Int. J. Nonlinear Anal. Appl. 15 (2024) 3, 315–327
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2023.29243.4096

Dynamic modeling for improving investment in the agricultural sector of the country

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(Communicated by Gholamreza Askari)

Abstract

Investment in the agricultural sector has a crucial role in the economic growth of the country. The variability of investment expenses on the one hand, and the extent and potential capacities of the agricultural sector on the other hand, increases the necessity of investigating the factors affecting the improvement of investment in this sector. Developing a dynamic model is an appropriate approach for analyzing complex feedback systems to improve investment in the agricultural sector of the country. In the present study, library research and interviews with experts were used to identify the factors affecting the improvement of investment in the agricultural sector in the country to develop a dynamic model. The participants of the present study include 20 experts in the natural resources management organization of the country and several university expert professors in the field of agriculture finance were interviewed. Based on the opinion of experts the key variables were identified and cause-and-effect and mathematical relationships between these variables were evaluated in the form of two diagrams of cause and effect and the flow state diagram in the dynamics system approach during the years 2011 to 2025 were simulated in the Vensim software. Then different scenarios were examined aimed to increase and improve the investment in the agricultural sector of the country. The findings show that by implementing policies to improve investment in the agricultural sector through increasing exports and implementing land protection laws and regulations, investment in the agricultural sector of the country can be improved.

Keywords: Investment, Agriculture, Dynamic model
2020 MSC: 91B54

1 Introduction

Due to the broad backward and forward linkages of agriculture with other sectors of the economy, investing in the agricultural sector as the main sector of producing food and raw materials for many industrial products is very vital. Since in this sector, both general and market products are produced, food security and rural development depend

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Received: October 2022 *Accepted:* January 2023

on its dynamism, so it is of great importance in all countries. Therefore, governments support this sector as it has multi-functional features. Despite the importance of this sector, based on the global statistics it can be observed that there is a lack of investment as one of the main factors of production. The lack of capital causes a decrease in the productivity of this sector and, as well as the loss of competitiveness of agricultural producers against the other sectors [1].

Although Iran has a suitable situation in providing food security, experts consider the lack of enough capital as one of the most important challenges in this sector. Evaluation of the investment issue in the agricultural sector consists of two parts. The first part includes the investigation of the agricultural sector completely independent from other sectors of Iran's economy and the analysis of investment and the factors affecting it in this sector, regardless of the influence and affectability of this sector on other sectors. The second part includes attention to the agricultural sector as a part of Iran's economy and the analysis of investment issues regarding its relations with other sectors. Since the first part is too far from reality, the second one is more appropriate [2]. Investing in the agricultural sector in Iran's economy can be considered as a strategic sector because of its potential in creating job opportunities for the country's growing workforce, provide food for the growing population, and also producing raw materials and inputs needed by industries. Considering the environmental conditions such as the existence of high-quality agricultural land in Iran, high annual production capacity, privileged position and environmental capability, proximity to the sea and other valuable ecosystems, the diversity of climatic and ecological conditions, rich sources of surface water and vegetation, rich surface sources of water and vegetation, having a favorable climate for planting, growing and harvesting a variety of agricultural products in a crop year are of the most valuable potential and actual capacities for investment in this sector, which has turned it into a suitable platform for investment [13].

2 Problem statement

Investment is one of the key factors and fundamental steps to start any economic and social activities. Expressing the investment process in a reasonable manner requires analyzing the basic nature of decisions. In this case, the activities related to the process of decision-making are analyzed and the important factors in the investment activity environment that affect their decision-making are examined. Making decisions in the investment process is a combination of science and art to achieve success. In the investment issue, we have to imagine what will happen, we are aware of the past events, but we cannot say that history repeating itself. The future is uncertain, but the future uncertainty can be managed [4]. Investors can make better decisions with the help of existing techniques and tools. As one of the most important parts of production, capital is very vital in improving the production level of economic activities and increasing the productivity of other production factors. In the agricultural sector, capital and investment are considered the key factors of growth and development [8]. Since we cannot ignore the role and importance of the agricultural sector in the economy and the development of this sector, it is very important to identify the obstacles and challenges of development and investment in this sector. Surveys indicate that the most important problems in this sector consist of the lack of financial resources, infrastructural problems, and the lack of private-sector investment in this sector. The process of attracting foreign direct investment (FDI) in Iran, compared to other countries, reveals the inefficiency of the current infrastructure in FDI. According to the macroeconomic indicators related to foreign investment, there is not a good situation for Iran's position. Based on the ease of doing business score of the World Bank Iran is ranked as 118th out of 189 countries, 150th out of 159 world economies in terms of economic freedom, and 150th out of 189 countries in terms of protecting minority shareholders rights. According to this data, Iran's economy is considered to be a closed economy with ineffective plans.

Compared to other countries, the gross domestic product (GDP) in Iran is 6.6% in the agricultural sector. The share of this sector is 17.4% in employment and 5.9% in non-oil exports. On the other hand, nearly 80% of the food in the country is currently supplied by the agricultural sector. At present, about 18 million hectares of the country's lands, including irrigated and rainfed areas, are exploited in the production cycle. 84.8 million hectares of pastures are under the supervision of the Ministry of Agriculture Jihad. Besides, nearly 80 billion cubic meters of the water resource capacity of the country is used in the agricultural sector. Iran has 14.3 million hectares of forests and rich genetic resources that are of strategic importance to the country. Besides, nearly 4.2 million people are active in this sector. However, despite these massive natural and human resources, Iran's country has not been able to reach its ideal position in the region and the world. Based on the data published by the Central Bank of the Islamic Republic of Iran, the amount of investment in the agricultural sector in 2011 was more than 87 thousand billion Rials which reached 35 thousand billion Rials in 2020. These findings reveal an average annual growth of -10.8% [2]. In the present study, a dynamic model is provided to improve investment in the agricultural sector of the country. Dynamic models are used to analyze complex socio-economic systems [7]. In fact, the dynamic model helps us to have a better and more accurate understanding of behavior and structure of the system [25].

3 Review of literature

Investment as the economic growth engine is necessary to achieve economic and social development. The increment in investment leads to an increase in production, an increment of value-added, an increment of welfare, employment increment, a decrease in the unemployment rate, and decrement in poverty. Capital and investment are two special and fundamental factors in the process of economic development [13]. Investing in the agricultural sector using quantitative and qualitative factors such as water, soil, climate, human power, energy, and initial capital stock leads to the growth of production and employment in this sector [10]. The investment trend in the agricultural sector has fluctuated a lot. The amount of investment has been an increasing trend since 1967, but in 1969 had a slight decrease, and then continued its increasing trend until 1976. Following the victory of the Islamic revolution and the changes in the agricultural sector, private investment decreased due to the lack of certainty about the future and the capital flight, so that it reached its lowest level in 1979. In 1980, with the decrement of government investment in the agricultural sector, the loans granted by specialized banks such as the Agricultural Bank grew significantly. Besides, in that year, due to the decrement in foreign exchange earnings of the government and consequently the decrement in oil exports, the import of agricultural raw materials was given priority over industry and services. Consequently, the supply of agricultural inputs and finally the investment of the private sector increased in this sector. In 1982, due to the sharp increase in inflation and the decrease in the price ratio of agricultural products to non-agricultural products, and consequently the decrement in savings and investment in the economy sector, the private sector investment decreased.

During the years 1984 and 1988, investment in the private sector faced many fluctuations, the main reason for which can be attributed to the increment of inflation, the decrement of oil revenues, and the decrement of the total value added in the agricultural sector. Simultaneously with the first development plan during the years 1989 and 1993, with the improvement of the banking system in the agricultural sector, and the elimination of the stabilization policy of prices of agricultural products, the investment of the private sector faced an upward trend. In the second development plan during the years 1974 and 1999, the investment of the private sector faced an increasing trend because of the increment of bank loans [1]. The third development plan during the years 2000 and 2004, it was tried to recognize the basic challenges of the agricultural sector as well as provide the requirements for realization of the sustainable development. As a result, the highest rate of investment growth happened in the third development plan.

In the third development plan, it was approved that 25% of the facilities granted by all the country's banks should be allocated to the water and agricultural sector in coordination with the relevant executive power. In the 4th development plan during the years 2005 and 2009, exactly like the third development plan, 25% facilities were available. Besides, the development of the agricultural sector and natural resources by focusing on self-sufficiency in the production of fundamental products and the expansion of support for the complementary transformation industries in this sector took place in such a way that the waste was decreased by 50%. The increment of the number of insured products to 94 as well as the increment of the insured area to 5396 thousand hectares a decrease in the distribution of chemical poisons by 29.7% was implemented in this plan. In the fifth development plan during the years 2011 and 2015, the attention to the development of investment in the agricultural sector was the highest with a rate of 28%. Besides, the total production of agricultural products increased from 102 million tons in 2007 to 143 million tons in 2014. In the sixth development plan during the years 2017 and 2021, the increment of increasing the investment share in the agricultural sector, and improving the total support to agriculture are being implemented [3]. Investment in the agricultural sector has a significant role in economic development and prosperity and includes many variables. Therefore, identifying the influencing variables on investment in the agricultural sector is very important for improving the investment process in this sector and improving economic growth.

The dynamics of a system is an approach to understanding the nonlinear behavior of complex systems over time using feedback loops. This method was introduced in 1961 by Jay Wright Forrester in his book in the title "Industrial Dynamics" and then spread rapidly. The dynamics of a system are implemented based on a cause-effect diagram and flow State diagram. All variables and their one-way and two-way relationships are designed based on the cause-effect diagram. Besides, the final variables are connected to the initial variables using a feedback loop that creates a diagram that is only theoretical and visual. In order to model the correct dynamics of relationships, several other variables should also be defined called surface and flow variables. Finally, the association of the system with the environment is also explained using the variables of spring (water source) and well [8]. This method has two fundamental differences from other statistical methods in solving problems. First, unlike other statistical methods, it does not limit the variables. Besides, in the analysis of dynamic systems, it tries to analyze all the elements involved in the behavior of the phenomenon in a closed boundary. The dynamics of systems are more suitable compared to other methods for studying complex systems [24].

Consequently, in the present study the dynamics system approach was used as it is a dynamic coherent approach for modeling. In the following, the studies conducted in this regard are described. [5] investigated the simultaneous

management policies of underground water resources and farmers' livelihoods using dynamic systems and different scenarios were evaluated. Their results indicated that the scenario of do not cultivating non-strategic crops was chosen as the balanced conflict resolution scenario and symmetric state. In addition, in a research that investigated and analyzed sustainable agriculture with two objectives of increasing productivity and protecting using dynamic systems, the results indicated that using sustainable agriculture through the optimal use of environmental resources such as groundwater will increase productivity in agricultural sector. stated that food production systems in agricultural sector are associated with many challenges and smart farming has an important role in moderating problems in this sector. indicated that one of the main reasons for utilizing dynamic systems in value chain analysis in development of agricultural sector is their ability to capture feedbacks, dynamical behaviors and time delays, modeling dynamics system and the roles of supporting systems over time, combination of several causal factors and measurement of the performance [6].

Bond et al. [6] investigated the role of soil system dynamics in the development of the agricultural sector using dynamic systems. They indicated that using tillage operations through waste management methods in the development of the agricultural sector by means of the method of cover cropping of plants is effective in regulating soil moisture and preventing soil erosion. In their study, Finco et al. [10] investigated economic liberalization on inflation and prices of agricultural products using a simulation method and indicated that liberalization of agricultural areas is one of the affecting factors on inflation. Shi et al. [22] investigated the effect of oil prices on the costs of agricultural products and the inflation caused by it using a dynamic model. They showed that the price of oil affects the inflation of agricultural products through the effect on the exchange rate. Komarek et al. [14] their research investigated the value of agricultural products and organizing the production and marketing of agricultural products using data analysis and presenting a model, indicating that creating an appropriate production and supply chain of agricultural products leads to better organization of production and market and reforming the market structure. Singh et al. [23] stated that dynamic systems modelling provides the capability of simulating the key variables of the relative yield of crops, the groundwater level and the groundwater salinity with appropriate accuracy.

Dutta et al. [9] evaluated the results of the validation of population-based variables simulation models, need for drinking water, industrial water needs and value-added. They indicated that this model has been well calibrated to reproduce the behavior of various parameters in the system that represented the ability of the model in simulating the water resources systems of Hashtgerd Plain under different policies in the future. Therefore, this model can be used as a supporting tool for decision-making in the evaluation of the effects of various decisions and actions on the water resources, agriculture and socio-economic systems of Hashtgerd Plain in the management of the water crisis in that region. Foster et al. [11] in their research investigated the design of the development model of agricultural products export with a dynamic systems approach. After reviewing the relevant literature, they collected the necessary information about the projects and the factors affecting their analysis were identified. After that, the association of factors and variables was determined in the form of a causal loop diagram, and then the flow chart was simulated and validated using Vensim software. By evaluation of the research that has been done so far regarding the investment interaction in the agricultural sector, it was clear that these researchers have only evaluated some aspects of the association of these components. However, in the present study, it is considered that these interactions are mainly affected by many factors that have causal relationships. In such an association, the mutual and multiple effects of variables affecting the system make it a need to use system dynamics as the best analysis tool. In our study, there were no predetermined hypotheses, and the designing, simulating and finally testing of the model was done by collecting the data.

4 Methods

Considering the type of research, objectives, and methods, the present study was done based on a quantitative research method. The problem that was taken in this study has not been addressed before. In this type of research, instead of testing the hypothesis, the objective is to collect patterns and ideas to achieve a deep comprehension of the subject and present the model. In this plan, data was first identified through library studies and interviewing experts. The findings of the interviews were used to present a dynamic model. The approach used in this research is the system dynamics method. Problem-solving is performed by the system dynamics model in the following 5 steps:

- Identification and problem definition;
- Developing a conceptual model (causal loop diagrams);
- Developing a mathematical model (draw a state diagram);

- Simulation and validation of the model;
- Defining different scenarios, choosing and implementing the right solution (Sterman, 2020).

In this research, for estimating the mathematical relations between different variables in the flow chart, the following methods have been used:

1. Using the opinions of experts when there is no official information and statistics about a variable;
2. Using the valid relations available in previous researches associated with the variables of investment improvement in the agricultural sector of the country.

5 Statistical population

The statistical population included experts from the Department of Agricultural Jihad and Natural Resources of the country and several university expert professors were interviewed in the agriculture finance scope. Experts are managers and professors who have opinions in the discussed field. So, qualified individuals are inherently limited. In the present study, an expert is a person who:

- Have a master's degree or higher.
- Have at least ten years of work experience in the field of the study.

The statistical population of this research includes experts in the qualitative part and experts and databases of the agricultural sector from the Central Bank in the quantitative part.

6 Data analysis and research findings

In this research, in order to provide a dynamic model to improve investment in the agricultural sector of the country, the effective factors in investment in this sector were investigated. The dynamic model is used to analyze complex and non-linear socio-economic systems. The process of implementing the model is as follows:

1. At the beginning, the variables affecting the improvement of investment in the agricultural sector were determined through library studies and interviewing experts. Then, the variables were determined based on the diagnosis and opinions of experts and managers who have been active in this industry for years. The relations of these variables were extracted based on the results of the interviews. In this stage, the achieved variables were connected to each other using cause and effect diagrams, based on that the type of relation between the variables and their impact factor was obtained.
2. After drawing cause and effect diagrams, feedback loops (balancing and reinforcing) are identified and then marked with appropriate labels. Then, the stock and flow diagrams, which have the capabilities of simulation in Vensim software, are determined based on these diagrams.
3. In the next step, simulation and analysis of policies are evaluated under different scenarios.

An important point about models is that it is not claimed that models are complete and comprehensive, but it can be said that they are functional for explaining relations and interactions and are not in conflict with reality.

Next, we will describe the loops of the model. The final objective of this system is to improve investment in the agricultural sector of the country. Besides, in this analysis, the important point is that each loop is finally examined based on the final objective of the system. The causal model consists of four increasing loops R1, R2, and R3.

Loop R1 indicates the relation between export and employment. Based on that, the improvement of investment in the agricultural sector will increase the export, and the increment of export will increase the employment in this sector. Besides, any increase in employment will lead to an increment of investment in the agricultural sector. Based on the studies done in this regard, there is a significant association between export and employment, so that with 1% increment in the export volume, employment increases by 0.17% (Amini et al., 2013). Based on library studies and experts opinion, the increment of employment leads to an increase in investment in the agricultural sector (Figure 1).

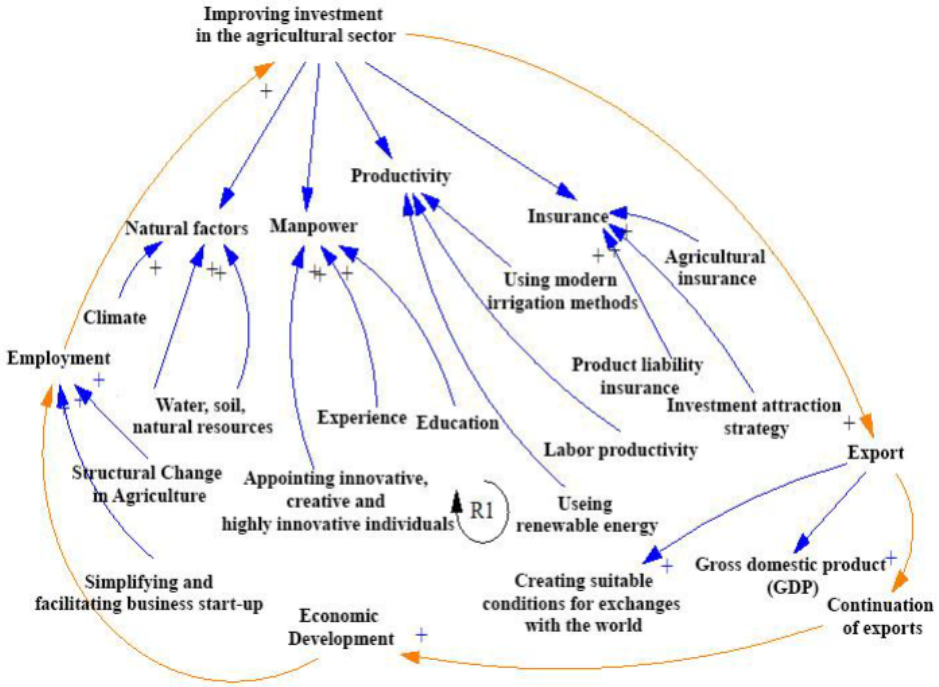

Figure 1: Cause-effect diagram of the interaction of the export and investment improvement

Coding is a systematic procedure developed by Strauss and Corbin to discover categories, characteristics and dimensions of data. The **binary repetition code** of length n or BRC(n) is defined by the encoding function E

$$0 \to z, \qquad 1 \to o$$

For a given BRC(n), P_d= 1 and $P_c = \frac{1}{2}$(for odd n).

The **minimum distance** d of a **linear code** L equals the minimum among with weights of non-zero code words.

Let L be a linear code of length n over F. Let $k \leq n$ be the dimension of L over F and choose a basis

$$X^1, X^2, \ldots, X^k$$

of L over F. Then any element in L is of the form

$$a_1X^1 + a_2X^2 + \cdots + a_kX^k$$

that is, a linear combination of the basis elements. A message vector

$$a = (a_1\, a_2\, \cdots\, a_k)$$

is thus encoded. $A[n, k, d]$ linear code has length n, dimension k, and minimum distance d.

Examine the linear code L of length over B with basis

$$\mathbf{B} = \left\{ \begin{pmatrix} 1 \\ 1 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 1 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 0 \\ 1 \\ 0 \end{pmatrix} \right\}$$

then the encoding function maps the message words using linear combinations of elements of B as follows:

$$000 \to 0000; 001 \to 1010; 010 \to 0111; 100 \to 1100; 110 \to 1011; 101 \to 0110; 011 \to 1101; 111 \to 0001$$

Notice that the set of code words is thus generated by **B**. Note the minimum distance is 1 since wt(0001) = 1. Thus L is a (4, 8, 1)-code and a [4, 3, 1] linear code.

$$P_d = P_c = 0.$$

The way of changing the R2 loop is that the increment of the investment in the agricultural sector will increase the protection of the land which leads to the improvement of integrated pest management. Integrated pest management increases farmer field school (FFS) which leads to an increment of education and investment in the agricultural sector.

Based on the expert's opinion, one of the ways to improve investment in the agricultural sector of the country is to increase land protection policies. Integrated pest management is an appropriate approach to combat pests using biological, agronomic, mechanical and chemical methods, which have a complex nature with the least risk for land protection [1]. Integrated pest management requires approaches that can institutionalize this technology and activities related to integrated pest management within society. Therefore, the strategy of farmers' field schools (FFS) or the school on the farm is defined as a strategy to achieve economic development in sustainable agriculture in the form of a global program [7]. This approach has been implemented in about 78 developed and developing countries worldwide, which has had positive effects in all of them [3]. Based on the studies conducted in Iran, it was observed that farmers' field schools have been able to increase the knowledge of farmers regarding the negative consequences of excessive use of poisons and pesticides, farmer's familiarization with the approach of integrated pest management, reducing the use of pesticides, reducing the cost of pesticides and producing healthy and organic products, and the increment of investment in the agricultural sector in the country [9] (figure 2).

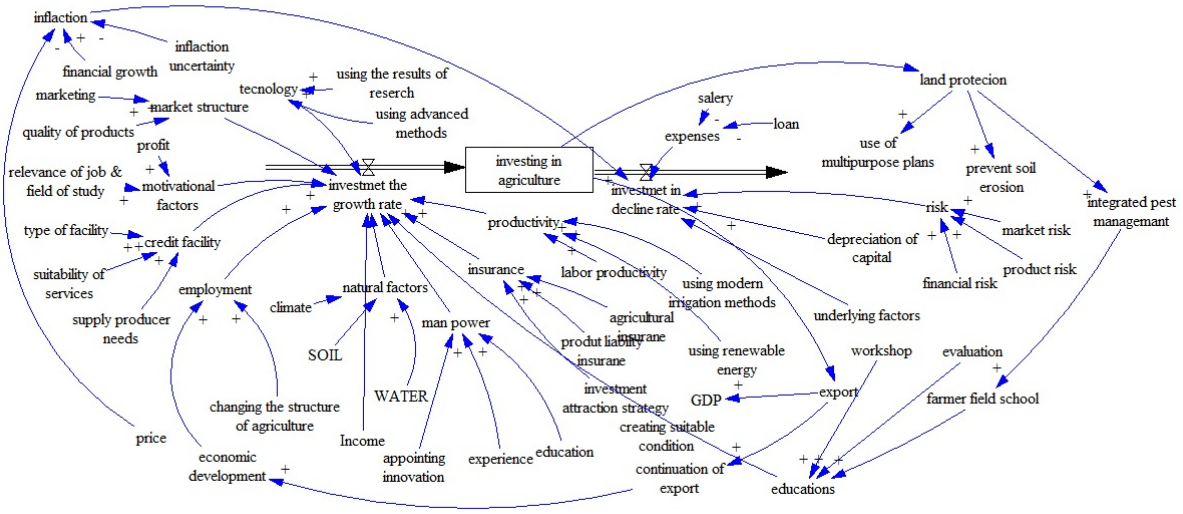

Figure 2: The cause-effect diagram of the interaction of the improvement of investment and land protection

6.1 Stock-to-Flow diagrams

Since in any organization management means interpreting and reacting to the opinions and passive events of the studied cause-effect model of real life, in many complex decision-making situations, determining the cause-and-effect relationships is a very complicated process. After drawing the cause-effect diagram and identifying the positive and negative variables and loops of the model, the next stage is identifying the state, flow, and auxiliary variables and drawing the flow diagram. The stock-to-Flow diagram indicates the variables used in the cause-effect diagrams that include cumulative variables (capital stock), changing variables (rate), auxiliary variables and constants. Stock or state variables are variables that vary with time and can be drawn over time. On this basis, the behavior of these variables can be observed. Flow variables are always defined in a time interval. Auxiliary variables describe the relations in the model and make it intelligible. Then, the stock and flow diagrams are modeled as equations, based on which the simulation of the system's behavior over time is done.

Considering the importance of investment in the country's agricultural sector, it is significant in the economic and social development of the country. Investigating the effective factors in improving investment in this sector and its dynamic modeling was done based on the theoretical foundations and the experts' opinions of the Department of Natural Resources. Agricultural Jihad Department and the university reviewed the research conducted in the theoretical foundations based on the data foundation method, then extracted model variables. After that, the cause-

and-effect relationships of the variables were formed and the final model of this research was drawn by developing and modeling in Vensim software. The indicators and relationships presented in the dynamic model indicate the effect of each variable by decreasing or increasing each of them. Besides, the changes in investment improvement can be observed in the outputs of the software. In order to ensure the accuracy and validity of the model, tests have been carried out, which are described in the following.

6.2 Goodness of fit test

The objective of this test is to answer the question of whether the structure of the model isn't in contradiction to the existing knowledge about the structure of the real system. In this research, based on library studies and interviews with the experts of the Department of Agriculture Jihad and Natural Resources of the country and several university professors specialized in this sector, as well as using the data foundation method, the factors affecting the improvement of investment in the agricultural sector were identified. The validity and reliability of this research were approved by experts and then the effect of the identified variables on each other was investigated through an Analytical Hierarchy Process (AHP) questionnaire. After that, the factors' adaptation rate was approved by the experts, and finally, a dynamic model was presented to improve investment in the agricultural sector of the country, and its overall structure was approved by the experts.

6.3 Parametric statistics

This test evaluates whether the parameters conceptually and numerically correspond to the real world [18]. The values of all model parameters were extracted from the Central Bank and Statistics Center of Iran during the years 2011 to 2020, which were approved by experts and advisors. For example, the investment value in the agricultural sector in 2011 based on the data of the Central Bank was 87 thousand billion Rials, which was used as the initial amount in the simulation.

6.4 Reconstruction of reference behavior

One of the most prevalent ways to check the validity of the model is to compare the real data with the simulated values which improves the model if there is a significant difference. For this purpose, the income variable and the percentage of the average absolute value of the error were calculated (see the table below). In this section, the investment variable was selected for validation which is one of the main variables of the mentioned problem. Due to the fact that the variable data of investment in the agricultural sector is available during the years 2011 to 2020, the year 2020 is considered to be the last year whose data is available in the Central Bank and Department of Agriculture Jihad. For this purpose, the investment variable in the agricultural sector of the country was investigated to measure the behavioral validity of the model which is the main variable of this model. The results simulated by the model were compared with the real data and the percentage of the average absolute value of the model error was calculated. As can be seen in the table below, the percentage of mean absolute error (AAEP=0.69%), has good validity and indicates a predictive behavior modeling similar to the actual value.

Table 1: Investment in the agricultural sector during the years 2011 to 2020 in billions of Rials.

Investment	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399
Real amount	87000	78456.5	71334.5	63146.3	57214.6	52463.1	47840.6	42805.4	38946.5	35000
Model prediction	87000	78720.9	71229.6	64451.2	58317.8	52768.2	47746.6	43202.9	39091.6	35371.6
AAEP=0.69%										

6.5 Boundary (conditions) test

Boundary testing is used to measure the efficiency of the model. Boundary conditions may not be ever observed in the real world. However, this test indicates whether the system exhibits expected behavior against the boundary conditions or not. Boundary testing examines whether the model behaves properly when the inputs are at boundary conditions such as zero or infinity. In other words, in this test, the stability of the model is shown in boundary conditions. This testing model includes important tools in order to find the limitations of the model and create a

stage for advanced comprehension [9]. In the final phase of the boundary testing process, model state variables are consisting of investment in the agricultural sector and income (as the main variables of the research). In the final phase of the boundary testing process, model state variables are consisting of investment in the agricultural sector and income (as the main variables of the research). The initial value of these variables, which are obtained based on the statistics of the Central Bank of Iran, the Statistical Centre of Iran and the Agricultural Jihad Department, were changed from low to high with very small hypothetical values and their effects were examined in the model. For example, the initial value of the state variable of investment in the agricultural sector is 87,000 billion Rials, and the values 87000000000001 and 870000000000005 are used as examining low and high values. The graphs and analysis of the initial value of the state variables are as follows: the validation results of in final phase of the boundary testing process regarding the changes in the state variables of investment in the agricultural sector and income (as the key research variables), as well as their effect on the auxiliary variables of export and land protection (as research loops), are shown in the following figures. In fact, the change in the state variables is shown for the change in the initial value of the state variables of investment in the agricultural sector and its effects on the research model.

The graph below indicates the improvement of investment in the agricultural sector for changes in the initial amount of investment in the agricultural sector. As is evident in the following graph, for the values of 87000000000000, 87000000000001 and 870000000000005, with any changes in the initial value of the state variable, the improvement of investment in the agricultural sector of the country is achieved and the graph is increasing with an upward trend.

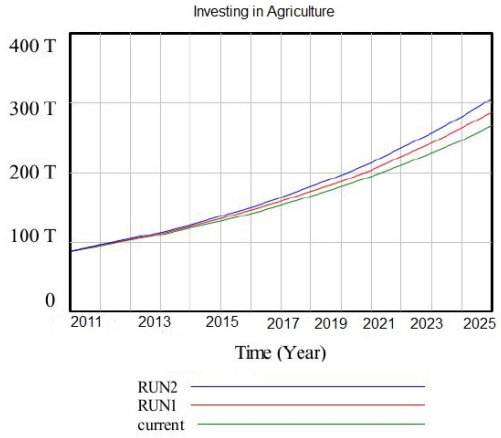

Figure 3: Improvement of investment per change in the initial amount of capital

The following graph indicates the change in the auxiliary variable of export per change in the initial amount of the improvement of investment in the agricultural sector. By changing the initial value of the state variable of investment improvement in the agricultural sector, it was observed that the export situation is improving with an upward slope.

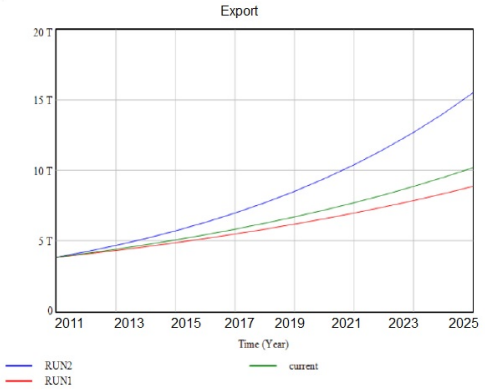

Figure 4: Exports per change in the initial amount of improvement in investment

The following graph indicates the status of land protection as a covariate variable for a change in the initial

amount of improvement of investment in the agricultural sector. An increase in the initial value of the state variable of investment improvement in the agricultural sector causes an increase in land protection, and land protection is increasing with an upward trend.

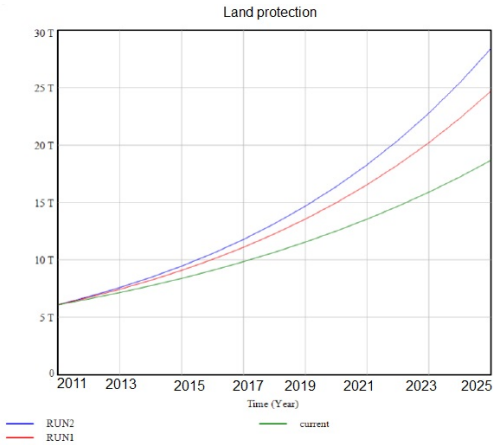

Figure 5: Land protection graph based on changes in the initial amount of improvement of investment

The results obtained from the above graphs confirm the sensitivity of the model results to the initial conditions. In fact, the change in the initial value of the state variables caused a change in the auxiliary variables, so that the increment of state variable caused the upward trend of the auxiliary variables and the improvement of the investment situation in the agricultural sector of the country.

6.6 Scenario analysis and choosing the best strategy

The graph below indicates the state of the system in two conditions no improvement and improvement of investment in the agricultural sector of the country. Investment in the agricultural sector has been declining in recent years so according to the statistics published by the central bank of Iran, the amount of investment in 2020 reached 35 thousand billion rials. Necessary corrective measures in various sectors of the economy, technology, environment and society are effective in improving investment in the agricultural sector in the future. These activities are the basis for the improvement of investment in this sector, which leads to an increment in investment with the implementation of a performance improvement Policy. However, with the absence of these activities, it gets worse year by year with a gentle slope and takes a downward trend. Improving investment through corrective actions will lead to an increase with an upward trend in investment in the agricultural sector of the country. In this research, different scenarios are investigated for improving investment in the agricultural sector of the country during the years 2011 to 2025, which are described below.

6.7 In the first scenario:

It has been stated that there is a significant association between the 10% increase in exports and the improvement of investment in the agricultural sector of the country. As could be seen from the output of the software (Following graph), the improvement of investment in the agricultural sector is increasing with an upward trend. With a 10% increase in exports, the improvement in investment increases with a steeper slope and reveals the growth of improvement in investment over the next four years. In fact, there is a significant association between the increment of exports and the increment of investment in the agricultural sector of the country.

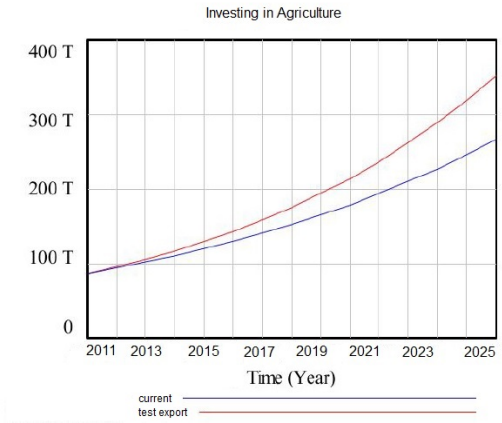

Figure 6: The association of export and their simultaneous effect on the improvement of investment in the agricultural sector

6.8 Examining the second scenario:

In this scenario, it is checked whether there is a significant association between a 10% increase in exports and a 10% increase in land protection simultaneously on the improvement of investment in the agricultural sector of the country. As can be seen in the output of the software (the following graph), with a 10% increase in exports and land protection, the investment in the agricultural sector will increase in an upward and steeper way. Besides, there is a significant association between increasing exports, protecting land and improving investment in the agricultural sector of the country.

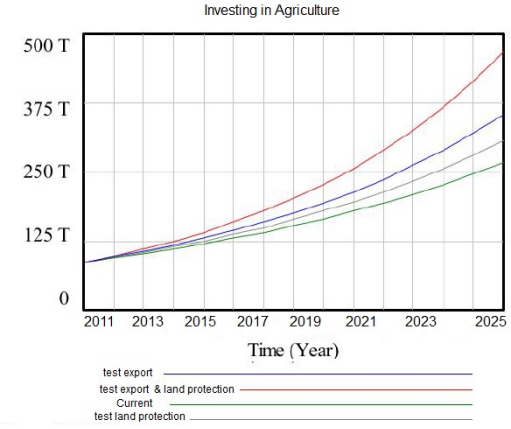

Figure 7: The association of land protection and export and their simultaneous effect on the improvement of investment in the agricultural sector

Based on the findings of this study and using the average ranking method, the scenarios were prioritized, based on which scenarios 2 and 1 are respectively the best scenarios to improve investment in the agricultural sector of the country.

7 Conclusion

In this research, it was tried to evaluate the process of investment improvement in the agricultural sector of the country using system dynamics. Therefore, this study is innovative from a methodological point of view. On the other hand, considering that so far there has not been a model for improving investment in the agricultural sector as a whole, this model can be assumed as an innovative one in terms of its subject. Based on the objectives of this study, effective factors for the improvement of investment in the agricultural sector of the country were identified and different dimensions of investment in this sector were evaluated. Here, a dynamic model was introduced to improve investment

in the agricultural sector of the country using the identified factors. Then, using Vensim software and simulation in it, three scenarios were implemented and analyzed. The findings show that by implementing the investment policy in the agricultural sector, the investment situation in this sector can be improved significantly. By implementing policies to improve investment in the agricultural sector through increasing exports and improving land protection, the capacity of production and the amount of investment in this sector can be improved. Undoubtedly, the implementation of the introduced model provides a good opportunity to improve the current situation through necessary corrective measures to solve investment challenges. Therefore, this model takes steps to improve and promote investment in the agricultural sector. As observed during the three scenarios, in order to improve the investment volume in the agricultural sector on the path to growth and development, paying attention to the export and land protection policies has a vital role.

By choosing the right strategy to increase exports, the rate of employment, growth and prosperity of the agricultural sector of the country will improve. These findings are in line with those presented by Sato et al. and Havemann et al. [12, 20]. Improving land protection through integrated pest management improves investment in the agricultural sector. Schut et al., Zachrison [21, 28]. By examining the scenarios, it was concluded that the good performance of the third scenario is due to its combined attention to export and land protection. Among the limitations of the research, we can mention the lack of complete access to new information and the lack of similar research in terms of the level of analysis. Also, the challenges related to the performance and examination of the study subject and its uniqueness caused many issues to be considered for the first time.

As it can be seen from the previous research, the emphasis of researchers is more on the effect of one or two factors. Besides, they evaluated the factors affecting the export of agricultural products, and employment in the agricultural sector through a dynamic model. Based on the findings of this study and in order to improve the investment in the agriculture sector of the country, this research, it was tried to evaluate the effective indicators from various dimensions and provide a model for the improvement of investment in this sector. Improving investment in the agricultural sector by considering effective indicators improves the investment volume in order to remove obstacles to the growth of investment and create a suitable platform for investment security. This model can be used for decision-making in a macro-investment scope in the agricultural sector of the country.

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