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"Being Typical" – The Representative Farms Method in Aquaculture and Fisheries

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ABSTRACT

The collection of economic data for fisheries and aquaculture is a pre-condition for an effective and sustainable management of marine and freshwater resources. To be able to promote "Blue Growth" it is important to understand the economic drivers both at the micro- and macro-economic level. Economic data collected for statistics purposes are based on historical account data and it is not uncommon, that the result from fisheries and aquaculture surveys are published two or more years after the financial accounts has been finalized. However, reliable data at the micro level for fishing vessels and aquaculture farms are not always available. Furthermore, when it comes to evaluate actual impacts on fisheries and aquaculture enterprises, political decision-makers need analysis showing real time scenarios. A network of representative model vessels and farms overcomes this research desideratum. According to *agri benchmark* network a typical fish farm or a typical fishing vessel is combines resources, labour and capital as established in the management and the addressed region today. The typical farm approach has the potential to evaluate the economic impact of new technologies, fisheries programmes, new managing frameworks or market conditions. The new approach of typical aquatic production systems has been tested in different countries among the globe in the recent years. My article sums up the principle of the approach and the experiences Thünen-Institute has made with typical farms and vessels so far.

KEYWORDS: Data Collection, Economics, Representative Farms, Typical Farm Approach

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1. Introduction

Understanding Blue Growth requires an insight into economic drivers that work at the level of individual operational units. Such insights are a pre-condition for evaluating the impact of changes to management and frameworks, regardless of whether the drivers of such change are political (e.g. Water Framework Directive or TACs) or environmental (e.g. climate change). In the case of European aquaculture and fisheries, the smallest units are farms and vessels, for which reliable and comparable data are often not available. Part of the difficulty stems from low response rates to classical economic surveys attempting to garner new data (PG ECON, 2019), resulting in poor data quality. Under the umbrella of the EU Horizon 2020 research and innovation programme and pilot studies for the EU Data Collection Framework (DCF), a new alternative method has been tested, in which data is sampled from a few representative farms. Results of the trial suggest that it not only supplements and complements existing economic data for aquaculture and fisheries, but may also represent a serious alternative to traditional strategies for data collection in the sector.

The first section of this technical note describes the development of the so-called *typical farm approach* from its historical roots in U.S. agricultural sciences. Section two explains the method itself with a special focus on the sampling procedure. Section three summarises various applications of the method in a variety of current projects, and the final section offers an implementation case study from the German Workplan of the EU data collection framework (DCF). The terms 'representative farm method' and 'typical farm approach' are used synonymously throughout this paper.

2. Theory

The typical farm approach in which a carefully well-chosen farms are documented in detail in order to represent a wider picture, has its origins in the need to evaluate and understand the economic impacts of new technologies or programs, or of changing management frameworks and market conditions (Feuz and Skold, 1990). The concept of a typical farm has its roots in the classical economics of Alfred Marshall (1890) and Frank W. Taussig (1911), who independently and almost simultaneously came up with the idea of representative firms, which are long-established and economically stable, well equipped and well managed but not too far ahead of their competitors. The representative firm method was subsequently developed and refined into an agricultural context in which the idea is to identify a farm that can be seen as typical of a certain type. Typical farm datasets now exist in two basic variations (c.f. Isermeyer, 2012; Feuz and Skold, 1990; Thompson, 1958). The real-concept representative farm method identifies existing individual farms, which exemplify the production factors of labour, capital and land in a typical way. In Europe, the Farm Accountancy Data Network (FADN), which has analysed European agricultural business since 1965, is one example of the real-concept method (FADN, 2019). The modal-real-concept takes a real farm as starting point and replaces any production particularities with virtual elements based on common or typical types, resulting in a model typical farm that does not exist in reality, but could do. The approach diverges significantly from one based on merged statistical averages, because a farm model derived from simple averages for quantity structures or prices is not necessarily viable in economic reality. Instead of merging averages, the modal-real-concept forms a coherent single farm dataset, based on a genuine archetype. In a very small sector, a modal-real farm has the additional advantage of anonymity while retaining important real-life details from a genuine profit-and-loss account.

After a peak of application in the 1960s, the rise of new economic statistical methods meant that the representative farm method began to be replaced by other forms of survey, but the 1981-86 financial crisis in farming led to its revival and further development, and a diffusion of typical farm thinking across the international scientific community (Lasner *et al.*, 2020; Isermeyer, 2012; Feuz and Skold, 1990).

Today, a range of different institutions apply the typical farm method or elements of it, including the Farm-level Analysis Network of the Organisation for Economic Co-operation and Development (OECD) (e.g. Kimura and Thi, 2013), Representative Farm Network of the Agricultural and Food Policy Center, Texas A&M University (Outlaw *et al.,* 2019), the Brazilian Agricultural Research Corporation (Embrapa) (Munoz and Barroso, 2018) and the international agricultural network *agri benchmark*. Since 2014, the latter has been working on an adjustment of the approach towards aquaculture and fisheries (Lasner *et al.,* 2017).

3. Method

In the context of aquaculture and fisheries, the representative or typical farm approach utilises a dataset from a farm or vessel with stable characteristics, earning adequate profit, not the best, not the worst, adequately equipped, and which represents a group of similar units using a common production method in the same region (Lasner *et al.,* 2020; Lasner *et al.,* 2017). The typical farm is based on real costs, investments and prices. It combines resources, labour and capital characteristics of current management in the exemplified region. The modal concept relies on diverse sources for pre-defining the example, but the pertinent characteristics are then verified empirically. In aquaculture and fisheries, the typical farm approach comprised three main interactive stages: abductive pre-definition of representative farms, inductive definition, and an abductive-inductive plausibility check. The pre-definition stage is based on knowledge available from the literature and statistics. The first step towards defining a typical farm is the identification of a sector which contributes a significant share of national production. This group or market must be clearly framed, for example as traditional pond systems producing portion-sized rainbow trout for human consumption in Germany. This framing will later delimit what can be represented by the model. An important region for the type of production being evaluated is then selected either for its share of national production and/or for its share in the total number of farms. In some cases, niche markets (e.g. organic farms) or future-looking production systems (e.g. recirculated aquaculture systems, RAS) might be included in a model as archetypes of good practice.

In the second stage, fish farmers (or skippers in the case of fishery vessels) and consultants from the selected production region are contacted and invited to form a focus group of up to 12 participants whose role is to define a representative farm, step by step. In most cases, the most useful first contacts are not potential focus group participants themselves, but local individuals with an understanding of the method and established relationships with local fish farmers who are able to perform the function of a door-openers and make introductions. The focus group is the core element of the typical farm approach in aquaculture and fisheries and thus the process of constitution should be handled with methodical care.

Once a focus group of relevant stakeholders has been organised, a researcher instigates and moderates discussions about the value of cost variables, input volumes, outputs and prices. The exact number of variable values to be defined depends on the production system, but the list includes at least 22 of the economic variables of the EU DCF[1]. Experience suggests that annual production volume is the best starting point (e.g. 25 tonnes of portion-sized brook trout as main species) for aquaculture systems and annual days at sea is a good starting point for modelling fisheries' vessels. Often the value of one variable is automatically linked to that of another: for example if the typical farm produces 25 t brook trout with a final harvest weight of 400 g per fish, it needs around 70,000 fingerlings at 10 g per piece, assuming a typical mortality of 10 % per production cycle. By working through these variables, a coherent picture of the typical farm is built up through consensus within the focus group. Simultaneously, and in contrast to statistical averaging, the defined variables control each other – for example Feed Conversion Rate (FCR) should meet the volume of fish feed used and the feed costs should be in line with feed volume and feed price etc. Finally, the modelled typical farm can be validated by real world fish farmers in accordance with their lived experience and by researchers, so that existing knowledge may be

[1] Turnover, subsidies, other income, total income, wages and salaries, value of unpaid labour, energy costs, stocking costs, feed costs, repair and maintenance, other operational costs, depreciation of capital, financial costs, extraordinary costs, total value of assets, net investments, debt, sales volume, stocking volume, feed volume, number of employees, full-time labour equivalent (FTE).

modified. The data collection procedure is summarised in Figure 1.

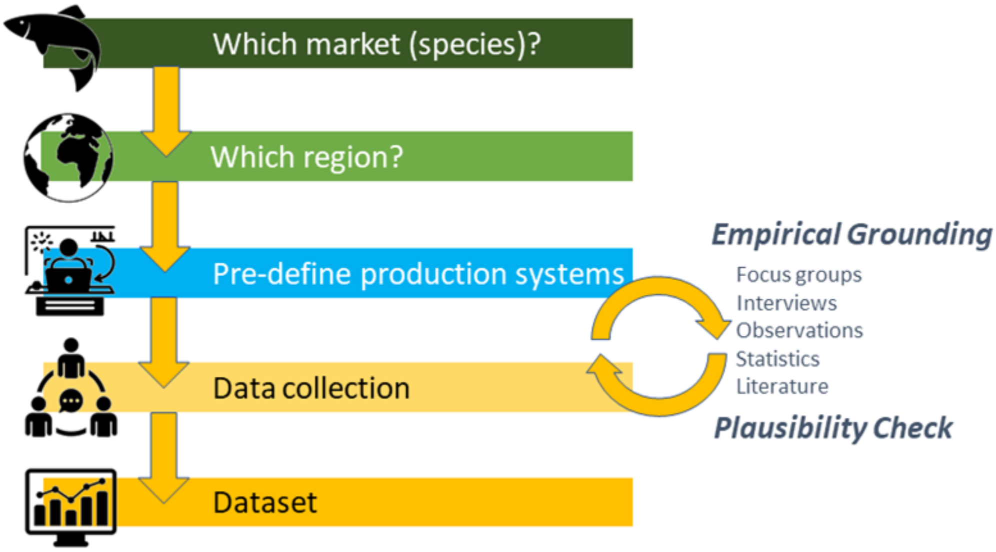

Figure 1. Schemata of the representative farm approach (according to Lasner et al., 2017)

Once a dataset for a typical farm (or a typical vessel) is defined, it is possible to model different economic operations at farm level (e.g. cost accounting, profit and loss account, profitability, economic and physical productivity, return on investment (ROI), energy return on investment (EROI) etc.). An example of the cash costs of different aquaculture production systems studied is given in Table 1.

Table 1. Production system, origin and cash costs of different European aquaculture grow-out systems in 2016

	FARM					
Species	**Carp**	**Organic Salmon**	**Seabass & Seabream**	**Char**	**Carp**	**Trout**
Code	**DE-FCP-5**	**IE-SAL-1540**	**TR-BSS-2000**	**DE-XXX-25**	**PL-FCP-190**	**TR-TRR-500**
Country	Germany	Ireland	Turkey	Germany	Poland	Turkey
Region	Aischgrund	Donegal	Muğla	Bayern	Dolina Baryczy	Muğla
Year	2016	2016	2016	2016	2016	2016
Main Technique	Earthen pond	Netcage	Netcage	Earthen Pond	Earthen Pond	Raceways
Annual Production (mt)	**5**	**1,540**	**2,000**	**25**	**190**	**500**
Cash Costs in €/kg Live Weight (LW)	**1,64**	**3,98**	**3,03**	**4,03**	**1,97**	**2,31**
Feed	0,24	1,92	2,23	1,58	0,59	1,28
Stocking	0,97	0,21	0,41	0,81	0,59	0,49
Power				0,04	0,02	
Oxygen				0,06	0,01	
Wages	0,00	0,31	0,06	0,41	0,33	0,16

Interests		0,01		0,30		
Others Variable Costs	0,19	1,11	0,25	0,04	0,11	0,31
Fixed Costs	0,23	0,42	0,08	0,79	0,31	0,07

Figure 2 shows the total costs and mean returns (including public payments) of different species in grow-out stage across selected European countries. The difference between costs and market returns demonstrate the farm model's profitability, which varies a lot across the types of farms and markets represented.

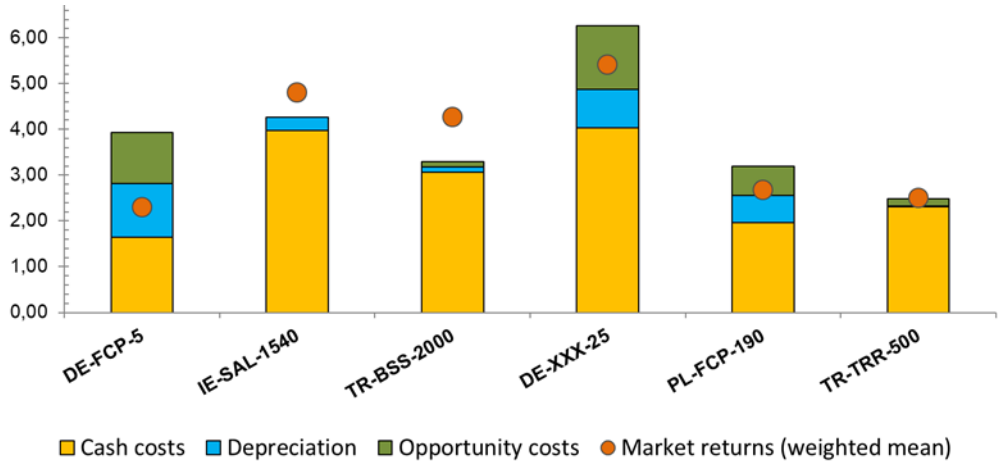

Figure 2. Cash costs and non-cash costs, market returns and profitability (€/kg LW) in selected grow-out systems 2016

Once established, the updating of typical farm dataset is less burdensome than its initial definition. The production systems of European aquaculture and fisheries are less dynamic than those in other high-tech sectors and typical operations are more stable in character than in terrestrial farms. Thus a brief annual interview with some established fish farmer partners is usually sufficient to update the dataset, with no need to repeat the full focus group procedure. As a rule annual changes tend to be limited to a few variables, which dominate the overall cost structure, e.g. feed prices in Turkish trout production systems, which account for up to 70 % of overall cash costs. Time series of these changes can be built up to evaluate the economic development of typical farms over time and to analyse framework changes as shown in Figure 3.

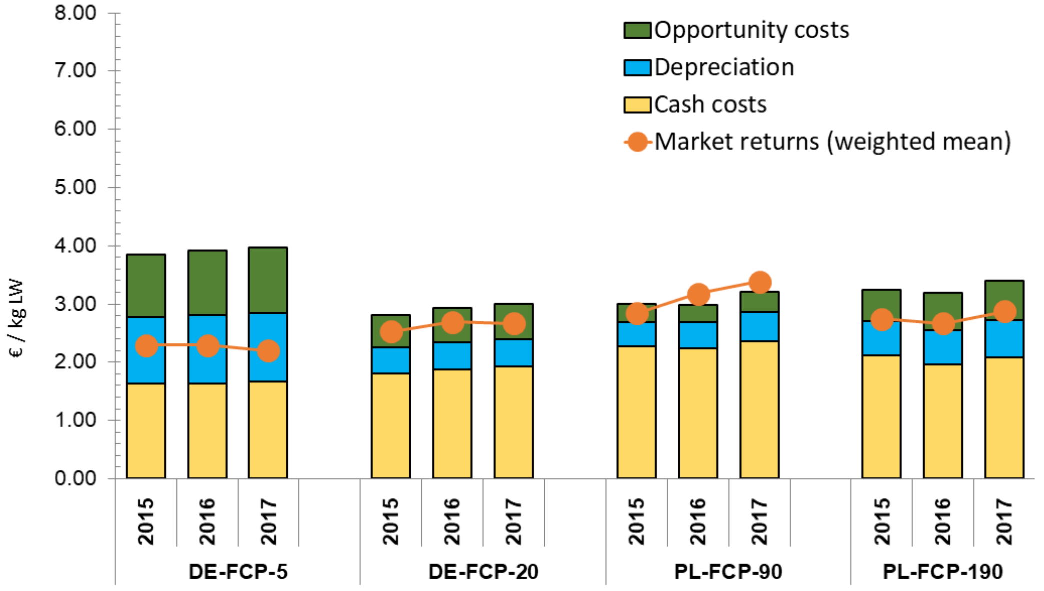

Figure 3. Cash costs, non-cash costs and market returns (€/kg LW) of selected German and Polish carp grow-outs 2015-2017 (Lasner et al., 2020)

4. The Lessons learned

The typical farm approach has been applied in various projects under the umbrella of the European Union's Horizon 2020 research and innovation programme and in two DCF studies. The "Strategic Use of Competitiveness towards Consolidating the Economic Sustainability of the European Seafood Sector" (SUCCESS) scheme, financed through Horizon 2020 from 2015 to 2018 was an entirely economic and social science project unique in European aquaculture and fisheries research. The core objective was to consolidate the economic sustainability and fitness of European fisheries and aquaculture sectors in order to reap the potential of seafood markets (EU COM, 2014). The project incorporated case studies that provided certain perspectives on the economic competitiveness of the European aquaculture and fisheries sector, including global drivers, consumer preferences, industries and trade value chain. Most of the case studies focussed on particular species or seafood markets and used existing statistical data from Eurostat and DCF for their analysis. For the carp case study, the data availability was poor, because the DCF did not require economic data pertaining to freshwater species to be included until 2017 ((EU) 2017/1004). In the absence of adequate economic data, the carp case study used the typical farm approach to compare the economic situation of carp farmers in two different European carp regions, the Aischgrund in Germany and Barycz Valley in Poland. Evaluation of four representative carp farms plus one particular case confirmed that under current market (stagnating national demand) and production (high fish loss by predators) factors, traditional carp grow-out and distribution operations are scarcely profitable (Lasner *et al.*, 2020). Fisheries Local Action Groups (FLAG) in both regions have risen to the challenge by developing region-marketing concepts with the carp as a core identity. In spite of well-developed region-marketing, there remained doubt as to how small-scale carp farmers might benefit from increasing tourism. With the help of typical farm models, promising strategies for maintaining the tradition of carp culture in Europe were identified, including premium prices for Protected Geographic Indication (PGI) labelled produce, compensation payments for fish losses to cormorants, measures to reduce predation, and diversification schemes. Most importantly from a science perspective, the SUCCESS carp case study demonstrated that fish production across an entire region can be convincingly represented by a few well selected and carefully defined farms. Expert interviews accompanying the project confirmed that the models were effective in mirroring the economic challenges of carp farming.

A further DCF pilot study from 2015 to 2016 investigated the extent to which German typical farm datasets were able to address gaps in DCF survey data and how the updating of datasets happened in practice. To date, early uses of typical farm datasets have been used to complement DCF surveys in situations where the response rate to traditional surveying had been poor and where the value of a single variable shows a large distribution. In such cases the typical farm dataset has aided the interpretation of data and provided realistic baseline values from which to make projections about the sector. Typical farm data has been particularly useful in providing a value for species of data which are difficult to collect directly via surveys, such as the value of unpaid labour in a given aquaculture region. As part of the pilot, a questionnaire was developed for use in stakeholder interviews, the result of which should allow a simple projection of pre-existing data to the current year. Data pertaining to 18 crucial variables was identified and retrieved via phone interviews, while the remaining 22 variables were updated on the basis of national statistics and publicly available price indices. The case study confirmed that farm models can be projected, but it is recommended that regular farmers' focus groups should be held in order to correct the results of the projection. The frequency of focus groups might be anything from bi-annual to five yearly, depending on the dynamics of the production system being evaluated.

The interdisciplinary "Climate change and European Aquatic Resources" (CERES) project goes considerably further, in conducting projections up to the year 2050. The overall objective of CERES (2016-2020) is to analyze the impacts of climate change on European fisheries and aquaculture by linking biological, environmental and economic packages of work. As part of the economic work package, typical farm datasets were collected to represent production of the continent's most important aquaculture species across diverse climate zones. The sampling included open (e.g. net cages) and closed productions systems (e.g. partly-recirculated raceways) in Atlantic maritime, continental and Mediterranean climates. Using farm models as archetypes and counterexamples, CERES was able to benchmark farm level effects of climate change according to four UN Intergovermental Panel on Climate Change (IPCC) scenarios: world market, national enterprise, global sustainability and local stewardship. The extrapolations incorporated future price assumptions under scenario-driven social and economic developments as well as temperature induced changes in harvest weight and FCR until 2050 and have been discussed in stakeholder groups. While it is in the nature of such far-reaching projections to carry a high degree of uncertainty, the ability to conduct such an exercise at farm level serves to open discussion on the possible consequences of climate change across the European aquaculture and fisheries sector and to identify likely beneficiaries and losers. From a methodical point of view, the long-term projections have shown the potentials and limits of the typical farm approach for diverse species and a full range of sector structures from the highly professionalized salmon industry to peasant-style carp farming in different EU Member States. It reconfirms the need for frequent integration of focus groups in building up time series of data that can be used to inform policy makers and politics. Moreover, the application of typical farm modelling across Europe permits a temperature and disease risk analysis under climate change scenarios that has identified likely regional hot spots, thus highlighting a potential of this approach that extends beyond pure economics.

Like CERES, the Horizon 2020 project "Green Aquaculture Intensification in Europe" (GAIN) is a large interdisciplinary research effort, which in this case links engineering, natural sciences and environmental impact analyses with economics. The project aims to support ecological intensification of the European aquaculture sector via innovations in production and in other parts of the value-chain. The economic feasibility of new feeds and precision aquaculture techniques and the development of innovative co-products are being analysed in typical farm models. An ability to test new measures and techniques before they enter the market may limit disinvestment by farmers. Conversely, a cost-effectiveness analysis with empirically grounded farm archetypes could convince what is known to be a conservative sector to adopt innovation and embrace modernisation. The project was launched in 2018 and will run until 2021. At the time of writing, the first economics results are yet to be published.

5. Outlook

The various projects in which the representative farm approach has been applied to European aquacultures and fisheries in recent years now amount to a useful pool of experience. A network of typical model farms can be regarded as a valuable tool whose applicability goes far beyond regular monitoring of the sector. A definite advantage of the approach is the availability of coherent farm level datasets that provide a sound basis for political advice and for the evaluation of new measures and technical innovation. The interplay of deductive-inductive techniques is a precondition for the establishment these datasets. In a sector where consistently low response rates to traditional surveys have resulted in a scarcity of statistical data, the typical farm approach provides an opportunity to project the sector's economics to fulfil the demands of the DCF. In consequence, German and Austrian workplans for collecting data pertaining to economic and social variables in the fisheries and aquaculture sectors (2020-21) now integrates the typical farm approach and in Germany, the supplementary typical farm approach is regarded as one of three main data sources as shown in Figure 4.

Figure 4. Triangulation of the DCF German Workplan (2020-21*)*

While European aquaculture plays a minor role in the world seafood market, the global situation pertaining to data collection is worse still. It may be that the approach and the networks of representative farms the approach fosters may be the answer to future international benchmarking between aquatic production regions. Some of the abovementioned scientific organisations such as *agri benchmark* or *Embrapa* have already gained experiences in analysing the competitiveness of aquaculture at a global level. Although recent applications of the typical farm approach in fisheries and aquaculture have been valuable, the approach is yet to be fully adapted from the field of terrestrial agriculture. While it has proven a useful supplement to the existing poor statistical data on aquacultural economics, it not yet known how reliably projections based on a network of typical farms concerning can be extrapolated to the whole sector. A follow-up DCF case study launched in June 2019 aims to build up such a network in Germany and test the reliability of resulting sector projections in comparison those based solely on survey data. The results of this case study will reveal the extent to which the approach outlined here should be regarded as a supplement to existing economic data collection methods in aquaculture and fisheries, or a wholesale alternative.

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