3. MAJOR ISSUES AND TRENDS

3.1. International trade in aquaculture products

Fish and fishery products are the most international of all foodstuffs. Annually, between 35 and 40 percent of fisheries production is traded internationally, reaching a value of about 50,000 million USD (FAO, 1999). While the volume of international trade of several wild-caught species, such as cod, hake, haddock, and pollock, has been declining since the late 1980s, the international trade of fishery products, such as shrimp and salmon, for which a substantial aquaculture sector has developed, has increased since 1980 (Anderson and Fong, 1997). The extent of regional and international trade in aquaculture products is difficult to analyze because trade in many aquaculture products is not yet well documented in the main producing countries, and because international trade statistics do not distinguish between wild and farmed origin.

This situation will change gradually as producers associations emerge in the main producing countries and begun to keep records, and in response to various trade regulations/pressure which distinguish between farmed and fished products (Lem and Shehadeh, 1997). The Federation of European Aquaculture Producers (FEAP) has already established a Marketing Information Database. The pilot phase of this project has been completed with the Greek and British Aquaculture Associations now running a monthly reporting service to their members. The interest and accuracy of the service is steadily increasing and data is seen as an excellent base for predicting production and price trends. The need for up-to-date market information remains a focal point for many producers and the FEAP is investigating the means for widening this project to include other national associations (FEAP, 1998).

Growth in trade has followed the growth in salmon production, as the bulk of production is concentrated in Norway and UK with limited domestic markets. The EU is the main market for the Norwegian Atlantic salmon (70 % of exports), however, Norway has targeted Asia as the future growth market in addition to further penetration of the European markets. Norway spent 7.25 million USD in 1996 on promoting salmon and trout. International trade in trout is much less that in salmon, with export reaching 55,000 mt in 1995 out of a total production of 384,000 mt, which is about 14 percent. Consumption is concentrated in trout producing countries, but Norway begun to farm large size, heavily pigmented trout for the Japanese market.

The European seabream/seabass industry intends to copy the success of salmon growers. Production reached about 60,000 mt in 1996, of which nearly 90 % was exported mainly to Italy and Spain. The main exporter was Greece with about 70 % of the production exported. Italy has been the almost the exclusive market for Greek production. However, as a result of market development efforts, about 15 % of Greek export in 1995 went to new markets (UK, Germany, France etc.), and the share of such markets is expected to grow (Stephanis, 1996). Trade in fingerlings was from Italy, Spain and France to farms in Greece, Malta and Croatia. As output of seabass and seabream has grown, costs have been driven down, and market prices have almost been halved during 1990-1995. The rapid saturation of the market and the parallel rapid decline in prices is attributed to the much smaller traditional market for these species compared to that for Atlantic salmon, lack of diversified products, inadequate market development, and the absence of technological advances. The substantial drop in price of these species should help open new markets and expand existing ones, provided acceptable profit margins can be sustained at the production end through improvements in productivity and diversification of products (Lem and Shehadeh, 1997).

Shrimp is already the most traded seafood product internationally, and Europe is one of the main markets after Japan and the USA for the major shrimp producing countries such as Thailand, Ecuador, Indonesia, India, Mexico, Bangladesh and Vietnam. Europe is an important market for a wide range of other aquatic products from all over the world. For example, the import of Nile perch from Kenya, Uganda and Tanzania increased from 4000 mt in 1990, to 18,000 mt in 1994 (Seafood International, 1997). The sources of the various import aquatic products are not only developing countries, but for example, American catfish producers have recently started exporting to Europe. Since 1996, the EU requires all seafood companies in EU member states and those making product to ship to the EU have in place an effective food processing control program, which is based on the HACCP (Hazard Analysis Critical Control Point) principles. Although increasing number of processing plants in those developing countries, which export aquatic products to Europe overcome present quality problems, the stagnation -and even decline- of the export of certain aquaculture products to Europe is projected (FAO, 1999). However, the competition with the relatively cheap import products from outside of the EU still remains one of the constraints of further development of aquaculture sector of EU.

In Central and Eastern Europe, marketing became the major issue in aquaculture development during the process of economic transition, as these countries move into the free market system. The aquaculture industry in these transition countries face serious difficulties mainly due to the considerable changes in ownership of aquaculture facilities, the abolition of the former state-led distribution system, and the lack of financial resources, and specific information. Important preconditions of aquaculture development in Central and Eastern Europe are, inter alia, the development of fish marketing infrastructure, the development of value added product range, and the improvement of marketing communication (EASTFISH, 1998; King and Silverside, 1998). The European Aquaculture Society organized conference on aquaculture development in Eastern Europe also concluded that there is a lack of experience in central and eastern Europe in business management and marketing, and recommended the organization of training programmes on this field (EAS, 1996). Although various workshops, conferences and training programmes have been organized in the past years with the assistance of EASTFISH and other international projects, further donor assistance is required to alleviate the existing serious marketing problems in this region.

In spite of the substantial differences between the aquaculture sector in different regions in Europe, marketing problems found to be major constraints in aquaculture development. According to the Federation of European Aquaculture Producers, many technical difficulties have been solved in the past decades in aquaculture, the major constraints of aquaculture development are the increasing market competition, falling/stable prices and rising costs, and market restructuring throughout Europe (FEAP, 1998).

Studies on the current status and future prospects for aquaculture in the EU member states (STOA, 1995-1996) also found marketing problems as primary constraints of the development of aquaculture sector of the EU such as:

- price volatility due to the imbalance supply and demand and cheap imports from outside of the EU;
- comparatively limited product range based on small number of species represented in format less suited to the contemporary food market.

The issues affecting future trade in aquaculture products, and relevant to European aquaculture are summarized in the followings (Lem and Shehadeh, 1997):

Externalities. Environmental and social concerns have already influenced farmed shrimp exports to North America and Europe in 1997. The importance of attaining sustainable aquaculture with no or limited externalities will force many exporting countries to adopt more sustainable production practices. The introduction of eco-labeling schemes will further increase this trend.

Quality. With growing concern about food safety, increasing efforts have been undertaken to improve the quality of aquaculture products. International codex standards cover aquaculture products, and the introduction of mandatory. HACCP requirements for exports to the USA and the European Union in 1997 will have strong impact on trade in aquaculture products in the near future. Some countries have developed comprehensive HACCP plans for selected aquaculture products; for example, the USA now has plans for catfish, crawfish and molluscan shellfish. In other countries, individual aquaculture producers undertake voluntary certification (ISO 9000) for control as well as marketing purposes.

Tariffs. Despite steady reductions in tariffs on fish and aquaculture products in recent years, tariffs as well as import licenses continue to represent barriers to trade in many countries. The European Union gives competitive advantages to domestic producers of many species, especially in the case of processed products. Average tariffs on imports from developing countries are now estimated at 4.8%, a cut of 27% from the previous level of 6.6% (FAO, 1995). The long-term trend, with growing membership in the World Trade Organization, will be for further reductions in tariffs.

Food security. Aquaculture is an important source of seafood because most of the production is consumed domestically by producing nations.

3.2. Changes in market characteristics

Fish and fishery products play an important role in food supply in Europe. There has been a significant increase in fish consumption in several Western European countries in the past decade. The total per caput consumption of fish and fish products is about 22 kg per year in the EU countries, varying from 12 kg in Germany and The Netherlands to 57 kg in Portugal (Eurostat, 1998). In the Central and Eastern European countries, however, there has been a dramatic decline in fish consumption, which fell from a high level of around 24 kg per year in the mid 1980s to around 6-9 kg today (FAO, 1998a).

The key issues facing aquaculture development in Europe can be broadly divided into two categories depending upon the farming system pursued (Tacon, 1997):

- *the intensive production of high value species* such as salmonids, marine finfish and molluscs within Western and Northern European countries, which are targeted towards luxury or niche markets; and
- *semi-intensive and extensive production of lower value freshwater finfish* such as cyprinids in Central and Eastern European countries, targeted towards domestic market.

With regard to the intensive production of high value species, the main issues facing the sector include (after Tacon, 1997):

- over-production and saturation of the markets for farmed salmon, seabass, seabream, mussels, and to a lesser extent oysters;
- total dependence of intensive farming systems for salmonids, eels and marine finfish upon capture fisheries for sourcing their feed inputs;
- decreased mollusc production within southern European countries due to the increasing occurrence of toxic red tides and consequent poisoning and disease problems;
- increasing competition with other users for available water resources.

In most Central and Eastern European countries the main issue faced by the aquaculture sector has been the drastic changes resulting from political-economic transition, which resulted in (after Tacon, 1997):

- the collapse of the state subsidies to the sector;
- high inflation and interest rates and the consequent lack of capital;
- the loss of traditional markets for selling their subsidized aquaculture production (within the former USSR area and domestically);
- adverse weather conditions in central European countries resulting drought and consequent competition for water resources.

Future demand for fish will basically be determined by the number of consumers and their eating habits and disposable income as well as by prices of fish. The growth rate of the population in Europe is less than it had been predicted; thus there will be a decline in demand for high-priced aquatic products, although some of this demand may be shifted to lower-priced fish products. The per caput demand in Europe has been downed by 6 percent compared with 1995. In the first few years of the next century, the demand for fish in Europe is likely to shift downwards as competing livestock products- particularly poultry and pork- become significantly cheaper. As far as the disposable income is concerned, the demand in Western Europe will not change much under the predicted slow economic growth scenario (FAO, 1999).

Fish consumption in Eastern Europe is sensitive to the changing economic situation. The current low fish consumption in Eastern European countries can directly be associated with the low disposable income in this region. Although there may be room for expansion in this region in the future, recent investigations indicate widespread economic slowdown with escalating structural problems in transition countries in 1998-1999. The aggregate GDP of the five more advanced transition countries (the Czech Republic, Hungary, Poland, Slovakia and Slovenia) had grown by 4.9 % in 1997, but grew only 3.0 % in 1998 (WIIW, 1999). Aquaculture, not being major food production industry in most of these countries, is especially vulnerable to the adverse affects of the economic slowdown and structural problems.

3.3. Quality of aquaculture products

While capture fishing deals with product quality mainly during catching, preserving of harvest and processing, quality of aquaculture products may be influenced throughout the whole technological chain.

Factors affecting product quality and safety:

- quality of broodstock and seed;
- feed additives and composition, feeding practice;
- water quality (micro-contaminants, off-flavor), and chemicals' use;
- harvesting procedure and accompanying activities;
- quickness of harvesting and measures for preserving the collected products;
- method of transportation of alive products;
- chilling of harvest, adequate quantity of ice;
- processing technology, distribution of products.

Recently introduced progressive innovations:

- biologically based anti-stalling agents for preserving the harvest;
- increased use of high freezing rates;
- advanced techniques for filleting and bone removal;
- enzymatic maturing without preservatives;
- use of biologically based pH stabilisers;
- smoking by "liquid smoke", and use of friction-based smoke generators;
- Modified Atmosphere Packing (MAP);
- advanced logistic facilities.

Use of chemicals and drugs in European aquaculture:

- marketing, distribution and application of chemicals are strictly regulated;
- hormonal preparations as growth promoters are not allowed to use;
- all drugs officially used should be certified as "Veterinary Medicinal Product" (VMP);
- Maximum Residue Limits (MRL) control was introduced into practice in 1990;
- successful substitution of traditional chemicals by alternative non-toxic compounds;

Requirements:

- to request advanced responsibility from farmers besides qualified official supervision;

- to perform all operations with chemicals in full accordance with the established prescriptions;
- to guarantee that quality of product will not be affected.

Quality and safety of processed aquaculture products

To ensure quality and consumer's safety, a number of management systems are effective in European processing industry. Most advanced approach considers integration of several quality management instruments into one system associated with the following terms:

  - Quality Assurance (QA),
  - Total Quality Management (TQM) or
  - Quality Management Programme (QMP).

Such concept may involve the following sub-packages:

- Quality control (QC)
- ISO 9000 series of standards (or EN 29000 series)
- Good Manufacturing Practices (GMP)
- Hazard Analysis Critical Control Point (HACCP) systems dealing with biological, chemical and physical hazards and controls.

Institutional assistance:

- Respective authorities in close collaboration with NGOs, scientists and producers are constantly revising the state of knowledge advances relative to aquaculture product processes, hazards and controls which results in the extension of number of controlled critical control points.
- Pre-requisite Programs, which are operational procedures (i.e. GMPs), that are necessary to be implemented at the enterprise before the actual development of HACCP plan. Standard Sanitary Operation Procedures (SSOP), which are in formal use only in the USA, but came also into voluntary use among European producers. SSOP includes documented GMPs for hygiene and sanitation required to meet the regulatory requirements for food control.
- In international trade quality and safety of aquaculture products are regulated by numerous multi- and bilateral agreements. The overall regulatory frame is settled out by the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and the Agreement on Technical Barriers to Trade (TBT).

3.4. Regulatory frameworks for aquaculture

Establishment, enforcing and further advancement of appropriate administrative and legal framework introduced and implemented within national and international jurisdiction are inevitable for promotion, support and regulation of efficient development of aquaculture sector.

Although the legal basis and some particular approaches may vary from one European country to another, the main content of regulatory framework, related to aquaculture, greatly coincides with the outlines of the Common Fisheries Policy (CFP) of the European Union and the Code of Conduct for Responsible Fisheries developed by FAO in consultation and collaboration with relevant United Nations agencies and other international organizations.

The CFP, European common fisheries policy, initially established within the articles 38 to 43 of the Treaty on European Union, undergoes constant development to match its particular targets in the changing society. In 1991 the European Commission have conducted half-term review of CFP, formalized in the so-called '1991 Report'. Following conclusions of this document, new basic Regulation establishing Community system for fisheries and aquaculture was adopted in 1992, together with new control Regulation in 1993. Structural elements of the CFP were completely overhauled in 1993 with the aims to enhance coherence between different aspects of the policy, to remove the partition dividing the CFP from other Community activities, and to assume profound changes affecting the sector.

Within the EU for certain aspects of fisheries legislation consultation of the European Parliament is obligatory. In the Parliament the Committee on Fisheries (constituted from the sub-committee of the Agricultural Committee in 1994) are considering fishery questions, prepares opinions on related Commission proposals for further adoption by the Parliament, and may debate any topic relating to fisheries policy. Legislation related to different areas of the CFP should be passed through the Council of Ministers, which e.g. sets the objectives and detailed rules for restructuring the Community fisheries sector, and lays down common marketing standards and detailed rules for the application of the prices system and imports regime for fishery products. The regulatory body, which initiates legislative and policy proposals, is the European Commission. The Commission also manages and administers the CFP, including the negotiation of international agreements.

The Code of Conduct for Responsible Fisheries (CCRF) provides a set of principal keystones for the development and implementation of fisheries regulations including principal issues related to aquaculture. Although the Code was elaborated assuming worldwide dimensions, number of established principles was based on the practice gained by European aquaculture.

The Code considers that regulatory bodies, responsible for existing and future aquaculture developments, should play a major role in adjustment of existing administrative and legal frameworks to address the specific characteristics and needs of the sector. In this process legal provisions and regulatory measures may need to be made more efficient to set clearly the privileges and responsibilities of aquaculturists. It is noted that aquaculture is frequently considered under a general fisheries legislation, and is often not being distinguished as the aquatic equivalent to agriculture.

There are many opportunities for increased understanding by institutional establishment and general public regarding the close similarity of aquaculture and agriculture. To achieve tangible and appropriate development of regulatory framework, which reflect understanding and appreciation of aquaculture needs, wide cooperation of aquaculture entrepreneurs, their associations, authorities, non-governmental organizations, and the media should take place.

Designated authority. It is necessary that the states determine (or set up) duly empowered and competent authority(ies), which should effectively support and, at the same time, regulate aquaculture and culture-based fisheries. These authorities are expected to establish or adapt correspondent institutional linkages with other authorities engaged in agriculture, rural development, use of water resources, protection of environment, health, education, etc. Respective legislative forms may be also generated as the manifestation of such linkages.

Legal framework. States and related aquaculture authorities should guarantee, that aquaculture sector is properly regulated and protected by legal instruments such as laws, regulations, orders, etc. which set up clear frame of responsibilities, rights and privileges of aquaculture sector. The character and content of these legal instruments should assume both current and potential aquaculture practices and approaches, employed in legal instruments, associated with similar activities.

Understanding and enforcement of aquaculture legislation. States and their aquaculture authorities should guarantee that whole set of relevant legal instruments is envisaged in a form, well understandable for those who are undertaking activities within the aquaculture sector. The legal instruments should provide maximal coverage, be adequately communicated, distributed, enforceable and enforced.

General responsibilities. Through their respective competent authorities, and in collaboration with relevant players from public area, states should support advance development of aquaculture sector, promoting wherever possible its sustainability, appropriate integration with rural, agricultural and coastal developments, and complementarity with the environment. That is also the responsibility of the states to ensure the understanding by general public of the benefits of aquaculture activities for better food supply and earnings production, and support efforts aspiring responsible actions of aquaculture entrepreneurs and all interested or connected with aquaculture.

Codes of Practice ("soft law"). Such kind of regulations can frequently better satisfy purposes of regulation of aquaculture activities, and can possess an important function to work as "regulatory instrument". The choice between soft and strict law can be more adequate if it assumes the basic character of essential purposes of the regulations applicable to aquaculture practices, and, at the same time, clearly determines the necessity to regulate and direct future "social conduct" of aquaculture entrepreneurs. It may be often recognized that there is much evident need to protect and promote aquaculture activities than to impose strict regulatory measures. Traditional forms of legal regulation which pursue rules enforced by communal and administrative penalties are generally not well suited to address all issues in aquaculture, in particular issues like product quality which require encouraging progressive involvement and adoption of appropriate measures rather than distinguishing between right and wrong (what's legal and illegal). Adherence to Codes may be problematic in that they are not enforceable but they are likely to be implemented by those concerned, given the moral weight they carry. Generally, traditional forms of legal regulation, employing compulsory rules enforced by e.g. penalties, are not well satisfied to address whole scope of issues related to aquaculture. The issues related to product quality in particular, require promotional progressive involvement and adoption of suitable measures rather than decision what is legal and what is illegal. The strict observance to the Codes can be sometimes difficult because they are not enforceable, but they are very probable to be implemented by the players themselves, as they are related to conventional moral commitments. To make the formulation, distinguishing, and legal targeting of soft or hard law measures (or their combinations) easier, broad and thorough cooperation between regulators and aquaculture entrepreneurs should be guaranteed. This should be based on involvement of aquaculture entrepreneurs during formulation, and recognition of their activity, commotions, and necessities. Potential problems which may arise from “over-regulation” and overlapping or conflicting legislative requirements should also receive proper consideration.

Genetics and aquaculture. Severe legal supervision and precautionary approach are practiced within regulatory framework, related to the genetic issues (especially genetic improvement) in aquaculture. It can be expected, as the trend, that these measures could be even strengthened. Special attention should be paid to advanced evaluation of genetic effects. Such effects may originate from interaction between farmed species and their wild relatives or can be caused by introduced species and by species that have been domesticated, or genetically modified within breeding programme. Undesirable genetic effects may include contamination of native gene pool through interspecific hybridization, degradation of native species that assimilate exotic genes, loss of native species or change in species composition through food competition or predation. Advanced evaluation of genetic effects should include a risk assessment that examines probability of escape from culture, survival of escaped organism, organism’s reproductive capability in the wild, both within itself and crossing with other species, and ability of specific genes from escaped organisms to be transferred to native species. Within these frame FAO has initiated the introduction of Codes of Practice and Guidelines for Responsible Use of Introduced Species and Genetically Modified Organisms and for Application of Precautionary Approach to Species Introduction (FAO, 1996).

Quality of aquaculture products. The related regulatory framework was considered in part 3c. In brief, the main legislative packages include regulations regarding certification of Veterinary Medicinal Products (VMP), controlling of Maximum Residue Limits (MRL) for drugs used in aquaculture, Hazard Analysis Critical Control Point (HACCP) systems (e.g. EU Council Directive 91/493/EEC and further explained their application in 94/356/EC), Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) and the Agreement on Technical Barriers to Trade (TBT).

Fish health and quarantine. The respective legislation and applicable areas were described in part 3g. The guiding documents which were considered are: Directive 91/67/EEC (OJ L 46, 19.2.1991; Bull. 1/2-1991), European Commission Decision 96/240/EC, EU’s Council of Ministers recent Amendments to Directive 91/67/EEC regarding imposed disease checks, European Council Directive 93/53/EEC, General Agreement on Tariffs and Trade, and International Agreement of Sanitary and Phytosanitary Measures (SPS Agreement, GATT, 1994).

3.5. Environmental aspects of aquaculture

Aquaculture, like many other farming activities, is dependent upon the use of natural resources such as water, land, seed and feed. The nature and scale of environmental interactions of aquaculture is determined by the quantity and quality of these resources, the access to appropriate resources and the method of use of these natural resources. The environmental aspects of aquaculture are extremely important in Europe, since the development of any aquaculture industry primarily depends on the environmental conditions and natural resources available, besides the marketability of products, availability of sites and cost of production.

Aquaculture production through its own impacts on the environment cause both ecological and social changes, while aquaculture is also dependent of the effects of other human activities made upon the environment. Examples for the impacts of aquaculture on the aquaculture production itself could also be found in intensive cage culture, where problems of self-pollution and transmission of diseases have occurred in areas where high density of farms requires the use of water contaminated by the surrounding facilities. For the long-term sustainability of aquaculture, interactions with the environment, influences on social and human factors and the use of natural resources have to move towards the direction of a required balance.

The development of aquaculture has in many cases been quite easily accommodated within the environment of the site used, and has resulted in very little changes its ecological characteristics. However, the rapid growth of more intensive forms of aquaculture has increased the potential adverse impacts on the surrounding environment. The main issues and key environmental problems associated with intensive farming are:

- *waste and nutrient loadings:* outputs of solids, nitrogen, phosphorus, drugs and chemicals;
- *water exchange:* needs for large amounts of water and frequent water exchange in intensive land-based and freshwater or marine cage systems;
- *escaped stocks:* from damaged production units, risk of genetic contamination of wild stocks, disease transmission, adverse effects on biodiversity.

Among these, probably the wastes from intensive aquaculture are the most serious problems. There are three principal sources of wastes: uneaten food, excreta, and chemicals and drugs. These include both solid and soluble pollutants affecting both the water column and benthic communities of the recipient water bodies. In extensive and semi-intensive systems loadings are lower, but may be significant locally, especially during seasonal draining for harvesting. Consequences of waste and nutrient loadings include local and general environmental degradation, mixing of stocks, reduced biodiversity, greater disease problems, and economic loss.

The use of various land and water resources by aquaculture is increasingly criticized by specific groups of people in certain locations, especially in those areas, which have high scenic value. The most common areas of conflict concern tourism and residential zones, where the visible presence of commercial activity may be considered to create significant disruption. These issues have to be judged according to the use of EIA (Environmental Impact Assessment) procedures involving the balance of economic benefit and local concerns.

Aquaculture sustainability

During the last decade, issues such as sustainable development, environmental interactions and long term sustainability of aquaculture received increasing attention at local, national and international levels. (Barg and Philips, 1997). The needs to address environmental interactions and sustainability issues for the benefit of sustainable aquaculture development has been reiterated at several global intergovernmental conferences including:

– the World Food Summit (WFS, 1996);
– the International Conference on the Sustainable Contribution of Fisheries to Food Security (FAO/Japan, 1995); and
– the FAO Ministerial Conference on Fisheries in 1995 (FAO Ministerial Conference, 1995).

Awareness of the major beneficial and adverse environmental interactions of aquaculture is also reflected in UNCED Agenda 21, Chapters 14,17, and 18. Following the 1992 Cancún Conference on Responsible Fishing, FAO was requested by member countries to draft an international Code of Conduct for Responsible Fisheries. The Code was adopted by FAO Member States during the 28th FAO Conference in 1995 (FAO, 1995).

The main conclusions and recommendations of a recent FAO EIFAC Symposium on Water for Sustainable Inland Fisheries and Aquaculture are summarized below (FAO, 1998b):

- Authorities and those in charge of fisheries and aquaculture development must seek collaboration with other agencies and other sectors of society in order to improve coordination of resource management.

- It is vital that governments empower fisheries and aquaculture authorities to promote actively the interests of inland fisheries and aquaculture, as well as adequately participate in resource management decision-making.

- Authorities in charge of fisheries and aquaculture need enhanced capacity to implement policies and regulations related to management of living and physical aquatic resources.

- There is a need for management strategies for water resources in general that incorporate the needs of inland fisheries and aquaculture. Those responsible for water allocation should consult with fisheries and aquaculture authorities. These strategies must encompass a range of aspects including social, economic and recreational considerations, biodiversity and the wider aquatic environment.

- In view of river basin management plans, which have to be prepared for a deadline of December 1999 in the EU member states, authorities representing inland fisheries and aquaculture management must identify groups responsible for the production of these plans and ensure that the needs of inland fisheries and aquaculture are adequately represented in the plans.

- Key government departments must recognize that inland fisheries have economic, social, biological and other values. For inland fisheries and aquaculture to be properly represented in the allocation of resources there is a need for improved economic and social evaluation of fisheries, aquaculture and associated aspects.

While international organizations and development institutions aim their initiatives at providing assistance to developing countries in Asia, Africa and Latin-America, the problems in poor regions of Europe has not adequately been addressed in their development assistance programs. Although the income of the rural population in the least developed regions of Central and Eastern Europe and the Mediterranean is higher than in most of the tropical developing countries, the social tensions are rather high mainly due to inequal distribution of wealth. Aquaculture in some of these less developed regions of Europe has similar features than in developing countries outside of Europe, and plays an important role in rural livelihood. Sustainable development of inland and coastal aquaculture in rural areas of Europe therefore may get higher priority in development assistance programs of international organizations and donor agencies in the future.

Ground and surface freshwater resources are finite but demand on them from various sectors and interests in society are increasing. Growing scarcity is therefore leading to competition between the various users including fisheries and becoming a main issue in Europe and elsewhere. Increasing demand for aquatic resources by a diverse array of user groups has resulted in environmental degradation, loss of habitat and conflict between various stakeholder groups. The mechanisms for assessing the impact of various activities are reasonably well established but overcoming the problems is still complex. This is because mechanisms for resolving conflicts within fisheries and between fisheries and other users are only now being developed. The key problem to be addressed is the promotion of sustainable use of water resources at an optimal level of exploitation, acceptable to all users whilst maintaining the potential to meet the needs and expectations of future generations. If aquatic resources are to be exploited on a sustainable basis in the future, concerted effort is needed to resolve the conflicts between user groups. Where possible, this must be based on available scientific evidence, close liaison between user groups, full cost-benefit analysis and transparency of the decision-making process. If this is to be successful it must involve cross education of all user groups, recognition of stakeholder participation and needs, and implemented at the local community level. It is recommended, that aquatic resource planning and management tools such as the river basin management plans being developed by the European Union member countries be used to facilitate the process of integrated water resource management (FAO, 1998b).

3.6. Biodiversity, genetics, and aquaculture

Genetic improvement programmes have been successfully applied in increasing production in Europe, for example Atlantic salmon and rainbow trout in Norway, common carp in Hungary, or sea bass and sea bream in the Mediterranean.

The traditional approach to stock breeding has relied on basic techniques of stock selection and the genetic improvement programmes were primarily targeted at the enlargement of production. Selective breeding was often based on simple parameters such as growth rate or size in many cases, with very little consideration for attributes such as disease resistance, tolerance to specific conditions, or product characteristics (flesh quality, body shape, coloration, smell). The significant advances in genetic science and biotechnology have the potential to offer radically different approaches, with dramatic consequences.

While the introduction of new species provides the first steps of the widening of biodiversity in aquaculture, most full use of genetic resources of aquatic species can be realized in the course of long-term process of genetic improvement by selective breeding and establishing of advanced broodstock. In some species (e.g. carp) history of selective breeding accounts thousand or even thousands of years. Nowadays short-term approaches of genetic improvement have been employed to provide prompt enlargement of aquaculture production. Along with interspecies hybridization and hormone-induced sex manipulation with subsequent breeding to obtain monosex populations, attention was also given to application in aquaculture of the techniques of gene transfer between species, or multiplication of own gene to expand production. Several transgenic strains of common carp, catfish, tilapia, and salmons were produced and are under testing for commercial use. In Europe transgenic Atlantic salmon underwent farm-scale trial at restricted facility in Scotland. Increased growth and high economic potential were confirmed but the trial evoked broad opposition from different public groups. The main concerns expressed were (after Bartley, 1997):

- possible escapement of transgenic fish could be followed by disruptions in natural populations and/or passing of transgene on to wild relatives;
- consumers will not accept GMOs (Genetically Modified Organisms);
- transgene could cause human health problems, e.g. allergic response;
- animal welfare may be compromised by addition of transgene; and
- genetic engineering is morally and ethically wrong.

At the same time, domestication and genetic improvement in the aquatic sector is still far behind if compared with agriculture livestock and crops, as only a relatively small percentage of aquaculture production comes from genetically improved species (Gjedrem, 1997). Therefore, there is a tremendous scope to increase productivity by applying techniques of genetic improvement, such as selective breeding, chromosome manipulation, hybridization, production of mono-sex groups, and gene transfer (Bartley, 1997). Beside gene transfer, methods of molecular genetics can also provide effective support for genetic improvement of aquatic organisms by modern analytical techniques. DNA analysis (especially MSA-Micro Satellite Analysis) allows to establish exact pedigrees, and to characterize genetic stock structure of natural populations, and family relationships in cross breads. MSA probes are in use in gene mapping in Atlantic salmon, carp, catfish, rainbow trout, and oysters. In 1998 large-scale project for genetic fingerprinting of farmed salmon was launched in Scotland.

The above-mentioned numerous concerns must be overcome before full commercial application of advanced genetic techniques with special regard to gene transfer. In response to these concerns, many researchers and developers are abiding by performance standards such as those produced by the US Department of Agriculture (ABRAC, 1995), and by international agreements, such as the Convention on Biological Diversity and the FAO Code of Conduct for Responsible Fisheries (CCRF). Technical guidelines have been produced to help implement the section of the FAO-CCRF that deals with aquaculture and the use and protection of aquatic biological diversity (Section 9.3 in CCRF, and Chapter 4. of Technical Guidelines of CCRF on Aquaculture Development).

In light of recommendations from the FAO-CCRF and international fora on aquatic animal diversity, specific actions have also been suggested towards a strategy for the sustainable use and conservation of aquatic animal diversity according to the followings (FAO, 1999):

- develop national curricula which integrate conservation and sustainable use of aquatic genetic resources into all levels of education;
- clearly assign national responsibilities for conservation and sustainable use of aquatic genetic resources among institutions and agencies;
- ensure international sharing of knowledge and methods through the Clearing House Mechanism and other appropriate mechanisms, including local communities,
- broaden the biosafety debate and future protocols to include alien species and genotypes;
- operationalize the ecosystem approach including the incorporation of transboundary and cross-sectoral elements for the conservation and sustainable use of aquatic

genetic resources;

– develop policies and practices for access to and benefit-sharing (monetary and non-monetary) from aquatic genetic resources.

Although new genetic techniques, such as gene transfer, may have some uncertainties, their responsible use could contribute not only to the increase of production of commercially important species, but the application of these techniques could also improve product quality, provide better sterility, and improved disease resistance.

3.7. Fish health and quarantine in aquaculture

Intensive methods of production in aquaculture are connected with high stocking density and intensive feeding. These factors together with handling stress, caused by e.g. regular grading make the balance in classical scheme fish/environment/pathogen more and more sensitive. In this connection diagnostics, sanitation, quarantine, vaccination and other issues related to fish health gain outstanding importance in modern fish farming.

Most serious diseases problems in European aquaculture

Viral diseases: viral haemorrhagic septicaemia (VHS) in salmonids;
infectious salmon anaemia (ISA);
infectious pancreatic necrosis (IPN);
infectious haematopoietic necrosis (IHN) in salmonids;
spring viremia (SVC) in carp culture.

Bacterial diseases: redmouth disease (ERM);
bacterial kidney disease (BKD);
furunculosis, vibriosis, vibrio viscosus (winter sores);
pseudomonadal septicaemia;
pasteurellosis and streptococcosis;
Gram-positive bacterial infection associated with vibriosis;
conventional bacterial infections like diplosomosis, mycobacteriosis, or mixosomatosis.

Parasitic diseases: sea lice infection in cage-cultured marine fish.

Examples for economic losses by diseases in aquaculture:

- viral diseases cause the most severe economic losses;
- about 50 MECU annual loss in trout culture within EU by VHS;
- about 625 MECU of losses in total for the past 20 years;
- cost of related control programs comes to £800,000/year only in UK (VHS, IHN);
- escalation of ISA in Shetland salmon industry in 1998-1999 (about 1,000,000 fish at a weight of 2 kg were infected);
- IPN killed every fourth salmon juveniles in 1998 in Norway.

Prevention and control of diseases:

- new integrated approach for control and cure of fish diseases
- SMA (System Management Approach);
- significance of farming environment;
- proper nutrition;
- sanitation through number of protective measures;
- avoiding of stress (use of immunostimulants);
- quick and precise diagnostics;
- vaccination.

To provide additional assistance in these activities the network of national and EU reference laboratories has been established in Europe. The network helps to standardize the use of advanced diagnostic methods, like FAT (Fluorescent Antibody Technique), ELISA (Enzyme-Linked ImmunoSorbent Assay), and PCR (Polymerase Chain Reaction) assay, especially for viruses. At the same time, complex diagnostics should be applied wherever possible for clear division of primary and secondary infections and definition of the main reason of mortality.

Gradual implementation of the principles of system management approach in European aquaculture greatly complemented to the decrease of drug use in fish farming. The optimized combinations of good husbandry with applied science allowed Norwegian fish farming industry to drop drug use from 30-50 tons in 1987 to 0.75 ton in 1997.

Regulatory measures

- establishment of internationally agreed severe quarantine regulations;
- standardized procedures for health certification;
- a support frame for launching of diseases eradication programs.

Legislation

- Community-wide legislation from 1993 (Directive 91/67/EEC) for:
  - general health specifications for aquaculture animals and products,
  - control programme of diseases
  - concept of approved farms and approved zones and approved farms in non-approved zones and establishes the procedure for designating them.
  - a regulatory framework for international trade of stocking material.

- European Commission Decision 96/240/EC to strengthen the control and prevent the spread of illnesses;
- European Council Directive 93/53/EEC for support of disease eradication programs in aquaculture.

By this regulations EU member states are obliged to move animals only from areas or farms with high health status to and between areas or farms with equal or lower health status.

Health regulations in international trade of aquaculture products:

– health certification and imposed disease checks;
– quarantine;
– use of chemicals in aquaculture.

These regulations became more tight and significant world-wide since coming in force of the new General Agreement on Tariffs and Trade, and the International Agreement of Sanitary and Phytosanitary Measures (so-called SPS Agreement). According the last agreement, the international agencies such as FAO, WHO, and OIE (Office International des Epizooties) have been recognized as reference points for solving of trade disputes arisen over the issues, related to aquatic animals health. Such engagements will be associated in near future with significant work within these international agencies to develop relevant technical guidelines and providing of technical assistance to their member countries.

3.8. Aquafeeds and feeding strategies

As aquaculture systems become more intensive, their dependency on the use of artificially compounded feeds (aquafeeds) becomes greater. Less intensive aquaculture systems rely partially or totally on animal and plant origin natural food produced within the system, usually stimulated by inorganic fertilization or/and organic manuring. Most of the global aquaculture production is derived from farms with semi-intensive and/or extensive management practices, using a combination of fertilization/manuring and supplementary feeding or compound aquafeed inputs. However, a continuously increasing fraction of aquaculture production is obtained from intensive systems relying entirely on commercial compounded feeds. Therefore, most of the commercial aquafeed industry is focused on intensive aquaculture systems requiring complete compounded diets. Fish feeding issues in Europe can be broadly divided into two categories similarly to farming systems: the use of nutritionally formulated diets for intensive production of high value species in Western and Northern Europe; and the use of cereals, green fodder, organic wastes and by-products in pond fish culture in Central and Eastern Europe.

According to Tacon (1997), the major global challenges facing aquafeed development are as follows:

- the need for aquaculture to be seen as a net contributor to total world fisheries landings and global food supply rather then a net consumer of potential food-grade fishery resources;
- the need for finfish and crustacean farming systems to develop feeding strategies based wherever possible upon the use of non-food grade locally available feed resources;
- the need for the development of improved feed formulation and on-farm feed and water management strategies tailored to the needs of the intended farming system or farm production unit in order to minimize feed wastage and its potential negative effect on the aquatic environment, and to maximize nutrient retention and the health status of cultured organisms.

These findings are highly relevant to the intensive aquaculture in Western and Northern Europe, where the salmon industry is one of the largest fish meal consumer all over the world. At present, nearly all farming operations for carnivorous diadromous finfish, marine finfish and crustaceans, which are based upon the use of aquafeeds, are net fishery resource “reducers” rather than “producers”. The quantity of inputs of dietary fishery resources in the form of fish meal, fish oil, crustacean by-product meals, trash fish etc. exceeds outputs in terms of farmed fishery products by a factor of 2-3 (Tacon, 1997).

There has been a growing trend in most countries toward the increased use of artificially compounded feeds for farmed aquatic animals. Smith and Guerin (1995) estimated that about 60% of the total aquafeed production in 1994 was produced in Asia (37%) and Europe (21%), with over half of the aquafeed produced being for salmonids (27%) and shrimp (25%), followed by catfish (7%), eel (7%), marine finfish (6%), and other non-carnivorous finfish (carp, tilapia, milkfish: 28%). On the basis of dietary feeding habit, 40% of total aquafeed production was for carnivorous finfish species, 35% for non-carnivorous finfish species, and 25% for shrimp. Projections for aquafeed production for the year of 2000 have been made by several authors and range from 7.5 million mt (Tacon, 1996) to 13 million mt (Pike and Barlow, 1999), and 37 million mt for the year of 2010 (Pike and Barlow, 1999).

In spite of the superior nutritional and economic merits of feeding regimes based upon the use of fishery resources as feed inputs for carnivorous fish and marine shrimp, the future availability and cost of these feed ingredients are both uncertain and unstable. Despite optimistic projections made by the fishmeal and fish oil manufacturing industry concerning the availability and use of these fishery products for animal feeds (including aquafeeds) over the next decade (Pike, 1997; Pike and Barlow, 1999), there are increasing doubts regarding the long-term sustainability of farming systems based entirely upon these finite and valuable fishery resources, in particular concerning the efficiency and ethics of feeding potentially food-grade fishery resources back to animals (including fish) rather than feeding them directly to humans (Rees, 1997). Thus, there is a need for finfish and crustacean farming systems to develop feeding strategies based wherever possible upon the use of non-food grade locally available feed resources.

In the short term, efforts could be focused on the potential use of non-food grade fishery by-products (i.e. fishery by-catch and discards, and fish meals produced from fish processing plants and industrial non-food fisheries). However, the long-term efforts must be placed on the use of by-products from the much larger and faster-growing terrestrial agricultural production sector:

- terrestrial animal by-products meals resulting from the processing of non-food grade livestock by-products;
- plant oilseed and grain legume meals;
- cereal by-product meals; and
- miscellaneous protein sources such as single-cell proteins, leaf protein concentrates, invertebrate meals, etc.,

However, the eventual success of these potential feed resources as fishmeal replacement in aquafeeds will in turn depend upon the further development and use of improved techniques in feed processing/manufacture and feed formulation, including the increased use of specific feed additives such as feeding stimulants, free amino acids, feed enzymes, probiotics and immune-enhancers (Hardy and Dong, 1997). According to Talbot and Hole (1994) feed manufacturers can contribute to reducing the environmental impact of aquaculture by:

- providing information to promote efficient husbandry in order to reduce wastage through uneaten food;
- optimizing nutrient retention by improving digestibility of nutrients and dietary nutrient balance;
- producing palatable feeds;
- adopting feed-processing technology that will reduce leaching, dust and pellet disintegration; and
- minimizing fish mortality through the development of health-promoting diets.

Fish feeding issues have a completely different dimension in pond fish culture, which is a dominant form of aquaculture in Central and Eastern Europe. Pond fish production is largely based on the utilization of low-value resources, including organic wastes and by-products. The dominant species in European pond fish culture are common carp, and Chinese carps, which are produced in polyculture together with some carnivorous species like wells, pike and pike perch. Although supplementary feeding with grains is a common element of fish pond technologies, the major source of nutrients for fish growth are natural organisms, which are produced in the pond itself by manuring and fertilization. European fish production shows great similarities to other pond production methods in various climatic and geographical regions of the world, and European results and experiences in pond fish culture are applied globally.

However, pond fish production has been decreased dramatically after the political and economical changes in Central and Eastern Europe. The carp production has fallen from 490,000 tons in 1990 to 170,000 tons in 1996 in these countries. The extensive amount of fish pond area of about 250,000 ha in the central and eastern European region (excluding the Independent States of the former Soviet Union), offers a promising opportunity for sustainable fish production. Pond fish production in many regions of Central and Eastern Europe could also be integrated with various activities such as irrigated agriculture, water management, waste processing, and recreation. For example, very good results have been reached with communal sewage-fed fish ponds in Hungary and Poland in the late sixties, however, the promising results have never been applied on larger scale. The principles of integration and waste recycling were not properly understood and promoted at that time, instead the intensification of pond fish farming was the main goal of development.

Later, during the transition period into market economy, when the fish production sector went through difficult restructuring, there have not been favorable conditions for the application of new methods, and relatively novel technologies. Most of the farmers applied well-known and rather standard technologies in their ponds without taking too much risk. The intensity level and the use of inputs however decreased dramatically. It seems however, that the fish pond production sector is recovering slowly, and farmers are more willing and capable to apply technologies, which are fit to the relevant ecological and socio-economic conditions. While the application of rather uniform fish pond technologies had been predominant in the former socialist countries, one can now observe a diversification in the European pond fish culture. Those relatively small size ponds, which are in good shape and having good water supply are used increasingly for intensive production of various species, among which common carp is still dominant. The production in these ponds is based on the application of various feed stuffs including pelleted feed. Those larger size ponds, where no optimal conditions are available for intensive culture (low water depth, difficult accessibility, water supply constraints etc.) serve for extensive or semi-intensive fish production, with intensive manuring and/or fertilization and supplementary feeding. There is another category of ponds, in which other functions than fish production have got priority. Large areas of the ponds are used now in Europe as habitats for various aquatic plants and animals (mostly birds), and also as recreational areas. In Hungary for example 14 percent of the fish ponds are under the management of various institutions and organizations of the Ministry of Environment.

3.9. International development aid (technical) to aquaculture

Much of the growth of the European aquaculture has been stimulated by scientific research and technology development. There is a broad-ranging and well developed research capacity with many productive and effective resources and concentrations of skills for aquaculture support in the West-European region, which has now the experiences of several decades of involvement with the aquaculture sector. Specialized and traditional science departments of universities and other non-university research centres also with substantial research capacity are conducting aquaculture research with various degree of involvement. The role of commercial research is also important, as a number of culture technologies for key aquaculture species have been developed by producer companies with the assistance of external specialists. Similarly, an increasing part of feed research and development is carried out directly by aquafeed companies. However, given the particular problems of the industry, the structural changes in many sectors, and the small financial margins, opportunities for industry-funded research and development -except of some internal product development- are rather limited.

At the European Union level, aquaculture research is primarily funded through the RTD Framework Programmes, which started in 1987. Within the First Framework Programme the Fisheries and Aquaculture Research Programme (FAR) was running for 5 years providing 13.3 MECU for aquaculture (37%), out of a total budget of 36 MECU for fisheries. From 1991 to 1994 18.5 MECU research funding was provided for aquaculture through the Agriculture and Agro-Industry, Including Fisheries Programme (AIR), which was 38% of the fisheries and aquaculture total budget of 48.7 MECU. Within the Fourth Framework Programme (1994-1998) aquaculture research was funded through the Agriculture and Fisheries Programme (FAIR), with a total budget of 72 MECU, of which aquaculture received a similar level of funding as before. For aquaculture and fisheries research in the Fourth Framework Programme Project proposals were invited under the following five key areas:

- impact of environmental factors on aquatic resources;
- ecological impact of fisheries and aquaculture;
- biology of species for optimization of aquaculture;
- socio-economic aspects of the fishing industry; and
- improved methodology.

Funding for research is also available through other different programmes such as Marine Science and Technology, Generic Science and Advanced Technologies for Nutritious Foods, and Environment programmes. The RTD funding is primarily spent on shared cost projects with the cooperation of two or more European institutions and companies. The quality of research and the degree of cooperation and coordination between institutions are increasingly important in order to ensure concerted and resource effective research.

The Fifth Framework Program of the EU for the period of 1999-2002 provides again appropriate conditions for supporting research and technological development, in which sustainable agriculture, fisheries and forestry are among the priority areas. The programme will stimulate transnational collaboration in research, particularly between universities (research centers) and industry, and the establishment of networks of excellence. The Fifth Framework Programme comprises four thematic programmes (covering a series of well-identified problems) and three horizontal programmes (responding to common needs across all research areas). Aquaculture and fisheries research is under the Thematic programme 1 (Quality of life and management of living resources) as the Key action 5, but funding is also possible within some other thematic programmes, i.e., Nos. 3 and 4, and also through the horizontal programmes. The aim of the Key action 5 (Sustainable agriculture, fisheries and forestry and integrated development of rural areas including mountain areas) is to support the development of knowledge and technologies for the sustainable use, transformation and management of natural resources. This knowledge will also be useful for the definition of Community regulations and standards.

For the sustainable fisheries and aquaculture the following priority areas have been idenfied in the 1999 calls under the Key action 5:

- interactions between environment, fisheries and aquaculture;
- scientific basis for fisheries management;
- improvement of aquatic production.

While in the developed Western European countries aquaculture development is largely based on the scientific and technical knowledge gained from research, the research sector has been one of the main looser of the transition period in Central and Eastern European countries. In spite of the tremendous intellectual value, which is available at universities and R&D institutions in Central and Eastern Europe, there are still serious constraints here mainly due to the poor instrumentation, inadequate core financing and limited international contacts. The need for market-led approach in research is more understood now in the research institutes, but competitiveness of the poorly equipped and staffed institutes is rather weak, and their accessibility to international competitive grant funds is rather limited.

There have been, however, some positive developments recently, and the international activity of Eastern European institutions shows some development. There have been various mechanisms provided recently by such as the TEMPUS, INCO-COPERNICUS, PECO-COPERNICUS, NATO-SfP etc., which facilitate the collaboration and networking among West- and East-European research institutions and universities. It has also had positive effects on the capabilities of Eastern European institutions to make possible to join ongoing EU-financed research projects during the last two years of the Fourth Framework Programme. It is a very recent favorable opportunity for the countries in accession to participate as full members in the 5th Framework Programme for Research and Development of the EU. Scientist from Central and Eastern European institutions also actively take part in the work of European aquaculture and fisheries organizations like EIFAC and EAS. However, the involvement of Eastern and Central European institutions in international research and development programmes of European importance is still limited, and far not proportional with the scientific resources available in Central and Eastern Europe. There is great willingness and enthusiasm on scientist level for more active collaboration in both Eastern and Western European institutions. However, financial means and additional mechanisms should further be exploited to launch new joint R&D projects, which will be based on complementarity and the most efficient use of valuable European scientific resources. With the aims to establish a wider and more rapid circulation of information concerning the results and progress of EU funded relevant non-EU funded programmes for research, technological development and demonstration (RTD) in aquaculture the so-called Aquaflow Project was started in 1998, funded by the EU. The network includes 14 EU-member countries, Norway, Iceland, and Hungary, which is the only country from the Central-Eastern European region. Future extension of the project scope to Central and Eastern European countries would greatly contribute to the development of sustainable aquaculture in Europe through improved communication between practice and science, and other stakeholders of research.

3.10. Financial assistance by the banks and aid agencies for aquaculture development

Aquaculture production is clearly market-led enterprise in developed countries of Europe, and well-developed financial institutional systems and related services have been available for aquaculture development. However, the aquaculture sector in Europe is going through a period of fundamental structural change, mainly because of the increased competition for resources and markets. In order to support actions undertaken at national level, the European Union has made available approximately over 3,000 million ECU to the whole fisheries and aquaculture industry, organizations and public authorities in EU member countries for the period 1994-1999 (EU, 1994). These finances have been allocated primarily through the Financial Instrument for Fisheries Guidance (FIFG) programme, which was complemented with other structural funds.

Although FIFG mostly aimed at the development of he fisheries sector, such as adjustment of fishing efforts, renewal and modernization of the fishing fleet, fishing port facilities etc., aquaculture has also been included in the fields of action either directly or indirectly through the development of product processing, marketing and product promotion. The direct support for aquaculture development is about 10 % of the FIFG fund, which is about 281 million ECU. Three main types of activities can be identified among those aimed at the development of aquaculture as follows: modernization of production facilities (both offshore and inland) through upgrading existing facilities and construction new ones; market development; and diversification of species. There have been several successful aquaculture projects in EU countries, which received financial aid from the Structural Funds of EU. For example, there is a spectacular growth of salmon cultivation in Scotland in the past decade, which represents an important new contribution to the economy of the region, especially for remote communities in Highlands and Islands. At present there are approximately 131 viable farming projects throughout the Scottish coastal region, employing some 6000 people and producing about 64,000 tons of salmon per year. Another good example is the development of Rio-Pesca company in Greece, which operates a hatchery for the propagation of seabass and seabream, and also land-based and sea-cage production units for these species with a total capacity of about 250 tons per year. The installation in the Messolonghi lagoon is now operating autonomously, and financing itself without the need for public funding. In 1990, under the Community structural aid for fisheries, a large scale, intensive eel farm, equipped with the latest technology was established in the Netherlands. Nijvis BV is one of the biggest eel farms in Europe, which has a production capacity of 500 tones per year. As a result of the water recycling technology, the water consumption of he system and the effluent discharge to the environment can be minimized.

While the situation of aquaculture development in the western part of Europe, including Scandinavia and the Mediterranean, shows gradual improvement, as the structural changes of the sector is taking place with considerable financial aid from the European Union, the situation of aquaculture industry in Central and Eastern Europe is still very problematic. The aquaculture sector in this region has not yet recovered fully from the shock caused by the sudden government withdrawal from financing aquaculture, and the fundamental structural changes in ownership. Furthermore, the institutional system is undeveloped, loans for aquaculture development are not available or not affordable, inputs costs are increasing, management practices are out of dates, there are poor marketing and distribution systems. In spite of the efforts of the individual governments to assist the development of the sector, and enhance the competitiveness on international markets, there is a great need for donor assistance both in terms of expertise and financing.

The European Union and its member states provides assistance to Central and Eastern European countries, and also to the Independent States of the former Soviet Union for the economic reform of these countries mainly through the PHARE and the TACIS programmes, respectively. With a budget of 1,037 million ECU in 1996 alone, the PHARE programme finances the European Union's assistance in the restructuring of the economies of Central and Eastern Europe (Albania, Bulgaria, Hungary, Poland, Romania, the Czech Republic, Slovakia, Estonia, Latvia, Lithuania and Slovenia, FYROM). The TACIS programme (528 MECU in 1996) aims to finance EU economic and technical assistance to the countries of the former Soviet Union and Mongolia (Armenia, Azerbaidjan, Bielorussia, Georgia, Kazakhstan, Kirghizstan, Moldavia, Russia, Tadjikistan, Turkmenistan, Ukraine, Ouzbekistan and Mongolia). While these aids represent undoubtedly a useful contribution to the overall restructuring of the economies in these countries, only very few aquaculture or aquaculture related projects have been financed in the framework of these schemes.

The European Union's enlargement to central and Eastern Europe presents a historical opportunity for Europe to unite by peaceful means. Between the year 2000 and each country's date of accession, and beyond, the targeted assistance currently available under PHARE, two new instruments will be introduced: a framework for assistance to agriculture and rural development (SAPARD); and a new instrument for regional policy (ISPA). This pre-accession aid will support projects that help the candidates prepare for accession, while familiarizing the authorities and other relevant organizations with the methods used to implement Community support measures. Although aquaculture and fisheries are not specifically mentioned among the objectives of the SAPARD programme (except the improvement of the processing and marketing of agricultural and fishery products), aquaculture could well be integrated with various actions in the framework of SAPARD programme, such as: improving the structures for quality, veterinary, and plant health controls; promoting agricultural production methods that aim to protect the environment; diversifying economic activities in rural areas, setting up producer groups; water resources management .

In order to support the development and modernization of the aquaculture and fish processing sectors of Central and Eastern Europe, both at the national and private sector levels, the EASTFISH project was established, which is funded by the Danish Government and executed by the Food and Agriculture Organization of the United Nations (FAO). Finding financing for investment projects is a key area of EASTFISH's activity. This includes the preparation of feasibility studies and business plans by a team of financial, technical and marketing specialists. EASTFISH have organized various training programmes, symposiums and conferences, and also assisted foreign investment projects in Croatia and Georgia.

3.11. Regional institutions and their assistance for national and regional capacity building

The importance of the wider context of development -political, social, environmental and legal factors influencing the sector- needs to be more widely recognized. In spite of the trend towards reduced government intervention in development, it has been argued that centralized regulations are needed to ensure equitable allocation and sustainable management of resources. However, public consensus and participation in decision making are also essential if conflicts are to be minimized and satisfactory compromises made among competing groups. Considerable political will is a prerequisite for successful establishment of sustainable approaches to development. This involves the adoption of various policy measures which may include, inter alia, extensive consultation with and/or participation of those affected by the proposed policy measures, strict adoption of the principles of inter-generation equity, and recognition of the need to devolve management to the lowest practical level of responsibility. The institutional demands are considerable. Appropriate legal frameworks, new skills and improved capacities, especially policy analysis at the sector and project levels, as well as new and efficient means of communication, will be required. Local training is also needed to enable decentralized management. These requirements underline the need for the formation and strengthening of appropriate institutional capacities and mechanisms for aquaculture development planning, management and control. There is also need to develop tools and guidelines and to ensure access to relevant information to help establish development policies and plans (Shehadeh and Pedini, 1997).

As it has been discussed earlier, one of the key issues in aquaculture development is, how aquaculture – especially as user of the limited and vulnerable fresh water resources- could properly be integrated into rural development programs and the rest of the economy. Human resource development and institutional strengthening are widely held to be the principal requirements for improving integration at the level of individual farms and communities, in river basin and coastal area management and at the level of sectoral and macroeconomic policies. The participation of all resource users and other stakeholders at an early stage is indispensable for effective land use planning and zoning, not least because of their intimate knowledge of socio-economic conditions and the state of natural resources. At the government level, the functions of the various agencies with regulatory and development mandates need to be well coordinated. Two broad distinctions can be made in the wide range of possible institutional arrangements for integrated river basin and coastal area management:

Multi-sectoral integration, which involves coordinating the various agencies responsible for river basin and coastal management on a basis of a common policy and bringing together the various government agencies concerned as well as other stakeholders so that they can work towards common goals by following mutually agreed strategies.

Structural integration, which, here, is an entirely new integrated institutional structure, created by placing management, development and policy initiatives within a single institution Willmann et al., 1998).

Multi-sectoral integration tends to be preferred since line ministries are typically highly protective of their core responsibilities and the associated power base and funding, however integrated planning and institutional coordination are often difficult to achieve and can entail significant costs. Many river and coastal management issues can be addressed through sound management but taking into full account the impacts of and interdependencies with other sectors and ecosystem processes (Willmann et al., 1998).

In Northern and Western Europe, modern advances of information and data processing technologies have dramatically increased the capacity of humans to analyze complex multiple resource-use options and to link up large number of people into integrated decision-making structures. Governments in these countries have become more aware of sectoral and environmental interdependencies. However, in Central and Eastern Europe there are still a lot of structural difficulties, which requires further efforts in capacity building. The following recommendations are referring to the improvement of overall rural development policy in central and eastern European countries (Greif, 1997), but these are also relevant to aquaculture, which can be considered as an integral component of rural development:

- it is absolutely necessary to make basic information available about regional structures in the countryside, the main problems rural inhabitants are in touch with and what the major needs are (capital, manpower, land) to achieve sound solutions;
- communal autonomy and self-determination must be improved all over Central and Eastern Europe. This will be indispensable if the new political systems are interested in sustainably developing social and economic conditions in rural areas, with their own growing local and regional centers. As the approach to Europe continues, enlarged rights and duties of communities will succeed and their political and financial capacity will grow;
- the arrival at a political decision for agriculture and agricultural activities (in different varieties) should be the fundamental element of rural societies and economies. Although the rentability of agricultural production is decreasing worldwide, there must

be a clear political declaration that agriculture and forestry (as well as aquaculture) form an economic, social and ecological basis for promising and long-term rural development policy (Greif, 1997).

The main elements of institutional capacity building requirements in aquaculture in Central and Eastern Europe have been summarized by EASTFISH (1998) according to the following:

- establishment of fish inspection system;
- technical training facilities;
- business management training;
- advisory service training delivery systems;
- fisheries information systems.

While aquaculture development is largely based on the scientific and technical knowledge gained from research in the developed countries of Europe, the research sphere has been one of the main looser of the difficult and prolonged transitional period in central and eastern European countries. In spite of the tremendous intellectual value, which is available in central and eastern European R&D institutions, there are serious constraints here mainly due to the poor instrumentation, inadequate core financing, limited international contacts. The need for market-led approach in research is more understood now in the research institutes, but competitiveness of the poorly equipped and staffed institutes is rather weak, and their accessibility to international competitive grant funds is rather limited. The international conference on aquaculture development in Eastern Europe, which was organized by the European Aquaculture Society in Budapest in 1996, was one of the first attempts to improve relationship between scientist from the West and the East. One of the conclusion of the conference was: “The Central and Eastern European sub-region has several valuable assets that include not only significant land, water and labour resources, but also traditions and appropriate technologies in aquaculture, impressive research and development capacities and, on the long run, immense market potentials. Proper utilization of these assets is a common interest, wasting them would be a loss for the whole Europe, fort the whole world” (EAS, 1996).

There have been some positive developments since then, and the international activity of eastern European institutions shows some development. There have been various mechanisms such as TEMPUS, INCO-COPERNICUS etc., which facilitate the collaboration and networking among west- and east-European research institutions. It is a recent favorable opportunity for the countries in accession to participate as full members in the 5th Framework Programme for Research and Development of the EU. Scientist from central and eastern European institutions also actively take part in he work of European organizations like EIFAC, EAS, and the representatives of the Czech Republic, Hungary and Poland regularly attend the Annual Meeting of Senior European Fisheries Cooperation Advisers since 1997. Experts from central and eastern European countries, mostly from Hungary, Poland and Czech Republic also involved in some development cooperation and training programmes for developing countries. The Fish Culture Research Institute, Szarvas, Hungary has taken on a pioneering task as it was the first East European institute responsible for the implementation of a major development cooperation project in Vietnam funded by a West European country, namely The Netherlands (Bilio, 1998a). However, the involvement of eastern and central European institutions in international research and development programmes of European importance is still limited, and far not proportional with the scientific resources available in central and Eastern Europe. There is great willingness and enthusiasm on scientist level for more active collaboration in both eastern and western European institutions. However, financial means and additional mechanisms should further be exploited to launch new joint R&D projects, which will be based on complementarity and the most efficient use of valuable European scientific resources.

3.12. Major shifts/changes in regional policies

The degree to which an aquaculture industry is impacted by public policy depends on many factors including the political and regulatory structure of the region (or nation), the extent of private property rights, the type of aquaculture industry, and the level of regulatory enforcement. In general, marine relative to freshwater aquaculture is more greatly impacted by regulatory policy, which reflects public ownership and the large number of regulatory agencies. The trend, however, is toward greater regulatory control for both freshwater and marine aquaculture, and in both developed and developing countries. Policy instruments are not developed within a coherent and well-ordered institutional process, but evolve as agencies attempt to formulate and implement policies based on vague legislative mandates: “Policy becomes made by those who implement it”. This process of adaptive implementation is driven by bargaining among user groups, decision-makers, and those charged with implementation. (Sylvia, 1997). Aquaculture will need to be considered within a multiple use of strategic planning process (Anutha and Sullivan, 1994). The government will need to allocate resources, minimize conflicts, and balance requirements of aquaculture with other objectives including the maintenance of sustainable ecosystems. Policy development is based on well-developed institutional systems, well-established legal and regulatory framework, and adequate property rights in the developed countries of Europe. Various directives and common policies, as well as related measures have been elaborated by the European Union, which assist national policy development in member states. In response to the policy problems which aquaculture now faces, economists and other modellers have begun to analyze policy problems and develop approaches for addressing aquaculture issues (Sylvia, 1997). However, even under the most favourable circumstances, which are available for policy development in many developed European countries, achieving good aquaculture policy is a difficult and time consuming process. Policy development in many European countries has continued to languish for a variety of reasons, including a scarcity of the human, institutional and financial resources; a lack of understanding, by both governments and aquaculture participants, of the potential benefits that good management can generate; and the reluctance of governments to make unpopular decisions (FAO, 1999; Sylvia, 1997).

Policy development for sustainable aquaculture faces tremendous difficulties in central and eastern European countries. Although aquaculture shows great varieties in various countries in this region, there are some common problems, which hamper policy development for aquaculture. The newly established institutions are not well staffed and also lack adequate financial resources. There have also been great changes in the property rights, and changes are still taking place in some countries. Progress has been made in the implementation of new legal and regulatory frameworks; however, the enforcement of the regulations is rather weak in many countries of the region. Policy development is one of the components of development assistance projects in central and eastern European countries, which are provided by international organizations and developed European countries**.** The PHARE Programme, various projects for the former Soviet Union in the framework of TACIS programme, FAO project for the development of the fisheries sector in Bulgaria, and the British Know How Fund assistance in Romania could be mentioned as good examples. However, regarding the trend of greater regulatory control in the future, and also the complexity and time-requirement of policy development in the transition countries in Europe, the international community should direct greater efforts towards improving the capabilities of the fisheries institutions in these countries.

3.13. Technological advances over the last decade

The European aquaculture industry is an emerging, diverse and productive contributor to the region's food producing sector and has grown significantly over the last two decades. Much of the growth in aquaculture has been stimulated by extensive scientific and technological development, making various forms of production technically and economically viable. However, markets have become a major issue recently, in which consumer demands, international competitiveness, health, environment and quality are getting far greater importance. Thus, the European aquaculture sector has had to learn how to integrate its products within markets that are increasingly more complicated to supply and to understand.

Historical background

The European aquaculture has centuries-old traditions. Historically, the freshwater carp and trout sectors were the first professional elements of commercial fish farming. These developed slowly at the beginning of the 20th century using artisanal production technology where young fish stocks were reared in ponds or tanks. The development of transportation technology allowing movement of fry and fingerlings from hatcheries to on-growing farms combined with the industrial manufacture of pelleted feeds led to a very rapid expansion of the sector's production in the 1970s. During this period, trout, salmon, eel and carp farming developed very rapidly in different areas of Europe. In the 1980s, viable hatchery technology was developed for the production of the young fish of valuable Mediterranean marine species, notably European seabass, Gilthead seabream and turbot. This opened the way for the development of commercial fish farming in the Mediterranean area (Italy, Greece, France, Spain and Portugal), where it was predicted that this could mirror the developments in salmon farming in the Northern Atlantic (Norway, Scotland and Ireland). In fact, the production of seabass and seabream has been increasing at a smart and constant pace for the last ten years, it is still far behind the Northern European industry in terms of production level, reduction of production costs and market diversification. More recently, additional species have been added to the list of potential products, notably sole, cod and a variety of Mediterranean finfish species.

Recent technological advances

During the last decade, significant technological developments were achieved, particularly in Western Europe, in genetic improvement, hatchery seed supply, introduction of new species into culture, better disease control, more accurate feeding, diet optimization, feed utilization, water quality management and effluent water treatment. For example, successful genetic improvement programmes have been completed for increasing production of salmon, tilapia, catfish and common carp. In addition, there has been an increasing interest in the practical application of gene transfer techniques to produce more productive and disease resistant cultured aquatic species. Significant advances have been achieved in fish nutrition with salmonid species and this has provided a good basis for research with other fish species. Nutritionally balanced and environmentally friendly diets have been developed for intensive feeding of fish; therefore, better control and reduction of nutrient loading into the environment have become possible. One of the major issues in aquafeed production today is further optimization of protein utilization and replacement of fish meal with alternative proteins by greater use of plant and animal by-products. Pronounced advances have also been achieved in waste management of intensive fish farms, both in collection and treatment of farm effluent waters. However, the improvement of environmentally friendly and water saving technologies is still of importance, taking into account the expected spreading of intensive aquaculture systems, particularly in Central and Eastern Europe. For the development of integrated, polyculture-based pond fish farming of omnivorous and herbivorous species should also be given high attention in future technological development, especially those culture systems, which are effective in organic waste utilization.

Most of the species produced by aquaculture were, at one time, highly prized and expensive products, essential qualities for a professional activity that was seen as being of high technical risk. As the technology has improved, principally through biological, nutritional and engineering developments, marketing and legislative risks have replaced the technical ones. As in most markets, rises in supply have led to falling prices. In addition, the requirements of the sector to respond to environmental and public health considerations have added considerable investment and operational needs. Consequently, the sector has to cross different technological, legislative and marketing barriers in order to consider itself to be a viable and sustainable profession.

Development of new systems

There have been important developments in new production and management techniques, particularly in Western Europe with water recycling systems, offshore aquaculture production units and artificial reefs, effluent water treatment and advanced monitoring and control systems for intensive farming. Most such developments mean gradual improvements of the existing systems through better design, better materials, components or construction, which, however, usually need considerable investments.

Water reuse or recycling systems have been widely developed over the last years, mainly for hatcheries, but also for market production. The construction of intensive production systems with partial or full water recycling can also be expected in Central and Eastern Europe as economy is gradually stabilizing in the region. Various intensive systems based on Western European technology have been put into operation recently in some central and Eastern European countries. The operation of these types of systems is based on the utilization of geothermal energy, which is abundantly available at certain regions in Eastern and Central Europe. The effluent water from the intensive systems could efficiently be treated in earthen fish ponds, which are also available in this region, thus the combination of intensive and extensive fish production systems offers a promising alternative for the sustainable development of fish production systems. Since water efficiency and environment friendliness are two basic guiding principles during the development of fish production systems regardless to the aquatic environment and production level, the development of combined intensive and extensive systems may have a greater importance all over in Europe in the future.

The aquaculture systems, which have already been developed, or being developed, provide a relatively good basis for the production of other marketable species. This may lead to production diversification, as many of the basic technological parameters could be understood and modified according to the specific requirements of the new entrants. For example, systems such as recycling units can provide highly controlled conditions for particular species. In addition, both intensive and pond-based semi-intensive aquaculture production systems could generally contribute to the better use of natural resources. More intensive systems require less area, and the production processes can be controlled efficiently. Semi-intensive systems may be more environmentally friendly and more socially acceptable due to their significant potential to use less exogenous supplementary feed inputs, while providing many opportunities of efficiently converting locally available feed resources (such as naturally available food organisms, and agricultural by-products and wastes) into production of fish affordable to a wide range of consumers in rural communities and urban centres (Tacon et al., 1995; Bailey, 1997). There appear to be significant opportunities for widening development perspectives toward alternative, more sustainable increases in food supplies, away from too narrow focus on promotion of sophisticated capital-intensive aquaculture production systems. There is also a considerable scope for much greater integration between fisheries, aquaculture and water resource management (Barg and Philips, 1997).

Sectoral characteristics of the European aquaculture

A wide range of aquaculture systems with a variety of cultured species is used in Europe, including both land-based (or terrestrial) and water-based (or immersed) production systems and involving different production environments (or habitats). The most important systems are intensive cages for salmon, trout, seabass and seabream, intensive or semi-intensive ponds for trout and carp, and intensive suspended culture of mussels. There are substantial differences in the production methods and knowledge involved; the scientific and technological base; and the consequences in the industry structure and sustainability.

The sectoral characteristics of the European aquaculture (after Courtney, 1998):

- vast majority (more than 90%) of the sector is SME;
- wide geographic dispersion all around Europe (mainly coastal and inland rural areas);
- production specialization (one or two species/products);
- most farms are distant from major markets;
- different training backgrounds for operation;
- resolution of many technological problems;
- rising legislative pressure on producers;
- increasing market competition and restructuring markets;
- falling/stable market prices and rising production costs;
- recognized need for useful and accurate information throughout the sector.

The increasing complexity of the business environment, the changing legal and regulatory frameworks, policies and market structures, the increasing competition for resources and also on the market make extremely difficult to find the optimal management options in aquafarms with special regard to small enterprises. Therefore, a key element of the future competitiveness and success of aquaculture is the improvement of the existing management practices, especially for small and medium size enterprises, and in Central and Eastern Europe. There is a growing and urgent need to improve the flow of information among farmers, scientists, public officials, NGOs, and interest groups, which will help farmers to base their decisions on a broader perspective and understanding. Organized training courses could also be efficient tools to assist farmers in improving their farming practices especially in the central and eastern European region.