INVESTIGATION OF THE OPERATION OF THE NATIONAL SYSTEM MODERATING ICE DAMAGE

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Abstract: *Humanity has always been interested in the possibility of modifying and influencing the weather. Many researchers, physicists, and meteorologists have dealt with the subject, but have never reached significant results. With the development of technology, the scientific communities find it difficult to accept the fact that in reality, it is not quite possible to influence the weather. This, among other reasons, is why they have begun to inspect how different atmospheric phenomena may be caused and extinguished. A significant breakthrough in these experiments was first noted in the middle of the 1900s due to which not only the scientific community began to apply weather control measures, but also the military for martial purposes. In Hungary, the first such measure was taken due to societal needs toward reducing the damages caused by hail, and the NEFELA Southern Hungarian Hail Prevention Association was formed. The system, which covers three Transdanubian counties, was based on French example, it applies a soil-generator hail prevention method and began operation in 1976. Today, the extent to which hail causes damage has justified the implementation of a nationwide system. The National Agricultural Chamber was granted support for the purpose of building such a system via a tender issued within the framework of Rural Development Program. I will examine the following hypotheses throughout my research:*

1. I hypothesize that the hail damage reduction system will work efficiently and yield results.

2. I hypothesize that as a result of the system's function, damage to agricultural areas will be significantly decreased within the first year.

In order to test my hypotheses, I collected data at the National Agricultural Chamber, the National Meteorological Service and the Government Office of Békés County.

My examinations reflect that this year saw an exceptionally high number of rain showers compared to previous years, however, despite this fact, the amount of ice damage reported has decreased to half, almost a third, thus, my first hypothesis has proven to be true. Furthermore, the data supports my second hypothesis as well, according to which damage in the agricultural industry has decreased significantly. We can see that the per hectare ice damage reported for each storm is shown to have decreased despite the increase in the number of storms. While assessing my findings, I would like to note that the implementation of the system has only just begun, thus we only have one year's worth of data available to us. At the same time, it is apparent that there is a significant change in the reduction of ice damage.

The conclusion to be drawn from the results of my research is that the function of the National Ice Damage Reduction System is efficient, there are fewer instances of hail with larger ice crystals and the amount and value of agricultural damage have decreased.

Keywords: *hail, moderation of damage done by hail, risk managemet, soil generator, System of Country's Moderation of Damage Done by Hail*

INTRODUCTION

Influencing and modifying weather conditions has long been a concern for mankind (BARTHOLY 2013) In the agricultural sector, besides drought, hail causes the greatest loss of yield, so the main goal was to reduce it (BELINSZKY 2018). In order to serve the emerging social demand, a nationwide system was established in Hungary. In addition, a network-based hail removal technology is used to perform the network. Our research deals with the effectiveness of ice reduction.

Many scientists, physicists and meteorologists have dealt with weather-changing activities, but no significant results have been previously recognized (BYERS AND BRAHAM 1949). In the experiments a significant breakthrough appeared only in the middle of the 1900s, after which the military, but also the army, started to apply the technologies of weather modification for military purposes. It is important to note that hail, as defined by the WHO, is a precipitate that falls in the form of ice cubes of 5 mm or more or irregular ice

cubes. For the formation of ice crystals, there is a need for condensation, the so-called ice-forming particles (VÁLI 1995, YOUNG 1993, AND GERESDI 2004). It is well known that smaller or larger ice grains are formed in every thunderstorm, so the question is not whether it contains clouds of ice, but whether they reach the surface before they completely melt. (KNIGHT C. A AND KNIGHT 2001, CSIRMAZ 2012). This is supported by model calculations, which show that there are ice eyes in every thunderstorm, if they do not melt until the soil surface is reached, then we are talking about hail (GERESDI 2004).

The first major experiment, which we can consider scientifically sound, was implemented by Vincent Schaefer in 1946 (GRABANT 2010). The American meteorologist wanted to model the process of icing on the wings of aircraft, and developed a fog chamber to develop it. During a power outage, the chamber overheated, trying to cool with dry ice (crystalline carbon dioxide) and silver iodide. Then he discovered completely that the dry ice had a cloud effect (HEGYFOKY 1989). Studying this phenomenon, it was concluded that with sudden changes in saturation vapor pressure, ice crystals are formed from over-cooled water droplets (CZELNAI 1996). The scientist wanted the result to be tested in natural conditions. With his motorbike, he flew into a cloud of clouds of dry ice. Snow crystals appeared in the area under the cloud, snow was falling, but no such phenomenon was detected in the surrounding areas, so the result of the experiment was proven. (JOHN, 1964)

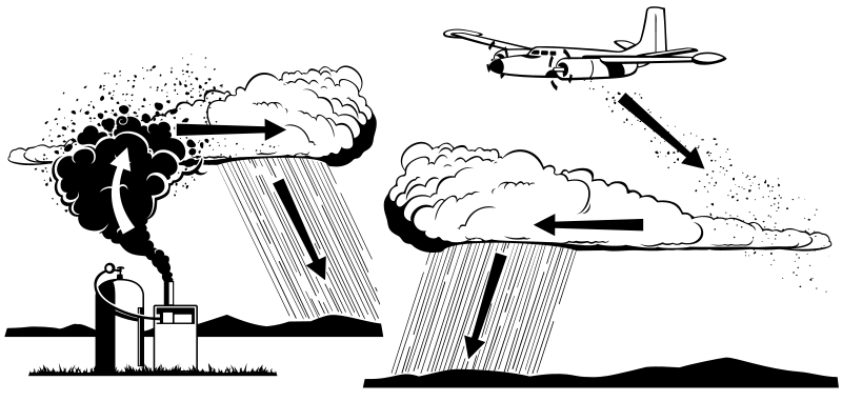

Fig. 1 Experiment with motorized small machine

After successful attempts, many countries have begun to deal with changes in atmospheric processes. In the United States, an attempt was made to modify a hurricane, causing a monsoon period in the Popeye operation during the Vietnam War (PETE 2000). Finally, in 1977, the international agreement was concluded under which the Geneva Convention was declared unlawful for military purposes.

In Hungary, the first system that specializes in mitigating and eliminating damage caused by hail was operating between 1976 and 1990, where missile hail removal was used. The high operating costs could not be met by the state budget, so the liquidation started. At the same time, in an increasingly large area, there has been a growing demand for an effective anti-hail protection system. In 1991, NEFELA Southern Hail Rescue Association was established to meet the demand. The association has commissioned a French model of soil generators, with which it has succeeded in introducing a proven method in Hungary.

During the hail removal, ground-level generators produce silver iodide (AgI) crystal molecules. To exert their effects, AgI particles must be introduced into the thunderstorms before the formation of ice grains, where crystals form under the effect of low temperatures and promote the formation of ice crystals as condensation seeds. (MOLNÁR 2016). During their development, the thunderstorm clouds absorbed the warm, humid air near the soil, while "vacuuming" the areas below them, and the silver iodide particles enter the cloud.

In the course of artificial intervention in the formation of ice, more and smaller ice is created than under natural conditions. The ice grains fall slower to the ground, allowing them to spend longer in the positive temperature range, reducing their size further due to melting. Luckily, it melts completely, reaching the ground as raindrops, or at least falling into much smaller grains of ice.

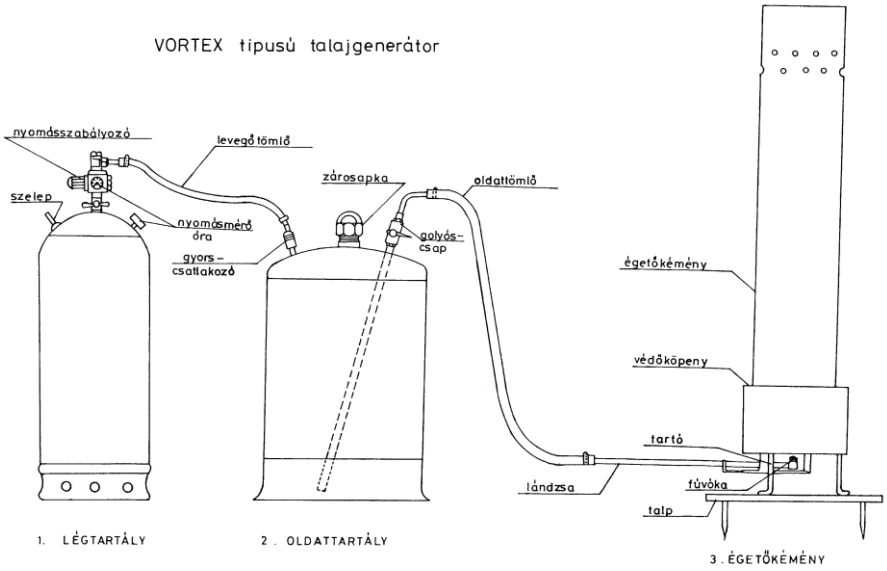

Fig. 2. Main units of the soil generator used by NEFELA: air tank (1), solution tank (2) and incinerator (3)

Ice damage is one of the most frequent damage events in Hungary, therefore the Rural Development Program states that it is of paramount importance to support hail protection at both national and producer level. The initiative is led by the National Chamber of Agricultural Economics. It was the first in Europe to build an ice-loss system covering the entire country. In the professional implementation, the ground generator technology was chosen based on the most favorable unit investment and operating costs. For nationwide coverage, 986 soil generators were needed, which were at the intersection of a 10x10 kilometer grid. Of the generators, 222 are automatic and the rest are "manual". In the operation of the system, the National Chamber of Agricultural Economics works closely with the National Meteorological Service. The system is switched on after the scratching received from OMSZ, and the affected people are informed about the weather conditions in three messages per day. The ice loss system started its operation on May 1, 2018, maintaining the 1.5 billion forints compensation from farmers' compensation payments, supplemented by government budget resources.

Soil-based hail removal works in a preventive way, and can not “blow out”, “melt” already formed ice grains, so the ice cloud coming from outside the protected area will unfortunately continue to cause damage. With this in mind, on the basis of preliminary calculations of the Chamber of Agriculture, the annual value of the annual membership fee can be kept up to ten times the annual value of HUF 50 billion using the system.

Objective

In the course of the research, we examined the operation of the National Ice Harm Reduction System, which triggered the greatest social and media interest of the past period. We were looking for an answer to the question of whether there was a noticeable change in the amount of ice damage reported and the amount of ice

damage paid as a result of the operation of the system. Many researchers have been involved in research on locally operating ice loss or hail development, but research into the new system has not yet been carried out.

Hypothesis 1: It is assumed that the ice reduction system works effectively and efficiently.

Hypothesis 2: It is assumed that damage to the agricultural area caused by the operation of the system has decreased significantly in the first year.

MATERIAL AND METHODS

During our analyzes, we analyzed the data published by the National Chamber of Agriculture, the National Meteorological Service, the Békés County Government Office and the Association of Hungarian Insurance Companies. We needed source data to examine the affected area from the weather, agriculture and insurance. First of all, we tried to get a comprehensive picture of the assumptions examined by using secondary research methods. In our work, we recorded the data in a table in the Microsoft Excel database management program, and then we performed correlations with basic statistical indicators. Pearson's correlation coefficient analysis was also used to support the hypotheses; the results of the analysis were only indicative because of the short operating time given, but our researcher demanded the application of the analysis.

RESULTS AND DISCUSSIONS

As the first area of investigation, we examined the evolution of the number of thunderstorm days, to which the National Meteorological Service provided source data. The time period is the May-June-July period, which is important to mention because it is the period when the chance of thunderstorms is greatest.

Table 1.

The number of thunderstorm days

Period	30-year average (1981-2010)	2015	2016	2017	2018
May	4	4,3	5,6	6,9	8,3
June	4,3	3,43	8,00	7,71	11,71
July	3	3,71	6,29	6,00	7,71
Total	**11,3**	**11,43**	**19,86**	**20,57**	**27,71**

From the 30-year comparison, which examines the period from 1981 to 2010, it can be seen that during the summer period, the number of thunderstorm days was similar for nearly 30 years. There is a significant difference in recent years. These values increased almost threefold by 2018 due to the 16% increase. On weekdays, it can be said that during the summer period, a thunderstorm with hail was recorded in Hungary on the 3rd day. In this case, we did not investigate the impact of climate change in our case, but the results of the co-researchers show that the number of extreme weather phenomena is constantly increasing due to climate change. These tendencies provided an appropriate basis for our research

Table 2.

Amount of reported ice damage

Year of Ice Damage	Reporting Ice Damage (hetare)	Compared to 2018
2015	43 426	200%
2016	38 319	177%
2017	53 297	246%
2018	21 674	100%

Table 2 shows the evolution of reported ice damage per hectare. The year 2018 was chosen as the base year, because this year the operation of the ice-loss system was started and we assumed that there would be a

decrease in the amount of ice damage here. The table clearly shows that in 2015, farmers were notified of more than 43,000 hectares. In 2016, the rate of reporting was lagging behind, but even so, to 317 hectares, ice damage was reported for 177% of the base year. The most striking, however, was in the year 2017 when more than 50,000 hectares had ice damage. With regard to these data, it can be clearly seen that there was a significant decline in reported ice damage in 2018.

Table 3.

Békés county ice damage data

Year of Ice Damage	Reporting -cases	Field pieces	Hectare
2015	35 db	49	73,5
2016	64 db	569	897,5
2017	75 db	738	1037,1
2018	63 db	166	289,9

In our research, besides the national data, we also carried out local investigations, where we investigated the hail damage affecting the Békés county, the number of reported applications, the number of plots declared and the amount declared per hectare. In the analysis of the data, it was also observed that a strong upward trend was followed by a sudden decline. The year 2017 can be considered as a peak when the size of the areas affected by ice damage exceeded one thousand hectares. By way of illustration, this area is the same as the size of 1400 football pitches. According to our conclusions, this is due to the fact that in 2017, besides the locally emerging thunderstorms, large supercells or even supercells were experienced over Békés county.

Table 4

Amount of paid ice damage

Year of Ice Damage	Report cases	Field pieces	Hectare
2015	35 db	49	73,5
2016	64 db	569	897,5
2017	75 db	738	1037,1
2018	63 db	166	289,9

Table 4 shows that the amount paid for ice damage for the full year, based on the data, was the highest in 2017, paying more than one and a half billion forints to farmers after the reported areas. At this point, it is important to note that the distribution of compensatory allowances per hectare is not the same for agricultural damage events. What does this mean? In the new agri-compensation scheme, we need to look at what the damage is and how it affects the yield reduction of plants. Damage claims can only be reported for adverse weather events, which is hail in the present case. When determining the payments, the reported damage event, its location and extent, as well as the yield reduction and the crop should be examined. It follows that a 50% reduction in yield per hectare of arable crops on the Great Plain will not be the same as the 50% yield reduction of the 1 hectare vineyard in the Villány wine region.

It can be seen from the table that, looking at the amounts paid per hectare, the cycle shows a lower but gradual increase after a significant increase. After the first year of the survey, data increased by 30%, followed by a steady 8% change. Paying for a thunderstorm for the reported hectares in the cycle fell by nearly half over the three-year period, rounded from $ 2,000 to $ 1250.

A comparison of the results showed that the amount paid for the full year was reduced to ice damage after the implementation of the ice-loss system, which can support the soundness of the system.

CONCLUSIONS

From the analysis of the first year of data following the commissioning of the ice mitigation system, we concluded that JÉGER's operation is successful. Larger but smaller ice crystals are formed in local and large-scale thunderstorms. As a result of this, damage to hail is reduced. Less damage causes less crop loss, and the amount of agri-compensatory payments made in this area is lower than in previous years. According to our studies, it can be seen that there was a significant change in ice reduction. As a result of the research, it can be concluded that the operation of the National Ice Harm Reduction System is efficient, that hail with larger ice crystals occurs less frequently, and the number and value of damage caused by agriculture has decreased.

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