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Evaluating the Productivity of Paddy Water Resources through SWOT Analysis: The Case of Northern Iran

Imaneh Goli [1], Hossein Azadi [2,3,4,*], Mehdi Nooripoor [5], Mirza Barjees Baig [6], Ants-Hannes Viira [7], Iulia Ajtai [8], and Ahsen Işık Özgüven [9]

[1] Department of Economics, Agricultural Extension and Education, Tehran Science and Research Branch, Islamic Azad University, Tehran 1477893855, Iran; imaneh.goli@srbiau.ac.ir
[2] Department of Geography, Ghent University, 9000 Ghent, Belgium
[3] Research Group Climate Change and Security, Institute of Geography, University of Hamburg, 20144 Hamburg, Germany
[4] Faculty of Environmental Sciences, Czech University of Life Sciences Prague, 165 00 Prague, Czech Republic
[5] Department of Rural Development Management, Yasouj University, Yasouj 75918-74934, Iran; mnoor-ipoor@yu.ac.ir
[6] Prince Sultan Institute for Environmental, Water & Desert Research, King Saud University, Riyadh 11451, Saudi Arabia; mbbaig@ksu.edu.sa
[7] Institute of Economics and Social Sciences, Estonian University of Life Sciences, 51014 Tartu, Estonia; Ants-Hannes.Viira@emu.ee
[8] Faculty of Environmental Science and Engineering, Babeş-Bolyai University, 400294 Cluj-Napoca, Romania; iulia.ajtai@ubbcluj.ro
[9] Faculty of Agricultural Sciences and Technologies, Cyprus International University, Haspolat, 99258 Nicosia, Turkey; aozguven@ciu.edu.tr
* Correspondence: hossein.azadi@ugent.be; Tel.: +32-(0)9-264-46-95; Fax: +32-(0)9-264-49-85

Citation: Goli, I.; Azadi, H.; Nooripoor, M.; Baig, M.B.; Viira, A.-H.; Ajtai, I.; Özgüven, A.I. Evaluating the Productivity of Paddy Water Resources through SWOT Analysis: The Case of Northern Iran. *Water* **2021**, *13*, 2964. https://doi.org/10.3390/w13212964

Academic Editor: Maria Mimikou

Received: 1 September 2021
Accepted: 16 October 2021
Published: 20 October 2021

Abstract: Water shortages in rice production represent a formidable challenge for the world's food, economic, and social security. Water is the most important single component for sustainable rice growth, especially in the world's traditional rice-growing areas. Therefore, this study attempts to evaluate the improvement of rice water productivity in Northern Iran on the basis of Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. This study is a qualitative-descriptive survey. A random sampling method was used to determine the sample size, and finally, 105 male and female rural facilitators in Sari city (the capital of Mazandaran Province located in Northern Iran) were surveyed. The results showed that the development of appropriate infrastructure, increasing new irrigation and drainage networks with the aim of increasing the use of efficient water technologies, was the most important strategy. The most necessary strengths, weaknesses, opportunities, and threats to improve the water productivity and management of paddy farms in the study area are, respectively, as follows: "fertile paddy fields and relatively good soils in most areas", "weakness in the participation and interaction of users in water resources projects and paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management", "improving irrigation planning", and "surplus harvest from Tajan River and drop in water level". Obtained findings may be used to address water scarcity and water quality management issues in the agriculture sector. The results demonstrate that, under potential climate change and water shortages, SWOT may be seen as a guide for contingency initiatives.

Keywords: paddy water resource; water resource management; water productivity; SWOT matrix; Iran

1. Introduction

Water is a scarce [1] yet an essential source for sustainable development (SD) [2–4] and farming [5,6] with numerous purposes, applications, and benefits [7]. Today, this resource faces major environmental [8,9], cultural, social, and political challenges [10] in Middle Eastern countries such as Iran [11]. Scientists fear that using Iran's water resources without considering their limitations could cause serious and big problems for Iran [12]. Iran's lack of water supply and overexploitation, especially in paddy fields, have demonstrated the urgent need to improve the productivity of the use of this important resource on paddy farms [13]. Water productiveness deals with the area of every unit of water in the gross domestic product. From this perspective, looking at the amount of water consumption, it can be said that, despite the high rate of water consumption in Iran, the production amount of this yard resource in Iran is very low [14]. In other words, the foremost problem of the agricultural quarter lies in increasing water quality, productivity, and water production [15]. According to Fang et al. [16], agriculture is the largest user of water in the world, accounting for 72% of global water consumption and 87% of water consumption in developed countries. In addition, the results of researches conducted by FAO [17] in 93 developing countries show that water supplies are decreasing in these countries and Iran is one of those countries [18].

Iran is among the countries confronting the condition of the water shortage in the tables of the international water resources institute [19], and due to natural climatic stipulations and the distribution of precipitation over time, water resources have a very heterogeneous spatial distribution. The sum of the precipitation differs over the years and also across the seasons, which causes problems for different industries, such as the food and agriculture industries, which have incurred major economic losses for these sectors [20]. Mazandaran Province possesses around 8.7% of Iran's renewable water resources. Renewable water accounts for about 10 billion m^3, and the global water request for the paddy farms of Mazandaran Province is about 4 billion m^3. While the usual surface water flows into the province account for about 33% of the whole water supply, this volume of water offers about 75% of the existing water needs of paddy farms [21]. However, the construction of several dams along Tajan's tributaries has changed the amount and quality of irrigation water available to the majority of Mazandaran's rice fields [22]. As a result, if strategies such as improving water quality and productivity are not implemented, Mazandaran's economy will face serious problems. Consequently, one of Iran's largest production regions of this strategic grain will be lost [23,24]. The Tajan River irrigation network irrigates around 180,000 ha of rice farms in Mazandaran, and 70,900 ha are traditionally irrigated by intermittent or permanent lakes, springs, and wells. The water demand for the rice fields of Mazandaran is estimated at 4 billion m^3 per year [21]. Considering the direct employment of over 300,000 purchasers in the rice area and its overall IRR (Iranian Rial) income of VND 45,000 billion, it can be assumed that rice development is the core of Mazandaran economy [21]. It is also important to pay heed to effective water supply management, groundwater depletion, surface water conservation, better energy usage productivity, and increased productivity. Integrated water resource management may be the least but a significant move forward [25]. The overexploitation of water sources for some areas has raised the chance of erosion [26]. In general, the efficiency of the water used by the agricultural sector in Iran is unsatisfactory. Currently, total water use is at 88.5 billion m^3, with agricultural use accounting for more than 93 percent and urban and industrial consumption accounting for less than 7% [27]. Sari County of Mazandaran Province is no exception, although this county's economy and subsistence are based on agriculture. Reducing the use of water and the implementation of water management initiatives in the agriculture sector are the key solution to these problems [28].

Water supply networks have been confronted with environmental changes, agricultural development, and population growth in recent years [29]. The standards of integrated water resource management (IWRM) have been extensively diagnosed as a probable technique to cope with those issues [29]. However, semi-arid and arid areas (such as

Iran) usually suffer from significant water resource shortages that need further innovation [30]. Consequently, water demand in these regions is increasing sharply for the infrastructure, industrial, and agricultural sectors [31]. Although the focus on the development of water resources remains the primary concern in arid regions, attention should be paid to a broad range of issues relating to socio-environmental management strategy and its consequences for provincial and national development [32]. Addressing these concerns illustrates the need to consider the requirements of SD in water management planning. The inclusion of sufficient empirical evidence is therefore crucial to make informed decisions on these issues [33]. Water resource planning has several layers, and the most important of which is strategic planning. Strategic planning provides a long-term perspective on the allocation of useful resources. Roberts [34], for example, offered an insight into metropolitan policy preparedness for the implementation of SD strategies in Scotland. Strategic water supply management by emphasizing specific outlooks, approaches, and productive projects can avoid dangerous scenarios in the future. Strategic management usually offers the maximum degree of decision making that can identify long-term objectives within a project [35]. Identifying policies and researching Strengths, Weaknesses, Opportunities, and Threats (SWOT) are the most important steps for successful strategic planning and decision making [36]. Analyses of SWOT have been carried out in several studies [37–43], covering different areas of water protection in industrial and developing countries. Nazari et al. [44], by using SWOT analysis, examined 40 variables in politics and fiscal, social, technical, environmental, and legal matters and showed that policy dynamism is the main reason for the failure of water irrigation management in Iran. Grippa et al. [45] have used SWOT analysis to better map, model, and understand the hydrological actions of water resources in important ecosystem services. The findings of their study reveal that, depending on soil quality, soil moisture, and wind patterns, the difference between water and land is frequently rather small, making water management challenging. In a study by Petousi et al. [6], SWOT analysis showed that reducing irrigation water, fertilizer control, exploitation of salt karst springs, sewage recycling, and construction of small dams are among the measures taken to manage water resources. Chitsaz and Azarnivand [33] used the SWOT technique to investigate water shortage management in arid regions of Iran. Their research findings indicate that offering alternatives to low-productivity, environmentally friendly industries and tourism through promoting private sector engagement in industry and tourism are Iran's top goals for water management. Nhamo et al. [46] argued that improvements in agricultural water management, especially in crop water productivity, allow the agricultural sector to share water equitably with other competing industries. According to Ekinci and Acar [47], in order to enhance water delivery performance, maintenance-repair works, which are critical for improved conveyance efficiency, should be completed on time, and all water delivery systems should be changed to lined-canals, if possible, rather than pipes. Apart from that, selecting drought-resistant crops is a smart way to conserve water. Deficit irrigation is another viable option for water-scarce areas, with up to 25% deficit irrigation using drip irrigation not resulting in substantial output decrease when compared to full irrigation. So far, many studies on water resources management (e.g., [48,49]) have been conducted in the world and even in Iran. Despite this fact, there is still little information about the causes of low water productivity, how to improve the yield, and the basic elements of coordinated control of agricultural water by rice farmers in the Northern provinces of Iran, in particular in Mazandaran, the center of rice cultivation in Iran [50,51]. However, there is much evidence that each country has its own unique external variables, such as opportunities and threats, as well as internal elements, such as strengths and weaknesses that improve or degrade water management. Therefore, the novelty of this study included the simultaneous study of different elements such as the Internal Factor Analysis Summary (IFAS), the External Factor Analysis Summary (EFAS), the Identification of the External Matrix, and the determination of the SWOT strategy to improve water productivity in Mazandaran Province. These elements have not been studied before. In addition, the present study identifies strengths, weaknesses, opportunities, and threats to water productivity in paddy lands. Finally, presenting strategies with high efficiency increases the stability of the decision-making process among paddy farmers, planners, and politicians. This study helps to determine the influence of different parameters on the water yield of rice fields. Therefore, it can be used as a comprehensive and practical decision-making tool to improve the performance of irrigation systems in rice fields. In this study, quantitative and qualitative factors are evaluated simultaneously and weighed scientifically. Most importantly, the results of this study provide a hierarchical analytical model to assess the status of irrigation networks in the paddy fields of Northern Iran along with the best management strategies to improve water productivity.

Findings can be helpful in strategy planning for decision makers. In addition, they can be useful for improving rice irrigation water productivity and management, increase the awareness of water management issues, and rehabilitate unsuccessful policy makers' irrigation water security schemes for the research area and related arid areas of the world. In addition, they can provide farm-level information for policy makers or the system irrigation manager. Consequently, given the significance of the integrated management of agricultural water supplies by paddy farmers in Sari County, Mazandaran Province, the purpose of this study was: (i) identifying strengths and weaknesses in water resources productivity, (ii) exploring threats and opportunities to improve water resources productivity, and (iii) presenting a range of water conservation techniques to ensure that available water is utilized efficiently and to reduce irrigation shortages among local paddy farmers in Sari County. Therefore, in step with the targets of the research, the primary study questions are as follows: (1) What is the status of paddy water resources through SWOT analysis in Sari County (located in Mazandaran Province in Northern Iran)? (2) What are the most important strategies to improve water productivity in Sari County?

2. Materials and Methods

2.1. Study Area

The research was performed in Northern Iran, in Sari County of Mazandaran Province (Figure 1). With an area of 538 km^2, Sari County is positioned in Mazandaran Province, bordering the Caspian Sea to the north. The county has a simple hilly area to the south. Due to favorable temperatures (average temperature is 15 °C) and sufficient rainfall (average rainfall is 789.2 mm), the hills of this region are filled with woods up to an altitude of around 1500 m where the sea water can touch. However, the higher altitudes sustain natural pastures [52]. Agriculture is the most important economic activity of the people living in the villages of the area, and more than half of its agricultural lands are covered with rice fields. Out of 22,508 hectares of paddy farms in Sari, 9800 hectares are irrigated with a new advanced method, and 12,708 hectares are irrigated with a conventional system, which more than half are fed by Tajan and its branches such as Zaramrud, Tajan, and Sefidrud [53] (see Figure 2).

Figure 1. Geographical location of Sari County in Mazandaran Province (Northern Iran).

Figure 2. Tajan River and its tributaries. (Irrigation source of rice farms in Sari city)

2.2. Data Collection and Sampling Method

This article used a descriptive-survey method. In terms of data collection methods, it is an analytical study and is performed through documentary and field studies. In the present research, documentary information was obtained by scanning library documents, and in field studies, Cochran formula, simple random sampling, direct observation, and interviews were applied. Finally, for data analysis, SWOT strategy and EXCEL and SPSS software were used. The studied population includes 201 rural facilitators of Sari who cultivated rice in the 2017–2018 crop years, and 105 of them were selected as the sample. The descriptive findings of this analysis indicate that between the men (n = 86) and the women (n = 19) surveyed, the average female age was 52 years, and the average male age was 68 years. As for marital status, 89.1% of the 19 female rural facilitators surveyed were married, and 92.3% of the 86 male rural facilitators surveyed were married. For the majority of women (44.6%) and men (49.2%), the highest standard of education was secondary education. The average work experience of women in facilitation work was 12 years and for men 24 years.

2.3. Survey Instrument

To address the research questions and to fulfill the goals of this study, based on the analysis of strengths, weaknesses, threats, and opportunities, a questionnaire was developed as the key testing instrument, and the data were gathered using this self-designed questionnaire. The research sample, according to Cochran formula, consisted of 105 rural facilitators. The study advisers and supervisors' views and suggestions, along with the views of researchers and experts from the Mazandaran Agricultural Jihad Organization, were used to determine the validity of the questionnaire. Once the required corrections were made, it was assured that the questions posed could be used for the calculation of the quality and characteristics of this study, and Cronbach's alpha was used to assess the reliability of the analysis (α = 0/98). After that, the SWOT analytical method was used to analyze information and present a strategic model for better water resource management.

2.4. SWOT Analysis

SWOT analysis is one of the key methods for balancing the weaknesses and strengths of the program with external threats and opportunities. This analytical model involves systematically identifying the factors that would be better aligned with the strategy. The rationale of the approach is that a successful plan optimizes the strengths and opportunities of the system and mitigates vulnerabilities and risks. Its most common use is to provide a rational framework for the systematic guidance of system discussions and strategies and ultimate selection of the appropriate strategy. To achieve appropriate strategies, a matrix of internal factors including financial resources (sources of income and investment opportunities), physical resources (facilities and equipment), human resources (e.g., farmers or target audiences), and external factors (e.g., competitors, prices, markets, and trends) is developed [54]. To explain how to identify internal and external variables, as shown by Susilo [55], the identification phase of internal factors is performed by registering all the strengths and weaknesses. The presentation of data by a factor that is positive (strength) is written before negative factors (weaknesses). The identification of external factors is performed by recording opportunities and threats. To this end, the internal variables are explained in Table 1, and the external variables are explained in Table 2. By examining internal factors, the most important factors, including the strengths and weaknesses, are listed [56]. Then, the above factors are assigned a number from zero to one, i.e., a coefficient such that the sum of the coefficients is equal to one. The most important factors listed in examining external factors are the threats and opportunities. The factors are then assigned a number between 0 and 1; that is, a coefficient such that the sum of the coefficients is equal to one. On the other hand, each one is given a score from one to four [57]. In the next step, the internal–external matrix is formed (see Table 3); in this matrix, in terms of final scores derived from the internal and external factors' evaluation matrix, the position of the subject under discussion is determined from four situations. These situations are aggressive, conservative, diverse, and defensive [56]. In the next step, the weighted sum of the internal factor matrix and the weighted sum of the outer factor matrix are extracted, and the coordinate axis is selected. In this way, the position of the strategies to be selected is determined. In the following, the SWOT matrix is formed, and strategies are developed. At this stage, four strategies are identified: (A) Strengths-Opportunity (SO), (B) Strength-Threat (ST), (C) Weakness-Opportunity (WO), and (D) Weakness-Threat (WT) (same). Then, the Quantitative Strategic Planning Matrix (QSPM) is used to investigate and refine the approaches (Figure 3 and Table 4, which are explained in the next sections). The list of strategic external elements, including all threats and opportunities, as well as strategic internal factors, including all weaknesses and strengths, is stated in the first column of the matrix. These factors are also combined with internal and external matrices. In the second column, the weighted scores for each strategy item are correctly extracted from the internal and external matrices and factors. In the following columns, the strategies are presented. Each column of each type of policy is divided into two sub-columns. An extra column, a charm score, and another extra column are the results of multiplying the charm score by the weight. In the Charm Score column, each strategic element is strategically measured and rated. To determine the point of attraction, one must answer this question. Does this factor influence the choice of strategy? If the target is not effective in choosing the strategy, the charm score is equal to one; if the target is effective in choosing the strategy, the charm score is equal to two; if the target candidate chooses the strategy to the extent acceptable, the charm score is equal to three, and if the target candidate chooses the strategy above, the charm score is equal to four [58].

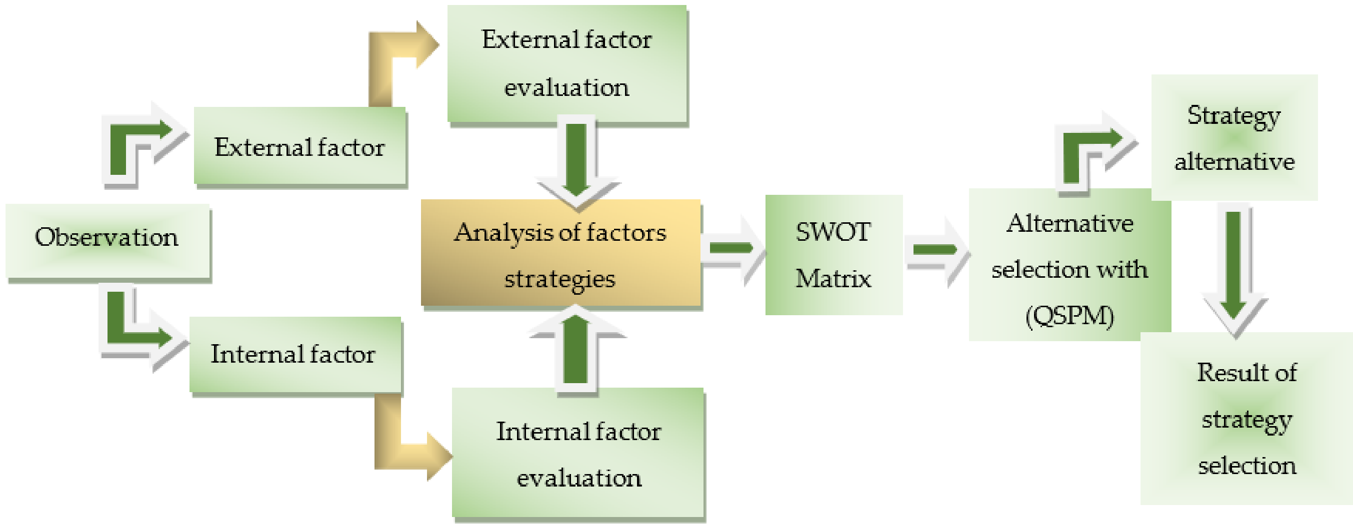

Figure 3. Conceptual framework of the study (adapted from Wati et al. [59]).

Table 1. Internal Factor Analysis Summary (IFAS) to improve water productivity.

	Row	Internal Factor	Weight	Score	Weighted Score
Strengths	1	High yield of many rice cultivars	0.039	4	0.156
	2	Fertile paddy fields and relatively good soils in most areas	0.062	4	0.248
	3	Suitable climatic conditions	0.042	4	0.168
	4	Culture and thinking of accepting new irrigation systems	0.043	4	0.172
	5	Existence of seedling production companies in the region	0.037	3	0.111
	6	Existence of suitable infrastructures to increase new irrigation and drainage networks	0.053	4	0.212
	7	Variety in agricultural activities (agriculture and horticulture, animal husbandry, and fisheries) and related products	0.037	3	0.111
	8	Significant institutional structures for agricultural facilities/crops/academic centers/research and development (R&D)	0.052	4	0.208
	9	Indigenous experience and knowledge about rice production	0.055	4	0.220

	10	Implementation of conservation tillage and sustainable agriculture programs	0.045	4	0.180
	11	Extensive network of rice cooperative centers and institutions related to rice production	0.040	4	0.160
	Sum	-	1	-	1.946
Weaknesses	1	Weakness in market management and control and regulation of water prices	0.043	1	0.043
	2	Not using new irrigation technologies (smart, etc.)	0.057	1	0.057
	3	Inefficient and inexperienced workforce in managing network operation	0.046	1	0.046
	4	Imbalance in water supply and demand	0.051	1	0.051
	5	Destruction of water canal cover in various forms	0.039	1	0.039
	6	Improper performance of water regulation and distribution structures	0.053	1	0.053
	7	Paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management, maintenance, and operation of networks	0.038	2	0.076
	8	Not using proper irrigation strategies (under-irrigation, etc.)	0.043	1	0.043
	9	Failure to observe the cultivation pattern proposed by Mazandaran Agricultural Jihad Organization	0.057	1	0.057
	10	Non-observance of water distribution law by operators (breaking locks and valves and stealing water)	0.035	2	0.070
	11	Weakness in the participation and interaction of users in water resources projects	0.038	2	0.076
	Sum		1	-	0.611

Table 2. External Factor Analysis Summary (EFAS) to improve water productivity.

	Row	External Factor	Weight	Score	Weighted Score
Opportunities	1	Existence of potential scientific and technical experts	0.035	3	0.105
	2	Improving irrigation planning	0.048	4	0.192
	3	Implementation of new irrigation methods	0.041	4	0.164
	4	Possibility of promoting drought-resistant species with high water productivity	0.042	4	0.168
	5	Wastewater treatment and reuse	0.043	4	0.172
	6	Strengthening network utilization companies to improve water productivity	0.046	4	0.184
	7	Possibility of improving crop rotation with an approach appropriate to the climate of the region	0.024	3	0.072
	8	Possibility of improving and automating irrigation networks	0.046	4	0.184
	9	Creating the ground for public participation in improving the state of the network	0.039	3	0.117
	10	Access to the Caspian Sea and the possibility of using seawater desalination, etc.	0.045	4	0.180
	sum	-	1	-	1.538
Threats	1	Lack of proper conditions in different parts of the province for maximum use of available water resources	0.049	1	0.049

2	Failure to allocate sufficient funds at the right time to build and complete water sector projects (which would lead to inconsistencies in the completion of irrigation networks and downstream dams and the lack of proper operation of the dam and other water facilities)	0.039	2	0.078
3	Existence of many operators of unauthorized wells in the province	0.042	1	0.042
4	Tensions due to intensified competition between water applicants	0.043	1	0.043
5	Decreased quality of water and soil resources (groundwater and soil salinity)	0.045	1	0.045
6	Not paying attention to water management and relative equilibrium in the field of water supply and use	0.046	1	0.046
7	Lack of government support to equip farms with new systems	0.048	1	0.048
8	The high price of equipment for new irrigation systems	0.051	1	0.051
9	Lack of alignment in institutions and organizations in charge of water and agriculture	0.051	1	0.051
10	Surplus harvest from Tajan River and drop in water level	0.041	2	0.082
sum		1	-	0.535

3. Result

3.1. SWOT Factor Analysis

In this segment, we can recognize external factors (threats and opportunities) and internal factors (weaknesses and strengths). Opportunities refer to favorable external factors that could give a competitive advantage whereas any unfavorable condition in the environment that might jeopardize the strategy's plans is considered as a threat. A danger might be a physical barrier, a limitation, or anything external that could create problems, damage, or injury [60]. Strengths refer to core competencies that give the environment an advantage in meeting the needs of its target. Weaknesses refer to any limitations an environment faces in developing or implementing a strategy [61]. According to these definitions, Table 1 refers to the internal factors and conditions (e.g., at the farm level and at the internal levels of related organizations) that can be effective in improving water resource efficiency and better management. In addition, Table 2 refers to the external factors and conditions at the farm and related organizations. In Table 1, the internal factor matrix is described based on the strengths and weaknesses of water resource management. In this matrix, weaknesses and strengths, weight, score, and weighted score (the product of the multiplication of columns four and five) are specified.

External factor matrix was explained based on the opportunities and threats of water resource management. In this matrix, opportunities and threats, weight, score, and weighted score (the product of the multiplication of columns four and five) are specified.

The results show that in Sari County, 11 internal strengths against 11 internal weaknesses and 10 external opportunities against 10 external barriers were identified. In this way, a total of 22 strengths and opportunities were identified as advantages, and 20 weaknesses and barriers were identified as limitations and bottlenecks to improve water productivity and deal with the drought crisis in Sari County.

The obtained results in internal factors analysis (Table 1) show that the most important strengths to improve water productivity and manage paddy farms in the study area are fertile paddy fields and relatively good soils in most areas, indigenous experience, and knowledge about rice production, and existence of suitable infrastructures to build new irrigation and drainage networks. According to the results of Table 1, the most important weaknesses resulting from the analysis of internal factors include weakness in the participation and the interaction of users in water resources projects; paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management, maintenance, and operation of networks; non-observance of water distribution law by operators (breaking locks and valves and stealing water); failure to observe the cultivation pattern proposed by Mazandaran Agricultural Jihad Organization; and using no new irrigation technologies (smart, etc.).

The opportunities presented in fact reflect the desirability level of local and regional conditions. Therefore, the analysis of external factors, as shown in Table 2, indicates that the most important opportunities are improving irrigation planning, strengthening network utilization companies to improve water productivity, improving and automating irrigation networks, and accessing the Caspian Sea and the possibility of using seawater desalination, etc.

Threats refer to environmental challenges arising from social, economic, political, and environmental conditions. Therefore, identifying and prioritizing them can prevent vulnerability. Accordingly, and based on the results of the external factors analysis, the most important threats contain surplus harvest from Tajan River and drop in water level, failure to allocate sufficient funds at the right time to build and complete water sector projects (which would lead to inconsistencies in the completion of irrigation networks and downstream dams and the lack of proper operation of the dam and other water facilities), high price of equipment for new irrigation systems, and lack of alignment in institutions and organizations in charge of water and agriculture.

The analysis of the data (Table 3) reflects the fact that the score obtained from the assessment of internal factors (strengths and weaknesses) is 2.55. Therefore, given that the sum of the strength factors is 1.946 and the total score of weaknesses is 0.611, superiority includes strengths. Thus, the ability to plan based on strengths and weaknesses is provided. The results of the evaluation of the external factors matrix (opportunities and threats) indicate that the weighted score obtained is 2.073. Therefore, given that the final weighted scores of the opportunity and threat factors are 1.538 and 0.535, respectively, it should be concluded that in the context of the subject, opportunities overcome threats. In general, reaching this situation requires its own strategies that can minimize weaknesses and deal with threats. In other words, taking into account the internal (strengths and weaknesses) and external (opportunities and threats) considerations shows that the attack policy (maximum) is considered the most important strategy in the management of water resources. It should be concluded that the opportunities can overcome the threats. In general, exploiting this situation requires its own strategies that can minimize the weaknesses and deal with the threats (Figure 4).

Table 3. Internal–external matrix to improve water productivity.

Internal Factors		**External Factors**	
Strengths	Weaknesses	Opportunities	Threats
1.946	0.611	1.538	0.535
Combined Factors			
SO	WT	ST	WO
3.484	1.146	2.149	2.556
Aggressive strategy	Defensive strategy	Contingency strategy	Adaptive strategy

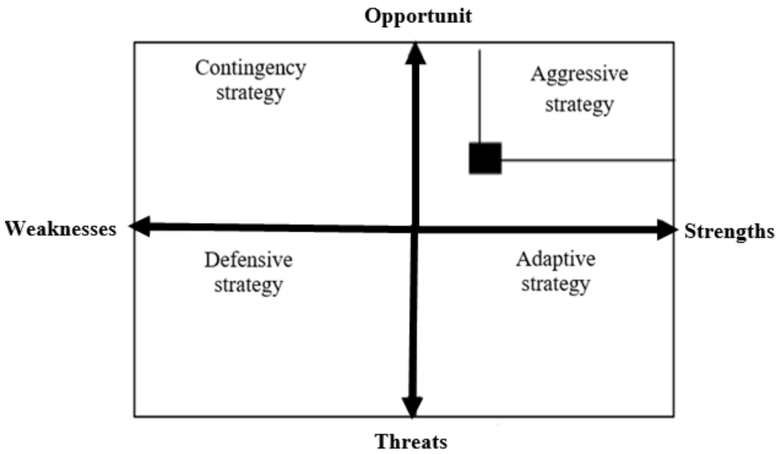

Figure 4. Strategy planning in the SPACE matrix based on SWOT.

Then, the SWOT matrix is developed based on the results obtained from the SWOT analysis (the results of external factor analysis matrix (EFE) and internal factor analysis matrix (IFE)). In fact, this matrix shows possible strategies by comparing the pair of internal and external factors with each other. This matrix is shown in Table 4. The first column shows the internal factors, including strengths (aggressive strategy) and weaknesses (defensive strategy), and the second column shows opportunities (contingency strategy) and threats (adaptive strategy). All strategies contain the SO, ST, WO, and WT strategies and are elaborated in Table 4.

Table 4. QSPM results analysis for SWOT strategy to improve water productivity.

	Strengths	**Weaknesses**
	S1: High yield of many rice cultivars	W1: Weakness in market management and control and regulation of water prices
	S2: Fertile paddy fields and relatively good soils in most areas	W2: Not using new irrigation technologies (smart, etc.)
	S3: Suitable climatic conditions	W3: Inefficient and inexperienced workforce in managing network operation
	S4: Culture and thinking of accepting new irrigation systems	W4: Imbalance in water supply and demand
	S5: Existence of seedling production companies in the region	W5: Destruction of water canal cover in various forms
	S6: Existence of suitable infrastructures to increase new irrigation and drainage networks	W6: Improper performance of water regulation and distribution structures
	S7: Variety in agricultural activities (agriculture and horticulture, animal husbandry, and fisheries) and related products	W7: Paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management, maintenance, and operation of networks
	S8: Significant institutional structures for agricultural facilities/crops/academic centers/research and development (R&D)	W8: Not using proper irrigation strategies (under-irrigation, etc.)
	S9: Indigenous experience and knowledge about rice production	W9: Failure to observe the cultivation pattern proposed by Agricultural Jihad Organization
	S10: Implementation of conservation tillage and sustainable agriculture programs	W10: Non-observance of water distribution law by operators (breaking locks and valves and stealing water)
	S11: Extensive network of rice cooperative centers and institutions related to rice production	W11: Weakness in the participation and interaction of users in water resources projects
Opportunities	**SO Strategies**	**WO Strategies**
O1: Existence of potential scientific and technical experts	1-Development of suitable infrastructures to increase new irrigation and drainage networks with increasing the use of water-efficient technologies	1-Analysis on water-saving agricultural practices
O2: Improving irrigation planning	2-Promoting drought-resistant species with high water productivity	2-Appointing water authorities with high levels of technical and professional expertise
O3: Implementation of new irrigation methods	3-Developing the Caspian Sea water desalination and wastewater treatment for reuse in rice fields and reaching an agreement on cross-border aquifer sharing	3-Providing particular formal training opportunities on water resource efficiency
O4: Possibility of promoting drought-resistant species with high water productivity	4-Combining indigenous experience and knowledge with new science and technology to increase water efficiency	4-Water supply sector human resource development planning
O5: Wastewater treatment and reuse	5-Formation of regional agricultural cooperation and water management organizations	5-Technical and professional training for professionals and agents of change
O6: Strengthening network utilization companies to improve water productivity		6-Improved climate forecasts and access to reliable data on water resources

O7: Possibility of improving crop rotation with an approach appropriate to the climate of the region		
O8: Possibility of improving and automating irrigation networks		
O9: Creating the ground for public participation in improving the state of the network		
O10: Access to the Caspian Sea and the possibility of using seawater (sweetening and so on)		
Threats	**ST Strategies**	**WT Strategies**
T1: Lack of proper conditions in different parts of the province for maximum use of available water resources	1-Promoting participatory water management and preventing populist developments	1-Measuring the amount of water used in agriculture and industry
T2: Failure to allocate sufficient funds at the right time to build and complete water sector projects (which would lead to inconsistencies in the completion of irrigation networks and downstream dams and the lack of proper operation of the dam and other water facilities)	2-Developing integrated plans to improve the water use efficiency	2-Reducing the cultivation of water-intensive plants and increasing rural entrepreneurship
T3: Existence of many operators of unauthorized wells in the province	3-Perceptions and attitudes of managers facing risks of water resource development plan	3-Fixed inappropriate cultivation patterns related to the availability of resources in the area
T4: Tensions due to intensified competition between water applicants	4-Adjusting water control limitations, from provincial limitations to watershed limitations, and remedy conflicts among stakeholders inside watershed limitations	4-Clarifying the present-day scenario and destiny demanding situations of the water and agriculture sector
T5: Decreased quality of water and soil resources (groundwater and soil salinity)		5-Using the media to disseminate information and educate the public about sustainable water management
T6: Not paying attention to water management and relative equilibrium in the field of water supply and use		6-Developing relationships with related organizations such as the Water Organization, the Environment Organization, and the Regional Water Organization to educate the use of water
T7: Lack of government support to equip farms with new systems		7-Enriching social capital
T8: The high price of equipment for new irrigation systems		
T9: Lack of alignment in institutions and organizations in charge of water and agriculture		
T10: Surplus harvest from Tajan River and drop in water level		

3.2. SWOT-QSPM Analysis

According to Tables 1 and 2, 11 internal strengths against 11 internal weaknesses and 10 external opportunities against 10 threats have been identified and investigated. In total, 22 strengths and opportunities were identified as advantages, and 20 weaknesses and threats were identified as limitations and bottlenecks to improve productivity in water resources management in Sarai County. According to Table 1, the most important strength to improve water productivity and manage paddy farms in the study area is fertile paddy fields and relatively good soils in most areas. Moreover, the most important weaknesses include weakness in the participation and interaction of users in water resources projects and paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management. According to Table 2, from the perspective of the promotional aids, the most important opportunity is improving irrigation planning, and surplus harvest from Tajan River and drop in water level are major threats facing the Sari County in the face of drought.

According to the sum of the internal factor matrix, it is concluded that in the study area, the strengths are more than weaknesses. In addition, considering the final sum of external factor matrix scores, the opportunities for water resources management are more than the threats. Following the analysis of internal and external variables and the preliminary development of the strategy, taking into account the previous directions, considering the type of reaction and the interaction of each internal and external factor, we can draw the SPACE matrix, which has four different strategies, including aggressive, competitive, defensive, and protective strategies (Figure 4). Based on the obtained values and according to the matrix, four types of strategies are suggested, and a desirable strategy for managing SO-type or aggressive strategy is proposed. Then, using a SWOT matrix of internal factors (strengths and weaknesses) and external factors (possibilities and threats), five techniques are diagnosed as follows:

SO1-Developing suitable infrastructures to increase new irrigation and drainage networks with increasing the use of water-efficient technologies

SO2-Promoting drought-resistant species with high water productivity

SO3-Developing wastewater treatment and the desalination of water from the Caspian Sea for reuse in rice fields and signing an agreement on sharing transboundary aquifers

SO4-Combining indigenous experience and knowledge with new science and technology to increase water efficiency

SO5-Forming regional organizations for agricultural cooperation and water management

Finally, by determining the relative importance of key strategies based on the QSPM matrix, more important strategies are derived from the determinants of the factors' impact. Based on the total attraction, the strategies at the end of the QSPM matrix column were arranged according to the relative charm (Table 5). The results of the quantitative planning matrix showed that among the strategies developed, the second strategy (promoting drought-resistant species with high water productivity) has the highest importance with a score of 10.935. The following techniques are in the next ranks: the third strategy (developing wastewater treatment and the desalination of Caspian Sea water for reuse in paddy lands and reaching an agreement on sharing transboundary aquifers) with a score of 10.524, the first strategy (developing suitable infrastructures to increase new irrigation and drainage networks with increasing the use of water-efficient technologies) with a score of 10.394, the fourth strategy (combining indigenous experience and knowledge with new sciences and technologies to increase the efficiency of water resources) with a rating of 7.201, and the 5th strategy (forming nearby cooperative agricultural and water control institutions) with a score of 7.59. Therefore, according to this research, the most important strategy was promoting drought-resistant species with high water productivity.

Table 5. Strategic planning matrix for prioritizing water resources management strategies (strengths and weaknesses).

Factors	Wi	So1		So2		So3		So4		So5	
		AS	WiAS	AS	WiAS	AS	WiAS	AS	WiAS	AS	WiAS
S1	0.156	3	0.468	4	0.624	4	0.624	3	0.468	1	0.156
S2	0.248	4	0.992	2	0.496	2	0.496	1	0.248	1	0.248
S3	0.168	2	0.336	2	0.336	2	0.336	1	0.168	1	0.168
S4	0.172	2	0.344	2	0.172	3	0.516	1	0.172	1	0.172
S5	0.111	3	0.333	3	0.333	4	0.444	3	0.333	1	0.111
S6	0.212	1	0.212	4	0.848	3	0.636	2	0.424	1	0.212
S7	0.111	2	0.222	2	0.222	2	0.222	4	0.444	1	0.111
S8	0.220	4	0.880	4	0.880	4	0.880	2	0.440	1	0.220
S9	0.180	1	0.180	4	0.720	4	0.720	2	0.360	4	0.720
S10	0.160	4	0.640	2	0.320	3	0.480	2	0.320	1	0.160
W1	0.043	4	0.172	1	0.043	2	0.083	1	0.043	1	0.043
W2	0.057	4	0.228	4	0.228	4	0.228	1	0.057	2	0.114
W3	0.046	2	0.092	3	0.138	1	0.046	3	0.138	1	0.046
W4	0.051	3	0.102	3	0.102	1	0.051	3	0.102	2	0.102
W5	0.053	4	0.212	3	0.159	1	0.053	3	0.159	1	0.053
W6	0.076	1	0.760	4	0.304	2	0.152	2	0.152	4	0.304
W7	0.043	3	0.129	4	0.172	4	0.172	3	0.129	1	0.043
W8	0.057	2	0.114	4	0.228	3	0.171	1	0.057	1	0.057
W9	0.070	1	0.070	2	0.140	3	0.210	2	0.140	4	0.280
W10	0.076	1	0.076	1	0.076	1	0.076	1	0.076	1	0.076
O1	0.105	3	0.315	3	0.105	1	0.105	1	0.105	1	0.105
O2	0.192	1	0.192	4	0.768	2	0.384	1	0.192	1	0.192
O3	0.164	1	0.164	2	0.328	1	0.164	1	0.164	1	0.164
O4	0.172	1	0.172	1	0.172	1	0.172	2	0.344	3	0.516
O5	0.184	4	0.736	1	0.184	2	0.368	2	0.368	1	0.184
O6	0.075	2	0.150	2	0.150	1	0.075	4	0.300	1	0.075
O7	0.184	1	0.184	3	0.552	3	0.552	1	0.184	4	0.736
O8	0.117	4	0.468	2	0.234	4	0.468	1	0.117	1	0.117
O9	0.180	1	0.180	2	0.360	4	0.720	2	0.360	2	0.360
T1	0.049	4	0.196	3	0.147	3	0.147	1	0.049	1	0.049
T2	0.078	4	0.312	2	0.156	1	0.078	1	0.078	1	0.078
T3	0.042	1	0.042	2	0.084	1	0.042	1	0.042	1	0.042
T4	0.043	1	0.043	2	0.086	2	0.086	1	0.043	1	0.043
T5	0.045	1	0.045	2	0.090	1	0.045	1	0.045	1	0.045
T6	0.046	3	0.138	4	0.184	2	0.092	1	0.046	1	0.046
T7	0.048	2	0.096	4	0.192	3	0.144	1	0.048	1	0.048
T8	0.051	2	0.120	4	0.204	2	0.102	1	0.051	1	0.051
T9	0.051	1	0.051	4	0.204	2	0.102	3	0.153	2	0.102
T10	0.082	3	0.246	2	0.164	1	0.082	1	0.082	1	0.082
	Total		**10.394**		**10.935**		**10.524**		**7.201**		**7.095**

4. Discussion

For the development of agricultural goods and services, water is the most important resource. However, in arid and semi-arid countries such as Iran, high levels of water stress, increased frequency, and intensity of droughts, all of which primarily driven by climate change dynamics, have decreased the stock of freshwater resources. Therefore, this study attempted to evaluate the productivity of paddy water resources in the North of Iran based on Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis.

According to the purpose of this study, the strengths are more than the weaknesses, and opportunities are more than threats. Based on the results of this study, five strategies were presented as the most important strategies for water resources management. These strategies are as follows: (1) developing suitable infrastructures to increase new irrigation and drainage networks with increasing the use of water efficient technologies; (2) promoting drought-resistant species with high water productivity; (3) developing wastewater treatment and the desalination of water from the Caspian Sea for reuse in rice fields and concluding an agreement on sharing transboundary aquifers; (4) combining indigenous experience and knowledge with new sciences and technologies to increase the efficiency of water resources; and (5) forming regional agricultural cooperation and water management organizations. The strategy of developing the suitable infrastructures to increase new irrigation and drainage networks with the increasing use of water efficient technologies was considered as the most important strategy. These results are consistent with the results of other studies such as those by Agarwal et al. [62], and Perry and Steduto [63]. Petousi et al. [6], in their study on SWOT analysis as a decision-making tool to evaluate each action, found that "the development of irrigation networks by increasing the exploitation of saline springs" and "sewage treatment and small dams with the help of new technologies" are identified as two key strategies for optimal water management. Agarwal et al. [62] presented the potential of groundwater using the Analytical Hierarchy Process (AHP) in their study. Their results showed that system dynamics and groundwater resources management need quantitative evaluation based on scientific principles, modern techniques, and timely and efficient training. As Perry and Steduto [63] showed, increasing irrigation efficiency through the application of modern technologies, such as drip irrigation, leads to significant water savings, releasing the saved water into the environment. These findings suggest that measures such as limiting water allocation are necessary to ensure sustainable levels of water use. Ali and Talukder [64] in their study identified that effective management of water for crop production in water scarce areas requires efficient approaches. Increasing water yield and drought tolerance via genetic development and physiological law can be the manner to reap performance and green use of water. Diamantopoulou et al. [65] said that the most important strategies for water resource management were the use of refined wastewater for irrigation and the availability of dams and surface water during the wet period. Pahlavani et al. [66] developed a strategy using the SWOT analysis methodology, and WO was the conservative top strategy. Finally, using five different strategies, QSPM matrix was presented, and the strategy of developing the suitable infrastructures to increase new irrigation and drainage networks with the increasing use of water efficient technologies with the highest score of attractiveness was considered as the best strategy for sustainable water resources development.

As shown in Table 1, the most important strengths to improve water productivity and manage paddy farms in the study area are fertile paddy fields and relatively good soils in most areas. Shafieyan et al. [67], in a study entitled "Identification of Strategies for SD of Rice Production in Guilan Province Using SWOT Analysis", showed that one of the strengths in the paddy lands of Guilan province is the existence of relatively good soils rich in organic matter. Iran has used most of its groundwater reservoirs and is presently one of the world's biggest customers of groundwater [44]. In addition, the increase in nutrients and salinity threatens the quality of surface water and groundwater resources in the study area. Low-quality irrigation water (for example because of the presence of large amounts of salt in lands near the coast), along with low rainfall and high evaporation, greatly affects the quality of the soil and the sustainability of agricultural production. Because Iran's rural economy is dependent on agriculture and agricultural industries, water and soil degradation pose major challenges for farm families and severely reduce their incomes. Therefore, the simultaneous management of water and soil in order to rehabilitate paddy lands in Northern Iran is necessary as the soils are relatively fertile in most areas. According to the results, the most important weaknesses include weakness in the participation and interaction of users in water resources projects and paying attention only to the physical development of irrigation networks and ignoring the issues of network operation and farmers' participation in the management. The majority of government assistance mechanisms fail to provide farmers with adequate knowledge and information, as well as enabling them to participate in water management initiatives. This is why adaptive co-management of water resources, i.e., cooperation of various stakeholders and institutions, is required to cope with the increasing water crisis in Iran. However, water crisis management requires cooperative governance models that fit the local conditions, as shown by Iliopoulos et al. [68]. Agriculture production can be increased by facilitating farmers' participation in water management projects and giving chances to them to engage with other stakeholders and higher authorities. These results are in line with the findings of Tantoh and Simatele [69] and Volenzo and Odiyo [70] and are confirmed by them.

As shown in Table 2, the most important opportunity is to improve the irrigation planning. Since the Islamic Revolution in Iran, the rural zone has received a range of government assistance to ensure food supplies, increase non-oil output profits, and reduce poverty in rural regions. Agriculture's contribution to overall growth, however, has decreased from nearly 33% to 13% [71]. Due to groundwater depletion, soil deterioration, and drought, further agricultural development is difficult, even as the agriculture sector faces increased pressure to be a successful engine for rural economic growth in Mazandaran Province. Moreover, climate change is projected to increase pressure on water resources and reduce agricultural production [72]. Despite the fact that climate change crises cannot be avoided, there is still a lot of room for planning and managing the tradeoffs of agricultural intensification by considering more sustainable production systems, such as multifunctional agriculture and reinforcing non-farm economies to ensure food security and poverty eradication [73]. Finally, the results indicated that the most important threat is surplus harvest from Tajan River and the drop in water level. Tajan River is one of the places for harvesting river materials such as sand in Sari County. Improper harvesting and excess of the capacity of river materials and sand washing workshops have had adverse effects on the bed, structural safety, water facilities located on the river and its shores, and most importantly the agricultural sector of this region. In this regard, according to calculations, the average allowable withdrawal from Tajan River (calculations were performed over a period of 26 years) is 4452 m^3 per year [74]. Therefore, over-harvesting from the river has led to a drop in water levels in the upstream and downstream lands, causing erosion and dropping in the riverbed to an undesirable extent.

5. Conclusions

Water productivity could be very low in Iran's agricultural zone, and the effectiveness of many water control packages is far from satisfactory. This study has a look at the offered techniques to pick out various internal and external elements that have an effect on the planning, layout, and implementation of water control applications and presents a hard and fast of technique to cope with them. In this study, the current state of irrigation water management in Sari was defined using a combination of SWOT and QSPM analyses. The SWOT analysis revealed 42 vital variables that improved or depreciated the control of water irrigation. A detailed review of these factors revealed that water control for irrigation would concentrate mainly on removing significant weaknesses and reducing risks. Decisionmakers conduct different initiatives in order to resolve the key vulnerabilities and risks found in the report, according to those findings. In addition, SWOT factors can be categorized into politics and cultural, social, technical, legal, and environmental matters to consider all aspects of excessive irrigation water use in Iran. Findings have shown that the problems posed in the management of irrigation water are diverse and multifaceted. Legislative, economical, technological, and political problems have also been identified as the main factors in managing irrigation water loss, and this indicates that the government has failed to avoid significant irrigation problems. The SWOT model seems to be a very successful solution to water resources management that offers a broader, more comprehensive view of the existing water policy conditions.

As a result, the government is expected to revisit current approaches to climate change adaptation and address water problems in the agricultural sector. In this regard, the most important problem refers to the determination of the appropriate solutions to ensure the safe management of irrigation. This result means that the government should resist authoritarian and short-sighted decisions and concentrate on practical approaches with more visible impacts on the effective use of irrigation water. These results also help to better understand the motivations of rice farmers to use agricultural capital efficiently. In addition, the results enable policymakers to concentrate on policies aimed at improving irrigation water capacity and encouraging more effective use of water in rice production in the area and in other arid regions of the world. Additionally, the hierarchical approaches identified in this study can be used as a roadmap to improve irrigation water productivity under water scarcity conditions. Finally, a major political concern in arid regions can be seen as the effective management of water supplies. There is a growing awareness of the community-based organizations' role in managing water resources, with a deeper understanding of the combined social and ecological processes. However, there is an emphasis on providing a situation or space for farmers and local authorities to gather together (such as a farmer's house). This situation should be able to create a social network between farmers and local authorities to discuss and decide on better options for water resources management and adaptation to livelihoods (based on the local conditions required). This ensures a consistent and efficient flow of information and, at the same time, reinforce intervention steps and increase the likelihood of achieving water quality. Farmers must receive the requisite training in the proper management and consumption of water supplies and must become acquainted with modern irrigation technology and methods. In addition, the consequences of releasing waste and environmental pollutants, as well as the optimal the use of pesticides and chemical fertilizers to reduce resource, pollution should be considered. While these measures can be maintained, implementing appropriate opportunities based on farm configuration and physical characteristics significantly increases the rate of technology adoption, resulting in significant reductions in emissions. A comprehensive water supply management policy, therefore, remains a priority to obtain support from agricultural authorities, to restore farmers' water-use alliances, and to support the creation of a community-based water management program. To maximize the total performance, an irrigation system that targets water quality must be built and promoted. In general, significant public sector investment in controlling water harvesting and salinity, as well as promoting the optimal use of the existing water supplies, would result in efficient water use in agricultural production. The current policy of expanding agricultural credit is a welcome move, particularly for smallholder farmers who lack access to this vital input. The on-farm water management infrastructure needs to be improved with the aid of water management research centers to plan and execute a broad variety of projects to enhance and conserve the country's limited water supplies in order to help improve productivity and sustainability. In the end, the value of water resources in achieving food security and sustainable livelihoods is undeniable. Therefore, it is suggested that future studies focus on the role of water resources investment in achieving food security and sustainable livelihoods. It is suggested to examine the functions, policies, challenges, and opportunities of different agricultural sectors from the perspective of natural resources and water management together with using the SWOT analysis. It is also recommended that future research examine the economic, social, physical, and political implications of improving water productivity and gender analysis in water resources management.

Author Contributions: I.G.: conceptualization, methodology, software, writing—original draft, and visualization. H.A.: supervision, conceptualization, reviewing and editing, and validation. M.N.:

reviewing and editing. M.B.B.: reviewing and editing. A-H.V.: reviewing and editing. I.A.: reviewing and editing; A.I.Ö.: reviewing and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This study received no findings from any organizations.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: We have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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