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OPPORTUNITIES FOR THE DEVELOPMENT OF BEEKEEPING INSURANCE IN THE REPUBLIC OF ARMENIA

Alongside concerns about the visible effects of storms, floods and desertification, concerns have arisen in recent years about the decline of both wild and domestic pollinators, especially bees. In general, climate change may reduce yields in the beekeeping sector and lead to slower bee growth and development. In worst-case scenarios, it may even cause bee deaths or contribute to bee migration. Insurance is one of the main tools to ensure stable incomes for farmers.

The main purpose of the article is to develop possible options for effective implementation and further development of insurance in the beekeeping industry. In the article, studying the issues of the introduction of cluster programmes in the sphere of beekeeping in the world and creation of clusters in the sphere of beekeeping, highlighting the possible options of development of the sphere for the Republic of Armenia, the most effective options of the introduction of insurance in the sphere of beekeeping of the Republic of Armenia are considered. The regions that are the closest and most expedient for introducing beekeeping insurance, from the perspective of efficient resource use and in anticipation of further development opportunities, are identified.

Keywords: *beekeeping, cluster analysis, honey production, bee, livestock*
JEL: G22, G28, Q14
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INTRODUCTION. The beekeeping industry is very important to our country, not only for food security but also for biodiversity. The beekeeping industry occupies a very important place for our country, not only in terms of food security, but also in terms of biodiversity.

In the context of ensuring food security of the Republic of Armenia, beekeeping occupies a special place, which with its developing potential not only contributes to the production of high quality natural honey and other bee products, but also plays a crucial role in preserving biodiversity and increasing crop yields through bee pollination, which can increase yields by up to 50 per cent and income by 10-15 times (Garibaldi, Aizen, Klein, Cunningham, & Harder, 2011).

Although there are currently about 190 thousand bee families in the Republic of Armenia, at least 250 thousand bee families are required for full pollination, which indicates the need to expand the industry (Reply to posts N 09.4/10308-2025, Statistical Committee of the Republic of Armenia and N ՎԿ/2-13/2076-2025, the Ministry of Economy of the Republic of Armenia).

Given the need to promote employment in rural areas and create stable incomes, targeted state support and effective policies aimed at the development of beekeeping are necessary. One of the steps on the way to the implementation of effective policy and the creation of stable incomes in the sphere of beekeeping in the Republic of Armenia is insurance. And for understanding the possibilities of introduction and development of insurance in the beekeeping industry of the Republic of Armenia, it is important to use resources effectively. Thus, the conducted analysis revealed the possible influence and connection of the studied indicators, as well as possible options for improving the level of efficiency.

LITERATURE REVIEW. **When considering the beekeeping industry, it should be noted that it has historically been significant for the agrarian sector of our republic. Since the Soviet years, beekeeping has been given great attention, as evidenced by the investments and efforts made in the framework of state support.**

It can be said that the importance of beekeeping to the economy, society, food security, and the survival and development of human civilization as a whole is inestimable.

Lack of proper attention to the development of beekeeping in any country can have catastrophic consequences. They are greatly increased by natural disasters caused by human activities and human economic activities that adversely affect honey plants and bee hives.

The emergence of new virus species, previously unexplored diseases and misconceptions about them have negative consequences for bee life, in some cases irreversible.

First, let us look at the logarithmic utility function in the beekeeping insurance industry. The logarithmic utility function, $u(x) = \beta * \ln(x)$, is widely used in agricultural insurance models, especially in situations where farmers have limited resources and operate in a high-risk environment. This function expresses diminishing marginal utility, indicating that farmers prefer to spread their risk evenly through insurance. M. King used the logarithmic utility function in his studies to assess farmers' attitudes towards agricultural insurance (M. King & Singh, 2018). His analysis showed that this function corresponds to diminishing marginal risk preferences, which is important in risk management models. Such models are especially useful in situations where farmers do not have sufficient information about their own risks. Yu An used the logarithmic utility function in his studies to assess farmers' willingness to pay insurance premiums, taking into account their subjective risk perceptions (Yu An, 2020). Thus, the logarithmic utility function is an effective tool for assessing farmers' risk preferences and determining insurance premiums in agroinsurance models.

The main systemic problems in the introduction and development of beekeeping insurance are:

- Lack of a statistical and information base: complete and reliable data on beekeeping production volumes, losses, and risks are limited.
- High degree of risk variability: the impact of diseases, climate change and pesticides is difficult to predict and model.
- Low solvency and willingness to pay to farmers: beekeepers' income is seasonal and unstable.
- Lack of interest of insurance companies: the sector is considered small-scale and high-risk.
- Absence of state support and subsidy programs specifically for beekeeping insurance.

In recent years, attempts have been made in the agricultural sector to use clusters as a means of regional and sectoral economic development, through the demand for high-quality and standardized agricultural raw materials in the food industry.

The analysis of cluster problems in the beekeeping sector in Turkey was highlighted as an example of an international experience study. Turkey, being very powerful and developed in terms of resources, currently has many problems in the beekeeping and honey and other bee products markets.

International research has explored a possible cluster analysis of the beekeeping sector in Turkey, evaluating the clustering strategy of the Black Sea region of Turkey (Theoman and Yeni, 2021).

Initially developed for the production sector, the clustering strategy has in recent years been applied to the agricultural sector as well, due to the growing demand for high-quality and standardised agricultural raw materials in the food industry. Within the evaluated beekeeping cluster, promotion of contract farming, establishment of a honey exchange, promotion of the establishment of companies specializing in the production of bee mothers and beekeeping products, introduction of geographically based products, and institutional support are considered important.

Regarding possible attempts to introduce insurance in the beekeeping sector, Bova, Colivici and Giovannini in their study noted that parametric insurance with a weather index, which has become common in agriculture, is not available in the beekeeping sector (Bova, Colivicchi & Giovannini, 2023). Similar types of insurance have been mentioned in previous studies (N. Nersisyan, 2022), (N. Nersisyan, 2024).

A review of parametric weather-indexed insurance pricing methods is presented to answer the question of insurance risk mitigation for beekeepers. It is recommended to compare the different forecasting methods presented in the literature to identify their advantages and disadvantages. Similarly, Mensah et al. examined how beekeepers' decisions in the Dormaa community and East Dormaa regions of Ghana are influenced by factors such as awareness, age of the farmer, number of hives and farming experience (Mensah et al., 2023).

State programmes to support beekeeping have been and are being implemented in our republic. In particular, the goal of the recently implemented programme is to support the development of beekeeping in the border communities of Armenia, solving the problems of the prevalence of small apiaries, shortage of honey crops and technical equipment. The project was launched last year. Within the framework of the project, it is planned to support the acquisition of 8000 bee families in Gegharkunik, Syunik, Tavush and Aragatsotn regions within two years with 50% reimbursement of costs, with an annual production of about 120 tonnes of honey. The initiative will simultaneously contribute to the efficient utilization of unused pastures, biodiversity conservation and the creation of alternative jobs for border villagers, which is of strategic importance for both the economy and sustainable development of the community. The beneficiaries of the programme are residents of Gegharkunik, Syunik, Tavush and Aragatsotn regions, who can receive compensation for the purchase of 10 to 50 beehives by applying electronically to the Ministry of Economy of the Republic of Armenia. The beneficiary can use the programme once, and in case of alienation of the hives, he/she is obliged to return the compensation within three months; otherwise it will be recovered through the court. However, the programme does not provide for risk mitigation measures, in particular through the use of any insurance instruments.

According to some studies, participation in group beekeeping has a positive and significant effect on honey production efficiency as measured by technical efficiency. Farmers who engaged in group beekeeping were less technically inefficient than those who did not participate. The results of the study showed that the total number of hives, type of hive and distance from available forest had a significant and favourable effect on honey production (Tadesse and Assefa, 2024). This idea is also applicable to the insurance sector, bringing together farmers with a small number of hives under one common goal: insurance.

Possible solutions for the introduction and development of beekeeping insurance:

- Develop and form a unified database of beekeeping risks, where real cases of losses and their causes will be collected.
- Apply parametric insurance models (for example, based on climatic indicators), which reduce the high costs of assessing losses.
- Subsidize part of the insurance premiums within the framework of state programs, promoting the involvement of beekeepers.
- Organize community/cluster insurance programs, when farmers unite, and insurance operates on a group principle.
- Raise awareness among beekeepers about insurance mechanisms and benefits.

RESEARCH METHODOLOGY. **Beekeeping is important for the production of marketable products and to provide opportunities for natural pollination of crops to increase crop yields.**

To study possible variants of the introduction of beekeeping insurance in our republic and to develop options for development and prospects, we have analysed indicators of beekeeping and quantitative indicators of livestock production.

In multivariate statistical analysis we have formed sections that are not isolated, but penetrate, pass into each other. These are cluster analysis, the method of principal components, and factor analysis. The features of multivariate analysis are most clearly reflected in the classification of objects through cluster analysis and in the study of relationships through factor analysis. Cluster analysis is a method of grouping multidimensional objects, which is based on the representation of the results of individual observations by points in the corresponding geometric space, with the subsequent allocation of groups as ‘clusters’ of these points.

Cluster analysis involves selecting compact, distant groups of objects and finding a ‘natural’ division of the selected object (in our analysis, the beekeeping sector) into clustered areas of objects. It is applied when the initial data are represented in the form of proximity or distance matrices between objects or points in a multidimensional space. The most common data are of the second type, for which cluster analysis aims at identifying some geometrically distant groups within which objects are close. The choice of the distance between the objects is the main point of the study; it largely determines the final variant of the separation of objects into classes for a given separation algorithm.

Studying the quantitative indicators of the number of hives and livestock production, the most optimal and effective variant of developing the initial steps in the insurance of beekeeping and promoting its further development through cluster analysis was presented. Using cluster analysis, we will have the opportunity to reduce the cost of investment in insurance in the beekeeping sector.

Geometrically, the objects within the cluster are located close to each other, while the distance between clusters is large.

FINDINGS, RESULTS, DISCUSSION. In recent years, the Republic of Armenia has paid great attention to the development of beekeeping. The state support programmes implemented in recent years are a vivid confirmation of this. However, farmers still lack a stable income.

Let us apply the logarithmic utility function to the beekeeping insurance sector:

$$u(x) = \beta * \ln(x)$$

- x − beekeeping income (in dollars) for a given year, for example: x = (honey quantity × average selling price) − direct costs.
- $u(x) = \ln(x)$ − utility function (let's take $\beta=1$).
- n − number of years under consideration.
- l − number of “stable/profitable” years, when income is above average.
- k − number of “lossy/low-profit” years, when income is below average ($n = l + k$).
- Wl − income above average (e.g., average of years with “good honey production and price”).
- Wk − average of years with below-average income (e.g., winter losses, low honey flow, diseases).
- $p_1 \approx l/n$, $p_2 \approx k/n$ − probability estimates of a profitable/lossy year (before the creation of a personalised database).
- P − annual insurance premium (policy price) with “below-average income restoration” coverage.

The farmer will accept insurance if:

$$\ln(Wl - P) > p_1 \cdot \ln(Wl) + p_2 \cdot \ln(Wk)$$

The standard transformation yields the same upper bound structure:

$$P < (k/n) \cdot (Wl - (n/l) \cdot Wk)$$

which is equivalent to the presented form:

$$P < (k/n) \cdot (Wl - Wk \cdot (n/l))$$ - the same substantive meaning.

This is the maximum “net” insurance premium at which the restoration of the Wl level (conceptually below-average income) is ensured “every year”.

In real practice, the following are added to it:

- risk premium (net risk value, reinsurance value),
- operating expense premium,
- profitability rate (according to company policy).

Let's use the utility function:

$$u(x) = \beta \cdot \ln(x), \quad \beta=1$$

where

- x − beekeeping income in a given year

The formula for calculating honey income (general):

$$Et = Qt \times Pt \times 1000$$

where

- Qt − production volume in thousand tons,
- P − average price (drams/kg),
- ×1000 − to go from “thousand tons” to kg.

Thus, we get the income in drams.

Table 1

Dynamics of beekeeping production volume, prices and total income in the Republic of Armenia (2018–2024)

(author's calculations with reply to posts N 09.4/10308-2025, the Ministry of Economics and No. VK/2-13/3133-2025, Statistical Committee of the Republic of Armenia)

Year	Volume (thousand tons)	Price (AMD/kg)	Income (AMD)
2018	2.2	3,888	8,553,600,000
2019	2.1	4,122	8,656,200,000
2020	2.2	4,078	8,971,600,000
2021	2.1	4,380	9,198,000,000
2022	2.1	5,087	10,682,700,000
2023	2.1	5,500	11,550,000,000
2024	2.0	5,822	11,644,000,000

The values of the utility function:

$$u(x)=\ln(x)$$
$$2018: u(x)=\ln(8,553,600,000)\approx 22.87$$
$$2019: u(x)=\ln(8,656,200,000)\approx 22.88$$
$$2020: u(x)=\ln(8,971,600,000)\approx 22.92$$
$$2021: u(x)=\ln(9,198,000,000)\approx 22.94$$
$$2022: u(x)=\ln(10,682,700,000)\approx 23.09$$
$$2023: u(x)=\ln(11,550,000,000)\approx 23.17$$
$$2024: u(x)=\ln(11,644,000,000)\approx 23.18$$

Let's calculate the average income for 2018–2024.

Sum of income:

$$8.5536 + 8.6562 + 8.9716 + 9.1980 + 10.6827 + 11.5500 + \\ +11.6440 = 69.2561 \text{ billion drams}$$

Average income:

$$69.2561 \div 7 \approx 9.89 \text{ billion drams}$$

Now we need to distinguish between “good” (Wl) and “bad” (Wk) years based on average income.

Bad years (Wk): when income < 9.89 billion → 2018–2020

− Average Wk = (8.5536 + 8.6562 + 8.9716) ÷ 3 ≈ 8.73 billion drams

Good years (W_l): when income > 9.89 billion: 2021–2024

− Average W_l = (9.1980 + 10.6827 + 11.5500 + 11.6440) ÷ 4 ≈ 10.77 billion drams

Let’s calculate the probabilities:

- Total years: $n = 7$
- Good years: $l = 4 \rightarrow p_1 = 4/7 \approx 0.571$
- Bad years: $k = 3 \rightarrow p_2 = 3/7 \approx 0.429$

Model formula:

$$P < \frac{k}{n} \cdot \left(W_l - \frac{n}{l} \cdot W_k\right)$$

Calculate:

$n/l = 7/4 = 1.75$

$(n/l) \cdot Wk = 1.75 \times 8.73 \approx 15.28$ billion

$Wl - (n/l) \cdot Wk = 10.77 - 15.28 \approx -4.51$ billion

$k/n \cdot (Wl - n/l \cdot Wk) = (3/7) \times (-4.51) \approx -1.93$

Since the model result was negative (≈ −1.93 billion drams), it cannot be converted into a positive solvency insurance premium under the conditions of the logarithmic utility function. This means that farmers' willingness to pay for insurance is practically very low, almost zero.

Analysis of honey production revenues for 2018–2024 shows that the average revenue was about 9.89 billion drams. Based on this, 2018–2020 can be classified as "bad" years (average revenue: 8.73 billion drams), and 2021–2024 as "good" years (average revenue: 10.77 billion drams). In general, the positive trend in revenue growth is observed especially after 2021, which is mainly due to an increase in prices and not an increase in production volumes.

The uncertainty of honey production revenues and declining trends in volumes limit farmers' willingness to purchase insurance.

Therefore, the establishment and effective operation of beekeeping insurance requires state support, a flexible structure of the insurance model, as well as a regional and cluster approach based on more in-depth data collection and analysis.

And now let us perform cluster analysis.

It is important to use the available resources as efficiently as possible in the implementation of the pilot programme, so we conducted a cluster analysis, identifying similar regions to apply a similar approach in terms of relevant indicators. By dividing the following indicators by regions: the number of bee families in the Republic of Armenia and the number of livestock production in the Republic of Armenia, we tried to find the most efficient options for resource utilization. Before the cluster analysis, let us consider the dynamic changes in the indicators that make up the cluster.

In 2013-2024, the dynamics of the volume of livestock production in the Republic of Armenia is generally characterized by a growth trend, but was accompanied by sharp fluctuations. If in 2013 the indicator amounted to 346.3 billion drams, then in 2018 it reached 477.1 billion drams, providing an increase of about 38%. During this period, stable growth phases are observed (2013-2015, 2017-2018), in which the main driving factors were the expansion of production and increased market demand. At the same time, declines were recorded in 2016 and 2019, which indicates the dependence of the sector on both internal and external risks: climatic conditions, disruptions in supply chains and the spread of animal diseases. In recent years, after 2020, the dynamics reflect a recovery trend.

Table 2

Determination of Dynamic Growth in the quantity of livestock production in the Republic of Armenia, 2013-2024 *(current prices, billion drams)*

Date	Volume, tons	An absolute plus $\Delta y_{i/i-t}$		Growth rate $T_{P_{i/1}}$, %		Growth rate $T_{npy_{i/1}}$, %		1% growth rate A/%/
		base	chain	base	chain	base	chain	base
2013	346.3	0.0		100.0		0.0		
2014	387.8	41.5	41.5	112.0	112.0	12.0	12.0	3.5
2015	395.4	49.1	7.6	114.2	102.0	14.2	2.0	3.9
2016	391.8	45.5	-3.6	113.1	99.1	13.1	-0.9	4.0
2017	439.3	51.5	47.5	113.3	112.1	13.3	12.1	3.92
2018	477.1	81.7	37.8	120.7	108.6	20.7	8.6	4.4
2019	442.4	50.6	-34.7	112.9	92.7	12.9	-7.3	4.8
2020	433.8	-5.5	-8.6	98.7	98.1	-1.3	-1.9	4.4
2021	465.3	-11.8	31.5	97.5	107.3	-2.5	7.3	4.34
2022	502.5	60.1	37.2	113.6	108.0	13.6	8.0	4.65
2023	500.5	66.7	-2.0	115.4	99.6	15.4	-0.4	5.03
2024	503.2	37.9	2.7	108.1	100.5	8.1	0.5	5.01

Although in 2020 a decline was recorded to 433.8 billion drams (98.7% compared to the base level), a noticeable increase is observed in 2021-2022, reaching 502.5 billion drams. Data for 2023-2024 show some stabilization, in the range of about 500 billion drams. This indicates that the sector is gradually overcoming shocks and gaining a basis for sustainable development. However, fluctuations in chain growth and growth rates prove that the livestock sector is still vulnerable to external and internal factors, and state support programs, development of risk management mechanisms and increased production efficiency are necessary for its stabilization.

Table 3

Determination of Dynamic Growth in the number of beehives in Armenia, 2015-2024

Date	Volume, tons	An absolute plus $\Delta y_{i/i-t}$		Growth rate $T_{P_{i/1}}$, %		Growth rate $T_{npy_{i/1}}$, %		1% growth rate A/%/
		base	chain	base	chain	base	chain	base
2015	245396	0.0		100.0		0.0		
2016	237217	-8179.0	-8179.0	96.7	96.7	-3.3	-3.3	2454.0
2017	237408	-7988.0	191.0	96.7	100.1	-3.3	0.1	2372.2
2018	237941	-7455.0	533.0	97.0	100.2	-3.0	0.2	2374.1
2019	228152	-9065.0	-9789.0	96.2	95.9	-3.8	-4.1	2379.41
2020	233196	-4212.0	5044.0	98.2	102.2	-1.8	2.2	2281.5
2021	208818	-29123.0	-24378.0	87.8	89.5	-12.2	-10.5	2332.0
2022	206853	-21299.0	-1965.0	90.7	99.1	-9.3	-0.9	2088.2
2023	190831	-42365.0	-16022.0	81.8	92.3	-18.2	-7.7	2068.53
2024	189050	-19768.0	-1781.0	90.5	99.1	-9.5	-0.9	1908.31

During 2015-2024, the number of beehives in the Republic of Armenia showed a steady downward trend, decreasing from 245.4 thousand units recorded in 2015 to 189.1 thousand units, which is a decrease of about 23%. If in 2016-2018 the rates of decrease were relatively mild, then in 2019-2021 more significant reductions were observed, the deepest of which, in 2021, amounted to -12.2% at the base growth rate. Despite the partial increase or slowdown in the decrease recorded in 2020 and 2022, the overall trend remained negative. In 2023-2024, the continued decline (-7.7% and -0.9% at chain rates) indicates a lack of stabilization in the sector and the possible impact of economic, climatic, as well as disease-related factors.

Table 4

***Number of bee families and livestock production in the Republic of Armenia by regions for 2015-2024, pcs. (author's calculations with** (Statistical Committee of the Republic of Armenia, Reply to post N 09.4/10308-2025, the Ministry of Economy of the Republic of Armenia, Reply to post N ՎԿ/2-13/2076-2025)*

Regions	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Average*
Number of bee colonies in the Republic of Armenia by region, 2016-2023, pcs.											
Yerevan	5864	6245	6197	6242	6243	6235	5302	4985	5010	761	**5308.4**
Aragatsotn	15892	12802	13347	14664	14980	15031	13185	12567	10699	12283	**13545**
Ararat	14031	14211	12957	12627	12100	12156	10853	9881	10084	9790	**11869**
Armavir	9108	8861	9252	8740	9641	9147	8264	8013	7261	6631	**8491.8**
Gegharkunik	41728	42642	40974	42152	41291	44584	40859	38128	35464	37610	**40543.2**
Lori	25512	25099	24920	23540	20727	23742	20948	20614	19096	17462	**22166**
Kotayk	26552	24942	27605	29396	26299	26915	25204	24625	20924	24458	**25692**
Shirak	18646	19045	18328	19697	18119	16027	14872	13478	12094	12778	**16308.4**
Syunik	43674	39732	39963	39901	39078	37605	31572	36707	30475	30378	**36908.5**
Vayots Dzor	22570	23189	23199	23821	22883	24077	22193	23071	22836	22461	**23030**
Tavush	21819	20449	20666	17161	16791	17677	15566	14784	16888	14438	**17623.9**
Volume of livestock production in the Republic of Armenia by region, 2016-2023, billion drams											
Yerevan	6.4	6.7	7.2	9.3	6.8	6.9	7.5	9.8	10.4	10.9	**8.2**
Aragatsotn	42.2	41.5	47.2	51	48.6	47.3	49.3	53.6	52.1	53.34	**48.6**
Ararat	28.7	28.6	32	33.7	32.1	31	33	35.5	35.7	36.58	**32.7**
Armavir	42.3	40.4	44.5	50.7	50.3	47.7	48.9	56.4	54.9	56.48	**49.3**
Gegharkunik	62.5	62.7	69.7	74	64.9	61.4	67.9	70.3	67.3	67.9	**66.9**
Lori	43.6	44.3	50	51.6	46.9	46.8	53.6	60.4	63	65.43	**52.6**
Kotayk	40.2	40.8	45.8	51.6	50.4	53.2	53.4	60.4	57.9	60.11	**51.4**
Shirak	52.2	50.9	58	62.4	56.4	54.3	58.7	62.8	59.6	60.53	**57.6**
Syunik	38.3	38	41.6	48	42.8	41.7	43.1	43.3	44.4	45.16	**42.6**
Vayots Dzor	14.8	14.3	16.8	16.6	16.2	16.8	16.3	18	17.7	18.06	**16.6**
Tavush	24.2	23.6	26.6	28.2	27	26.7	33.6	32	37.5	39.16	**29.9**

Let us perform cluster analysis based on the averaged data in Table 3. To calculate the distance between the objects we will use the Euclidean distance formula:

$$d_{ij}=\sqrt{\sum_{k=1}^{m}(X_{ik}-X_{jk})^2}$$

$$d_{11}=0$$

$$d_{11}=0$$

$$d_{12}=\sqrt{(5{,}308.4-13{,}545.0)^2+(8.2-48.6)^2}=8{,}236.70$$
$$d_{13}=\sqrt{(5{,}308.4-11{,}869.0)^2+(8.2-32.7)^2}=6{,}560.65$$
$$d_{14}=\sqrt{(5{,}308.4-8{,}491.8)^2+(8.2-49.3)^2}=3{,}183.66$$
$$d_{15}=\sqrt{(5{,}308.4-40{,}543.2)^2+(8.2-66.9)^2}=35{,}234.85$$
$$d_{16}=\sqrt{(5{,}308.4-22{,}166.0)^2+(8.2-52.6)^2}=16{,}857.66$$
$$d_{17}=\sqrt{(5{,}308.4-25{,}692.0)^2+(8.2-51.4)^2}=20{,}383.65$$
$$d_{18}=\sqrt{(5{,}308.4-16{,}308.4)^2+(8.2-57.6)^2}=11{,}000.11$$
$$d_{19}=\sqrt{(5{,}308.4-36{,}908.5)^2+(8.2-42.6)^2}=31{,}600.12$$
$$d_{110}=\sqrt{(5{,}308.4-23{,}030.0)^2+(8.2-16.6)^2}=17{,}721.60$$
$$d_{111}=\sqrt{(5{,}308.4-17{,}623.9)^2+(8.2-29.9)^2}=12{,}315.52$$
$$d_{22}=0$$
$$d_{23}=\sqrt{(13{,}545.0-11{,}869.0)^2+(48.6-32.7)^2}=1676.08$$
$$d_{24}=\sqrt{(14058.5-8{,}491.8)^2+(48.6-49.3)^2}=5053.20$$
$$d_{25}=\sqrt{(13{,}545.0-40{,}543.2)^2+(48.6-66.9)^2}=26998.21$$
$$d_{26}=\sqrt{(13{,}545.0-22{,}166.0)^2+(48.6-52.6)^2}=8621.00$$
$$d_{27}=\sqrt{(13{,}545.0-25{,}692.0)^2+(48.6-51.4)^2}=12147.00$$
$$d_{28}=\sqrt{(13{,}545.0-16{,}308.4)^2+(48.6-57.6)^2}=2763.41$$
$$d_{29}=\sqrt{(13{,}545.0-36{,}908.5)^2+(48.6-42.6)^2}=23363.50$$
$$d_{210}=\sqrt{(13{,}545.0-23{,}030.0)^2+(48.6-16.6)^2}=9485.05$$
$$d_{211}=\sqrt{(13{,}545.0-17{,}623.9)^2+(48.6-29.9)^2}=4078.94$$
$$d_{33}=0$$
$$d_{34}=\sqrt{(11{,}869.0-8{,}491.8)^2+(32.7-49.3)^2}=3377.24$$
$$d_{35}=\sqrt{(11{,}869.0-40{,}543.2)^2+(32.7-66.9)^2}=28674.22$$
$$d_{36}=\sqrt{(11{,}869.0-22{,}166.0)^2+(32.7-52.6)^2}=10297.02$$
$$d_{37}=\sqrt{(11{,}869.0-25{,}692.0)^2+(32.7-51.4)^2}=13823.01$$
$$d_{38}=\sqrt{(11{,}869.0-16{,}308.4)^2+(32.7-57.6)^2}=4439.47$$
$$d_{39}=\sqrt{(11{,}869.0-36{,}908.5)^2+(32.7-42.6)^2}=25039.50$$
$$d_{310}=\sqrt{(11{,}869.0-23{,}030.0)^2+(32.7-16.6)^2}=11161.01$$
$$d_{311}=\sqrt{(11{,}869.0-17{,}623.9)^2+(32.7-29.9)^2}=5754.90$$
$$d_{44}=0$$
$$d_{45}=\sqrt{(8{,}491.8-40{,}543.2)^2+(49.3-66.9)^2}=32051.40$$
$$d_{46}=\sqrt{(8{,}491.8-22{,}166.0)^2+(49.3-52.6)^2}=13674.20$$
$$d_{47}=\sqrt{(8{,}491.8-25{,}692.0)^2+(49.3-51.4)^2}=17200.20$$
$$d_{48}=\sqrt{(8{,}491.8-16{,}308.4)^2+(49.3-57.6)^2}=7816.60$$

$$d_{49}=\sqrt{(8{,}491.8-36{,}908.5)^2+(49.3-42.6)^2}=28416.70$$
$$d_{410}=\sqrt{(8{,}491.8-23{,}030.0)^2+(49.3-16.6)^2}=14538.24$$
$$d_{411}=\sqrt{(8{,}491.8-17{,}623.9)^2+(49.3-29.9)^2}=9132.12$$
$$d_{55}=0$$
$$d_{56}=\sqrt{(40{,}543.2-22{,}166.0)^2+(66.9-52.6)^2}=18377.21$$
$$d_{57}=\sqrt{(40{,}543.2-25{,}692.0)^2+(66.9-51.4)^2}=14851.21$$
$$d_{58}=\sqrt{(40{,}543.2-16{,}308.4)^2+(66.9-57.6)^2}=24234.80$$
$$d_{59}=\sqrt{(40{,}543.2-36{,}908.5)^2+(66.9-42.6)^2}=3634.78$$
$$d_{510}=\sqrt{(40{,}543.2-23{,}030.0)^2+(66.9-16.6)^2}=17513.27$$
$$d_{511}=\sqrt{(40{,}543.2-17{,}623.9)^2+(66.9-29.9)^2}=22919.33$$
$$d_{66}=0$$
$$d_{67}=\sqrt{(22{,}166.0-25{,}692.0)^2+(52.6-51.4)^2}=3526.00$$
$$d_{68}=\sqrt{(22{,}166.0-16{,}308.4)^2+(52.6-57.6)^2}=5857.60$$
$$d_{69}=\sqrt{(22{,}166.0-36{,}908.5)^2+(52.6-42.6)^2}=14742.50$$
$$d_{610}=\sqrt{(22{,}166.0-23{,}030.0)^2+(52.6-16.6)^2}=864.75$$
$$d_{611}=\sqrt{(22{,}166.0-17{,}623.9)^2+(52.6-29.9)^2}=4542.16$$
$$d_{77}=0$$
$$d_{78}=\sqrt{(25{,}692.0-16{,}308.4)^2+(51.4-57.6)^2}=9383.60$$
$$d_{79}=\sqrt{(25{,}692.0-36{,}908.5)^2+(51.4-42.6)^2}=11216.50$$
$$d_{710}=\sqrt{(25{,}692.0-23{,}030.0)^2+(51.4-16.6)^2}=2662.23$$
$$d_{711}=\sqrt{(25{,}692.0-17{,}623.9)^2+(51.4-29.9)^2}=8068.13$$
$$d_{88}=0$$
$$d_{89}=\sqrt{(16{,}308.4-36{,}908.5)^2+(57.6-42.6)^2}=20600.11$$
$$d_{810}=\sqrt{(17276.5-23{,}030.0)^2+(57.6-16.6)^2}=6721.73$$
$$d_{811}=\sqrt{(17276.5-17{,}623.9)^2+(57.6-29.9)^2}=1315.79$$
$$d_{99}=0$$
$$d_{910}=\sqrt{(36{,}908.5-23{,}030.0)^2+(42.6-16.6)^2}=13878.52$$
$$d_{911}=\sqrt{(36{,}908.5-17{,}623.9)^2+(42.6-29.9)^2}=19284.60$$
$$d_{1010}=0$$
$$d_{1011}=\sqrt{(23{,}030.0-17{,}623.9)^2+(16.6-29.9)^2}=5406.12$$
$$d_{1111}=0$$

Let us form the results of calculations into matrices.

	1	2	3	4	5	6	7	8	9	10	11
1	0	8236.7	6560.65	3183.66	35234.85	16857.66	20383.65	11000.11	31600.12	17721.6	12315.52
2		0	1676.08	5053.2	26998.21	8621	12147	2763.41	23363.5	9485.05	4078.94
3			0	3377.24	28674.22	10297.02	13823.01	4439.47	25039.5	11161.01	5754.9
4				0	32051.4	113674.2	17200.2	7816.6	28416.7	14538.24	9132.12
5					0	18377.21	14851.21	24234.8	3634.78	17513.27	22919.33
6						0	3526	5857.6	14742.5	**864.75**	4542.16
7							0	9383.6	11216.5	2662.33	8068.13
8								0	20600.11	6721.73	1315.79
9									0	13878.52	19284.6
10										0	5406.12
11											0

Objects 6 and 10 are the closest, at a distance of 864.75. Let's merge those two clusters

R_2=

	1	2	3	4	5	6,10	7	8	9	11
1	0	8236.7	6560.65	3183.66	35234.85	16857.66	20383.65	1100.11	31600.12	12315.5
2		0	1676.08	5053.2	26998.21	8621	12147	2763.41	23363.5	4078.94
3			0	3377.24	28674.22	10297.02	13823.01	4439.47	25039.5	5754.9
4				0	32051.4	13674.2	17200.2	7816.6	28416.7	9132.12
5					0	17513.27	14851.21	24234.8	3634.78	22919.33
6,10						0	2662.23	5857.6	13878.52	4542.16
7							0	9383.6	11216.5	8068.13
								0	20600.11	**1315.79**
									0	19284.6
										0

Objects 8 and 11 are the closest, at a distance of 1315.79. Let's merge those two clusters.

$R_3=$

□	1	2	3	4	5	6,10	7	8,11	9
1	0	8236.7	6560.65	3183.66	35234.85	16857.66	20383.65	1100.11	31600.12
2	□	0	**1676.08**	5053.2	26998.2	8621	12147	2763.41	23363.5
3	□	□	0	3377.24	28674.22	10297.02	13823.01	4439.47	25039.5
4	□	□	□	0	32051.4	13674.2	17200.2	7816.6	28416.7
5	□	□	□	□	0	17513.27	14851.21	22919.33	3634.78
6,10	□	□	□	□	□	0	2662.23	4542.16	13878.52
7	□	□	□	□	□	□	0	8068.13	11216.5
8,11	□	□	□	□	□	□	□	0	19284.6
9	□	□	□	□	□	□	□	□	0

Objects 2 and 3 are the closest, at a distance of 1676.08. Let's merge those two clusters

$R_4=$

□	1	2,3	4	5	6,10	7	8,11	9
1	0	6560.65	3183.66	35234.85	16857.66	20383.65	11000.11	31600.12
2,3	□	0	3377.24	26998.21	8621	12147	2763.41	23363.5
4	□	□	0	32051.4	13674.2	17200.2	7816.6	28416.7
5	□	□	□	0	17513.27	14851.21	22919.33	3634.78
6,10	□	□	□	□	0	**2662.23**	4542.16	13878.52
7	□	□	□	□	□	0	8068.13	11216.5
8,11	□	□	□	□	□	□	0	19284.6
9	□	□	□	□	□	□	□	0

Objects 6,7 and 10 are the closest, with a distance of 2662.23. Let's merge those two clusters.

$R_5 =$

⬚	1	2,3	4	5	6,10,7	8,11	9
1	0	6560.65	3183.66	35234.85	16857.66	11000.11	31600.12
2,3	⬚	0	3377.24	26998.21	8621	**2763.41**	23363.5
4	⬚	⬚	0	32051.4	13674.2	7816.6	28416.7
5	⬚	⬚	⬚	0	14851.21	22919.33	3634.78
6,10,7	⬚	⬚	⬚	⬚	0	4542.16	11216.5
8,11	⬚	⬚	⬚	⬚	⬚	0	19284.6
9	⬚	⬚	⬚	⬚	⬚	⬚	0

Objects 2,3 and 8,11 are the closest, with a distance of 2763.41. Let's merge those two clusters.

$R_6=$

□	1	2,3,8,11	4	5	6,10,7	9
1	0	6560.65	**3183.66**	35234.85	16857.66	31600.12
2,3,8,11	□	0	3377.24	22919.33	4542.16	19284.6
4	□	□	0	32051.4	13674	28416.7
5	□	□	□	0	14851.21	3634.78
6,10,7	□	□	□	□	0	11216.5
9	□	□	□	□	□	0

Objects 1 and 4 are the closest, at a distance of 3183.66. Let's merge those two clusters

$R_7=$

□	1,4	2,3,8,11	5,9	6,10,7	9
1,4	0	**3377.24**	32051.4	13674.2	28416.7
2,3,8,11	□	0	22919.33	4542.6	19284.6
5,9	□	□	0	14851.21	3634.78
6,10,7	□	□	□	0	11216.5
9	□	□	□	□	0

Objects 1, 4 and 2,3,8,11 are the nearest to each other, with a distance of 3377.24. Let's proceed by merging these two clusters.

$R_8=$

□	1,4,2,3,8,11	5	6,10,7	9
1,4, 2,3,8,11	0	22919.33	4542.16	19284.6
5	□	0	14851.21	**3634.78**
6,10,7	□	□	0	11216.5
9	□	□	□	0

Objects 9 and 5 are the nearest to each other, with a distance of 3634.78. Let's proceed by merging these two clusters.

$R_9=$

□	1,4,2,3,8,11	5,9	6,10,7
1,4,2,3,8,11	0	19284.6	**4542.16**
5,9	□	0	11216.5
6,10,7	□	□	0

Objects 1,4,2,3,8,11 and 6,10,7 are the nearest to each other, with a distance of 4542.16. Let's proceed by merging these two clusters.

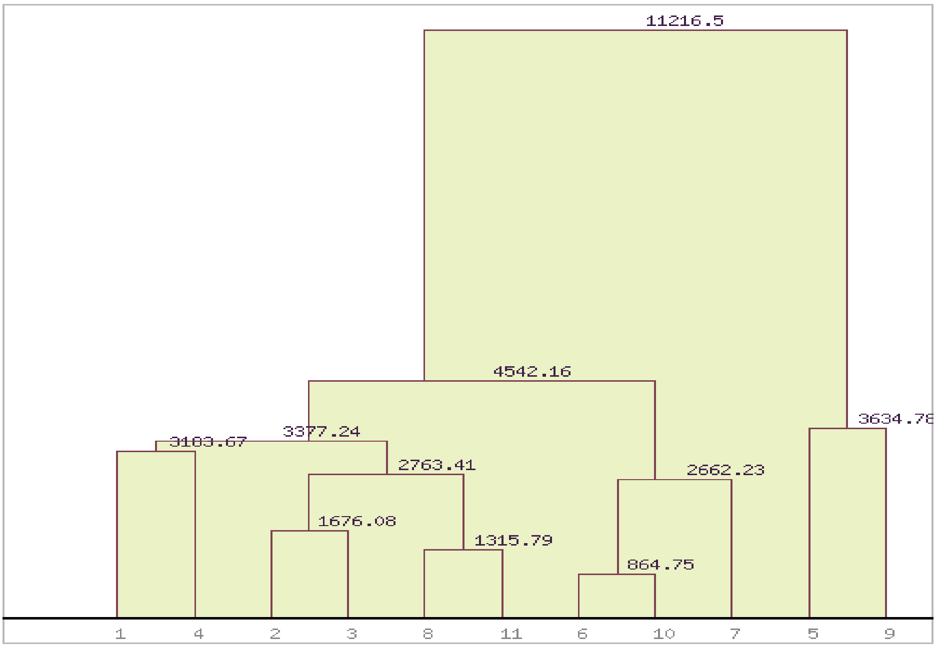
$R_{10}=$

□	1,4,2,3,8,11,6,10,7	5,9
1,4,2,3,8,11,6,10,7	0	**11216.5**
5,9	□	0

Thus, as a result of cluster analysis, we obtained a picture according to which the regions are "close" to each other in terms of the indicators under study:

1. Lori and Vayots Dzor
2. Shirak and Tavush
3. Aragatsotn and Ararat
4. Yerevan and Armavir
5. Gegharkunik and Syunik

Let us also reflect the results of the calculations using a histogram, below:



CONCLUSION. Summarizing the analysis, it can be said that the beekeeping industry is of great importance for the Republic of Armenia, and ensuring a stable income in this industry is one of the primary issues. And one of the cornerstones for promoting sustainable activity and development of the beekeeping industry is insurance. Thanks to the analyses conducted, it was possible to identify changes in the number of beehives in the Republic of Armenia and quantitative indicators of production in the livestock industry of the Republic of Armenia.

The model results which were negative, show that farmers' willingness to pay for insurance is actually quite low. In other words, the uncertainty of honey production revenues and the tendency for volume reduction reduce the attractiveness of the insurance system for farmers. They are more inclined to avoid additional costs than to invest in insurance. This once again emphasizes that to form effective insurance mechanisms in the sector, a complex policy of state support, subsidies and ensuring long-term sustainability is necessary.

In recent years, the quantitative indicators of bee population have decreased, while the quantitative indicators of gross livestock production have increased.

In this paper, a cluster analysis of the number of bee families and livestock production by regions of the Republic of Armenia was carried out. Calculations show that Lori and Vayots Dzor, Shirak and Tavush, Aragatsotn and Ararat, Yerevan and Armavir, as well as Gegharkunik and Syunik are 'close' to each other by the studied indicators. As it is known, there is a continuous process of adaptation of agricultural insurance in Armenia. Therefore, taking into account the results of the cluster analysis and the emerging 'close' cluster, we propose to implement the same palliative programmes in the above-mentioned regional pairs, taking into account the specifics of the latter. This will optimize the process of improving agro-insurance in the Republic of Armenia, as well as increase the efficiency of potential pilot programmes.

Thus, as a result of the analysis we can say that when implementing a pilot insurance programme in the beekeeping industry, 'close' clusters should be taken into account in order to implement the most optimal resource inputs and an effective pilot programme.

As a result of the analyses conducted, it is recommended:

- ✓ Include the beekeeping sector among the priority areas of agricultural insurance, taking into account its economic and ecological significance.
- ✓ Implement insurance pilot programs in regional clusters: Lori-Vayots Dzor, Shirak-Tavush, Aragatsotn-Ararat, Yerevan-Armavir, Gegharkunik-Syunik pairs.
- ✓ Apply similar insurance models in regional clusters, adapted to the environmental and economic characteristics of each region.
- ✓ Use a cluster approach to reduce the resource costs of the insurance system and increase its efficiency.
- ✓ After the success of the pilot programs, gradually expand the insurance system to other regions of the Republic of Armenia.
- ✓ Ensure effective state-private sector cooperation in the process of introducing the insurance system.
- ✓ Organize awareness-raising and training programs at the regional level for beekeepers on the mechanisms and advantages of insurance.

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