

MULTIDISCIPLINARY PERSPECTIVES ON AN EMERGENT FISH PRODUCT: THE TANK OF BRITISH TILAPIA.

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ABSTRACT

This paper presents the interim results of an ongoing research project funded by the 'Research Councils UK' Rural Economy Land Use programme. The project has a multi-disciplinary perspective on the potential production and marketing of tilapia as a niche product under a diversification strategy for UK arable and dairy farmers; in addition to marketing and production issues the implications for sustainability and public health are considered. The tripartite disciplinary research focus: marketing, aquaculture and public health, along with entrepreneurship and commercial partners, aims to develop technical guidelines for sustainable tilapia production along with market and social analysis throughout the value chain. Concomitant health impact assessments add to the appraisal of the direct and indirect impacts of UK tilapia culture. The paper establishes current knowledge and perceptions of industry and consumers of this novel tilapia farming process and product, including sustainability, health benefits and food safety. This background established, the paper presents the interim marketing findings. The UK is shown to be a latecomer to the tilapia table, yet it is contended that there is significant niche market potential. Ethnic, green and other consumer segments are identified within the at-home market along with components of the foodservice sector. Secondary data analysis is supplemented with primary data from consumer focus groups and in-depth interviews with organisational channel members. Preliminary consumer research results provide a clearer insight into understanding of perceptions and attitudes towards sustainable aquatic food production, health concerns with fish, organic aquatic food products and tilapia. It appears that whilst there is significant emergent interest in the concept of a greener farmed product, delivering a competitive product advantage still presents a number of challenges to prospective producers.

Keywords: tilapia, sustainable aquaculture, consumer perceptions

THE PROJECT

In recent years the sustainability of wild fisheries and the aquaculture industry has been called in to question, while the media publicise the depletion of wild stocks and unsustainable practices, most notably in the salmon farming industry. Dwindling fish stocks, polluted oceans and their consequential health concerns for fish consumption along with the environmental damage caused by unsustainable farming practices, have prompted industry players to search for sustainable species and alternative farming methods [1].

This project investigates a sustainable method for a warm water fish to be produced in the UK as an alternative means of land use and an additional source of income for farmers. The interdisciplinary research is funded by the Research Councils UK Rural Economy and Land Use Programme (RELU) which aims to advance understanding of the challenges that rural areas in the UK are experiencing and promote sustainable development. The research aims to develop a novel aquaculture approach, adopting a sustainable and environmentally friendly production method for farmed fish and encouraging the

integration of the warm water species, tilapia, into mainstream farming in the UK. This might allow diversification and other benefits for small scale producers whilst stimulating growing niche markets for fresh fish in the UK. In addition to marketing and production issues the implications for sustainability and public health are considered. The tripartite disciplinary research focus: marketing, aquaculture and public health, along with entrepreneurship and commercial partners, aims to develop technical guidelines for sustainable tilapia production along with market and social analysis throughout the value chain. Diversifying from conventional agricultural production poses major challenges, including lack of market information, the novelty of the fish products and the lack of appropriate production models. Therefore, the research will develop new knowledge around the opportunities for production of tilapia in rural areas, examine the concerns in small fish farming enterprise decision-making and investigate the potential for organic certification and other routes to differentiate and enhance product values. Consumers' perceptions of such products and assessment of their impact on environmental and public health factors are also considered.

WHY TILAPIA?

Tilapia has long since been recognised as a hardy, adaptable, warm water fish with considerable potential for further contribution to aquatic food supplies [2]. More recently an FAO report described it as 'the fish of miracles': one that can solve the protein problems of developing countries while satisfying the increasing demand for fish in the developed world [3]. Tilapias are noted to be highly suitable for low cost aquaculture as they thrive on a herbivorous diet, cutting out the requirement for high cost fish feeds which typically account for up to 80% of production costs and necessitate use of diminishing wild stocks. Farming herbivorous tilapia therefore has the potential to be a more sustainable source of protein with fewer environmental impacts; and with its firm, white flesh and mild taste could be a suitable substitute for wild whitefish stocks which are increasingly over-fished and relatively expensive. The research investigates the potential for tilapia to be raised domestically as a sustainable, high value product for niche markets, focusing on a fresh, local supply to meet emerging needs as opposed to the current British tilapia supply which is dominated by frozen, low unit value imports.

The novel production systems under development are based on simple technology requiring minimum inputs and monitoring, and may be appropriate as a diversification option for arable or livestock farmers. Utilising on-farm resources such as old farm buildings, re-use of excess heat and energy, and local feeds such as grass meal and barley could significantly reduce the set-up and running costs of such an operation. A variety of cheap insulation is readily available and easily installed in farm buildings to maintain the warm water temperature (28°C) required to farm tilapia. Produced as an environmentally friendly fish with local credentials, tilapia might then be marketed at a premium, and potentially with sustainable accreditation or organic certification.

Tilapia are currently farmed in more than 75 countries, making it one of the most widely farmed fish in the world [4]. Its global farmed production exceeds that of salmon [5], as does its popularity in non-European countries. Table I below shows that nearly two and a half million tonnes of tilapia were produced globally in 2005, the majority of which was farmed. Numbers of wild caught tilapia are modest in comparison as producers capitalise on the tilapias' amenable farming qualities. Despite its global fame, the tilapia is still relatively unknown in Europe, where it is predominantly consumed by ethnic groups and non-European populations. Table 1 shows how negligible the European tilapia market is, at an estimated 10,000 tonnes, compared with the USA and global perspective.

Table I: Tilapia Imports and Production 2004

	Europe (Tonnes)	USA (Tonnes)	World (Tonnes)
Imports Frozen Whole	7808	57432	Aquaculture 1820000
Imports Frozen Fillet	648	36204	Capture 640000
Imports Fresh Fillet	430	19381	
Domestic Production	528	43257	
TOTAL	10000 approx	156000 approx	2.46million tonnes approx

Sources: FAO FIGIS 2006; US Dept of Commerce 2006 & Globefish 2005.

Not least because of this relatively low current standing, it is frequently envisaged that the future of tilapia in Europe could duplicate the expansion in America, where accelerated growth in the last decade has seen tilapia rise from niche ethnic markets to become America's 6th most popular seafood [6]. However, despite these frequent optimistic forecasts, tilapia has yet to emerge as a key component of the European market. Quantifying the domestic production and imports of tilapia to Europe remains problematic because tilapia is not yet listed as a separate commodity, but instead, grouped with other minority freshwater fish. The FAO estimate European production of tilapia to be only 528 tonnes for 2004, with the Netherlands, Belgium and Switzerland leading production. The figures for 2005 may be substantially higher than this as the UK now produces increasing quantities of tilapia and a recent €15 million investment in 2006 to build Europe's largest tilapia farm in Belgium indicates expectations of market expansion.

PRODUCTION CRITERIA & TECHNICAL CHALLENGES

In Europe tilapia is conventionally produced in heated recycled aquaculture systems (RAS) which tend to be technically complex and have high investment costs that have prevented their uptake by non-specialist farming communities. Such systems provide nutritionally-balanced processed feeds to fish reared at high density, maintaining water quality and fish welfare through removal of wastes in separate filtration systems. The natural feeding environment of tilapias, however, allows them to grow on the heterotrophic food organisms that thrive on such waste, provided that water quality, especially dissolved oxygen can be maintained. In turn, the consumption of this high quality natural food *in situ* reduces the crude protein requirement, and necessity for inclusion of fish and meat meals, in feeds. It is this approach, activated suspension technology (AST), which is under investigation as a more sustainable and farmer-friendly production method for tilapia in the UK. Can the waste feed, conventionally removed by a filter in RAS systems, be retained in the system and used as a further source of feed for the tilapia using AST technology? If so, the benefits of such AST systems would include minimal impacts on marine ecosystems, improvements in sustainability and health through the reduction in fishmeal/oil usage and risk of contamination through commercially produced feeds, improvements in traceability and a reduction in food or rather 'fish miles' amongst others. There is also potential for this to be an organic fish product.

Being a tropical species, tilapia require a temperature of around 28⁰C to grow, which presents Europe with a potential production disadvantage. Despite the prevailing British climate, appropriate use of insulation can keep energy costs very low and some farmers may also be able to capitalise on on-farm or local surplus heat energy, currently not used. There is significant potential for UK farmers to produce

AST tilapia by insulating underutilised farm buildings, re-using low value thermal heat and sourcing on-farm or local vegetable protein sources of feed for tilapia. More elaborate technologies might also emerge such as use of methane produced from dairy cattle in AST systems.

Having outlined the broad context of the project, it will be appreciated that a number of interconnecting, and sometimes disparate, research threads are entwined. The key issues explored in the technical trials are the relationships between fish density, feeding regime and water quality and their impacts on production efficiency and fish welfare in AST systems. In addition to the third round of technical trials which are ongoing, welfare trials are investigating the quality and quantity of microbial flocs as fish food. An emergent understanding of the potential viability of the production system is also being garnered from trials with a commercial partner in England which is specifically comparing the performance and costs between the AST and RAS systems. Whilst the detail of these related aspects of the study cannot be covered within the confines of this paper, it is important to acknowledge their influential role in shaping the target markets for the product produced..

TILAPIA MARKETS

Within Europe the UK is considered to be the major market for tilapia with Belgium and France also increasingly important. Tilapia is also gaining acceptance in Germany, however, the recent abundance of good quality, cheap imports of catfish (basa and tra) from Vietnam have outstripped tilapia [7]. In general southern European consumers prefer whole tilapia, while their northern counterparts prefer the more familiar fillet format; yet it is the ethnic markets that are the fastest growing, shaping the demand for tilapia especially in major cities such as London, Paris and Amsterdam [3]. Therefore, the whole tilapia is most commonly available in Europe although fillets, steaks and value-added variations are emerging; especially in markets where a diverse range of consumers are demanding a wider choice of species in more convenient forms. The fillets and variations of value-added tilapia products have had little growth in the past as the species traditionally has been less well known outside ethnic populations which themselves prefer the whole fish. Earlier launches of fillets and other products have experienced limited uptake due to relatively high prices. However there are indications that as European consumers increasingly demand a greater variety of fish species and perceive fish to be a healthy meal choice which is quick, clean and convenient to prepare [8, 9, 10], price may become less of a constraint than in the past.

Growth in the European tilapia market is difficult to evaluate accurately as tilapia is not yet specified as a separate commodity in import data; consequently there is no official registry of the main exporters and volumes coming into the EU. Tilapia is however specified by the major exporting countries. Taiwan and China are the biggest sources of frozen tilapia to the EU while Zimbabwe and Jamaica supply the majority of fresh tilapia [3, 11]. Until recently Belgium was the only domestic producer of tilapia within the EU, however, the Netherlands, France and the UK have since joined domestic EU production. As noted earlier, a €15million investment was recently made in Belgium to build Europe's largest tilapia farm with capacity for 3000 tonnes per year [12]. This represents a significant expansion of domestic European production which was estimated at only 528 tonnes in 2004 as shown in Table I.

Currently the tilapia market in the UK is very small, yet as previously mentioned, it is often proposed that significant growth can be expected, as indeed was found within the USA where, in little more than a decade, the tilapia grew from a being newly listed species in 1992 to become the 6th most popular consumed US seafood in 2004 [6]. The optimism around its potential has resulted from a number of accepted characteristics including its low production cost, firm texture, white flesh and bland taste which make it amenable to western European preferences for fish. Importantly tilapia might also be seen as a basic building block upon which other added value characteristics might be built thus extending the product range beyond that traditionally associated with the whole fish or indeed simple fillet variants.

However, it would appear that the European, and more specifically the UK consumer, has yet to demonstrate widespread awareness and acceptance of the product.

Despite the absence hitherto of a mainstream market within the UK there are a number of quite significant niche market segments. Typically these consist of specialist frozen and local fish markets within cities, some also selling fresh (and thawed) fish. Interviews indicate price generally to be the more important attribute although within certain groups there are indications of a willingness to pay for superior quality products too. Like the rest of the population, the ethnic groups which constitute the significant share of the customer base of these markets have changing tastes and are willing to deviate from traditional preferences. Similarly within supermarkets, tilapia has become a more regular part of the fresh fish counter and also within some pre-packed chilled displays. Perhaps of greater interest in the context of the smaller production units likely to be associated with this project, is the emergence of tilapia in online retailers, up-market fishmongers, and some restaurants and other food service providers. An indicative range of market prices for the various forms of tilapia currently found in the UK is shown in Table II below.

Table II: 2005/6 Average Tilapia Prices UK £/kg (Farm gate, wholesale, retail, specialist)

	Live tilapia (red) £/kg	Fresh whole tilapia (red) £/kg	Fresh whole tilapia (black) £/kg	Frozen whole tilapia (black) £/kg	Frozen fillet tilapia £/kg
Farm-Gate Source: commercial partner & UK producers	4.00 – 5.00	2.70 - 4.00	2.50 - 3.00	NA	4.00 Maximum
Wholesale Billingsgate Fish Market	NA	3.00 - 5.50	3.00 – 4.00 (Belgium)	1.20 -1.75 dependent on size of fish	3.30 frozen Nile fillet 1.60 frozen steak
Retail Supermarket (Tesco, Asda, Morrisons, Harrods)	NA	8.00	NA	NA	NA
Retail Markets Frozen Fishmonger/ Local markets	NA	NA	5.50	2.20 - 4.00	3.50 – 4.50
Retail Online Specialist Fish Society	NA	NA	NA	NA	£16.00

Source: personal communications and observation retail/wholesale outlets across the UK

CONSUMER RESEARCH

Having reviewed the more general market characteristics revealed largely from secondary data analysis and some observational information it was considered essential to supplement this with primary research from consumer focus groups and interviews with organisational channel members. An initial exploratory consumer questionnaire was conducted in 2005 at the Mela, part of the International Edinburgh Arts Festival, to gain some insights into the broad area of fish as food. The Mela is an annual intercultural festival which attracts a diverse group of people and it provided an ideal opportunity to gain a cross-section of socio-cultural attitudes and perceptions. Exploration focused upon consumers' environmental awareness and implications of consuming fish, perceptions of seafood and health, the concept of organic

food, as well as awareness of tilapia amongst consumers from a variety of British and ethnic backgrounds. The range of responses gathered highlighted a number of interesting favourable perceptions but also too indicated apparent confusion over issues with organic and sustainable food production. These demanded further and more detailed investigation. The ensuing focus group discussions were therefore shaped around these issues and progressively explored participants' attitudes towards health, food and fish, the perceived health benefits of fish consumption, sustainable food production, organic fish and participants awareness, perceptions and purchase habits concerning tilapia.

Necessarily the discussions touched upon many other subjects such as wider concerns with the quality and freshness of fish available in different types of retail outlet, packaging and wider concerns with healthy eating, including obesity, in the UK, amongst other things. Whilst a research guide underlay the overall direction of the discussion it was considered important not to direct the conversation into particular topics and indeed to elicit views perceived relevant by the various respondents. The focus groups were held in Glasgow, Stirling, Edinburgh and London with a range of white British and ethnic participants recruited via posters in libraries, community halls, groceries and health food shops and cafes. No attempt was made to select the sample according to quotas of age, gender, socio-economic groups or suchlike; instead a reliance upon a self-declared interest in the topic of food and health, and being a fish consumer, was the only criteria set. In practice this self-selecting process produced a diverse range of participants often with markedly different food consumption lifestyles and concerns. The research provided a clearer insight into understanding the perceptions and attitudes of these consumers and the key emerging findings are next discussed.

Perhaps the most trenchant message is that there is a strong desire for fresh, traceable fish amongst UK consumers. Quality is an important issue underpinning this and recent food scares have given rise to greater consumer awareness and concerns for where their food has come from and how it has been produced. Purchasing food that is 'fresh' and has a stated origin appeases fears and is frequently associated with higher quality. Consumers were found to be more questioning of the food on supermarket shelves and expressed a desire for more locally produced food due to both environmental concerns and their perceptions of quality. The desire for local food is linked with traceability issues, and it is apparent that many consumers assume food produced in their own country is evidently safer and of higher quality than imported food. Whilst these front-of-mind opinions may undoubtedly be significant, further questions emerge about the wider implications for the apparently less-favoured foods; and indeed whether these expressed views match their actual buying behaviour.

Participants also shared a number of concerns traditionally found in exploration of fish consumption more generally. Knowledge and understanding of the product, often perceived to be specific and unique to an individual species, was reported to cause concerns amongst those tasked with both buying and preparing the product. Apart from the more evidently adventurous, consumers felt that their lack of experience would lessen their inclination to try any new species. In this context the place of purchase may be important since traditional sources of information about what to buy and how to prepare were more often associated with specialist retailers rather than multiple retail outlets. With the relative demise of fishmongers it may simply be a matter of time before consumers feel equally at ease with the in-store information available either in person or on-packs from supermarkets. But in the short run, the launch of new species does appear to have a more challenging time. Consumers also reported the influence of various media sources which could provide information on fish selection and preparation; the rash of 'celebrity' chefs was cited as being of particular importance. However it should also be noted that various other media conduits provided both additional positive and negative communications which also tended to have high credibility.

Alternative routes to gaining experience of new species were recognised through the foodservice sector wherein product solutions should be delivered rather than the perceived challenges that might be

encountered at home. Notwithstanding the fact that the risk averse and less frequent restaurant diners may wish to stick to what they know, rather than what is new, foodservice has traditionally played an important role in the consumption of fish away from the UK home [13]. The gastro-pub scene and other food service markets are growing as UK consumers eat out more and become more experimental with unfamiliar products and fish species. With regards to fish, people are more willing to try new species, particularly outside of the home where the preparation and perceived 'hard work' is done for them. Despite the growing trend for fresh high quality fish, frozen fish retains key price attractions especially for the foodservice sector and it remains to be seen whether tilapia could sustain demand for a fresher local product that would also entail a higher price.

A number of the focus group participants showed green consumer traits and an array of concerns that are typically associated with green purchase behaviour were identified. They tended to be concerned with sustainable food production, environmental friendliness, less chemicals, less food packaging, slow food production and a desire for food with lower transportation miles and ethical products like fair trade. In addition to shopping at conventional retail outlets, such consumers also increased patronage of farmers' markets which fitted their needs for stronger local links in food supplies. Green or eco-consumerism is an evolving market niche which is no longer exclusive to 'eco-food fighters'[14]. A recent study by the IGD [15], identifies a widening range of groups of consumers within the developing eco market. It also appears that green consumers are not necessarily organic consumers. Often the packaging, transport miles and sometimes pretentious image of organic food conflict with a green consumer's ethos. Consumers of organic food see themselves as green, but some participants considered the reduction in chemical and pesticide use in organic food to be less important than supporting local farmers and reducing the packaging of their food.

The green phenomenon has been fueled further by the media attention given to issues such as global warming, pollution and specifically in the case of fish, depleting wild stocks and unsustainable aquaculture practices. This consumer awareness and attraction to buying green could have implications for a fish species such as tilapia which is not only herbivorous and sustainable, but a palatable white fish produced locally and able to access markets both in rural and urban settings. The potential for tilapia production in warehouses and other suitable buildings in cities as well as farm buildings will increase access to not only farmers markets but local inner city markets with a wide range of consumers.

Notwithstanding concerns and reservations about organics, organic certification for tilapia is also a possibility and the price premium might reward small scale farmers who will not benefit from economies of scale or enjoy the cost advantage of frozen tilapia importers. Welfare issues and irrational regulations could however cause problems for farmers seeking certification. The concept of organic certification for fish and seafood is fairly new, and many regulations are still under development [16, 17]. Unlike certification for livestock and agriculture, organic fish certification will require separate regulations for each individual species, and undoubtedly there remain unresolved debates over whether some regulations are necessary and practical. For example, with regards to tilapia, the AST production system would be very similar to its natural habitat and feeding patterns in earthen ponds with turbid water conditions. However, some contend that fish produced in such murky environments cannot be observed or monitored and so their welfare may be compromised. Another example of seemingly contradictory regulations concerns the building of an insulated roof over the tanks to help conserve energy costs in keeping the water warm. However some certifying bodies would deem this roofed environment to be unnatural for the fish which would thus prohibit certification. Currently, whilst the potential for organic certification exists, there are many issues to be resolved and associated bureaucracies to be breached before this is likely to become widespread..

Green opportunities and up-market restaurants aside, the British tilapia market has perhaps most potential within its growing ethnic markets. The array of ethnic populations who are familiar with tilapia and

regularly purchase it from various market stalls, fishmongers and ethnic grocers around the UK may be interested in a fresh or even live tilapia product which will be of higher quality than current frozen imports. At present, frozen imports, often of low quality, are available at highly competitive price points and so dominate the market. However, responses from some of the focus groups indicated some willingness to pay a bit more for locally produced tilapia that is fresh and of better quality. Attitudes towards tilapia differ amongst the various ethnic groups, and therefore the willingness to pay for a fresh product will also vary. Potential is seen amongst Chinese consumers who are interested in buying live tilapia, whilst Filipino consumers would rather a regular supply of fresh, high quality whole tilapia. On the other hand, many Bangladeshi tilapia consumers only buy it as a cheap substitute for more popular species such as hilsha and rohu. In cases such as this the price difference between fresh and frozen tilapia dissuades purchase of the fresh fish. Elsewhere however it remains to be seen whether the launch and consistent delivery of products which meet or exceed consumers' quality expectations might attract those who currently favour lower priced frozen products.

CONCLUSIONS

The results so far appear to support our initial premise of their being a number of niche markets for tilapia produced from local small-scale environmentally-friendly units. Whilst the more mainstream market for tilapia has generally been characterised by consumers who have been late in adoption of the species, certainly when compared to the USA, there are signs of change. Consumers' responses tended to confirm the general lack of knowledge about tilapia. However, the focus groups, and interviews with various channel members suggest that awareness is increasing and can be expected to continue to expand as wider exposure occurs through more extensive market presence.

Currently some mix of green, ethnic and up-market foodservice markets would seem to hold the most likely prospects for the planned production but these sectors will need to be specifically targeted as there would not appear to be any generic gap within the market. As might be expected, in all cases there is likely to be increased competition from other potential substitutes. In the case of ethnic markets, the entrenched position and acceptance of much cheaper frozen imports will demand a focus upon gaining a preference for higher quality, probably fresh, products and a willingness to pay a price premium for this. Evidence gathered suggests that green consumers might be most influenced by the tag of verifiable local production. This of course raises the dilemma as to what constitutes 'local' and the need for production units to service a sufficiently large geographical area. The emergent growth of farmers' markets might provide some scope to reach target consumers. But at the same time the need for communication with the prospective customer base and product support can place disproportionately heavy demands upon small producers.

One route to establish communications and promote awareness of the product is within the foodservice sector and once more the relatively small scale of production will tend to favour outlets catering for higher unit value diners rather than those who are more price-focused. The emergent trend of gastro pubs, selected ethnic restaurants and such like, emphasising local supplies and potentially green credentials would thus seem to be the more obvious initial targets. In practice individual farms will determine their selection of potential targets according to their location and the logistics of servicing a fresh product, combined with the demands of their core agricultural operations. Solutions to the problems of small volumes being required at frequent intervals might be addressed by co-operative models of distribution, such as have been found in trout [18], whereby product is collected then distributed centrally. This of course raises questions over the costs and benefits of scale which may counter the emphasis upon small production units. Scaling up might curtail any price premium charged for product uniqueness but, on the other hand, might more than compensate through lower unit costs.

Whilst the origin of the research project lay within rural diversification, it could be that this type of aquaculture production is also, possibly more, amenable to urban environments. The units are intended to be self-contained and thus essentially footloose with variable output capacity. In terms of the markets identified above there may be some merit in such locations, although interesting questions do then emerge about consumers perceptions of an environmentally friendly food product being grown in an urban location. Another variant could see farmers' production units simply being contracted out to larger scale producers, as in the poultry sector, whereby the farmer only oversees the husbandry of the fish but then leaves post harvest decisions to the central buyer. Since the launch of this project, such an initiative has been proposed in the UK for a more intensive RAS system. Such a decentralised model is an interesting counterpart to the more general trend of industrial concentration elsewhere within aquaculture. Having considered a number of alternative options it would appear at this stage at least that, whichever route is selected, delivering a competitive product advantage will present a number of challenges to prospective adopters.

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