** Aquaculture activities by the groups have clearly defined jurisdiction, which allows them to exclude nonmembers. Even if the water body in which the aquaculture project takes place belongs to the community, the aquaculture activity itself belongs to the group only. The group is clearly defined and formally registered, with rules establishing how new members can join or current members can leave.

- **Proportional equivalence between benefits and costs:** Members of the aquaculture group are able to derive direct benefits from being a member of the aquaculture project. If nonmembers can equally benefit, this acts as a perverse incentive for collective action.

- **Collective-choice arrangements:** Members of the aquaculture group are able to craft some of their rules and regulations to ensure that they shape the direction of the aquaculture project. Such rulemaking powers are important as externally imposed rules would undermine their legitimacy and weaken local accountability.

- **Local ownership:** Members of the aquaculture groups collectively own the aquaculture project and the assets. Local and collective ownership will more likely result in sustainability, with benefits being continued after the project support has ended.

- **Monitoring:** Monitoring helps ensure there is no tragedy of the commons as espoused by Hardin (1968). The monitoring costs must be low and the aquaculture group members must easily detect discrepancies. The rules and monitoring criteria are locally developed to be considered legitimate rather than externally imposed.

- **Graduated sanctions:** Graduated sanctions act as a deterrent mechanism. The aquaculture group members locally develop sanction mechanisms, which include warning and admonishment for offenders as well as graduated penalties to discourage repeat offenders.

- **Conflict resolution mechanisms:** The aquaculture groups develop conflict resolution mechanisms perceived as just and fair by all members of the group and by the broader community to ensure that as and when conflicts arise, they are swiftly dealt with.

- **Minimal recognition of rights to organize:** The aquaculture groups are empowered to organize themselves as and when they deem it necessary locally. Local self-organization ensures that the group can meet urgently to discuss issues relevant to the effective management of their aquaculture activities. Such rights are availed to all the members, including women, youth, and other marginalized community members of the aquaculture group.

- **Nested institutions within polycentric governance:** The aquaculture group is linked with other institutions such as traditional leadership, ward (councilors), and district-level authorities. Such linkages enable the group to apply the subsidiarity principle to make decisions at the appropriate unit of governance. If, for instance, an offender has been sanctioned and refuses to abide by the adjudication decision, the issue can be escalated to a higher-level authority, such as a traditional leader or a district-level authority as appropriate.

Way forward and scaling

Learning from this approach, the process for site selection is being streamlined for the five regions of northern Ghana with the development of an open-access suitability mapping tool that will consider both the physical characteristics of the reservoirs and the socioeconomic settings of the potentially benefitting communities. With the engagement of local authorities and reservoir users in the development of the tool, and weighting of criteria and capacity building, this aims to provide future implementers the ability to select the most suitable sites for upscaling aquaculture in small reservoirs.

Second, a rigorous assessment of the benefits of fish cage culture in small reservoirs is being implemented. This will allow for quantifying the beneficiaries' impacts, costs, and trade-offs. These results are expected to provide decision-makers and implementers with robust and quantified evidence to develop this approach further.

Third, the enabling environment is key in supporting the upscaling of fish cage culture in small reservoirs. If the policy is supportive, value chains for inputs (fingerlings and feed) and harvests (fresh or transformed) need to be developed with stronger engagement from the private sector.

Finally, qualitative research is being conducted to learn lessons from similar group-based aquaculture experiences that took place in Ghana in the past or that are currently being implemented by other organizations. The results from this research would provide insight into how to increase sustainability in this project and its future expansions.

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Fish cage installed in a small reservoir *(photo:* IWMI).

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CGIAR Initiative on Aquatic Foods

The CGIAR Initiative on Aquatic Foods aims to tackle systemic challenges to the sustainability and resilience of aquatic food systems, including data gaps that lead to exclusion of the sector from wider food and nutrition policies and programs, and limited research investment. Working closely with research partners in fisheries and aquaculture, civil society, industry, and governments, the Initiative contributes to the reduction of greenhouse gas emissions from the production of aquatic foods and enhance ecological and social resilience through development and dissemination of improved fish strains, better management practices, integrated fish-rice production systems, and fish-friendly irrigation systems.

Citation

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