The barriers for the adoption of traceability systems by Romanian fish farms

Lorena Dediu, Liliana M. Moga, Victor Cristea

"Dunărea de Jos" University of Galati, Faculty of Food Science and Engineering, Galati, Romania. Corresponding author: L. Dediu, lorena.dediu@ugal.ro

Abstract. This paper aims to highlight the factors underlying the decision to implement the traceability system and determine the barriers affecting the implementation of the traceability system (TS) products from fish farms in Romania. The present study, surveying 59 companies with fishery commercial activity, highlighted the importance of the decisive factors in the application of traceability in aquaculture activities such as improving product quality, improving the management of food quality, exploiting markets abroad, adapting to the consumers demand for healthier and safer products, expanding domestic market, ascending public image, product differentiation etc. The analysis therewith highlights the main barriers for adoption of TS, namely: lack of adequate policies to support enterprises in adopting traceability systems, the lack of qualified staff and the high cost of traceability systems. The study describes also the perceived benefits achieved by introducing a traceability system such as improvement of public image or improvement of market competitiveness.
Key Words: traceability, food safety, quality, barriers, fish farms.

Introduction. Although has a relatively low contribution to the intern economy, fishery represents an important traditional production sector in Romania. Currently, Romanian domestic fish production has an upward trend over the last years (since 2010 when registered a dramatic decline) reaching approximately 19.6 metric tons in 2015 (56% from fisheries and 44% from aquaculture) (www.anpa.ro). Despite the recovery of the past few years, local fish production still cannot meet the consumers' needs (despite that average consumption of 5 kg per inhabitant is still the lowest value for EU) and preferences, thus covering less than 20 percent of the total demand (Dobrescu 2015). The imports are also stimulated by the lack of local valuable species and poor processing opportunities.

Presently, Romanian fishery sector struggles to restructure through the modernization of the old production systems and building up new and modern infrastructures, aiming the increase of productivity by adopting new technologies (http://gain.fas.usda.gov).

Fish processing has recorded also a decline over the past years, the surviving processing plants utilizing as raw material mostly imported fish species and less domestic species (Dobrescu 2015). Through the Operational Programme for Fisheries and Maritime Affairs fish processing is a priority for Romania and thus, in the following period, new processing plants are expected to grow. In order to be part of the global market, implementation of traceability systems are mandatory.

Traceability is defined as the ability to follow the movement of a food through specified stage(s) of production, processing and distribution (Codex Alimentarius Commission 2004). Since the food system is becoming more and more complex, traceability developed as an important tool to deal with problems associated with food safety and quality assurance. In the last decade there has been an increased focus on product traceability in food supply chains due mainly to the tragic and costly food crises that took place (Bosona & Gebresenbet 2013). In this context traceability became important for many public policymakers, business decision makers, consumers and

special interest groups, and hence traceability requirements become strengthened (Aung & Chang 2014).

Traceability in the aquaculture supply chain aims to ensure the safety and quality of aquatic organisms and to verify that they are farmed in compliance with national or international management requirements or to meet national security and public safety objectives. In order to facilitate trade within European Union (EU), traceability has also become a vital tool and a requirement for market penetration. However, since fishery products are highly perishable food items, a lot of particular conditions and more difficulties have to be taken into account compared to other food products (Nicolae et al 2015).

Implementation of a traceability system offers the ability to trace the origin of a product and the capability to detect and minimize the risk in timely manner when the food crises occur. The traceability system can also be helpful in terms of production optimization since facilitate production planning and scheduling or ensuring optimal use of raw materials (Zhang & Kim 2015). Implementation of a traceability system (TS) could be used as a part of a competitive strategy (Canavari et al 2010) or to increase company coordination in the supply chains (Banterle & Stranieri 2008).

Despite the above mentioned benefits, the Romanian aquaculture companies are only in the incipient stage of the TS implementation due mainly to some difficulties represented by non uniform methods and formats for data collection and communication (Moga et al 2015) but also to other barriers preventing traceability system adoption to a large extent.

The present study main goal is to analyze the barriers and the influencing factors for the implementation of TS for fish products in Romania.

Material and Method. Quantitative descriptive data were collected through a cross-sectional consumer survey in eight counties during the period November 2014 - May 2015. The questioners investigate barriers like improvement of the products' quality, improvement of food quality management mode, the highlight of enterprisers, exploiting market abroad, adaption to health and safety of consumption demand, expanding the domestic market, ascending corporate public image, product differentiation, customer requirements, follow the similar enterprises which have adopted the traceability system, and the encouragement and preferential policies of government.

In order to measure the effects of barriers in implementing TS in enterprises, Likert Attitude Measure Table with the 1-5 scale: 1 - disagree, 2 - neither agree nor disagree, 3 - slightly agree, 4 - agree, 5 - strongly agree was adopted for respondents evaluating each parameter. Descriptive analysis was used to evaluate the difficulty of implementation of TS.

Principal component analysis approach is also used to study the motivations of implementing the technology besides the methods above. Principal component analysis approach is a method which can reduce the dimensionality and extract the key components with significantly effect for more detailed analysis and which is used to determine the key factors influencing the implementation of TS.

Results and Discussion. From all 59 surveyed enterprises 67.80% are private enterprises, 22.03 % are joint venture and 6.78 % are state owned enterprises. In terms of turnover the larger number of companies (over 45%) registered from 500,000 to 2,500,000 RON (Figure 1). In Romania, fish production is oriented towards national market and therefore only 8.47 % exporting companies were identified.

In Romanian supermarkets, many buyers are purchasing fishery and aquaculture products based on its appearance but rarely acknowledge the details of its quality information. For converting the quality information to consumers from producers before purchase, TS is a very good tool to attach the information on the production, and improve confidence of consumers in the quality of fish products. For the study on influence factors of implementing of TS, two types of factors are divided from any possible factors can be investigated: motivations of implementing TS and barriers in implementing TS.
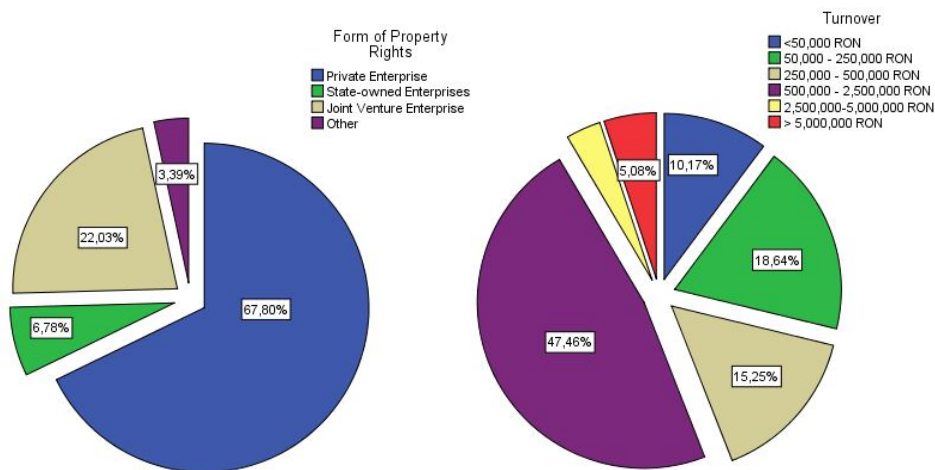
Figure 1. Characteristics of the surveyed fish farms in terms of form of property and turnover rate.

Factors underlying the decision to implement a traceability system. Although most of the aquaculture farm managers and retailers believe that traceability information could add value to the products, there are however some drawbacks represented by the costs and supplementary time and effort in adopting and using technology. However, motivation is a critical factor for implementing traceability because motivation is closely linked to the identification of benefits and costs associated with traceability (Karlsen et al 2013).

The study carried out shows that identifying costs and benefits is essential when companies decide to implement traceability. In the context of increasing willingness of customers to pay for greater access to information about origin and history of food, the companies have different motivations for implementing costly TS. The present study tried to identify the factors interfering with the motivation for implementing a TS in aquaculture farms in Romania. Thus, in order to reflect motivations of implementing TS comprehensively eleven internal and external factors interfering with the motivation behind the decision were evaluated.

The statistics information about the eleven indexes is listed in the Table 1. In general, all the average value of the indexes are higher than 3.6, and nine from eleven are higher than 4. This indicates that these factors can effectively attract Romanian enterprises to implement the TS. Product differentiation, improvement of the products quality, expanding the domestic market, ascending corporate public image, improvement of food quality management mode, the encouragement and preferential policies of government are the factors which are higher than 4.50 which means that these are considered as majority factors attracting Romanian enterprises applying the TS. The highlight of enterprisers, customer requirements and adaption to health and safety of consumption demand have an average rank below 4.50 but also strong impact on the decision of implementing a TS system. Besides, exploiting market abroad, and following the similar enterprises which have adopted the traceability system also impact the implementing TS positively and strongly, even though the three parameters are less than 4.00.

For simplifying of motivations factors, principal component analysis approach was used to reduce the dimension with SPSS. Eleven components variables about motivations of implementing TS are extracted in the present study using SPSS. For the cumulative percent of the first four components accounts for 68.27% and the components' eigen values are larger than1.00 (Table 2).

Table 1

Descriptive statistics for factors underlying the decision to implement a traceability system

Factors	Mean	Std.
Improvement of the products quality	4.81	0.545
Improvement of food quality management mode	4.73	0.611
Highlight of enterprises	4.49	0.817
Exploiting market abroad	3.92	1.179
Adaption to health and safety of consumption demand	4.39	0.891
Expanding the domestic market	4.75	0.659
Ascending corporate public image	4.75	0.801
Product differentiation among competing companies	4.83	0.461
Customer requirements	4.10	1.125
Follow the similar enterprises which have adopted the traceability system	3.68	1.074
The encouragement and preferential policies of government	4.63	1.128

Table 2

Mean score and principal component analysis of factors underlying the decision to implement a traceability system

Factors	Component			
	1	2	3	4
Improvement of food quality management mode	0.800			
Highlight of enterprises	0.796			
Improvement of the products quality	0.770			
Ascending corporate public image		0.891		
The encouragement and preferential policies of government		0.862		
Exploiting market abroad			0.783	
Follow the similar enterprises which have adopted the traceability system			0.645	
Product differentiation among other products				0.952

The Table 2 displays the component matrix emphasizing four principal components. In PC-1 (28.21% from total variance) improvement of food quality management mode showed the highest positive loading (0.800) followed by highlight of enterprisers (0.796) and improvement of the products quality (0.770). The PC-2 (17.53% from total variance) was more relevant to ascending corporate public image and the encouragement and preferential policies of government with high positive loadings (0.891, 0.862). Exploiting market abroad (0.783) and follow the similar enterprises which have adopted the traceability system (0.645) show high positive loading in PC-3 (13.353% from total variance), while the fourth component, PC-4 (9.17% from total variance) is highly correlated with product differentiation among other products (0.952).

Thus the main motivation for TS implementation seems to be represented by quality assurance both in terms of production and products followed by more pragmatic motivation such as public image of the company or encouragement policies. Customer requirements showed no very obviously in any PCs but due do its strong effect was shared into first three components.

Barriers of traceability system adoption. Implementation of a new technology is, without any doubt, accompanied by many barriers of which the most important is the economic factor, primary taken into consideration by an enterprise. Besides, because the management and technical processes should change, management and technical personnel should be trained or employed as soon as the system operated. There are also a series of external factor restricting the application of the new technology such as the lack of uniform market standard and related preferential policies.

The description statistics for barriers for traceability systems implemented in Romanian fish farms are presented in the Table 3. Within the tested items 83.1% from the respondents strongly agreed that the lack of related preferential policies is the biggest obstacle followed by the shortage of management and technical personnel and high cost of system implementation considered by 66.1 %, respectively 64.4%, from the

respondents as important barriers for traceability system implementation. The traceability implementation in Romania is considered also difficult from the perspectives of uncertain future earnings and management process changing (strongly agreed by 54.2%, respectively 47.5 % from respondents).

The statistical analysis showed that there are not significant differences among groups defined based on turnover (p > 0.05, Krushal-Wallis test) but significant among groups defined based on form of property regarding high cost of system implementation (state own and joint venture enterprises consider financial aspects as main barrier for implementation of TS).

Table 3

Perceived barriers in implementing traceability system in Romanian fish farms (%)

Barriers	Disagree	Neither agree or disagree	Slightly agree	Agree	Strongly agree
The high cost of system implementation	13.6	-	15.3	6.8	64.4
The shortage of management and technical personnel	18.6	3.4	5.1	6.8	66.1
Non-uniform market standard	5.1	-	52.5	15.3	27.1
The difficulty of management process changing	13.6	-	25.4	13.6	47.5
The difficulty of work process changing	13.6	-	30.5	11.9	44.1
The lack of related preferential policies	10.2	-		6.8	83.1
Uncertain future earnings	27.1	6.8	3.4	8.5	54.2

In order to assess the main barriers for traceability system implementation respondents were asked to score 7 potential constrains in the decision to implement on a five-point Linkert scale from "very important" (5) to "very unimportant" (1). The most highly ranked barriers were associated with high cost of TS implementation, but the shortage of management and technical personnel also ranked high (Table 4). Principal component analysis was used to group barriers into broad categories reflecting three fundamental factors (which collectively accounted for 74.22% of the total variance) hindering adoption of TS in Romanian fish farms. Loadings derived for each of these factors using a Verimax rotation are presented in Table 4. The PCA indicates that barriers related with the difficulty of management process changing and workpiece process changing accounted for 41.13 of the variance in importance scores. Factor 2 which accounted 18.79 of total variance is highly correlated with the shortage of management and technical personnel and the lack of related preferential policies, while factor 3 (14.30% of total variance) is correlate with cost of system implementation and non-uniform market standards. Factor uncertain future earnings showed no very obviously correlation in any PCs but due do its strong effect was shared into first three components.

Table 4

Mean score and principal component analysis of perceived barriers to implement a TS

Barierrs	Mean	Component		
		1	2	3
The high cost of system implementation	4.08	0.077	0.096	0.902
The shortage of management and technical personnel	3.98	0.099	0.800	0.139
Non-uniform market standard	3.59	0.172	0.437	0.573
Uncertain future earnings	3.56	0.576	0.658	0.339
The difficulty of management process changing	3.81	0.931	0.044	0.038
The difficulty of workpiece process changing	3.73	0.754	0.190	0.432
The lack of related preferential policies	4.53	0.037	0.702	0.337

The benefits of company following the implementation of a traceability system. The benefits or advantages that may affect business adoption decisions can be grouped into two categories: those which appear in the internal business environment and more related to the external business environment (Table 5).

Table 5

Categories for benefits for traceability system implementation

	Benefits	N	Mean	Std. deviation
Internal benefits	Improvement of product quality and food safety management	59	4.68	0.706
	Ascension in supply chain management level which the enterprises belong to	59	4.46	0.837
	Reducing loss of food for safety reason	59	4.59	0.853
	Average		*4.58*	*0.11*
External benefits	Extending products trade in market	59	4.75	0.779
	Improvement of corporate public image	59	4.90	0.305
	Improvement of market competitiveness	59	4.80	0.581
	Average		*4.82*	*0.08*

Our findings show that all enterprise categories are aware of the benefits resulting from implementation of TS in their production chain. The external benefits seems to be slightly more important than the internal benefits with an average of 4.82 for the first type over 4.58 for the second (Table 5).

However, the results pointed out that perceived benefits are also different depending on the companies' profile and turnover. Thus, for smaller companies improvement of product quality and food safety management tend to be perceived as the most important internal benefit (4.68±0.13), while for medium and big companies reducing loss of food for safety reason is seen as an important internal benefit (4.69±0.22). Regarding the external benefits, the small and medium enterprises consider extending products trade in market as main benefit while larger companies associate implementation of TS with improvement of corporate public image. The study emphasized a significant positive correlation of turnover and perception of public image improvement (Spearman correlation coefficient 0.389; $p < 0.01$) and a negative correlation of turnover and improvement of product quality (Spearman correlation coefficient 0.42; $p < 0.01$) because this appears to be a key to survival for small enterprises.

The perception on benefits of traceability system implementation on fish farms depends also on the type of ownership (Table 6). The study reveals that private companies are more aware about the importance of product quality assurance during the production cycle and about the benefits of managing systems for tracing fish during their life time in the farm comparing with joint venture and state-owned enterprises.

Table 6

Categories for benefits for traceability system implementation

Benefits of TS implementation	Form of property rights	Mean	Std. error
Improvement of product quality and food safety management	Joint venture enterprise	3.62	0.241
	Private enterprise	4.98	0.025
Extending products trade in market	Joint venture enterprise	4.85	0.104
	Private enterprise	4.88	0.053
	State-owned enterprises	3.00	0.552
Improvement of corporate public image	Joint venture enterprise	4.85	0.104
	Private enterprise	4.90	0.048
Improvement of market competitiveness	Other	4.00	0.663
	Private enterprise	4.85	0.076
	State-owned enterprises	4.00	0.577
Ascension in supply chain management level which the enterprises belong to	Joint venture enterprise	3.62	0.241
	Private enterprise	4.75	0.093
	State-owned enterprises	4.00	0.577
Reducing loss of food for safety reason	Joint venture enterprise	4.23	0.257
	Other	2.50	0.891
	Private enterprise	4.78	0.098

Conclusions. Analyzing the results we can conclude that all the interviewed farms managers agree that the lack of related preferential policies is the most important barrier, while uncertain future earnings has the lower influence. However, one of the main barriers that impede the adoption of TS in fish farms are related also to the high cost of system implementation followed by the shortage of management and technical personnel. Romania's capacity to support the TS implementation in fishery sector by relevant laws and regulations is still inadequate. The government should provide policy guarantee for adoption of TS. Likewise, to encourage traceability application/implementation, government could provide training and promote capability building on traceability requirements and system.

Based on the present situation of Romanian fishery process enterprises, it is impracticable to force all the enterprises to implement the TS, because of the lack of capital, technology and human resources. Therefore, the government selects sample enterprises with big size and capability taking the consequences to establish TS, and support them and provides adequate cost-benefit information. Secondly, the government is supposed to give enterprises demonstration and stimulation. After implementation, the returns of TS will reveal gradually. The effects have to be publicizes and give more policy and financial support to enterprises so as to strengthen their confidence in TS adoption.

References

Aung M. M., Chang Y. S., 2014 Traceability in a food supply chain: safety and quality perspectives. Food Control 39:172-184.
Banterle A., Stranieri S., 2008 Information, labelling, and vertical coordination: an analysis of the Italian meat supply networks. Agribusiness 24:320-331.
Bosona T., Gebresenbet G., 2013 Food traceability as an integral part of logistics management in food and agricultural supply chain. Food Control 33(1):32-48.
Canavari M., Centonze R., Hingley M., Spadoni R., 2010 Traceability as part of competitive strategy in the fruit supply chain. British Food Journal, 112:171-184.
Dobrescu M., 2015 Fish and seafood market brief - Romania. Global Agricultural Information Network Report No. 1505. Available at: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Fish%20and%20seafood%20Market%20Brief-%20Romania_Bucharest_Romania_4-27-2015.pdf. Accessed: September, 2016.
Karlsen K. M., Dreyer B., Olsen P., Elvevoll E. O., 2013 Literature review: does a common theoretical framework to implement food traceability exist? Food Control 32:409-417.
Moga M. L., Cristea D. S., Antohi V. M., 2015 The adoption of the traceability system in Romanian fish farms. Proceedings of International Conference "Risk in Contemporary Economy" XVIth Edition, Galati, Romania. ISSN online 2344-5386, pp. 44-46.
Nicolae C. G., Moga L. M., Nenciu M. I., Bahaciu G. V., Marin M. P., 2015 Particularities and management of the distribution chain for fish and fishery products. AgroLife Scientific Journal 4(1):111-116.
Zhang Y., Kim Y., 2015 A study on adapting advanced traceability system between feed manufacturer and salmon farmer in a farmed salmon supply chain. Master thesis, Norwegian School Of Economics, Bergen, pp. 11-12.
Codex Alimentarius Commission, Procedural Manual Fourteenth Edition, 2004 Available at: www.codexalimentarius.net. Accessed: September, 2016.
*** http://gain.fas.usda.gov - Fish and seafood Market Brief- Romania.
*** www.anpa.ro.

Lorena Dediu, "Dunărea de Jos" University of Galaţi, Faculty of Food Science and Engineering, Department of Aquaculture, Environmental Sciences and Cadastre, Domnească Str. 47, 800008 Galaţi, Romania, e-mail: lorena.dediu@ugal.ro
Liliana Mihaela Moga, "Dunărea de Jos" University of Galaţi, Faculty of Food Science and Engineering, Department of Aquaculture, Environmental Sciences and Cadastre, Domnească Str. 47, 800008 Galaţi, Romania, e-mail: Liliana.moga@gmail.com
Victor Cristea, "Dunărea de Jos" University of Galaţi, Faculty of Food Science and Engineering, Department of Aquaculture, Environmental Sciences and Cadastre, Domnească Str. 47, 800008 Galaţi, Romania, e-mail: victor.cristea@ugal.ro