Review Article

Strategical analysis of environmental management in relation to the effects of agricultural pesticides on water and aquaculture: A case study on Butachlor

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Abstract

The principled use of agricultural pesticides and prevention of their negative consequences requires environmental management with a comprehensive and long-term approach. This article is done with the aim of strategic analysis of the environmental management of the effects of agricultural poisons with an emphasis on Butachlor poison. The current research is a non-experimental (descriptive) research in terms of its practical-developmental goal and data collection method, which was conducted in a survey method. The statistical population included persons who are in charges in this approach. Sampling was done by purposeful method and theoretical saturation was achieved with 8 people. The effects of agricultural pesticides were identified using semi-structured expert interviews of internal and external factors of the environmental management model with qualitative thematic analysis. Then the analysis of factors and presentation of suitable scenarios was done using SWOT analysis and Quantitative Strategic Assessment Matrix (QSPM). MaxQDA software was used to perform thematic analysis, and SWOT analysis calculations were performed in Excel software. Based on the evaluation matrix of internal and external factors, the appropriate strategy for environmental management of agricultural toxic effects should minimize environmental pressures and threats by improving and strengthening internal weaknesses. Based on the quantitative strategic planning matrix analysis, the best scenario is the formulation of laws and regulations about the amount of poison consumption.

Keywords: Strategical Analysis, Environmental Management, Agricultural Toxins, Butachlor Poison

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Introduction

Modern agriculture has led to great achievements in the field of increasing food, the productivity of production resources, and

improving the standard of living. The role of this agricultural method in food security and welfare is undeniable. But due to excessive reliance on foreign inputs (especially fertilizers and chemical poisons), destructive effects have been imposed on the environment (Hmaekhani *et al*., 2022). The agricultural sector is one of the economic axes. The contribution of the agricultural sector to employment, national income, food production, and cooperation with other sectors is significant, but goals for environmental sustainability should be considered (Bahjani and Pishbin, 2022). In recent years, environmental protection has been the focus of decision-making in the agricultural sector. Currently, farmers should be provided with the necessary knowledge and tools for an acceptable profit through more production from the environment and these production resources should also be protected (Geravandi *et al*., 2021).

Modern agricultural systems emphasize the preservation of the environment due to the continuous use of chemical fertilizers. It is possible to protect various types of organisms by reducing the entry of chemical fertilizers and chlorine pesticides into water and soil to restore the cycle of nature (Ranjkesh, 2021). According to the report of the Food and Agriculture Organization (FAO) of the United Nations, the world population will reach more than 1.9 billion people in 2050. Providing food for this growing population requires a 70% increase in the production of agricultural products. Therefore, this challenge has increased the scope of agricultural activities, and the use of pesticides, poisons, and chemical fertilizers (Zangina *et al*., 2021).

Improvement in the production of food and agricultural products, increase in population, and supply of nutritional needs is the focus of development and progress in third-world societies. The use of scientific and technical achievements in the field of cultivation and land exploitation methods, the development and evolution of technology in the field of agricultural machinery construction, the expansion and development of scientific methods of combating pests and plant diseases, the production and consumption of various chemical fertilizers have caused a fundamental change in agricultural production (Deknock *et al*., 2019).

In general, chemical compounds used in agriculture against pests and diseases affect plant organs, soil, water, air, and food. If its amount exceeds the permissible, it will cause important risks to human and animal health. Improper use of these toxins causes biological imbalance, the emergence of resistant breeds, and environmental pollution (Garcia *et al*., 2022). Every year, thousands of people are poisoned by pesticides, and almost half of this damage occurs in the third world. This issue has historical roots. In 1983, two million people were exposed to pesticide poisoning, which caused 400,000 deaths (Kaushik *et al*., 2020). Environmental issues should not be ignored to increase the population's food production.

Recently, advanced countries have reduced the use of chemical poisons to control plant pests and diseases with special agronomic, biological, and physical methods

(by choosing the type, amount, and time of using poisons). Therefore, the lethal effects of chlorine toxins are reduced and natural control agents are used for the biological control of pathogens and plant pests (Zamora-Sequeira *et al.*, 2019; Rani *et al*., 2021). Chlorine toxins have a special role. The D.D.T poison is one of the cases where the permissible amount of food contamination is 1 ppm. If the contamination exceeds this limit, the food must be destroyed (Kaur *et al*., 2019). Butachlor agricultural poison is one of these poisons. The effect of this poison depends on the amount of water available to the plant, which leads to the survival of pesticides in food products. Several cases of toxicity of this pesticide have been reported in the water sources of Asian and African countries. Butachlor is a major environmental hazard to aquatic ecosystems and microorganisms such as green algae and fish (Kumar *et al*., 2022; Zhu *et al.*, 2022). The widespread use of these types of pesticides has caused pollution of water systems. There are more than 95 herbicides registered in the country, Butachlor with 1266 tons (more than 15%) having the highest amount of consumption compared to other herbicides. This poison is one of the most important pesticides used in Iran and it causes a lot of damage by contaminating water sources (Nozhat *et al*., 2021). Excessive input of butachlor poison in water sources causes various diseases. These toxins are a potential threat to human health due to the effect on the activity of the cholinesterase enzyme and disturbance in the central nervous system. Butachlor has harmful effects, especially on fish. It is more in cold water fish than warm water fish. Butachlor decomposes more slowly in water with low temperatures and multicellular organisms are exposed to it for a longer period (Elmdoust *et al*., 2017).

This poison is widely used by rice farmers in the northern regions of the country and has harmful effects on various species of organisms, especially aquatic animals. This issue requires careful monitoring and control, which requires strategic analysis. In the present study, internal and external factors for strategic decision-making about the environmental effects of Butachlor agricultural poison and its implementation strategies have been investigated. Also, the current situation related to the management of this poison in the country will be determined by SWOT analysis. Then, the best scenario to improve the current situation and achieve the objectives of environmental management to reduce the effects of Butachlor will be presented by developing different scenarios.

Literature review

Behjani and Pishbin (2022) conducted a study on the sustainable development of agriculture from the perspective of production cooperatives. The results showed that there is a significant relationship between production cooperatives and sustainable agricultural development from an economic and environmental point of view. Also, there was a significant relationship between production cooperative companies and environmental development. Hmaekhani et al. (2022) have explained the driving factors of sustainable

agricultural development. The results showed that five factors, including infrastructural, environmental, planning, economic and technological factors, constitute the driving factors of conservation agriculture. Geravandi et al. (2021) studied the typology of experts' mentalities regarding the obstacles to the development of sustainable and environmental agriculture. Based on the research results, technology-oriented, tradition-oriented, knowledge-oriented, awareness-oriented, and institution-oriented are very important to protect the environment in agriculture. Ranjkesh (2021) has examined the importance of sustainable agricultural development regarding environmental protection. Organic agriculture is one of the sustainable agricultural strategies to reduce the use of chemical fertilizers and pesticides, but it has not been realized in practice. Therefore, in recent decades, many efforts have been made at the international level to move toward sustainable development. Nozhat et al. (2021) have conducted a study related to the removal of butachlor poison from the water environment by the adsorption isotherm method of graphene oxide modified by organic dendrimers. The results showed that functionalized magnetic graphene oxide effectively absorbs butachlor poison and the absorption percentage is significantly affected by the investigated parameters. Panahandeh et al. (2016) compared the changes in Hinosan and Butachlor in the underground water resources of Gilan province. The investigations showed that the content of Hinosan and Butachlor toxins is not more than the standard and permitted limits. Other studies have investigated the effects of butachlor poison on various types of fish. So far, the effects of butachlor poison on salmon (Nafisi Bahabadi *et al*., 2016; Elmdoust *et al*., 2017), carp (Hedayati *et al*., 2017), and redfish (Zarei *et al*., 2017) have been investigated. Studies related to the research topic can be categorized into three main axes: sustainability and environmental considerations, strategic analysis, and chlorine agricultural toxins. Preliminary investigations showed that none of the previous studies have focused on the strategic analysis of environmental management to the effects of agricultural pesticides.

Research methodology

The present study is applied research for the strategic analysis of environmental management of the effects caused by butachlor agricultural poisons. Data collection is also a non-experimental (descriptive) research from the viewpoint of the method and time frame, which was done with the survey-cross-sectional method. The statistical population of the research includes the persons who are in charges in the fields of agriculture and environment. The exact determination of the sample size for qualitative research does not follow a specific relationship, but between 5 and 25 people have been suggested (Boddy, 2016; Vasileiou *et al*., 2018). Generally, the interview process in the qualitative analysis should continue until theoretical saturation. Non-probability and purposeful methods were used for sampling in the qualitative section.

The sampling process continued until theoretical saturation was reached and finally 8 people participated in the qualitative part. In the second stage, a panel of managers consisting of eight persons of the above-mentioned fields was used for strategic analysis. Interviews and questionnaires were used to collect research data. Semi-structured interviews are more suitable for qualitative studies (Danaifard *et al*., 2013), therefore, was used in this research. Then a questionnaire was used for strategic analysis.

The Holstein coefficient was used to evaluate the reliability of the qualitative part. For this purpose, the text of the conducted interviews was coded in two stages, and then the percentage of observed agreement (PAO) was calculated:

$$PAO = \frac{2M}{N1 + N2} = \frac{66}{97 + 85} = 0.725$$

The observed agreement percentage of PAO in this study was calculated as 0.725, which is greater than 0.6, so the validity of the qualitative part is favorable. Theme analysis (theme) and MaxQDA software were used to analyze the data collected through interviews in the qualitative section. Identification of the main and subcategories of the research was done using this method. After identifying the strengths, weaknesses, opportunities, and threats, the combined SWOT-QSPM approach was used for strategic analysis. SWOT analysis method has been used for the strategic evaluation of Butachlor agricultural poisons. Also, the evaluation and selection of the best scenario were done using the quantitative matrix of strategic planning.

Research findings

In terms of gender, 5 people were male and 3 were female. In terms of age, 2 people were less than 35 years old, 4 people were between 35 and 45 years old, and two people were over 45 years old. In terms of education, 7 of the experts had a doctorate and one person had a master degree. Finally, two people had between 10 and 20 years of experience in the related work field, and six people had more than 20 years of work experience in the studied industry.

Table 1. Demographic characteristics of the qualitative section

Demographic characteristics		Frequency	Percentage (%)
Gender	Male	5	63
	Female	3	38
Age (year)	Lower than 35	2	25
	Between 35 to 45	4	50
	Higher than 45	2	25
Education	Master	1	13
	Doctorate	7	88
Work experience (year)	10 to 20	2	25
	More than 20	6	75
	Total	8	100

The interview protocol includes five open questions that are listed in Table 2. During the interview process, it was anticipated that new questions would be asked if necessary.

Table 2. Thematic analysis of interview questions

Question Number	Interview Questions
1	What is the importance of environmental management strategic analysis on the effects of butachlor agricultural toxins?
2	What are the strengths of environmental management on the effects of Butachlor agricultural toxins?
3	What are the weaknesses of environmental management on the effects of Butachlor agricultural toxins?
4	What are the future opportunities for environmental management on the effects of Butachlor agricultural toxins?
5	What are the future threats to environmental management on the effects of Butachlor agricultural toxins?

The process of interviewing continued until theoretical saturation was reached and no new issues were raised after 8 interviews. Then, each interview was entered into MaxQDA software separately as text. The text of the interviews was analyzed by the thematic analysis method. Repeated reading of the data was done to familiarize the researcher with the content depth of the data actively (searching for meanings and patterns). The method proposed by Attride-Stirling (2001) was used to code the data in the qualitative analysis of the theme. First, semantic units were broken into sentences and paragraphs related to the main meaning. Semantic units were also reviewed several times and then appropriate codes were written for each semantic unit and the codes were classified based on semantic similarity. The flow of analysis was repeated as each interview was added. 97 codes were identified in the open coding stage. Finally, 4 overarching categories and 27 basic themes were obtained through axial coding. The indicators of strategic analysis extracted from the interviews by the thematic analysis method are presented in Table 3.

Table 3. Indicators of strategic analysis on environmental management of Butachlor agricultural poisons

Main factors	Basic topics
Strengths	Use of less dangerous and cheaper pesticides by farmers; Farmers' interest in planting resistant species; the willingness of farmers to use integrated pest management methods; familiarizing farmers with weed management methods; use of crop rotation by farmers; Water and fertilization management by farmers to increase crop competitiveness and reduce weed growth
Weaknesses	lack of technical and economic ability of farmers in managing poisons; lack of mechanization of pesticide spraying systems in farms; Farmers' lack of knowledge about the consequences of their consumption; Releasing poison containers in nature
Opportunities	Globalization and the inevitability of people's tendency to have a healthy environment; increase in the price of poisons; The existence of research and scientific centers to investigate poisons and their effects; the existence of less dangerous herbicides to replace with butachlor poison; The existence of social networks to educate and raise awareness about the consequences of adverse management; The possibility of changing the performance of organizations
Threats	lack of planning to reduce the consumption of butachlor poison in the country; Absence of laws and regulations to control the consumption of agricultural pesticides; lack of a comprehensive plan to dispose of poison containers; planning and policy contrary to green agriculture; Lack of planning for the approval and sale of agricultural pesticides; conducting research and studies on the harmful effects of toxins; lack of organizations and associations to support the reduction of toxic consumption; Existence of outdated and low-quality poisons; The proximity of paddy fields to residential areas; Lack of proper transportation and efficient regulations

The current research is done with a strategic approach. Therefore, the comprehensive topics were categorized in the form of strengths, weaknesses, opportunities, and threats. After the strengths, weaknesses, opportunities, and threats were identified, the combined SWOT-QSPM approach was used for strategic analysis. An evaluation matrix of internal and external factors should be formed to perform a SWOT analysis. This requires the weight and score of the existing conditions. The weight of each element was obtained using Swara. Managers were asked to assign a score between 1 and 4 to each indicator to determine the score of the current situation. Each index is determined using the current status score mode. Finally, the final score of that index was obtained by multiplying the weight of each factor by the status score. The internal factors evaluation (IFE) matrix is presented in Table 4.

Table 4. Internal factors evaluation matrix (IFE)

Internal factors	Symbol	Sub-criteria	Weight	Status score	Balanced score
Strengths	S1	Use of less dangerous and cheaper pesticides by farmers	0.194	3	0.583
	S2	Farmers' interest in using resistant species	0.068	3	0.204
	S3	The willingness of farmers to use integrated pest management methods	0.12	3	0.359
	S4	Farmers' familiarity with weed management methods	0.114	4	0.455
	S5	Use of crop rotation by farmers	0.065	3	0.194
	S6	Water management and fertilization by farmers	0.059	3	0.178
Weaknesses	W1	Lack of technical and economic capacity of farmers in poison management	0.096	1	0.096
	W2	Non-mechanization of spraying systems in fields	0.053	2	0.106
	W3	Farmers' lack of awareness about the consequences of using and managing pesticides	0.157	1	0.157
	W4	Releasing poison containers in nature	0.075	1	0.075
Total sum			1		2.406

The total sum of the internal factors evaluation matrix (2.406) from the IFE matrix indicates the dominance of weaknesses over strengths. The evaluation matrix of external factors (EFE) is presented in Table 5.

Table 5. External factors evaluation matrix (EFE)

Internal factors	Symbol	Sub-criteria	Weight	Status score	Balanced score
Opportunities	O1	Globalization and the inevitability of people's tendency towards a healthy environment	0.018	3	0.054
	O2	Increase in the price of poisons	0.118	4	0.474
	O3	The existence of research and scientific centers on the investigation of poisons and their effects	0.097	4	0.388
	O4	Low-risk herbicide to replace Butachlor poison	0.137	3	0.412
	O5	The existence of social networks for education and awareness	0.025	3	0.074
	O6	Lack of organizations and associations to support the reduction of poison consumption	0.029	3	0.087
Threats	T1	Lack of macro planning in the country to reduce the consumption of poisons	0.052	2	0.104
	T2	Absence of laws and regulations on the amount of consumption of agricultural pesticides	0.074	2	0.147
	T3	Lack of a comprehensive plan for the disposal of poison containers	0.066	1	0.066
	T4	Planning and policy contrary to green agriculture	0.079	1	0.079
	T5	Lack of planning in the process of approval and sale of agricultural pesticides	0.019	2	0.038
	T6	Research and studies on the harmful effects of toxins	0.063	2	0.126
	T7	Lack of organizations and associations to support the reduction of poison consumption	0.043	1	0.043
	T8	Existence of outdated and poor-quality poisons	0.058	2	0.116
	T9	The proximity of paddy fields to residential areas	0.086	2	0.172
	T10	Lack of proper transportation and compliance with regulations	0.036	2	0.073
Total sum			1		2.452

The total sum of the evaluation matrix of external factors (2.452) indicates the dominance of environmental threats over opportunities. The scores obtained from the evaluation matrix of internal factors and the evaluation matrix of external factors should be placed in their vertical and horizontal dimensions to determine the strategic position of environmental management on butachlor agricultural poisons and determine suitable strategies for it. This matrix corresponds to the SWOT matrix and identifies the appropriate strategies for the organization, which is presented in Figure 1.

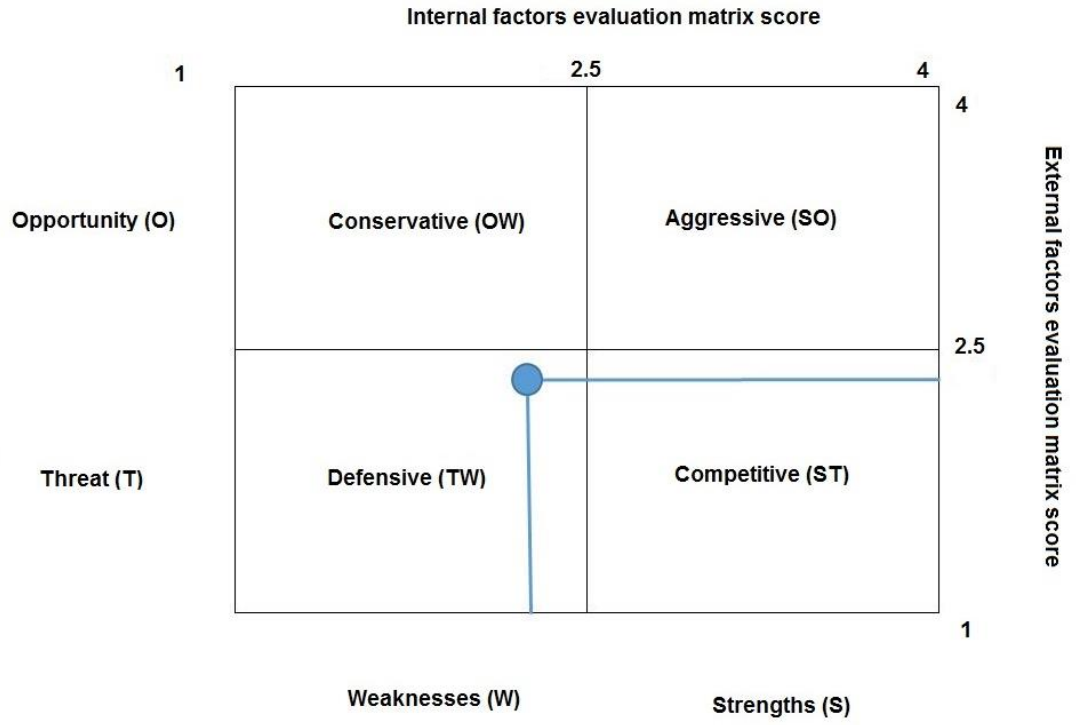

Figure 1. Internal and external matrix analysis.

The results obtained from the evaluation matrix of internal and external factors indicate that the strategic status of environmental experts on Butachlor poison is in defensive mode (WT). This situation is caused by the dominance of internal weaknesses over internal strengths and environmental threats over opportunities. According to Figure 1, the conditions are ready to use defensive strategies. The SWOT method systematically analyzes each of the strengths, weaknesses, opportunities, and threats identified in the previous stage and reflect the strategies appropriate to the situation. In the SWOT model (after listing the factors of strength, weakness, opportunity, and threat), the desired strategies are obtained in the order of weighted points from their intersection. Therefore, this matrix always leads to four categories of ST, WT, WO and SO strategies. Table 6 shows the SWOT analysis matrix.

Table 6. Matrix of management strategies and solutions for Butachlor poison

	Strengths (S)	**Weaknesses (W)**
Internal priority factors	Use of less dangerous and cheaper pesticides by farmers	Lack of technical and economic capacity of farmers in poison management
	Farmers' interest in using resistant species	
	The willingness of farmers to use integrated pest management methods	Non-mechanization of spraying systems in fields
External priority factors	Farmers' familiarity with weed management methods	Farmers' lack of knowledge about the consequences of using and managing pesticides
	Use of crop rotation by farmers	
	Water and fertilization management by farmers to increase crop competitiveness and reduce weed growth	Releasing poison containers in nature

Opportunity (O)	**Offensive strategies (SO)**	**Revising Strategies (WO)**
The inevitability of the world's people's tendency towards a healthy environment Increase in the price of poisons The existence of research and scientific centers to investigate poisons and their effects Availability of less dangerous herbicide to replace Butachlor poison The existence of social networks for education and awareness about the consequences of adverse management	Appropriate and targeted use of research conducted on poisons and their effects Study and research on planting alternative crops in the region to reduce weeds Providing conditions for the production of organic products	The role of research centers in the development of low consumption of toxins The role of poison container management (separation, collection, and recycling of poison containers) Using the capabilities of social networks in the field of training and awareness of farmers about the consequences of using poisons Researching the use of biodegradable containers to manage poison containers
Threats (T)	**Diversity Strategies (ST)**	**Defensive Strategies (WT)**
Lack of planning to reduce the consumption of butachlor poison in the country Lack of definitive rules and regulations for the use of agricultural pesticides Lack of a comprehensive program in the field of disposal of poison containers Planning and policy contrary to green agriculture Lack of planning in the field of approval and sale of agricultural pesticides Conducting research and studies on the harmful effects of toxins Lack of support from organizations and associations to reduce the consumption of poisons Existence of outdated and poor-quality poisons The proximity of paddy fields to residential areas Lack of proper and compliant transportation	Paying attention to the role of organizations and NGOs to reduce poison consumption Government supervision in managing the use of poisons (date of poisons, method of use, etc.) Compilation and revision of poisons management rules and regulations Attracting the support of research and academic centers for research on the harmful effects of toxins Attracting the support of the government for the planning and management of agricultural pesticides Government control over the transport of poisons (according to the rules of the Basel Convention)	Educating farmers about the consequences of their consumption and management Providing conditions and encouraging farmers not to use poisons Providing credits needed by producers in the agricultural sector Compilation of rules and regulations regarding the consumption of pesticides in farms Raising the level of public culture about the importance and status of green agriculture

Offensive strategies (SO): It is possible to exploit external opportunities by using internal strengths in the implementation of SO strategies. Every organization is interested in taking advantage of internal strengths and external events in this situation.

Conservative strategies (WO): The objective of WO strategies is to compensate for weaknesses with advantages in opportunities.

Defensive strategies (WT): The objective of WT strategies is to reduce internal strengths and weaknesses and avoid threats from the external environment. This situation is inappropriate and will be dangerous. Therefore, this situation should be avoided by reducing operations, integration, and other methods.

Competitive strategies (ST): In this strategy, internal strengths will be used to prevent the negative impact of external threats and remove them. A list of different strategies is prepared using the SWOT matrix in four different groups. The results obtained from the evaluation matrix of internal and external factors indicate the state of environmental management in conservative mode (WO). So the conditions are ready to use competitive strategies.

A quantitative strategic planning matrix or QSPM is one of the methods of evaluation, monitoring, and supervision to realize the strategy. This method is used in many management and strategic planning researches. This method specifies which strategic options are possible and prioritizes the strategies.

QSPM matrix formation steps

The matrix includes the list of strategic factors outside the organization (all threats and opportunities) and strategic factors within the organization (all weaknesses and strengths) in the first column. These factors are from IFE and EFE matrices. The weighted score of each strategic factor is extracted from the IFE and EFE matrix and inserted in the second column. Other strategies obtained from the SWOT matrix including four strategies (WO, ST, WT and SO) are placed in the next columns. Columns related to types of strategies are divided into two sub-columns (AS sub-column and TAS sub-column). The attractiveness score is placed in the AS column. Each strategic factor is measured with the desired strategy and a score is given. This question must be answered for the attractiveness score: Does this factor affect the selection of the mentioned strategy? If the answer to this question is positive, the attractiveness score should be given specifically based on the relative attractiveness of each strategy to the other strategy.

The attractiveness points are as follows:

Score 1 = not attractive

Score 2 = somewhat attractive

Score 3 = acceptably attractive

Score 4 = highly attractive

If the answer to the above-mentioned question is negative, it shows that the strategic factor does not affect the choice of strategy. Therefore, the attractiveness score for that strategy in the strategic factor row will be equal to one. The scores of the second column are multiplied by the attractiveness score and the total attractiveness score is entered in the TAS column. These values show the relative attractiveness of each factor in the desired

strategy. The sum of TAS scores is calculated in the bottom row of the table, which is the strategic priority score. Hence, the different strategies of an organization will be prioritized with a numerical value and will be compared with each other.

According to the evaluation matrix of internal and external factors, cover strategies should be investigated to avoid threats (WT) and reduce weaknesses.

Scenario (WT1): Improving the level of public culture about the importance and status of green agriculture

Scenario (WT2): training farmers about the consequences of poison consumption and their management

Scenario (WT3): Compilation of laws and regulations related to the amount of consumption of poisons

Scenario (WT4): Providing conditions and encouraging farmers not to use poison

Scenario (WT5): Providing the necessary facilities to supply the credits needed by producers in the agricultural sector

A quantitative approach analysis of strategic planning has been used to identify the attractiveness of the developed strategy implementation scenarios. The scenarios have been prioritized by forming the Quantitative Strategic Planning Matrix (QSPM). The quantitative matrix of QSPM strategic planning is presented in Table 7.

Table 7. Quantitative strategic planning matrix

Indices	Weight	WT1		WT2		WT3		WT4		WT5	
		AS	TAS	AS	TAS	AS	TAS	AS	TAS	AS	TAS
S1	0.0971	2	0.194	4	0.388	4	0.388	2	0.194	4	0.388
S2	0.0339	2	0.068	4	0.136	2	0.068	3	0.102	3	0.102
S3	0.0598	2	0.120	2	0.12	4	0.239	1	0.06	1	0.06
S4	0.0569	2	0.114	3	0.171	4	0.228	3	0.171	2	0.114
S5	0.0323	2	0.065	3	0.097	2	0.065	2	0.065	2	0.065
S6	0.0297	4	0.119	2	0.059	2	0.059	1	0.03	3	0.089
W1	0.0478	2	0.096	2	0.096	3	0.144	4	0.191	2	0.096
W2	0.0265	1	0.026	3	0.079	3	0.079	1	0.026	1	0.026
W3	0.0783	1	0.078	4	0.313	4	0.313	3	0.235	2	0.157
W4	0.0377	2	0.075	4	0.151	4	0.151	4	0.151	4	0.151
O1	0.009	3	0.027	4	0.036	3	0.027	1	0.009	4	0.036
O2	0.0592	2	0.118	4	0.237	3	0.178	4	0.237	3	0.178
O3	0.0485	1	0.049	2	0.097	4	0.194	4	0.194	4	0.194
O4	0.0687	1	0.069	4	0.275	3	0.206	2	0.137	3	0.206
O5	0.0123	2	0.025	4	0.049	2	0.025	1	0.012	2	0.025
O6	0.0145	2	0.029	2	0.029	4	0.058	3	0.044	1	0.015
T1	0.0259	2	0.052	3	0.078	2	0.052	2	0.052	4	0.104
T2	0.0368	1	0.037	1	0.037	3	0.11	1	0.037	3	0.11
T3	0.0332	3	0.1	4	0.133	4	0.133	3	0.1	3	0.1
T4	0.0394	1	0.039	3	0.118	4	0.158	3	0.118	1	0.039
T5	0.0094	3	0.028	2	0.019	4	0.038	3	0.028	2	0.019
T6	0.0316	2	0.063	2	0.063	3	0.095	2	0.063	3	0.095
T7	0.0214	1	0.021	4	0.086	4	0.086	4	0.086	1	0.021
T8	0.0290	2	0.058	2	0.058	3	0.087	2	0.058	3	0.087
T9	0.0430	2	0.086	4	0.172	4	0.172	4	0.172	1	0.043
T10	0.0181	3	0.054	4	0.073	2	0.036	1	0.018	4	0.073
Total	1	1.809		3.168		3.387		2.589		2.590	

Discussion, conclusions, and suggestions

This research was done with the aim of strategic analysis of environmental management on agricultural poisons (case study: butachlor agricultural poison). Based on the results of the research, the WT3 scenario (compilation of rules and regulations on the consumption of poisons) is ranked 1st with a score of 3.387. The study of Kumar et al. (2022) also refers to the compilation of laws and regulations and is consistent with the results of this research. Based on the results, the WT2 scenario (training of farmers about the consequences of their consumption and management) is ranked 2nd with a score of 3.168. The study of Behjani and Peshbin (2022) also mentioned this issue and it is consistent with the results of the present study. The WT5 scenario (providing the necessary facilities to provide the credits needed by agricultural producers) is ranked 3rd with a score of 2.59. This result has been confirmed in the study of Li et al. (2022). Finally, the WT1 scenario (raising the level of public culture about the importance and status of green agriculture) is ranked 5 with a score of 1.809. The study of Rashidpour et al. (2022) also confirms this result.

Based on the research results, the following practical suggestions are presented:

Strategy: Compilation of laws and regulations on the use of poisons

1- The requirement of governments to approve official laws to prevent the activities of production and use of chemical substances declared by the convention, import, and export of chemicals by natural persons and governments.

2- More control and supervision on the quality of poisons produced inside and outside and imported poisons

3- Monitoring the correct consumption of poisons based on their remaining limits

4- Harmonizing the consumption of chemical poisons in the country with global indicators

Strategy: training farmers about the consequences of consumption and their management

1- Many farmers do not understand the information included in the label of poisons, which is related to factors such as the specialization of actions and lack of familiarity with foreign languages. Illiteracy is one of the factors involved in this problem. This problem can be solved with training sets and orientation classes.

2- It is necessary to use several personal protection devices when using pesticides. Therefore, it is suggested that farmers should be informed about personal protection, familiarity with protective devices, and their effects on short-term and long-term health.

3- Required educational measures, including toxicology and its application, prevention methods, short-term and long-term side effects, and effective use of various personal protective equipment should be carried out by experts. These collections should be in simple, clear, local, and non-specialized Persian language.

Strategy: Providing the necessary facilities to provide the credits needed by producers in the agricultural sector

1- interest-free or low-interest bank facilities for producers of organic products

2- Investing and improving financial resources in the production, processing, and marketing of organic products

3- Providing incentives for farmers to insure organic agricultural products

4- Guaranteed purchase of organic products from producers by supporting organizations

5- Allocation of subsidies to producers of organic products

6- Commercialization and dissemination of new research findings in the field of organic agriculture

7- Clarification of comprehensive government support policies for producers and consumers of organic products

8- Establishment of tax exemption for producers of organic products

9- Payment of direct subsidies from the government to organic farmers

10- Interest-free or low-interest loans and facilities for farmers of organic products

Strategy: provision of facilities and encouragement to agriculture without the use of poisons

1- Improving the technical knowledge of experts with new and advanced technology, creating advanced awareness about the consumption of agricultural pesticides, revising the methods of spraying, the scientific and principled use of modern spraying tools, and determining their appropriate types based on the conditions of different regions and crops.

2- The use of personal communication resources in changing the appropriate environmental attitude related to the consumption of poisons by farmers, continuous and regular visits of experts to the fields, and communication with rice farmers to teach the principles of consumption of poisons and environmental hazards.

3- Based on the influence of the communication media, programs should be prepared by the provincial radio and television media and the responsible offices about the dangers of indiscriminate and unprincipled consumption of poisons.

4- To establish a specialized agricultural network in the provinces in their mother tongue and teach programs related to chemical inputs and basic methods of their application.

5- Farmers with a higher level of education have a more positive attitude towards chemical pesticides. Therefore, awareness and education cause positive changes in increasing the behavioral safety level of farmers.

6- It is possible to provide suitable conditions for changes in farmers' knowledge by providing specialized information, educational and promotion classes, and experts' contact with farmers.

7- Agricultural experts should provide necessary recommendations to farmers regarding the last spraying before harvest.

8- It should be prohibited to spray some products at night with an excessive number of

spraying times on public paths and roads around villages.

Strategy: Improving the level of public culture about the importance and status of green agriculture

1- The use of integrated weed management (IWM) systems is a combination of the best methods and tools of agricultural systems, which reduces the harmful effects of weeds by destroying them. These scientific methods are affected by the level of scientific development, the rate of population growth, the economic and political situation of each region, and the macro decisions of countries.

2- The study and assessment of the environmental health risk of chemical poisons may lead to a better understanding of the global problems of these poisons and be useful in finding a suitable solution.

3- The use of Eco-Friendly Technologies such as nanotechnology, optimizing the production methods of chemical poisons based on reducing their toxicity, producing biological poisons, and increasing the awareness of farmers can be suitable factors for improving the production of agricultural products along with reducing the harmful effects on humans and environment.

4- More efforts should be made to promote methods of optimizing the use of pesticides and marketing organic products. Because encouraging farmers and the community to use pesticides optimally and produce organic products improves the health conditions of people and the environment, creates and maintains food security, self-sufficiency in the production of agricultural products, and longer shelf life of manufactured products.

5- Due to the poverty of the rice farmers and their low income, it is suggested to create spontaneous, cooperative, and voluntary organizations to negotiate with the organizations and receive the necessary support and hold promotional training courses.

6- The responsible organizations must formulate clear rules and regulations that are enforceable. Because the last cycle of producing organic products is getting the organic label. The clarity of receiving this label motivates farmers to produce organic products.

7- To provide financial support to organic rice cultivation by granting subsidies because organic production reduces production efficiency and the high price of biological and alternative fertilizers reduces the farmer's profit. Therefore, rice farmers suffer a lot of losses. These financial supports are common throughout the world and are essential in the process of transition to organic farming.

8- To provide and support organic inputs (seeds, pesticides, and biological fertilizers) at reasonable prices to rice farmers is a policy to compensate for the cost of controlling pests and weeds and removing obstacles in organic rice cultivation. Also, the distribution and access to these inputs must be managed.

9- The government should visit the organic farms with successful results and prepare videos and educational packages and present them to the rice farmers of the region.

Conflict of interest

The authors have no conflict of interest in this work.

References

Attride-Stirling, J., 2001. Thematic networks: an analytic tool for qualitative research. *Qualitative Research*, *1*(3), 385-405. https://doi.org/10.1177/146879410100100307

Behjani, M. and Pishbin, S., 2022. Investigating the Effects of Production Cooperative Companies on Sustainable Agricultural in City of Jahrom. *Sustainable Agricultural Research*, *2*(1), 75-89. (In Persian)

Boddy, C.R., 2016. Sample size for qualitative research. Qualitative Market Research: An International Journal. https://doi.org/10.1108/qmr-06-2016-0053/full/html

Danaifard, H., Alvani, M. and Azar, Adel., 2013. Qualitative research methodology in management: a comprehensive approach. Tehran: Safar Publications. (In Persian)

Deknock, A., De Troyer, N., Houbraken, M., Dominguez-Granda, L., Nolivos, I., Van Echelpoel, W. and Goethals, P., 2019. Distribution of agricultural pesticides in the freshwater environment of the Guayas river basin (Ecuador). *Science of the Total Environment*, *646*, 996-1008. https://doi.org/10.1016/j.scitotenv.2018.07.185

Elmdoust, A., Mirvaghefi, A. and Gholamzadeh, P., 2017. Effects of Mutagenic Butachlor Herbicide on Some Blood Parameters in Rainbow Trout (*Oncorhynchus mykiss*). *Journal of Fisheries*, *70*(1), 36-43. (In Persian)

Garcia, M.G., Sánchez, J.I.L., Bravo, K.A.S., Cabal, M.D.C. and Pérez-Santín, E., 2022. Presence, distribution and current pesticides used in Spanish agricultural practices. *Science of the Total Environment*, 157291. https://doi.org/10.1016/j.scitotenv.2022.157291

Geravandi, S., Moradi, F. and Babaei, M.H., 2021. Typology of Experts' Attitudes on Constraints of Conservation Agriculture Development (A Q Methodology). *Sustainable Agricultural Research*, *1*(2), 91-106. (In Persian)

Hedayati, A., Darabitabar, F. and Forouhar Vajargah, M., 2017. The safety evaluation of prebiotic isomalto-oligosaccharid on the liver and gill tissues in common carp (*Cyprinus carpio*) exposed to lethal concentrations of butachlor toxin. *Journal of Aquatic Ecology*, *7*(1), 152-157. (In Persian)

Hmaekhani, A., Rashidpour, L. and Rasouliazar, S., 2022. Explaining the Factors Promoting the Development of Conservation Agriculture Using Factor Analysis (Case Study: Boukan County). *Sustainable Agricultural Research*, *2*(1), 90-103. (In Persian)

Kaur, R., Mavi, G. K., Raghav, S. and Khan, I., 2019. Pesticides classification and its impact on environment. *International Journal of Current Microbiology and Applied Sciences*, *8*(3), 1889-1897. https://doi.org/10.20546/ijcmas.2019.803.224

Kaushik, G., Dar, M.A. and Chiu, J.F.V., 2020. Pollution status and biodegradation of organophosphate pesticides in the environment. In Abatement of environmental pollutants (pp. 25-66). Elsevier. https://doi.org/10.1016/B978-0-12-818095-2.00002-3

Kumar, V., Swain, H. S., Roy, S., Das, B. K., Upadhyay, A., Ramteke, M. H. and Banerjee, H., 2022. Integrated biomarker approach strongly explaining in vivo sub-lethal acute toxicity of butachlor on *Labeo rohita*. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 109427. https://doi.org/ 10.1016/j.cbpc.2022.109427

Li, N., Zhang, J.J., Liu, J., Zhang, N. and Yang, H., 2022. Biodegradation of butachlor in rice intensified by a regulator of OsGT1. *Ecotoxicology and Environmental Safety*, *242*, 113942.
https://doi.org/10.1016/j.ecoenv.2022.113942

Nafisi Bahabadi, M., Dadgar, S., Lakzaei, F., Mohajeri, Z. and Abdolahi, R., 2016. The effect of subacute concentrations of Butachlor herbicide on some blood parameters in rainbow trout (*Oncorhynchus mykiss*). *Iranian Scientific Fisheries Journal*, *25*(2), 151-160. (In Persian)

Nozhat, S., Hasani, A., Ahmad Panahi, H., Moniri, E. and Monavari, M., 2021. Investigation of Adsorption Isotherm of Modified Graphene Oxide by Organic Dendrimers to Remove Butachlor Pecticides from Aqueous Solution. *Journal of Water and Wastewater*, *32*(1), 53-68. (In Persian)

Panahandeh, M., Ashoornia, M., Rahbar, H. M. and Modabberi, H., 2017. Comparison the changes of two Hinosan and Butachlor toxins in Groundwater resources from Guilan province. *Journal of Environmental Research and Technology*, *1*(2), 13-18. (In Persian)

Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A.S. and Kaushal, J., 2021. An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Cleaner Production*, *283*, 124657. https://doi.org/ 10.1016/j.jclepro.2020.124657

Ranjkesh, N., 2021. An overview of the importance of sustainable agricultural development in order to protect the environment. *Iranian Plant and Biotechnology*, *16*(2), 49-56. (In Persian)

Vasileiou, K., Barnett, J., Thorpe, S. and Young, T., 2018. Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC medical research methodology*, *18*(1), 1-18. https://doi.org/ 10.1186/s12874-018-0594-7

Zamora-Sequeira, R., Starbird-Pérez, R., Rojas-Carillo, O. and Vargas-Villalobos, S., 2019. What are the main sensor methods for quantifying pesticides in agricultural activities? A review. *Molecules*, *24*(14), 26-39. https://doi.org/ 10.3390/molecules24142659

Zangina, U., Buyamin, S., Abidin, M.S.Z. and Mahmud, M.S.A., 2021. Agricultural rout planning with variable rate pesticide application in a greenhouse environment. *Alexandria Engineering Journal*, *60*(3), 3007-3020. https://doi.org/10.1016/j.aej.2021.01.010

Zarei, M., Taghavi, H. and Nazarhaghighi, F., 2017. The effects of butachlor on indicators of pathological contaminants chronic kidney tissue and muscle in goldfish (*Carassius auratus*). *Veterinary Researches & Biological Products*, *30*(1), 89-99. (In Persian)

Zhu, S., Liu, Y., Li, Y., Yi, J., Yang, B., Li, Y. and Zhang, H., 2022. The potential risks of herbicide butachlor to immunotoxicity via induction of autophagy and apoptosis in the spleen. *Chemosphere*, *286*, 131683. https://doi.org/10.1016/j.chemosphere.2021.131683