Index insurance as a tool for enhancing climate resilience and sustainability in agricultural ecosystems of Armenia

Gohar Voskanyan[11], *Meri* Manucharyan[1, 2], *Alvard* Matinyan[1, 2], *Tsovinar* Kocharyan[1], and *Liana* Khachatryan[1,3]

[1]The Institute of Economics after M. Kotanyan of the National Academy of Sciences of the Republic of Armenia, 15 Grigor Lusavorich Str., Yerevan 0015, Armenia
[2]Armenian National Agrarian University, Faculty of Agribusiness and Economics, 74 Teryan Str., Yerevan 0009, Armenia
[3]Armenian State University of Economics, Chair of Theory of Economics, 128 Nalbandyan Str., Yerevan 0025, Armenia

Abstract. The increasing frequency and intensity of extreme weather events due to climate change pose a significant threat to the stability and biodiversity of agricultural ecosystems. This study explores the potential of index-based insurance as a innovative financial mechanism to promote sustainable agricultural practices and enhance the climate resilience of farming systems in Armenia. The analysis employs a suite of methodologies, including comparative and statistical analyses, to assess the role of index insurance in mitigating production risks associated with biological stressors, such as droughts and floods, which directly impact crop yields, soil health, and local agro-biodiversity. The paper argues that the strategic implementation of index insurance can serve as a critical instrument for safeguarding farmers' livelihoods, thereby encouraging the adoption of biodiversity-friendly and environmentally sustainable farming methods. As a key outcome, the establishment of a state-supported insurance entity is proposed to facilitate the development and integration of such financial tools, ensuring the long-term ecological and economic sustainability of Armenia's agricultural landscapes.

1 Introduction

Agriculture is one of the oldest forms of human activity, the main function of which is to provide people with food. Despite current global economic development trends, the problem of hunger still exists in the world today. Despite its importance, agriculture is one of the riskiest activities, exposed to a variety of risks. In this case, there is a need to implement measures that will help mitigate agricultural risks or reduce the negative consequences caused by them. This scientific study focuses on index insurance as a risk management innovative method. The purpose of the article is to identify the patterns of

[1] Corresponding author: vos.gohar@mail.ru

agricultural risk management through index insurance and present recommendations for the introduction of index insurance in Armenia and other developing countries. To achieve the set goal, materials published by various researchers and international organizations on this topic were studied, which are presented in the literature review section. The current state of state-supported agricultural insurance in the Republic of Armenia, the development trends of key insurance indicators, and the main problems that exist in this sector were studied and presented. As a result of the research conducted in the work, the advantages of using index insurance were presented and clear recommendations were made in this direction, which are presented in the conclusions section.

2 Literature Review

2.1 Risks and risk management in agriculture

Agriculture is one of the most important types of human activity. It is a means of protecting the environment, represents a technical and cultural factor in the preservation of civilization [1]. Agricultural development is also essential to maintaining a growing world population [2]. Agriculture deals with living organisms and is exposed to natural and climatic risks, which is why it is considered a risky sector. Agriculture, unlike other sectors, deals with objects in the process of growth and development and is subject to the impact of natural disasters [3]. M. Meuwissen and others in their scientific work have identified the following risks threatening agriculture: production risks, price risks, personal risks and institutional risks [4]. Referring to the importance of risk management in agriculture, L. Girdžiūtė noted that risks have a major impact on the decisions made by farmers, which is why effective risk management in agriculture is very important [5]. Risk mitigation might be soon a key driver of agricultural policy [6]. Agricultural risk management is even more effective if several risk management tools are implemented simultaneously [7].

2.2 Agricultural insurance

Insurance is one of the tools for managing risks threatening agricultural activities [8]. Insurance is an ancient economic category that has today penetrated almost all spheres of human activity. Especially in developing countries, agricultural insurance has always been in the focus of attention of various stakeholders [9]. One of the peculiarities of agricultural insurance is that it is not implemented in almost any country without state support. There are two main types of agricultural risk insurance. They are traditional insurance products and innovative agricultural insurance products. Index insurance has been in use since 2005 and is becoming more popular every year [10].

2.3 Index insurance

Index insurance is an innovative risk management product that is used not only in agriculture, but also in other sectors. On one hand, the increasing availability of this financial service offers a big opportunity for benefits to both farmers and providers. On the other hand the complexity of this risk management tool, especially to a population that may not be familiar with the concept of insurance and may have low levels of literacy, can lead to poorly-understood index insurance products that may do more harm than good [11].

3 Materials and Methods

3.1 Data collection

The basis for collecting the necessary information for the research was scientific works by various authors on the topic, as well as materials published by various international organizations (FAO, UN, OEDC, EU, WB, ADB, GIZ, ILO etc.). The legislative acts, theoretical foundations, and numerical data on agricultural insurance in Armenia were taken from the official website of the of the Government of Armenia.

3.2 Methods

In the paper, comparative, analytical, descriptive, exploratory, induction and deduction mathematical and statistical methods were used.

As we have already mentioned, traditional agricultural insurance products are based on actual losses incurred by farmers. In this case, to calculate the insurance compensation, data such as the area of the insured crop area, the average yield per unit area, the market price of the unit crop, as well as the insurance coverage are necessary. In other words, if we express this with a mathematical formula, we get:

$$Indemnity = Insured\ crop\ area * Averege\ yield * Price * \frac{Insurance\ coverage}{100\%} \tag{1}$$

When a farm purchases Index insurance, the indemnity is calculated as
Dollar Amount of Protection
Trigger Yield
Trigger Yield Realized Yield

$$\text{Indemnity per acre} = \text{Max}\ (0, \frac{\text{Trigger Yield} - \text{Realized Yield}}{\text{Trigger Yield}}) * \text{Dollar Amount of Protection} \tag{2}$$

Where,
Trigger Yield = Expected County Level Yield ×Coverage.
The realized yield is the NASS estimate of the county average yield for the county where the farm is located. Coverage levels range from 70 to 90 per cent in 5 per cent increments.
The Dollar Amount of Protection is calculated as
Dollar Amount of Protection = Expected County Yield × Price Election× Scale
Where scale is chosen by the policyholder but is limited to between 90% and 150% [12].

An important quantity in insurance is the insurance premium, which is the amount paid by the policyholder to the insurer to purchase an insurance contract. For both traditional and innovative products, the insurance premium is calculated using the following formula:

$$\text{Premium} = \text{Expected Loss} + \text{Risk Margin} + \text{Administrative Costs} \tag{3}$$

Expected loss is the part of the insurance premium that is calculated based on statistical data and indicates the average size of losses.

A risk margin is added to the insurance premium by insurers to compensate for deviations from statistical averages.

Administrative expenses are all the expenses that the insurer incurs in the course of its activities, including salary payments, costs related to data collection, and amounts transferred to reinsurers and intermediaries [13].

4 Results

Theoretical work on managing agricultural risks through insurance has been carried out in Armenia since the 1990s. However, practical steps were taken only in 2019, when the Armenian government adopted a decision on the implementation of a pilot program for agricultural insurance with state support. In the figure 1 we present the number of insurance policies and the area of insured acreage in 2019-2024.

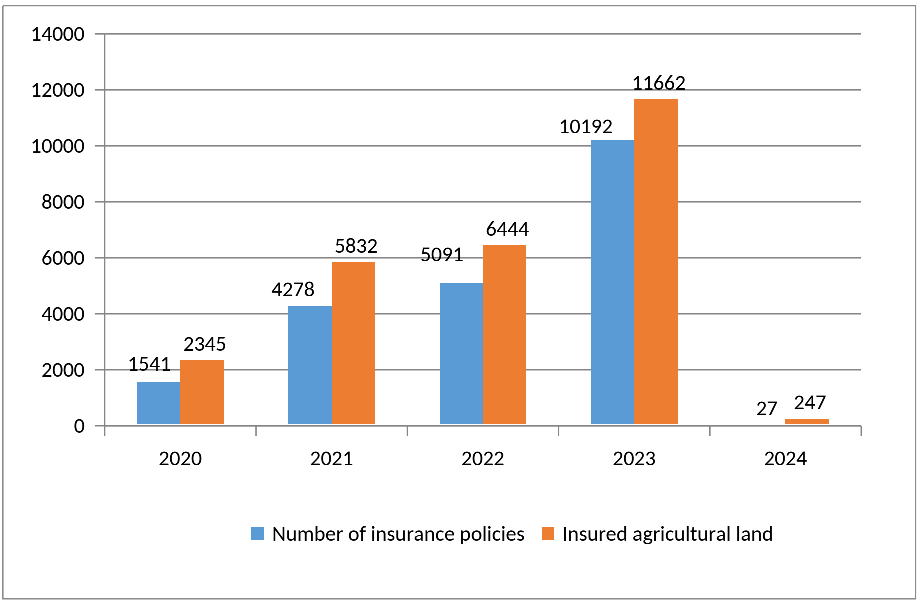

Fig.1. Number of insurance policies and insured agricultural land in the Republic of Armenia in 2020-2024. The figure was compiled by the authors based on data published by the Ministry of Economy of the Republic of Armenia [14]

As the data in the chart shows, growth trends were observed for selected insurance indicators during 2020-2023. In particular, the number of insurance contracts signed in 2023 increased 6.6 times compared to 2020, and the area of insured arable land increased approximately 5 times. In other words, the average annual growth rate for insurance contracts was 2.2, and for insured acreage, it was 1.7. Logically, the downward trends should have been at approximately the same pace. We can see in the chat the number of insurance contracts in 2024 decreased by 377 times compared to 2023, and the area of insured arable land decreased by more than 47 times. Having followed the processes related to agricultural insurance in the Republic of Armenia for years, we can identify the main reasons that led to the situation in 2024. Among those reasons are:

- ✓ Non-professional specialists included in the agricultural insurance system,
- ✓ Lack of highly qualified loss adjusters,
- ✓ Low effectiveness of dissemination of information on agricultural insurance among farmers.
- ✓ Implementation of agricultural insurance through private insurers,

✓ Incorrectly selected insurance products, etc.

The pilot program for state-supported agricultural insurance in Armenia was planned to be implemented for a period of 5 years. Taking into account the downward trends in the last year, it becomes clear that after 2025, state-supported agricultural insurance may be completely discontinued in the Republic of Armenia. Once this prediction we made becomes a reality, it will be inevitable to develop a new agricultural insurance program and implement it with completely different principles. In this case, it is necessary to clearly distinguish which risks can be managed through agricultural insurance traditional products and which through index insurance.

5 Conclusions

In the face of increasing risks in agriculture and due to global challenges, effective agricultural risk management is becoming even more important. In Table 1, we have presented the general characteristics, advantages, and disadvantages of index insurance summarized as a result of our research, which must be taken into account when applying it in practice.

Table 1. Main characteristics of index insurance*

Description	Advantages	Disadvantages
The basis for insurance payments is not the actual losses suffered by farmers, but pre-calculated indexes.	➢ Moral hazard and adverse selection problems are absent. ➢ There is no need to collect detailed information to conclude an insurance contract. ➢ There is no need for a loss adjustment to provide insurance compensation. ➢ The administrative costs are lower.	➢ Insurance compensation can be either higher or lower than the actual losses suffered by the farmer (Basis Risk). ➢ Setting up the index parameters is technically complex. ➢ Long-term meteorological and other data are needed to develop the indexes. ➢ Not all risks can be insured with index insurance (for example, hail). ➢ There is a need for reinsurance protection.

* The table was compiled by the authors.

We believe that agricultural risks in the Republic of Armenia, in particular frost and drought risks, should be managed through index insurance. In the process of implementing index insurance, all circumstances that may hinder this process must be taken into account. Such obstacles may include a low level of insurance culture, high poverty and low income levels, especially in rural areas, low level of awareness, low level of cooperation between various state and non-state bodies and structures, etc. Implementation commonly involves public-private partnerships where the products are initiated and designed by outside researchers, NGOs, or multilateral agencies in partnership with local insurers using philanthropic or public funds [15] .

Thus, taking into account the results of our studies, for the purpose of introducing index insurance, we propose establishing a state insurance company that would coordinate the entire agricultural insurance process. The company should act as an intermediary between all those structures that have certain functions in the process of introducing index insurance.

In Figure 2, we present the potential participants in the development and implementation of index insurance.

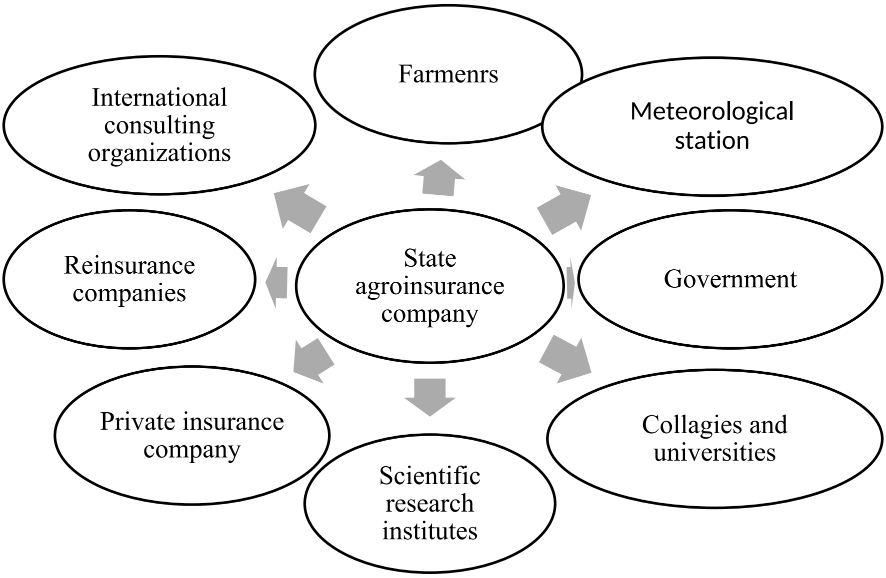

Fig.2. The main participants of the index insurance system. The figure was created by the authors

Farmers must be financially stable to be able to pay for insurance. Here, we also emphasize the level of awareness among farmers and the real benefits of obtaining insurance. In this system, we particularly emphasize the role of scientific research institutes, which should work on the study and development of this product. They should cooperate with international organizations and insurance and reinsurance companies that have experience in the field of index insurance. The meteorological station must provide 30 or more years of data for the development of indices. The availability of qualified specialists is also important for the implementation of index insurance. Colleges and universities have work to do in this direction, and they should include topics on index insurance in their curricula. As already mentioned, reinsurance protection is very important for index insurance, and to obtain it, insurers must find reinsurers who have experience in index reinsurance. As we know, state support is an important prerequisite for agricultural insurance. In this regard, the government should allocate funds to subsidize index insurance premiums. Currently, there are a number of international consulting organizations operating in the world that provide support and advice to countries that have decided to implement index insurance. According to our proposed system, farmers can sign index insurance contracts with both the state agricultural insurance company and private insurance companies. The State Agricultural Insurance Company must establish strong, mutually beneficial and effective ties between all participants in the index insurance system, which will ensure the establishment and development of this system. We believe these recommendations may also be useful in the process of introducing index insurance in other developing countries.

References

1. C. Tindeche, A. Marcuța, L. Marcuța, Importance of the Agricultural Sector as a Branch of the National Economy, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. **14**, 299-305 (2014)
2. E. Aifa, Theoretical and Empirical Overview of the Importance of Agriculture in the Economic Development of a Developing Country, Pakistan Journal of Life and Social Sciences, Pak. j. life soc. Sci., **22(2)**, 5462-5468 (2024), https://doi.org/10.57239/PJLSS-2024-22.2.00406
3. L. Theuvsen, Risks and Risk Management in Agriculture**,** Zeszyty Naukowe SGGW w Warszawie - Problemy Rolnictwa Światowego **13(4),** 162-174 (2013), https://doi.org/10.22630/PRS.2013.13.4.73
4. M.P.M. Meuwissen, B. Hardaker, R.B.M. Huirnei and A.A. Dijkhuizen, Sharing risks in agriculture; principles and empirical results, Netherlunds Journal of Agricultural Science **49**, 343-356 (2001)
5. L. Girdžiu, Risks in agriculture and opportunities of their integrated evaluation, Procedia - Social and Behavioral Sciences, **62**, 783 – 790 (2012), https://doi.org/10.1016/j.sbspro.2012.09.132
6. I. Lipinska, Managing the Risk in Agriculture Production: The Role of Government, European Countryside **8(2)**, 86-97 (2016), https://doi.org/10.1515/euco-2016-0007
7. W. Vroege, T. Dalhaus, R.. Finger, Index insurances for grasslands – A review for Europe and North-America, Agricultural Systems, **168**, 101-111 (2019), https://doi.org/10.1016/j.agsy.2018.10.009
8. A. Newman, I. Fischhendler, An archetype for insurance thresholds for extreme natural events in the agricultural sector, Climate Risk Management **36** (1): 100434 (2022), https://doi.org/10.1016/j.crm.2022.100434
9. J. R. Skees, Challenges for Use of Index-based Weather Insurance in Lower Income Countries, Agricultural Finance Review **68**, 197-217 (2008), https://doi.org/10.1108/00214660880001226
10. L. Johnson, Index insurance and the articulation of risk-bearing subjects, Environment and Planning A, **45**, 2663–2681, 2663(2013), https://doi.org/10.1068/a45695
11. C. Fonseca, Helping farmers understand index insurance: Guidelines for consumer education interventions, International Labour Organization, paper **45**, 26 (2016)
12. B. J. Barnett, Agricultural Index Insurance Products: Strengths and Limitations, Ag Econ Search, 44 (2004)
13. M. B. Diaz-Caneja, C. G. Conte, R. Catenaro, F. J. G. Pinilla, Agricultural Insurance Schemes, Joint Research Centre – European Commission, 218 (2008)
14. State support for agricultural programs, Ministry of Economy of the Republic of Armenia, Report, 13p., (2024)
15. N. D. Jensen, C. B. Barrett, Agricultural Index Insurance for Development, Applied Economic Perspectives and Policy **39(2)**: 199-219 (2017), https://doi.org/10.1093/aepp/ppw022