**MANITOBA - CANADIAN MODEL AQUA-FARM INITIATIVE**

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**Final Report, Inter-Provincial Partnership**

**for Sustainable Freshwater Aquaculture Development**

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<https://www.gov.mb.ca/agriculture/livestock/aquaculture/pubs/m-cmfi-2018-final-report.pdf>

In 2001, the Inter-Provincial Partnership for Sustainable Freshwater Aquaculture Development (IPSFAD) was established to promote the sustainable development of freshwater aquaculture in Canada. The principal objectives of this national, private, not-for-profit organization are to: ♣ Create consensus regarding applied research, development and commercialization (RDC) priorities identified principally by industry; ♣ Promote applied research, development and commercialization projects and assemble required research and/or technology transfer expertise for execution; ♣ Foster the establishment of necessary synergies among various players while avoiding duplication of work and making optimal use of resources; and ♣ Organize and seek funding for projects that result directly from priorities identified by industry. IPSFAD developed an Industry Action Plan reflecting stakeholder consensus regarding research, development and commercialization issues requiring priority attention. The Action Plan was developed using stakeholder input garnered through regional workshops in which the challenges and opportunities pertaining to sustainable freshwater aquaculture development were identified and prioritized. It presents a consolidation of applied research, development and commercialization requirements that reflect priority needs in the sector, spanning 16 initiatives within 6 thematic groups. The development of a land-based Canadian Model Aqua-Farm (CMAF) is a core component of IPSFAD’s Industry Action Plan.

The Canadian Model Aqua-Farm Initiative is based on the Danish experience with a similar model fish farm program. The Danish Model Farm Program served to overcome concerns about aquaculture development that were primarily related to environmental issues. The result of the program in Denmark was a novel approach to land-based aquaculture that enabled further industry expansion in an environmentally responsible manner and improved the prosperity of the industry as a whole. Furthermore, the results of the Danish Model Farm Program have been accepted by industry, government and NGO stakeholders, thus facilitating regulatory review and approval of applications for new aquaculture development.

The development of a standardized farm model, which addresses the basic technological, production, financial, environmental and regulatory aspects of commercial aquaculture would be a milestone in Canadian aquaculture. Therefore, development of a landbased ‘model farm’ program became a central component of the IPSFAD Action Plan. A ‘model farm’ is a production unit that successfully integrates the most current technologies in terms of: ♣ nutrition and feeding strategy ♣ manure processing and management ♣ fish health management ♣ production management ♣ design of infrastructure and equipment ♣ operational practices and standards ♣ water conservation and utility The objective was to prepare a design that would optimize both financial and environmental performance of the operation.

Once thoroughly assessed and documented, model farm inputs and outputs become recognized as standards and are more readily accepted by regulatory authorities, thus facilitating site application and approval processes. The modular design would enable the facility to be easily duplicated, bringing a measure of standardization to industry practices and performance. The model farm initiative was intended to establish norms and baseline standards pertaining to the biological, technological, financial and environmental sustainability of land-based freshwater aquaculture. A fundamental component of success would be the participation of provincial and federal regulatory officials in the environmental assessment of these technologies so that aquaculture applications based on the ‘Canadian Model Aqua-Farm’ could be recognized, understood and accepted by the authorities. By incorporating a production and financial benchmarking program, the CMAF would also establish economic standards that could enhance investor confidence.

**Scale: Minimum Economically Sustainable Size**

The underlying objective of developing the model farm is to enable industry expansion. Therefore, the scale of the model farm should be economically sustainable and thus the minimum size necessary to achieve financial autonomy must be targeted. It is estimated that this is likely to be a modular design having capacity to produce 100 to 200 metric tonnes of fish per year. Principles 1. The model farm must be industry-driven. This means that it must: ♣ be financially viable; ♣ be environmentally sustainable; ♣ uphold fish welfare requirements; ♣ facilitate industry expansion; ♣ earn social licence from consumers and other stakeholders; and ♣ support effective communications.

**2.1 Background**

Financial projections indicated that an investment of $942,000 was required to launch the venture; $693,000 (74%) was needed for capital expenditures (i.e. tanks, water filtration equipment, pumps, fish culture equipment, etc.) and another $249,000 (26%) for the working capital (i.e. feed, fingerling purchases and other operating expenses). In addition to these costs, it was anticipated that the project partner would have available latent infrastructure to contribute to the venture. This included an agricultural building of suitable size with an adequate power supply, an existing water supply (well), effluent management facilities, etc. The latter are considered to be sunk costs contributed to the operation. Although some of this infrastructure may not be in place at a development site (e.g. main water supply well for the fish farm, adequately sized effluent management facilities, barn insulation), it was recognized and understood that any project partner would make these additional investments toward the project.

**2.3 Site Assessment**

The site selected for the Manitoba – Canadian Model Aqua-Farm is located in the Interlake Region of Manitoba, an area known for its abundant groundwater resource (Figure 2). The site is located across the eastern divide of the carbonate aquifer where groundwater is of good quality for freshwater usage.

3.1 Technical Design

A principal concept underlying the expansion of commercial aquaculture in central Canada is utilization of vacant agricultural buildings such as hog barns. Typically being long and narrow (i.e. about 12 to 24 meters wide by 60 to 120 meters long), the Manitoba Canadian Model Aqua-Farm was designed to fit into such buildings to facilitate wide-spread adaptation of the technology via utilization of this latent infrastructure. A rectangular circulating tank, consisting of two long, narrow raceways that share a common dividing wall, has been selected to maximize rearing space within the barn and to minimize effort related to fish handling; namely sizing, grading and harvesting . The principal structure in the facility is a modified, D-ended ‘Burrows raceway’. A layout of the facility is presented in Figures 5, 6 and 7. Technical specifications are outlined in Table 2. Figure 5: Layout of the Manitoba – Canadian Model Aqua-Farm 7

At the Model Farm Planning workshop, delegates concluded that both raceways and circular tanks have merits and that both designs should be considered in the model farm initiative. A second model farm project that will incorporate a similar production strategy but which will utilize circular tanks is in the early planning stages. Drum Filter Rearing Unit Low-Head Oxygenator (LHO) CO2 Stripper Pump Sump Moving Bed Biofilter

**4.2 Fingerling Stocking Strategy**

To maintain a relatively steady harvest volume throughout the year, it is necessary to stock fingerlings into the system every three months. The production plan requires approximately 39,700 twenty-gram fingerlings four times per year. Fingerlings are purchased from existing hatcheries, some of which may have to adjust their egg sourcing and production strategies to meet this demand.

**4.4 Feed Requirements**

Feed ration has been calculated taking the following factors into account:

♣ The projected gain in biomass for each growth period

♣ A biological feed conversion ratio of 1.00 : 1 from 20 grams to 100 grams, 1.05 : 1 from 100 to 500 grams and then 1.10 : 1 from 500 grams to 900 grams (1.06 kg feed / kg gain overall)

♣ 2% feed waste - comprised of fines and unconsumed feed.

This strategy requires monthly feed rations ranging from 10,700 kg to 13,110 kg with an average ration of approximately 11,543 kilograms feed per month.

The overall feed conversion ratio is projected to be 1.06 to 1 (Boucher and Vandenberg 2005; Bureau et al. 2006)

**6.2 Components of the Performance Management Program**

To verify that the stated objectives for the model farm are addressed, a monitoring and performance improvement program was developed to collect and evaluate data and information that would enable an accurate assessment of performance. In accordance with the stated objectives, a component tree has been produced to describe the data and information requirements in two principal areas:

(1) Operational Sustainability and

(2) Environmental Sustainability.

Operational Sustainability can be further segregated into sub-components for Production, Productivity and Economics (Figure 22). The performance measurement system is intended to generate data and information that will be used to support informed decision-making in these areas. The significance of these four components is explained below.

Production: Several fundamental production parameters (i.e. inputs and outputs) must be quantified to derive specific indicators related to the productivity, economics and environment components.

Productivity: The operational efficiency of various aspects of the biological production system will be evaluated by measuring key ratios of inputs and outputs.

Economics: A fundamental objective of the model farm project is to demonstrate the financial viability of the venture. Collection of economic data pertaining to a range of inputs and outputs is essential to gauge financial performance.

Environment: Environmental sustainability is another principal objective of the model farm initiative. The environmental effects of the model farm project will be determined using a variety of parameters that are pertinent to regulatory compliance within the sector.

**8.3 Capital Costs**

The capital cost to establish the Manitoba model farm were slightly higher than anticipated. The actual capital costs to build the Manitoba model farm in comparison with the budget values are presented in Table 20. The variance was due to several principal factors; namely: • the decision to upgrade the electrical supply to a 3-phase service; • the addition of sludge cones and a micro-particle filter (static bed filtration) to the water treatment systems; and • The installation of over-tank walkways. The actual cost to construct the Manitoba model farm was $6,317 per tonne of production capacity. This did not include the cost of latent infrastructure; that is, the barn, well and manure lagoon.

**8.1 Biological Performance**

Due to the disease event that occurred during the seventh month of operations, the owner of the model farm elected to not purchase additional cohorts of fish beyond Cohorts 1 and 2. As a result, the production plan was seriously compromised and the venture never attained a steady-state level of production. Nevertheless, key biological parameters achieved within the farm are presented in relation to the projections (Table 18). Prior to the disease event, the growth, survival and FCR of the fish were as expected or better than expected. Once the disease event occurred, performance declined.

**8.5 Conclusions & Recommendations** (in full from the original document)

Although the Manitoba – Canadian Model Aqua-Farm operates today as a private aquaculture venture, the initiative did not attain a steady-state of production during the 30-month trial period and, therefore, a full evaluation of all of the parameters relating to the design, equipment and operations was not possible. As a result, the principal objectives of the model farm initiative in relation to production, productivity, financial viability and environmental sustainability were not attained. Nevertheless, performance monitoring and management results generated sufficient data to suggest that the projected performance of the model farm venture could be achieved in this facility. The principal structure in the facility was based on a modified, D-ended concrete raceway that incorporates the water reconditioning systems within the footprint of the unit. This design is well suited for installation into existing agricultural buildings. Concerns regarding poor water quality in raceways vis-à-vis circular tanks were not realized, due in part to the relatively high turnover rate of the raceways in the model farm in comparison with the much lower exchange rate that is typical of flow-through facilities.

A recirculation rate of 99% was achieved. The design of the rearing tank, conditioning tank and treatment systems have been modified since the Manitoba model farm was built, making them more efficient and productive.

The production plan was developed to produce 130 metric tonnes of rainbow trout annually within approximately 12 months of stocking fingerlings. The planned production was curtailed due to an acute mortality event in the first two cohorts and to fish marketing considerations that prevented fully stocking the facility with subsequent cohorts during the monitoring period. Furthermore, the production strategy was altered to focus on production of larger fish (Figure 24). This change in the biomass management plan resulted in a Cost of Goods Sold of $ 8.79 / kg (Table 17). It is important to note that the economics of producing smaller trout (< 1 kg) can be influenced by the periodic shifts in market demand for larger fish.

Introducing a new cohort of fingerlings into a RAS system up to four times per year means that biosecurity will be an on-going concern. New ventures should consider producing their own juveniles (up to 20 grams). This would require the addition of a modest eyed egg incubation system and a first feeding system to be added to the venture. Similar facilities built subsequent to the Manitoba model farm have this capacity and have been able to manage the biosecurity risks accordingly.

The objectives of the M-CMAF initiative were ambitious. The initiative resulted in significant knowledge gained in areas such as site assessment, development planning, construction, commissioning and production performance. This knowledge is valuable towards establishing a model for freshwater land-based aquaculture in Canada. The nature of the public – private partnership and the finite time period of the M-CMAF initiative presented challenges that compromised the ability to attain all of the desired outcomes. Training and skills development did not become as strong a focus of the M-CMAF as was envisaged. In the future, it would be useful to develop a similar model farm initiative in conjunction with educational institutions, applied research groups and/or community organizations to better address the need for practical learning through training and skills development programs. This approach would be another step towards facilitating industry expansion and bringing a level of standardization to the industry that is currently lacking.

There is still a need to establish a modular system that can be used to stimulate operator and investor confidence, and there is still significant interest from the agricultural community to investigate freshwater land-based aquaculture as an economically viable and environmentally responsible way to diversify the traditional livestock production business. The Manitoba – Canadian Model Aqua-Farm Initiative furthered the establishment of norms and baseline standards for indoor, commercial, land-based, freshwater aquaculture. Results achieved during the monitoring period suggest that ongoing efforts to build on this and similar initiatives should be considered to facilitate expansion of freshwater land-based aquaculture in Canada.