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SUMMARY – In small island states of subtropical and tropical latitudes, shortage of space and fresh water as well as competition for these scarce resources from other economic sectors such as tourism usually limits the potential for aquafarming to the marine environment. Moreover, these more lucrative sectors usually force aquaculture away from the prime foreshore sites out into the more exposed waters. Modern technology has come up with very practical and reliable, commercial scale cage structures for offshore sites. Increasingly sophisticated equipment such as for feeding, grading and harvesting have made life easier out at sea and have made possible the strict control over all activities concerned.

Key words: Offshore, aquaculture, cages, feed technology.

RESUME – *"L'aquaculture marine à Malte : Stratégies et développement". Dans les petits états insulaires sous des latitudes tropicales et subtropicales, le manque d'espace et d'eau douce, ainsi qu'une concurrence âpre pour ces précieuses ressources à partir d'autres secteurs de l'économie comme le tourisme, font qu'en général les potentialités disponibles pour l'aquaculture soient limitées au milieu marin. De plus, ces activités plus lucratives déplacent habituellement l'aquaculture hors des meilleurs sites littoraux et la repoussent dans des eaux plus exposées. La technologie moderne a mis au point à l'échelle commerciale des structures de cages flottantes très pratiques et fiables, pour des sites en mer ouverte. Des équipements de plus en plus sophistiqués pour l'alimentation, le tri et la récolte facilitent la vie en offshore et ont rendu possible un contrôle strict de toutes les activités concernées.*

Mots-clés : *Offshore, aquaculture, cages, technologie de l'alimentation.*

Aquaculture developments in Malta

Being a small island in the middle of the Mediterranean Sea with considerable territorial waters sitting on the continental shelf linking Italy with North Africa, Malta has considerable potential to develop a sizeable aquaculture industry. More importantly, it is uniquely placed to capitalize on the excellent qualities and favourable temperatures of the surrounding sea water. In fact, all the farms currently operating on an intensive commercial scale are utilizing exclusively offshore technology for ongrowing marine species –mainly sea bass *Dicentrarchus labrax* and sea bream *Sparus aurata* (Agius, 1997).

All farms were established post-1991 and there are currently four companies operating five large commercial scale sites. There are also two small-scale land-based units. Production has soared from 60 metric tonnes in 1991 to 1500 metric tonnes in 1996 and over 2000 metric tonnes were expected in 1998 (Tables 1 to 3). The total licensed potential production of the existing units is approximately 3000 metric tonnes per annum; this is expected to be achieved by the year 2000. Another 500 tonne production unit, fully Maltese-owned, being planned, using plastic cages manufactured by Fusion Marine in Scotland. Hatchery production of juveniles is currently restricted to 1 million sea bream per annum but a hatchery with a target of 5 million per annum has the potential to be developed.

Approximately 95% of the above production is exported to Italy packed fresh under ice in 7 kg boxes and transported by means of refrigerated lorries (Agius, 1997).

The prevailing technology generally involves exposed-site cages consisting of a rubber or metal framework which supports the hanging net. Some farms have adopted standard off-the-shelf cages such as Dunlop and Farmocean, but over the years have carried out various minor but important modifications to improve their efficiency and safety.

Table 1. Aquaculture annual production in Malta (1991-1998)

Year	Production in metric tonnes			Estimated Value (000's of US$)
	Sea bream	Sea bass	Total	
1991	40	20	60	520
1992	150	150	300	2400
1993	350	250	600	4800
1994	550	350	900	7200
1995	800	500	1300	9700
1996	1100	400	1500	10,100
1997	1600	400	2000	12,400
1998 (est.)	1800	400	2200	13,200

Table 2. Evolution of production of sea bream and sea bass production units by size class in Malta

Unit production (t)	Number of units			% total number of units (1996)	% total production (1996)
	1990	1996	Prev. 2000		
5 to 30	–	2	3	28.57	2.00
30 to 100	–	–	–	–	–
100 to 200	–	1	1	14.28	11.33
200 to 500	–	4	5	57.14	86.66
500 to 1000	–	–	–	–	–
>1000	–	–	–	–	–
Total no. units	0	7	9	100	100

Table 3. Production systems for sea bream and sea bass farming in Malta

	Number of units		Production (t)		% total production	
	1990	1996	1990	1996	1990	1996
Earth ponds (Vallicultura)	–	1	–	20	–	1.33
Raceways and concrete tanks	–	1	–	10	–	0.66
Inshore cages	–	–	–	–	–	–
Semi-offshore and offshore cages	–	5	–	1470	–	98.00

For the Dunlop cages, the Tempest II is the model in use, with a total of 20 such cages in Malta. These are 16 m square; giving a rearing volume of ~3000 m^3 when fitted with a 12-m deep net. For FarmOcean cages, the model in use is the largest available, with a rearing volume of ~4500 m^3. These are fitted with an automatic feeding system and can be partly submerged in rough weather. One of the farms has assembled their own cages using second-hand floating rubber hoses discarded by the oil industry. These consist of six hoses joined to form a circular cage of approximately 18 m diameter, with a volume of ~2500 m^3 at 10 m depth. There are approximately 25 such cages.

Approximately 70% of the total shareholding in the aquaculture sector is Maltese-owned, the rest being owned by investors from European Union countries. There is no restriction on foreign investment or on repatriation of profits. Two companies use expatriate technical management whereas the rest use local expertise. Following an amendment to the Industrial Development Act in 1991 (controlling investment in industrial projects), aquaculture qualified as manufacturing industry for

the incentives accruing under the Aids to Industries Scheme such as: (i) ten-year tax free holiday on profits; (ii) low interest rate loans; (iii) subsidized rents on premises; and (iv) training grants.

However, a major disincentive is a 15% tariff on all fish exports from non-member countries such as Malta into the European Union.

Development strategies in small islands

Developing aquaculture in an island state is normally considered an important objective in view of established fish eating habits and declining wild fish catches. However like any new sector, such a development may risk the consequences of competition from established producers enjoying economies of scale. It is therefore vital to identify all possible bottlenecks and develop the appropriate strategies accordingly. Indeed it may be easier to develop such an activity in territorial islands rather than island states since the former usually form part of a bigger socio-economic force. Of the numerous issues that need to be addressed, four key requirements emerge (Agius, 1997; Lensi, 1997; Sarusic, 1997; Stephanou, 1999):

(i) Identify objectives particularly markets; even with thriving tourist industries, small islands typically have small and easily saturated local markets and therefore export is the only viable option. It is imperative therefore that the commercial scale production is geared directly for export. Priorities should be set for international product quality standards, securing regular product consignments (this may be difficult with small farm units and for enterprises with exposed sites), and overcoming trade barriers such as the 15% tax on sea bass and sea bream exports to the European Union.

(ii) Identify appropriate technology; in small islands where tourism is likely to be one of the pillars of the economy, and with a number of other users such as shipping potentially creating pressure on the coastal zone, the offshore option may be the only one. Indeed it may not be advisable to pursue land consuming options such as pond based shrimp farming.

(iii) Identify assets; the profitability of aquaculture activities depends on capitalizing on natural and other assets. For example, with their very favourable temperatures Maltese waters may have a significant edge for Mediterranean marine fish culture, with winter temperatures ensuring year round growth and therefore lower production costs. The availability of favourable fiscal policies could also play a determining role. For instance in Malta aquaculture is classed under manufacturing industry and therefore benefits from incentives such as a 10 year tax-free holiday on profits, subsidized rents on premises and training grants. The proximity of the Maltese industry to the European Union markets is also an important asset. This is particularly important in the case of perishable goods since the relatively short journey ensures that the product arrives fresh.

(iv) Identify limitations; in a small country there is a higher possibility that specialized human resources such as senior managers, biologists and pathologists, certain services such as heavy marine equipment, as well as some of the materials required, such as feeds, chemicals and antibiotics may not be available. These will therefore have to be imported at higher than average costs, at least until the sector develops sufficiently to support local inputs.

Developmental framework

To ensure that the industry would be established in an organized and environmentally sustainable way, a set of Policy and Design Guidelines for Aquaculture Development was established within the framework of a National Structure Plan for the Maltese islands (Anon, 1994). This is a ten-year plan reviewable every two to three years. Its main objective is to achieve at the end of the ten-year period a production of 5000 to 7000 metric tonnes per annum. The approach is to base the industry on a relatively small number of large fattening units. The plan caters for:

(i) A maximum of two hatcheries each producing at least 5 million fingerlings per annum.

(ii) A maximum of twelve offshore cage farms each producing about 400 to 500 metric tonnes per annum. this is planned in two phases (a maximum of six in the first five years) in order to allow for monitoring of possible environmental impact.

(iii) A very limited number of small scale onshore units with a maximum production of 150 metric tonnes each per annum, to produce species other than those that can be grown in cage culture to secure product diversification on the market.

These guidelines urge the developer to:

(i) Ensure that the farm is located in a search area identified in these same guidelines.

(ii) Ensure that the farm.

- Is at a depth of between 30 and 45 metres.
- Is located in a well-flushed area.
- Occupies less than 50,000 m^2 of surface area.
- Is located clear of *posidonia* beds/meadows.
- Has minimal visual impact.
- Minimizes impact with other users such as tourism, navigation.
- Possesses an adequate land base with minimal impact on the foreshore.

(iii) Prepare a full Environmental Impact Assessment (EIA) at own cost (typical cost is ~ US$20,000). This should include all relevant aspects, notably water quality baseline study, benthic mapping of the seabed and a socio-economic appraisal of the proposed development.

(iv) Submit an annual environmental monitoring report at own cost (typical cost is ~ US$20,000).

(v) Keep records of input into the environment, e.g., feed, chemicals.

(vi) Comply with veterinary requirements.

(vii)Guarantee fish health monitoring by an approved laboratory.

(viii) Allow regular inspections by the relevant authorities.

(ix) Deposit a bond to cover restoration costs.

Concluding remarks

Whilst considerable development in marine aquaculture has been witnessed in a number of islands and island states such as the Greek islands, Croatia, Malta and Cyprus in the past decade the emphasis still lies primarily on inshore systems, mostly employing rigid steel or wooden cages. Many of the more recent cages made of plastic and other semi-rigid material, though proposed for more offshore production environments, are only really suitable for semi-exposed conditions with maximum recommended wave heights of under 4 to 5 metres. However, In Malta, there are now several working examples of farms operating in highly exposed conditions, with a good record of structural soundness and technical viability.

However, in the initial stages of the sector, there has also been too much of a "get rich quickly" mentality with too many entrepreneurs wishing to invest, leading to a proliferation of small units and uncoordinated development. The industry has some way to go in order to mature into one of similar stature to that of salmon, with numerous problems still in need of resolution. There is an urgent need for better planning, which will lead to improved organization and management of the industry. This should then be underpinned by a number of technical considerations such as improved genetic stocks, improved feeds, improved marketing and product presentation as well as a better understanding of fish health practices.

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