OPTIMAL FARM SIZE FOR THE PRODUCTION OF THE MEDITERRANEAN MUSSEL (*MYTILUS GALLOPROVINCIALIS*) IN GREECE

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ABSTRACT

The profitability of the Mediterranean mussel (*Mytilus galloprovincialis*) farming depends on a combination of factors including natural productivity, technical practices, production costs and product pricing. In an effort to analyse the financial risks of the mussel farming in Greece, we examined the profitability of the different farm sizes (1 to 4 ha) under the present situation of the local market and the modern production practices. Assuming that a farm works at a reasonable 80 % of its annual capacity and uses the widely accepted long-line technique, it was demonstrated that a farm size less than 2 ha is not viable economically. Moreover, the cost of the new establishments and the modernization of the existing ones is affordable only if larger enterprise structures are adopted. Consequently, the past EU and/or public support (up to 45% of the total cost of the fixed assets) has been critical for the development of the industry. Taking in account that the majority of the Greek mussel farms are rather small (1-2 ha), we concluded that for financial sustainability the sector needs to be restructured and be organised in larger schemes, such as those of producers organisations or co-operatives, in order to benefit from scale economics and attract better funding.

Keywords: Mediterranean mussel, *Mytilus galloprovincialis*, farm size economics

INTRODUCTION

Mussel farming in Greece was introduced in the late 70's while modern cultivation techniques i.e. single-floating long-line systems were introduced in the 80's (Theodorou *et al.*, submitted). The estimated production for the 2008 was about 36,000 tonnes produced by 523 licensed farms and exported by 80 % as fresh product mainly to Italy. As the old technology farms are subject to relocation being situated in environmentally sensitive areas (Natura 2000 network) and their licenses have been suspended the single-floating long-line systems constitute today the industry's standard producing nominally 100 tonnes per hectare. The area occupied by old farms using poles or hanging parks ranges between 0.1-0.2 ha, while the 218 long-line farms occupy between 1 to 15 ha each, with an average of *ca*. 3.5 ha per farm.

The sector faces a series of structural problems such as poor marketing, lack of organized expedition centres and purification plants, an imminent legislation change to reorganise the farm sites in new aquaculture parks, as well as a series of uncertainties such as harmful algal blooms (HABs), seed availability etc (Theodorou *et al.*, submitted) all of which contribute to the marginal profitability of the relatively small farms. No detailed analysis exist in Europe to highlight the effective or optimal farm size

for financially sustainable mussel farming. On the contrary, data of EU on the sector are inconclusive regarding economic performance (Commission of EU, 2009) except for a recent study (Framian BV, 2009) which gives a thorough insight but does not focus on optimal size.

The present study tries to highlight the profitability of mussel farming in Greece under the present challenges, focusing on enterprise budgets of different farm sizes. The budget analysis was followed by a sensitivity analysis on different sizes according to methodology recently reviewed by Kam & Leung (2008).

METHODS & MATERIALS

Data from 8 selected single-floating long-line mussel farms of different size and location in Greece were used to develop spreadsheets of budget and fixed assets. Guided interviews of 49 farmers were also used to infer averages on production costs (labour, consumables etc) comprising the variability imposed by small differences in the application of the same more or less production protocol. The survey was carried out during October – December 2008, and established the production and management assumptions for a hypothetical operation according to Adams *et al.*, (2005).

Production assumptions

Realistic production scenarios were developed for hypothetical mussel farms ranging 1-4 ha in occupied sea area assumed to be fully operating, situated in same location (2 miles from port), constructed under the same material specifications and equipped with same modern equipments and boat of reasonable size. The assumed production system was a long-line of 100 m long polypropylene ropes placed at 10 m distance to each other for as much as the occupied area allows, loaded with 200 pergolari of 15 kg per m average final product weight harvested annually.

Financial Assumptions

The sales price used in the present financial analysis is the current bulk export price as the majority of the production (70-80%) is export oriented. No bank loan neither for the construction nor for operating the farm have been taken in account for the scenarios. The depreciation of the installation and the equipments was accounted for a period of 8 years. The total capital investment was estimated for each farm size. The financial analysis utilized standard enterprise budgeting techniques as used by Adams & van Blokland (1998) for hard clams and Adams et al., (2001) for southern bay scallop commercial cultures in Florida.

RESULTS & DISCUSSION

From the data presented in Table I it was evident that the most important asset was the boat contributing up to 60% to the total fixed cost for the smallest size farms. A number of tools including boat, car, small boat with outboard (tender to the working vessel) and the grading machine of the “French” type account for the 60-80% of the fixed cost depending on size. The rest belongs to floating gear with lighthouses expanding as expected with size while the cost of the necessary services (license, feasibility study) was kept low in general terms. Normally, there was a government/EU funding to implement the investment contributing usually up to 45 % of it hence, alleviating a lot of the investment risk and rendering easier the decision to take the necessary steps for the venture by the farmers practically, of a rural background (fisheries, or agriculture) with low profile in education or social status. License fees were about 1000 Euros per hectare per year adapted for inflation every four years by the Greek state, which in general has the policy to license small farms to lot of stakeholders, instead of large farms to a few, as a means of improving social cohesion and financial status of the local coastal communities.

Table I. Fixed Cost for a range of sizes of Greek mussel farms (values in €)

	Farm size				
	1 ha	**1.5 ha**	**2 ha**	**3 ha**	**4 ha**
Licensing, Prefeasibility Study Surveys	10,000	11,000	12,500	13,500	15,000
Moorings	14,300	21,450	28,600	42,900	57,200
Ropes	11,935	17,903	22,785	35,805	45,570
Floats	2,500	3,750	5,000	7,500	10,000
Lighthouses	6,800	6,800	6,800	6,800	13,600
Working vessel (15 m long)	140,000	140,000	140,000	140,000	140,000
Working boat 6 m	6,000	6,000	6,000	6,000	6,000
Outboard engine (20hp)	4,000	4,000	4,000	4,000	4,000
Car	21,000	21,000	21,000	21,000	21,000
Grading Machine Line	39,600	39,600	39,600	39,600	39,600
Total	**256,135**	**271,503**	**286,285**	**317,105**	**351,970**
Government - EU funding (45%)	127,724	122,176	151,934	142,697	158,387
Own Contribution (55%)	128,411	149,326	134,351	174,408	193,584

The farm size did not raise directly proportional the operating cost (Table II). In fact an increase in size by a factor four corresponds to a little more than double running cost. The major contribution in the rise is labour and consumables that more or less follow proportionally the size increase. However, as depreciation shows a maximal increase of 1.3 for 4 times increase in size, the overall running costs exhibit a medium increase respectively. Labour is a major part of the cost as although considerable modernisation took place recently, the sector is still labour intensive involving normally the farmer himself and members of his family (unpaid labour, Framian BV 2009) who use extra help by employing experienced workers from either the local community or immigrants residing in the vicinity.

Table II. Operational cost for a range of sizes of Greek mussel farms (values in €)

Operational Cost	***Farm Size***				
	1 ha	**1.5 ha**	**2 ha**	**3 ha**	**4 ha**
Annual Fee for Sea Rentals	1,000	1,500	2,000	3,000	4,000
Energy	1,500	2,250	3,000	4,500	6,000
Labour cost	15,000	22,500	25,000	45,000	50,000
Consumables (plastic nets, ropes, etc)	2,500	3,850	5,000	7,700	10,000
Insurance	500	500	500	500	500
Maintenance Service	1,000	1,500	2,000	3,000	4,000
Depreciation (8 years)	32,017	33,938	35,786	39,638	43,996
Others (2%)	5,123	5,430	5,726	6,342	7,039
Total	**58,640**	**71,468**	**79,011**	**109,680**	**125,536**

Table III. Annual Income and profitability for a range of size of Greek mussel farms

Annual Income and profitability	*Farm size*				
	1 ha	**1,5 ha**	**2 ha**	**3 ha**	**4 ha**
Production (tons)	100	150	200	300	400
Income (average sales price 0,35 €/kg)	35,000	52,500	70,000	105,000	140,000
Pre-tax profit (when not funded) (€)	-23640	-18,968	-9,011	-4,680	14,464
Pre-tax (when funded) (€)	-6,674	-3,696	11,980	13,157	34,263
Net profit (not funded) (€)	-11,140	-218	-6,398	-3,323	10,270
Net profit (when funded) (€)	-4,739	-2,624	8,506	9,341	24,326
Annual Return of own contribution (when not funded) (%)	-4.35	-0.08	-2,23	-1.05	2.92
Annual Return of own contribution (when funded) (%)	-3.69	-1.76	6.33	5.36	12.57
Net profit % (when not funded)	-32	-0.4	-9	-3	7
Net profit % (when funded)	-14	-5	12	9	17

Assuming a good production period with a harvesting yield close to the production capacity of each farm (100 tonnes/ha) and a bulk export price of the mussels (in pergolari) at 0.35 euro/kg, the annual profitability is marginally positive (7%) even for the largest farm size (4 ha) without public funding included in the initial investment (Table III). With the governmental-EU funding (45%) the 2 ha farms show 12 % net profits, the 3 ha farm 9 % (lower than for 2 ha due to the extra personnel and not part-time employment), while the 4 ha 17%. The smaller farms 1 & 1.5 ha give negative results. These results indicate that the profitability is related to the public support for the fixed assets and to the farm size that must be at least 2 ha. In any case a farm size of 4 ha provides profits that might ascertain financial viability.

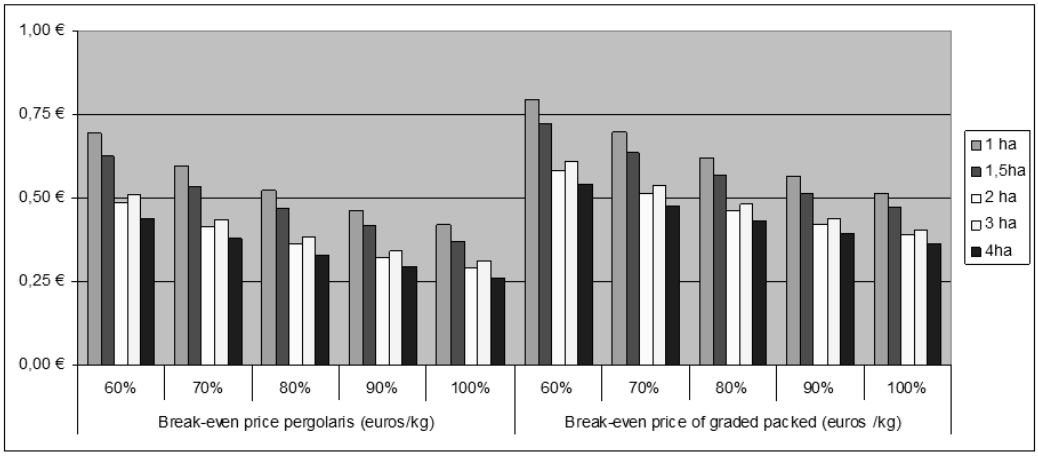

Figure 1. Break-even price for Greek mussel farm profitability depending on different size (1-4 ha) and different production effectiveness (% of annual production capacity).

The Single-Variable Method was applied to estimate the effects of the harvesting yield on profitability operations funded by governmental-EU funds, since mussel farming in Greece is viable only under the public support as it was demonstrated in Figure 1. For each sensitivity scenario, only the one variable emphasized, the yield, is allowed to change (from 60 % up to 100% of the production capacity of each farm size). All other variable levels were maintained at the baseline value. The break-even price (total cost per kilograms of harvested mussel) is presented within the sensitivity analysis. The break-even price is the minimum income needed to cover the costs associated with facility investment and operation, including depreciation (Adams et al., 2005).

As the break even prices are affected by the farm sizes (McCullough *et al.*, 2001), the largest mussel farm (4 ha) in the present study, has the lowest break even prices at any exploitable product quantity (level of the harvesting yield). To minimize potential for loss, farms should target to a minimum acceptable yield that would vary with farm size (Valderrama & Engle, 2001). The breakeven price shows that the Greek mussel production is profitable for a minimum of 90% yields in 2 ha & 3 ha farms while a 4 ha farm has a lower minimum acceptable harvesting yield of 80%.

The profit margins improved when final product was in the graded packed form, and yields were up to 70% for 4 ha farms, or 80% for 2 & 3 ha farms. The 1.5 ha farms need to operate at the 100% yield of the theoretically accepted capacity in order to be profitable, which in reality is not feasible due to losses during the grading process. In any case, farms smaller than 2 ha have a higher production cost and are not viable in the mass wholesale market. Alternative marketing strategies such as direct sales into the local market where producers are able to differentiate their product e.g. on the basis of quality, locality, service or brand, may be is a survival solution. Again as it was mentioned by Adams & van Blokland (1998) extra additional operating (labour, distribution, packing materials, etc) and infrastructure (i.e. packing station, retailing outlets) costs must be added.

CONCLUSION

The Mediterranean mussel farm industry in Greece is an export oriented activity based on the production of "raw material" (pergolari). Albeit the modernization of the production process adopted by new farms, the analysis done in this study for different farm sizes, showed that the investment tends to be viable and profitable only when the farms receive EU-governmental support and have a size larger than 2 ha.

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