

Factors Affecting Mussel Farming Development As Nutrient Removal Option In The Baltic Sea

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Abstract: Mussel farming is becoming more and more important as good and healthy food, good feed for animals and also efficient cleaner of sea water. Researchers world-wide have investigated many aspects of mussel farming and many research results are discussed in scientific publications. It was performed extensive research around the Baltic Sea in Baltic Sea region countries on possibilities for blue mussel production taking into account many factors of such production. For finding views of involved in decision-making it was conducted expert survey on evaluation of several factors in activities of mussel production in the Baltic Sea. For most of the questions in expert survey it was used evaluation scale 1-10, where 1- smallest grade and 10 – biggest grade. Expert findings were that there are needed subsidies for mussel farming in the Baltic Sea to clean the sea water.

Key Words: Mussel Farming, Sea Water Cleaning, Baltic Sea Region

1. INTRODUCTION

More and more academic researchers devote their efforts to analyse different aspects of environment including possibilities to clean sea water as it is becoming more and more important issue especially with introduction of Green Deal of EU. There are several possibilities to clean sea water and in recent scientific findings have indicated that good support for that is blue mussel production.

Mussel farming is suggested as an option for mitigation of nutrients in water. It is a new area for research as well as mussel production in the Baltic Sea region thus many aspects of mussel farming including marketing and product development aspects should be analysed to realise mussel farming development needs and factors affecting field development potential.

Current research devote attention on several factors on mussel production in new area for mussels - the Baltic Sea with special attention to cleaning of sea water performed by blue mussels. It was performed extensive research around the Baltic Sea in Baltic Sea countries on possibilities for blue mussel production taking into account many aspects of such production. For finding views of involved in decision-making it was conducted expert survey on evaluation of several aspects in evaluation of mussel production in the Baltic Sea. For most of questions in expert survey it was used evaluation scale 1-10, where 1- smallest grade and 10 – biggest grade. For survey data analysis it was used analysis of indicators of descriptive statistics, cross-tabulations by different variables, analysis of variance (ANOVA) and correlation analysis.

2. MATERIAL AND METHODS

Research methods applied in the paper: studies and deep analysis of scientific publications presented in academic environment, survey of several stakeholders involved and interested in mussel production. For data analysis there were used the measures of descriptive statistics: characteristics of central location or tendency, indicators of variability or dispersion. It was applied cross-tabulations by several variables; testing of statistical hypotheses on equality of arithmetic means for several independent groups with use of t-test and the analysis of variance – ANOVA; for evaluation of relationships between different variables included in the research it was applied correlation analysis.

Expert survey was developed, evaluated in pilot survey and improved for experts' to grade by them several factors related to subsidization of mussel farming with the aim to reduce contamination of nutrients in the Baltic Sea water. Experts for survey were invited from several countries: Denmark, Estonia, Finland, Germany, Latvia and Sweden. Experts were selected by their working experience from mentioned countries. For most of analysed aspects there was used evaluation scale 1 – 10, where 1 – not affect; 10 – affect in great extent.

3. LITERATURE REVIEW

Mussels are very useful for se water cleaning as filters water and reduces nutrients in water and are important for governments of the countries to support the production of blue mussel (Gren et al., 2009; Gren, 2019), analysing aspects of improving

the transparency of sea water, as well as important factors of mussel production in new place - sea in the North part of the globe were analysed by Stadmark & Conley (2011). Mussels are suggested as a tool for mitigation of nutrients (Petersen et al., 2014; Arunachalam, et al, 2016) and making wide area for researchers.

Environmental concerns for global issues, as well as reasonable environmental knowledge by the population of respective countries and subjective norms being as reality in many countries have developed as important drivers related to relatively high price and at the same time relatively low availability of the respective product (Hjalager, et al, 2015). Scientists have noted that often low level of trust by consumers for getting green products have introduced as major barriers for purchase of green products (Joshi & Rahman, 2015; Allegro, et al, 2021). Researchers have suggested to pay big attention to knowledge of the population of the country (Almeida, et al, 2015; Horstmeyer, 2020) as well as making serious impact of consumers' environmental concern on green possible consumption ideas and realisation (Makatouni, 2002) as well as other aspects.

Researchers have suggested for making questions on quality of those products (Baris Bingol, et al, 2008) making unexpected worries for producers and keeping producers competitive (Laxe, et al, 2016). Several countries have different experience (Sagun & Saygi, 2021) which can be discussed for adoption in other countries. Framework of sustainable marketing has been highlighted by scientists and discussed on international arena (Morrison & Lowe, 2021; Gordon et al. 2018) by combining several marketing approaches: critical marketing, social marketing and green marketing (Griskevicius et al., 2010) often making influence for final decision making of the consumers for their choice.

Sustainable consumption especially food and food production are important limiting factors, which are contingents for long-term economic growth of the respective country's economy together with environmental and social requirements (Moon, 2018). Several countries have several priorities (Sjölander-Lindqvist, 2015) in solving those questions which have to be taken into consideration. In Canada it is evaluated many

opportunities for use of different aquaculture benefits (Noakes, 2018). Different quality assurance policies and applications take place (Soderlund, et al, 2008) where several experiences could be considered to overtake also by other developed countries around the globe.

The more positive attitude, the more willingness of customers is to purchase green products over conventional alternatives (Vazifehdoust et al., 2013). Consumers do not believe that products produced accordance to ecological standards bring specific benefits (Dobbs, et al., 2011), however, over time, the consumer's purchasing habits changed to a more ethical and environmentally friendly and more efficient food for health reasons and quality of life.

Most government initiatives have realised their plans and initiatives to respect and take into account the ecological consequences of environmentally inappropriate industrial and manufacturing activities and processes as well as making several steps for promoting sustainable consumption (Chen, et al, 2023) and it is noted as significant influencer for noting and discussing negative environmental implications (Kumar Kar & Harichandan, 2022) which could influence attitude of the population for decisions of purchasing food taking into account recommendations for food variety and food quality.

Researchers have underlined that the government of Canada confirms significance of impact on reducing negative environmental consequences (Zolfagharinia et al., 2023) and researchers have investigated several other aspects also including importance of organisational aspects (Raudeliūnienė, 2022; Davidavičienė, & Raudeliūnienė, 2022; Raudeliūnienė, 2022) where organizational knowledge is on great importance and attention by the researchers. Several countries have developed their innovative solutions (Bargoni, et al, 2022; Chen, et al, 2023) and discussed them on international academic community.

3. RESULTS AND DISCUSSION

Distribution of expert's evaluations on organisation of mussel farming by subsidies of mussel farming with the aim to reduce presence of nutrients in the analysed area is included in table 1.

Table 1. Distribution of Experts' Evaluation about Subsidies of Mussel Farming with the Goal to Decrease Presence of Nutrients in the Baltic Sea

Answers	Count	Share (in %)	Valid Share (%)	Cumulative Share (in %)
Yes	37	67,3	67,3	67,3
No	18	32,7	32,7	100,0

Total	55	100,0	100,0
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Source: Authors' prepared calculations based on Zaiga Ozolina conducted expert survey, n=55.

The results indicated that 67,3 percent of answers by experts accepted subsidised of blue mussel production by farming with goal to decrease presence of nutrients in the Baltic Sea and 32,7 percent of answers by experts revealed that mussel farming should not be supported by subsidies with

the aim to reduce presence of nutrients in the analysed area.

Mussel production initiatives in the Baltic Sea depends on several factors, however previously has not been researched relationship between attitude and assessment of development of various aspects.

Table 2. Results of Correlation Analysis Based on Experts' Evaluation on Factors Affecting Mussel Farming Development and Subsidies of Mussel Farming with the Aim to Reduce Contamination of Nutrients in the Baltic Sea

	Indicators	Subsidies	Labour force / Human resource	Financing (subsidies, loans)	Formal, informal education	Marketing events	End-use market	Government support	Environmental pollution
Subsidies	Pearson Correlation	1	-0,227	-0,221	-0,359**	-0,472**	-0,466**	-0,423**	-0,211
	Significance (two-tailed)		0,096	0,104	0,007	0,000	0,000	0,001	0,121
	N	55	55	55	55	53	55	55	55
Labour force / Human resource	Pearson Correlation	-0,227	1	0,544**	0,639**	0,613**	0,480**	0,367**	0,512**
	Significance (two-tailed)	0,096		0,000	0,000	0,000	0,000	0,006	0,000
	N	55	55	55	55	53	55	55	55
Financing (subsidies, loans)	Pearson Correlation	-0,221	0,544**	1	0,674**	0,638**	0,635**	0,567**	0,424**
	Significance (two-tailed)	0,104	0,000		0,000	0,000	0,000	0,000	0,001
	N	55	55	55	55	53	55	55	55
Formal, informal education	Pearson Correlation	-0,359**	0,639**	0,674**	1	0,697**	0,620**	0,565**	0,499**
	Significance (two-tailed)	0,007	0,000	0,000		0,000	0,000	0,000	0,000
	N	55	55	55	55	53	55	55	55
Marketing events	Pearson Correlation	-0,472**	0,613**	0,638**	0,697**	1	0,794**	0,638**	0,545**
	Significance (two-tailed)	0,000	0,000	0,000	0,000		0,000	0,000	0,000
	N	53	53	53	53	53	53	53	53
End-use market	Pearson Correlation	-0,466**	0,480**	0,635**	0,620**	0,794**	1	0,696**	0,513**
	Significance (two-tailed)	0,000	0,000	0,000	0,000	0,000		0,000	0,000
	N	55	55	55	55	53	55	55	55
Government support	Pearson Correlation	-0,423**	0,367**	0,567**	0,565**	0,638**	0,696**	1	0,520**
	Significance (two-tailed)	0,001	0,006	0,000	0,000	0,000	0,000		0,000
	N	55	55	55	55	53	55	55	55
Environmental pollution	Pearson Correlation	-0,211	0,512**	0,424**	0,499**	0,545**	0,513**	0,520**	1
	Significance (two-tailed)	0,121	0,000	0,001	0,000	0,000	0,000	0,000	
	N	55	55	55	55	53	55	55	55

** . Correlation is statistically significant at the 0.01 level (two-tailed).

*. Correlation is statistically significant at the 0.05 level (two-tailed).

Source: Authors' calculations based on Zaiga Ozolina conducted expert survey, n= 55.

Correlation analysis revealed that experts’ answers regarding mussel farming development aspects such as labour force aspect, financing and environmental pollution do not correlate significantly with evaluation regarding subsidization of mussel farming with the aim to reduce contamination of nutrients in the Baltic Sea.

Results indicate that experts’ answers revealed correlation of mussel farming’ subsidization with the aim to reduce contamination of nutrients and such mussel farming development factors as formal education, marketing events, end-use market and government support.

Table 3. Distribution of Experts’ Evaluation about Subsidization of Mussel Farming with the Aim to Reduce Contamination of Nutrients in the Baltic Sea

Mussel production subsidization with goal to decrease presence of nutrients in the Baltic Sea		Employees	Financing sources	Education	Marketing events	End-use market	Government support	Environmental pollution
		Yes	Arithmetic mean 5,03	7,35	6,65	7,39	8,11	8,38
	N 37	37	37	37	36	37	37	37
	Standard deviation 2,995	3,293	2,965	2,382	2,378	2,228	2,764	
No	Arithmetic mean 3,61	5,72	4,28	4,47	4,89	5,61	5,22	
	N 18	18	18	17	18	18	18	
	Standard deviation 2,704	3,707	2,906	3,002	3,818	3,806	3,370	
Total	Arithmetic mean 4,56	6,82	5,87	6,45	7,05	7,47	6,13	
	N 55	55	55	53	55	55	55	
	Standard deviation 2,955	3,486	3,127	2,913	3,268	3,096	3,013	

Source: Author’s conducted survey, evaluation scale 1-10, where 1- not needed; 10 – needed, n=55.

The experts, who evaluated positively regarding mussel farming subsidization with the goal to decrease presence of nutrients in the analysed area, evaluations for governmental support were very high with arithmetic mean of the expert evaluations 8,38, end-use market with arithmetic mean of the expert evaluations 8,11 and financing sources with arithmetic mean of the given grades by experts has reached 7,35 what is high value.

The experts, who evaluated negatively regarding mussel farming subsidization with goal to decrease the presence of nutrients in the Baltic Sea, evaluated labour force with arithmetic mean 3,61, financing with arithmetic mean 6,82 and government support with arithmetic mean 7,47.

Government support as factor affecting mussel farming development was evaluated the highest

between both groups (who support and does not support mussel farming subsidization with the goal to decrease the presence of nutrients in the analysed area).

Labour force as factor affecting mussel farming development was evaluated lower in comparison with other factors affecting mussel farming development in the Baltic Sea.

Academic researchers in several branches have evaluated differences in evaluations by expert’s gender even taking into account the research results that attitudes by gender have not influenced the investigation results.

The results of the grading by experts have not showed that there is statistically significant difference by experts gender.

Table 4. Main Results of Analysis of Variance (ANOVA) by Expert Grading on Mussel Production Subsidization with the Goal to Decrease Presence of Nutrients in the Baltic Sea – the Experts’ Survey Results by Expert’s Gender

	Sum of Squares	Degrees of freedom	Respective variances	F	Significance
Between Groups	0,001	1	0,001		
Within Groups	12,108	53	0,228	0,004	0,948
Total	12,109	54			

Source: Author’s realised survey, n=54

Table 5. Results of Analysis of Variance (ANOVA) on Expert Evaluations on Mussel Farming Subsidisation with the Aim to Reduce Presence of Nutrients in the Water of Baltic Sea - the Experts' Survey Results by Expert's Age Group

	Sum of Squares	Degrees of freedom	Respective variances	F	Significance
Between Groups	1,428	4	0,357	1,671	0,172
Within Groups	10,682	50	0,214		
Total	12,109	54			

Source: Author's realised survey, n=54.

The testing of statistical hypotheses by analysis of variance (ANOVA) was performed to determine statistical difference of average evaluations by age groups. To analyse this aspect more detailed analysis was applied.

The experts in age 55-64 answers more negatively on mussel farming subsidisation with the aim to reduce contamination of nutrients in the Baltic Sea. Experts in age 25-34 and in age 65-74 answered only positively about mussel farming subsidisation.

Table 6. Results of Analysis of Variance (ANOVA) on Expert Evaluations on Mussel Farming Subsidisation with the Goal to Decrease the Presence of Nutrients in the Water of Baltic Sea - the Experts' Survey Results by Expert's Occupation

	Sum of Squares	Degrees of freedom	Respective variances	F	Significance
Between Groups	1,810	3	0,603	3,125	0,034
Within Groups	9,267	48	0,193		
Total	11,077	51			

Source: Author's conducted survey, n=51.

The results on testing statistical hypotheses on equality of arithmetic means by analysis of variance (ANOVA) has indicated statistical significance in evaluations by expert occupation.

Experts representing public administration – government, ministries were more negative regarding mussel farming subsidisation with aim to reduce presence of nutrients in the water of Baltic Sea. Experts representing scientists are more positive regarding mussel farming subsidisation with aim to reduce presence of nutrients in the water of Baltic Sea. Regional government representatives and fishermen are more positive regard blue mussel production subsidisation with aim to reduce presence of nutrients in the water of Baltic Sea and make it cleaner.

CONCLUSIONS

Mussel farming as important factor influencing sea water cleaning is becoming more and more important due the green policy in environment protection to what many researchers world-wide have devoted their research.

Mussel farming development as nutrient removal option is influenced by several obstacles and research revealed that lack of stakeholders knowledge and trust in green products and attitude to purchase green products might impact consumers' believe in the products.

Mussel farming in the Baltic Sea could be realised by financial support of the national governments what

is considered by most of the experts as the biggest part of experts' answers indicated that they accept subsidised of mussel farming with aim to reduce presence of nutrients in the water of Baltic Sea. More detailed aspects on introduction of subsidiaries for mussel production could be clarified by respective governmental representatives and could be research agenda for deeper analysis in future.

The mussel farming development could be developed by wider marketing activities and end-use aspect and information could be prepared for certain age groups.

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