联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Alimentación y la Agricultura | منظمة الأغذية والزراعة للأمم المتحدة

COORDINATING WORKING PARTY ON FISHERY STATISTICS

Twenty-sixth Session

Rome, Italy, 15-18 May 2019

Sixth Meeting of the Aquaculture Subject Group and Twenty-seven Meeting of the Fisheries Subject Group

Aquaculture farming systems
---- An update of knowledge intended for potential use for statistics

Author: FAO

Document Summary

This document presents the objectives and the process in which a long list of known culture methods used in aquaculture production operations worldwide was compiled during an expert workshop organized by FAO in collaboration with NACA in December 2018. The list is expected to be improved and used as reference to update the aquaculture farming systems classification for data collection.

The culture methods in this document is presently sorted with or without hierarchy layers under 15 categories. The categorization and hierarchy layer of the culture methods was determined by applying a set of criteria and considerations agreed upon during the above said workshop, which are also presented in this document.

Participants of this CWP session are invited to (a) review the draft list and suggest culture methods, that have been overseen, for inclusion in the list; (b) identify geo-regions with high probability of certain culture methods in local use omitted from the list; (c) review and improve the criteria and considerations to be used to determine the hierarchy level of culture methods; (c) discuss and suggest options to improve the categorization and hierarchy layer setting of the listed culture methods.

The meeting is expected to produce a further extended list of aquaculture culture methods, along with consolidated categorization and improved hierarchy structure under each category. The consolidated categories are expected to serve eventually as an updated standard culture methods classification, supported by the list of culture methods as technical reference materials.

Background

The existing FAO aquaculture statistics collection questionnaires collect national production data by species, by culture environment and by culture method. The culture methods applied in aquaculture production operations are often interchangeably called farming systems, production systems, etc. The worldwide reporting of aquaculture data to FAO by national authorities is comparatively better in terms of data quality and consistency in the species and culture environment details. In contrast, the statistical details in the applied farming systems for production are far less reported by the producing countries and territories.

Apart from the generally low report-back rate on production data disaggregated by farming system, the consistency along the timeline is also questionable in some countries that do collect and report such data. Mismatching of farming system classification used nationally and internationally is one of the important causes to the prevailing problem of low report-back rate and the poor quality of some reported farming system disaggregated data.

For data collection at field level, there are also confusions between mixed concepts of farming systems and the facilities or sites used for adopting certain farming systems.

As an initial effort to address the aforesaid problems, a technical workshop was organized by FAO in collaboration with the Network of Aquaculture Centres in Asia-Pacific (NACA) in China in December 2018 to investigate the conventional and newly emerging aquaculture practices, farming systems and facilities, focusing on their implications to the potential need for updating the FAO aquaculture farming system classification in current use for aquaculture statistical data collection and reporting. The workshop produced a list of conventional and newly emerging culture methods in aquaculture as a major output.

Aquaculture farming systems classification is current use

The current classification of aquaculture farming systems, or culture methods, in use by FAO since 1984 for global aquaculture data collection includes five specified culture methods for finfish, crustaceans and miscellaneous aquatic animals, and two specified culture methods for molluscs only, plus other method (specified or unspecified). The same classification is also used for data collection on aquaculture areas and farming facilities associated with the culture methods.

1. Ponds and tanks
2. Enclosures and pens
3. Cages
4. Raceways and silos
5. Barrages
6. On bottom (for molluscs only)
7. Off bottom (for molluscs only)
8. Other methods (specified or unspecified)

Apart from that there have been confusing and misleading terms used and improper combinations of culture methods for grouping or categorization in the current classification of aquaculture farming systems, or culture methods used by FAO, some relatively newly emerged culture methods are yet to be included in the classification for adequate data collection.

In Europe, EUROSTAT, with the mandate in collecting aquaculture data in 28 European Union member countries has moved “tanks” out from the combined “ponds and tanks” group to be part of the new combination of “tanks and raceways” group. The culture method “barrages”, which is less relevant to European aquaculture context has been deleted, while the increasingly important recirculating aquaculture system has been formally institutionalized as separately listed standalone culture method for data collection.

In Asia, the culture methods employed for aquaculture production operation are diverse. Some culture methods are special or unique in accordance with the local conditions and traditions.

Worldwide, aquaculture farmers, together with associated academies and supporting industries, have been active in renovation and innovation in farming systems development, resulting in more diverse culture methods than decades ago. New culture methods are in need of being incorporated in an updated aquaculture farming systems classification to better suit the statistics activities worldwide.

Criteria and considerations the list of culture methods with hierarchy structure

As result of the brainstorming session of the aforesaid workshop, a flat list of conventional and newly emerging culture methods in aquaculture was compiled. The workshop discussed and agreed on a set of major criteria and considerations for the evaluation of all the culture methods tabled for their final inclusion in the list of culture methods with a hierarchy structure. The criteria and considerations agreed upon include, but not limited to the following.

- Need of continuity of the current classification into the new one in the future;
- Envisaged practicality in field data collection;
- Usefulness to administrative registration of producing entities;
- Level of production efficiency, productivity and potential for upscaling;
- Level of scientific and technological innovation, sophistication and integration with sectors such as ICT, automation and manufacturing engineering;
- Dependence on the use of natural resources, especially limited resources like land, freshwater and space;
- Potential conflicts with other resource users;
- Level of requirement for capital investment, maintenance and cost of operation;
- Friendliness to environment, or environmental sustainability, including effluent and waste treatment;
- Energy use efficiency in production operations;
- Use of artificial feeds vs utilization of natural productivity of aquatic environment;
- Characteristics of culture methods in terms of biosecurity and health management of farmed species as well as food safety of final harvested products;
- Degree of horizontal and vertical integration with other activities;
- Susceptibility and resistance to potential natural disasters and extreme hydraulic, oceanographic and climatic conditions;
- Safety of workers / operators.

List of aquaculture culture methods in aquaculture

A list of culture methods in aquaculture compiled by the experts attending the December 2018 workshop is presented in this document for comments and suggestion for improvement. The listed culture methods are basically arranged on a few hierarchy levels, together with some further divisions under major categories as a flat list according to the above described criteria and considerations. The list divides all compiled culture methods into 15 categories below.

1 Culture with earthen ponds
2 Culture with tanks and raceways
3 Culture with man-made and semi man-made water bodies
4 Culture in lakes and other natural water bodies
5 Culture with cages
6 Culture with pens and enclosures

7 Culture with close containment systems
8 Culture with fish rearing vessels
9 Culture with RAS (recirculating aquaculture systems)
10 Culture with aquaponics system
11 Culture in rice fields and other aquatic crop plantation fields
12 Culture methods for shelled molluscs
13 Culture methods for seaweeds (marine macroalgae)
14 Culture methods for microalgae, including cyanobacteria
15 Other culture methods

It is obvious that some categories overlap in coverage. For instance, the method of RAS (recirculating aquaculture systems) utilizes tanks for rearing target species in most cases. But RAS culture method differ very significantly from traditional tank culture in terms of technical sophistication, productivity, level of assurance in biosecurity, food safety level of the products, and requirement for capital investment, etc. Therefore RAS culture should be separately categorized for statistics collection and the volume of rearing space of tanks in RAS culture need to be counted separately, too.

The compiled list of culture methods should be seen as an initial draft, which needs to be enriched by including additional culture methods in some regions that may have been omitted by the experts of the December 2018 workshop.

The full list of culture methods in aquaculture compiled by the FAO-NACA joint workshop on aquaculture farming systems is as follows.

1 earthen ponds

excavated or constructed earthen ponds (usually of regular shape)

modified or renovated natural ponds (often less regular in shape and larger in size)

earthen ponds without lining

earthen ponds with lining

- lined with synthetic material
- lined with cement and other materials

rain-fed undrainable earthen ponds

irrigated and drainable earthen ponds

- irrigated with surface water
- irrigated with underground water
- irrigated with brackish or sea water
- irrigated with underground sea water

earthen pond monoculture

earthen pond polyculture

- in-pond mixed polyculture

- partitioned pond polyculture
  - pond polyculture with species partitioned by net or fence
  - pond polyculture with species partitioned with cages or happas
  - pond polyculture with species partitioned with baskets or boxes on floating racks

earthen pond culture without in-pond integration

earthen pond culture with in-pond integration

- in-pond integration with aquatic vegetable planted on pond bottom
- in-pond integration with floating aquatic plants
- in-pond integration with plant crops on floating beds

earthen ponds without aeration

earthen ponds with aeration

- aerated with floating aerator, paddle wheel or air-jet
- aerated with on-bottom nano-hose aeration

earthen pond culture without effluent treatment for discharge

earthen pond culture with effluent treatment for discharge

- effluent treated on farm with manufactured facilities and equipment
- effluent treated with uses of extra ponds for sedimentation and bio-treatment
  - effluent treated with on-farm uses of extra ponds for treatment
  - effluent treated with communal uses of extra ponds for treatment

earthen pond with in-pond raceway recirculating system

- with in-pond raceway recirculating system built on bottom
- with in-pond raceway recirculating system floating above bottom

earthen pond with out-of-pond tank recirculating system

partitioned pond system & split-pond system

openly exposed earthen ponds

greenhouse-covered earthen ponds

- earthen ponds covered with greenhouse of permanent manufactured structure
- earthen ponds covered with greenhouse of temporary structures

earthen ponds with steep dykes

earthen ponds with exposed area for other related uses

Earthen ponds with area for sunbath or feeding of farmed animals (turtles, frogs, etc.)
Earthen ponds with area for green folder plantation for feeding farmed animals in ponds

earthen ponds irrigated without heating or cooling
earthen ponds irrigated with heating or cooling
earthen ponds irrigated and heated
earthen ponds irrigated and heated with geothermal energy
earthen ponds irrigated and heated with other energy (e.g. power plant waste hot water)
earthen ponds irrigated and cooled
earthen ponds irrigated and cooled with cold water from LNG regasification terminal
earthen ponds irrigated and cooled with OTEC deep sea water

2 tanks and raceways

raceways
raceways of permanent construction (cement and bricks, etc.)
raceways constructed with removable structure and materials
traditional stone walled flow-through tanks in mountainous regions

raceways openly exposed
raceways under roof or covering
raceways in greenhouse
raceways in greenhouse of permanent manufactured structure
raceways in greenhouse of temporary structures

tanks
tanks of permanent construction (cement and bricks, etc.)
tanks constructed with removable structure and materials
tanks manufactured by industry

tanks openly exposed
tanks under roof or covering
tanks in greenhouse
tanks in greenhouse of permanent manufactured structure
tanks in greenhouse of temporary structures

* additional filter by type water used for raceways and tanks:
  surface water, pumped or diverted
  underground water
  brackish or sea water
  underground sea water

3 man-made and modified water bodies used for aquaculture

small reservoirs, dammed water bodies and barrages
irrigation canals and ditches
borrow pits and dugouts
ex-mining pools
impounded land depression areas (caused by mining, etc.)
crop farm ponds and farm reservoirs
small lagoons or salt marshes modified with water management facilities like water gates
valliculture and jiwei (gei-wai), etc.

** additional filter by period of impoundment in the year*
  of permanent impoundment
  of seasonal impoundment

4 lakes and other natural water bodies used for aquaculture

lakes
oxbow lakes (locally called "boars" in Bangladesh and West Bengal, India)
wetland (locally called "beel" or "beal" in Bangladesh and India)
seasonal flood plains
seasonal lakes (locally called seasonal tanks in Sri Lanka)
potholes (in North America)

** additional filter by period of impoundment in the year if needed*
  of permanent impoundment
  of seasonal impoundment

5 cages

traditional / conventional net cages
stationary traditional / conventional net cages in shallow waters
floating traditional / conventional net cages
traditional wooden / bamboo cages

modern net cages

metal framed floating net cages (HDPE = high-density polyethylene)
metal mesh cages
perforated metal sheet cages
flexible framed floating net cages
HDPE framed floating net cages (HDPE = high-density polyethylene)
with on-the-spot monitoring, control and management platform
without off-the-spot land-based monitoring, control and management

modern net cages of synthetic netting materials
modern net cages of copper alloy wire net fitting

modern net cages installed in protected coastal area or inside fjords
modern net cages installed in exposed offshore area

modern net cages without fish waste collection devices for disposal/treatment on land
modern net cages with fish waste collection devices for disposal/treatment on land

ultra-modern net cages (engineered/manufactured with latest tech and automation)
floating (or semi-submersible) ultra-modern net cages
fully submersible or bottom-sitting ultra-modern net cages

6 pens and enclosures

traditional net pens supported with poles
modern net pens with fortified supporting frame

enclosures without supporting poles or frame
enclosures supported with poles or frame

7 close containment culture system (in the sea, lake or reservoirs)

8 fish culture vessels

modified from decommissioned cargo ships

purposely designed and constructed fish culture vessels

9 recirculation aquaculture systems (RAS) with manufactured equipment

RAS system with tailored design and manufactured facilities and equipment

single storey large rearing tank installation

multiple storey small-to-medium rearing tank installation

stacked multi-storey boxes for individual rearing of aquatic animals (crab condominium)

RAS system using modified recycled structures (out-of-use shipping containers, etc.)

10 aquaponics

commercial scale aquaponics system

small backyard scale aquaponics system

11 rice-fish culture and other integrated farming systems with plant crop

rice-fish culture

rice-fish culture in conventional rice field (paddy)

rotational rice-fish culture

rice-fish co-culture

rice-fish culture in renovated rice field (paddy) to suit aquaculture

rotational culture

co-culture

rice-fish culture without artificial feeding

rice-fish culture with artificial feeding

farming integrated with other aquatic plant crops

integration with aquatic vegetables

integration with aquatic herbs, flower, etc.

12 culture of shelled molluscs (and benthic animals like sea cucumber & sea urchins)

on-bottom culture

sea ranching - seeds sowed at seabed

inter-tidal mudflat - seeded sowing (shelled molluscs)
(polyculture with other species in coastal earthen ponds is also commonly practiced)
(culture of gastropod molluscs in tanks is also commonly practiced)

off-bottom culture
longline ropes (suspended vertically in column) with anchors and buoyance
net bags on stationery racks installed in inter-tidal zone or in shallow sea
baskets or trays on stationery racks installed in inter-tidal zone or in shallow sea
rafts (with seeded ropes for culture attached)
poles (of rock, cement, bamboos and other materials)
lantern net cages suspended from floating longline or raft (mostly for scallops)
perforated plastic boxes suspended from floating longline or raft
abalone houses in floating net cages
automated truss-structured abalone culture platform (modern high-tech)

13 culture of marine macroalgae (seaweeds)
longline ropes (suspended horizontally or vertically in the sea) with anchors and buoyance
web or net of ropes fixed on stationery racks or poles typically in inter-tidal areas
rafts or floating racks (with seeded ropes for culture attached)
floating baskets (chained with ropes; seaweeds protected from grazing animals)
sleeve shaped long net bags (seaweed seedling held inside)
suspended net trays (mostly for sea grapes)
(tanks are used, too)

14 culture of microalgae (including cyanobacteria, etc.)
plastic bags (transparent)
closed biophotoreactors systems (tubes or flat panels)
(raceways and tanks are more commonly used)
(tanks also used)

15 other culture methods
specified with description for data collection / reporting
not specified for data collection / reporting

###