"INTEGRATING SOCIAL DIMENSIONS INTO AGRI-CLIMATE CHANGE ADAPTATIONS"
2022-1-MK01-KA220-ADU-000086031

MUNICIPALITY OF ROSOMAN ADAPTATION STRATEGY ON CLIMATE CHANGE IN THE AGRICULTURAL SECTOR 2024 2034

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Rossoman, 2024

НАЦИОНАЛНА АГЕНЦИЈА ЗА ЕВРОПСКИ ОБРАЗОВНИ ПРОГРАМИ И МОБИЛНОСТ

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MUNICIPALITY OF ROSOMAN

STRATEGY FOR ADAPTATION TO CLIMATE CHANGES OF THE AGRICULTURAL SECTOR

STRATEGY FOR THE ADAPTATION TO CLIMATE CHANGES OF THE AGRICULTURAL SECTOR OF THE MUNICIPALITY OF ROSOMAN

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РОСОМАН

INTRODUCTION

Climate changes are one of the biggest challenges facing humanity. Global climate changes cause changes in the values of a large number of meteorological elements, which move in the direction of deterioration of the conditions for the overall agricultural production. Climate change represents one of the biggest threats, and according to future forecasts, it will represent an even greater challenge for agricultural producers. Climatic conditions represent the group of basic factors that determine the survival of plants, their development, fertility and quality of fruits. Any greater concession from the optimal values of any climatic factor causes disruptions of the physiological and biochemical processes, which ultimately have a negative impact on the overall agricultural production.

Climate change is a reality that affects and will continue to reshape the daily lives of individuals, affecting their work, livelihoods, health, housing, access to water, food security and nutrition.

Rural populations are expected to bear the brunt of the effects of climate change, primarily due to their high dependence on natural resources, which are the most vulnerable to climate-related changes. In addition, they often have limited resources to protect themselves, adapt, or recover from losses. Effective policies and actions to address these impacts will depend on transforming the social and economic relationships that contribute to vulnerability.

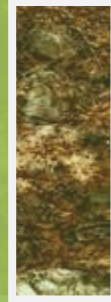
Bearing in mind the implications facing the municipality of Rosoman, it is implementing the project "Integrating social dimensions in the adaptation of agriculture to climate change". This project tries to bridge the critical gap between the adaptation of agriculture to climate change and the social dimensions that underpin it. , especially at the local level.

This project is designed to actively engage local farmers in identifying climate change-related challenges and empower them to play a central role in decision-making processes for adaptation strategies.

In the project, an approach was developed to enable comprehensive and complete action of the municipality in dealing with the implications of climate change on the population. The project includes several dimensions:

- Initial social impact assessment
- Development of a prototype of a municipal strategy
- Reduction of barriers and limitations for the involvement of farmers in adaptation processes
- Integration Guide for Social Dimensions

The strategy should ensure the direct involvement of agricultural communities, that the proposed measures for adaptation to climate change are correlated with the real needs of the most affected.



PROFILE
OF THE MUNICIPALITY OF ROSOMAN

Location and geography of the municipality of Rosoman

The municipality of Rosoman, founded in 1996, was previously a territory within the municipality of Kavadarci. Since its foundation, it has gained a reputation as one of the progressive municipalities in North Macedonia.
Centrally located in Povardarieto and in the center of the Tikveshka Kotlina, the municipality of Rosoman stretches from the northeast to the southwest along the Crna Reka river. It borders the municipalities of Kavadarci, Negotino, Gradsko and Chaska. The municipality has predominantly flat terrain, but there are also hilly and mountainous regions, with an average altitude of 140 meters, which places the municipality in one of the lowest regions in North Macedonia. The municipality of Rosoman is spread over the Crna Reka valley, which expands into a wide basin and creates alluvial deposits (soils). To the southwest, the municipality is surrounded by hills with an altitude of 200-500 m. The highest point of the municipality is the peak at 1,005 meters (Rouen peak). On average, this area has a slightly higher altitude of 315 m with gentle slopes. Geologically, the lower regions consist of sedimentary rocks. The Black River valley is marked by extensive alluvial deposits, while the surrounding hills have Pliocene and Eocene sediments. The west is geologically more diverse, with rocks from the Paleozoic to the Mesozoic period. The soils that are represented in this region are very favorable for the cultivation of vines and orchards and have a positive influence on obtaining quality grapes and fruit.

Settlements and demography

The rural communities in Rosoman are predominantly agricultural and livestock production. In some of the settlements, a decline in population is observed due to urban migration, while in others such as Manastirec and Rosoman, population growth is observed. This growth is the result of changes in agrarian practices, geographical advantages and soil fertility. From a tourist point of view, the municipality has potential for rural and agro-tourism, especially wine tourism. Settlements such as Rosoman, Manastirets, Palikura and Trstenik, located near the R-106 road, have the best prerequisites for wine tourism. Settlements with a peaceful rural atmosphere are an excellent opportunity for recreational tourism.
The key settlements in the municipality of Rosoman are:

- Rosoman
- SIrkovo
- Manastirec
- Palikura
- Kamen Dol
- Debrishte
- Ribarci
- Kruchevica
- Mrzen Oraovec

Climate and hydrography

The municipality is located in the central part of Macedonia and in the immediate vicinity of the Vardar valley, where a mix of continental and Mediterranean climate is established. Summers are typically hot, sometimes exceeding 40°C, while winters are mild, with temperatures falling to -20°C. The average annual precipitation is 510 mm, and prolonged dry periods occur during the summer. However, the annual duration of solar insolation of about 2500 hours contributes to the creation of excellent conditions for growing vines and fruit crops. The region also has an abundance of underground water, especially in the alluvial plains along the Vardar and Crna Reka rivers.

Agriculture in the municipality of Rosoman

Rosoman municipality boasts a rich agricultural heritage. The combination of the favorable geographical location, favorable climate and fertile soils make this region ideal for various application of agricultural practices in several agricultural activities. In this municipality, as with other parts of the Vardar planning region, agriculture is a significant subject/factor for the economy, and for the livelihood of the population in Rosoman.

Land use

Of the total area of Rossoman, a significant portion, approximately 3,406 hectares, is devoted to agriculture. This land is precisely segmented for different agricultural areas such as orchards, vineyards, arable land and orchards.

The orchards cover an area of 364 hectares. The influence of the Mediterranean climate, for fruits such as apples, peaches and cherries, makes the region of the municipality of Rosoman quite suitable for their cultivation. Also, the extended duration of solar insolation, on average about 2500 hours per year, guarantees the achievement of optimal maturity in the fruits, a good yield with excellent taste and a high content of nutrients.

Vineyards in the municipality occupy a large part of the arable land, about 944 hectares. The production of wine is deeply rooted in the history and culture of North Macedonia, and especially in the last few decades when it took a strong momentum in the municipality of Rosoman. Prolonged sunny days, combined with favorable geological and topographical conditions, ensure obtaining grapes with unique flavors, which ensure obtaining high quality wines that are in high demand on the market.

The largest part of arable land with 1,968 hectares, however, includes arable land and gardening. This includes cultivation of field crops, vegetables and other crops. Favorable soil and climatic conditions create opportunities for growing multiple crops throughout the year, ensuring the availability of agricultural products in multiple seasons.

Challenges

Despite the recorded advantages, agriculture in the municipality of Rosoman faces certain challenges. One of the most pressing challenges is the prolonged dry periods during the summer months and the occurrence of droughts. Summer droughts sometimes last up to three months, and can seriously affect crop yields. However, the region is adapting to such climate challenges. Modern irrigation techniques, including drip irrigation, are increasingly being used by farmers to mitigate the effects of these dry spells.

CLIMATE AND CLIMATE CHANGES IN THE MUNICIPALITY OF ROSOMAN

Statistical data

In an attempt to obtain a comprehensive understanding of the climate changes occurring in the municipality of Rosoman, a request was submitted to the Hydrometeorological Administration of the Republic of Macedonia for specific data and research on the topic. Unfortunately, direct research studies and targeted climate change data specific to Rossoman are not currently available. To facilitate our request, the Hydrometeorological Service has provided us with alternative data.

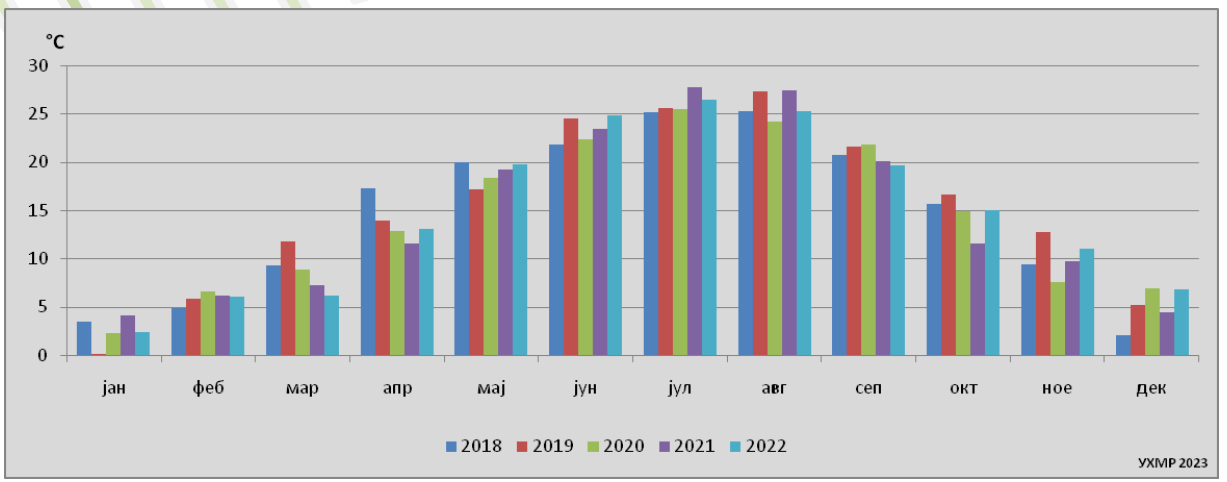
The provided data were processed through the CLIDATA software package and were obtained from the Automatic Meteorological Station in Gradsko, Veles. This station, positioned at 41°34'N and 21°56'L with an elevation of 197 meters above sea level, collects a range of meteorological information. The database covers a five-year period spanning from 2018 to 2022, offering insight into prevailing weather conditions and potential trends indicative of climate change in the wider region that includes Rossoman.

Considering the nature of the current climate changes and their evident manifestations, the need for a more detailed and localized climate analysis for the municipality of Rosoman is recognized. In order to achieve this, there is a proposal from the Hydrometeorological Administration of the Republic of Macedonia to establish an automatic meteorological station directly within the municipality. This station would conduct meteorological measurements that adhere to the standards set by the World Meteorological Organization. Installing such a station would be a significant step towards accurately monitoring the local climate, analyzing the effects of climate change and formulating effective adaptation and mitigation strategies in response to these environmental challenges.

The municipality of Rosoman, located in the center of North Macedonia, is a classic example of climate interaction, and of the gradual development and establishment of new relationships between climate factors due to global climate change. This points to the need for constant monitoring and provision of relevant data on the impact of climate change, which are crucial for agricultural practices and the daily life of residents in the municipality of Rosoman.

Climate characteristics of Rossoman

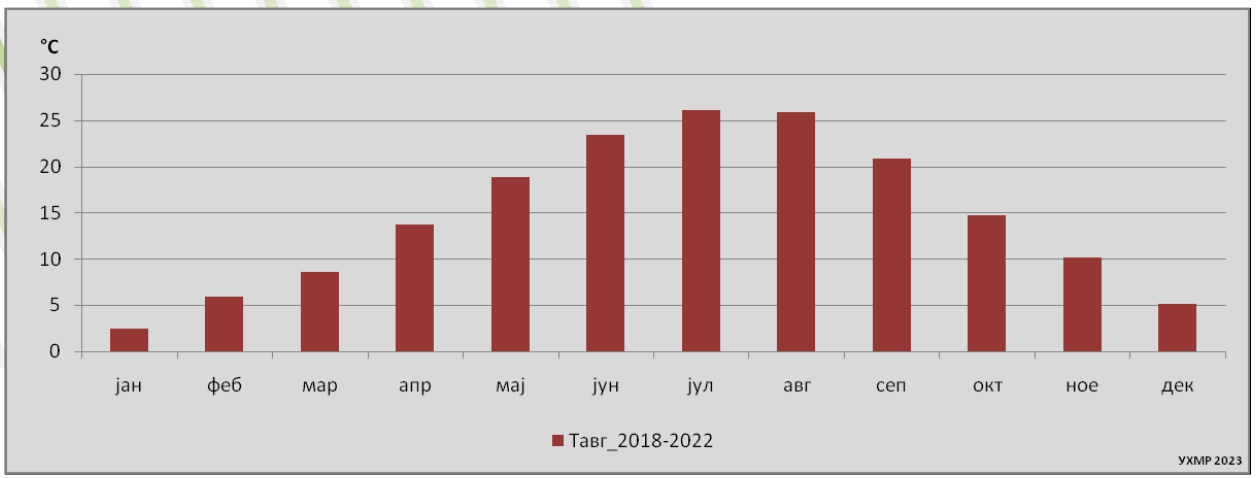
The location of the municipality of Rosoman near the Vardar Valley creates a mix of continental and Mediterranean influences. Summers are characterized by high temperatures, sometimes over 40°C. This prolonged heat, reinforced by an average annual duration of solar insolation of approximately 2,500 hours, and the application of appropriate agricultural practices, enable the successful cultivation of agricultural crops, especially the cultivation of vines. Winters are usually mild, with occasional extremes. Cold air masses from the north can sometimes cause temperatures to drop to -20°C. Precipitation, although not abundant, averages about 510 mm per year, with the most precipitation occurring in May and November. Precipitation is not evenly distributed and most often in the summer months there are prolonged dry periods, which last up to three months..



Story of the average monthly air temperature and weather conditions
Source Directorate for Hydrometeorological Affairs, https://uhmr.gov.mk/

Manifestations of climate changes

Recent decades have brought remarkable changes in climatic conditions in Rossoman, mirroring broader trends in global climate change. Data from 2018 to 2022 indicate significant temperature variations, with extremes such as a record high of 42.2 °C and a low of -10.8 °C. This indicates a wide range of temperature fluctuations that may be indicative of the impacts of climate change. Annual precipitation also varies significantly, from 314 mm in 2022 to 439 mm in 2020. Precipitation variability has a huge impact on local agriculture, water resources and ecosystem health. Extreme weather events, such as the maximum daily rainfall of 45.8 mm recorded on 27 August 2018, indicate changing climate patterns.

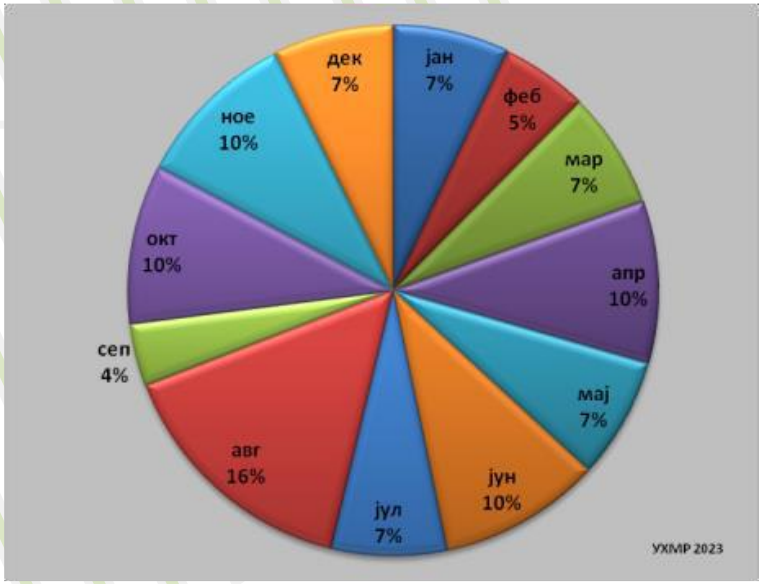


Display of average monthly air temperatures
Source Directorate for Hydrometeorological Affairs, https://uhmr.gov.mk/

Prolonged dry periods: Rosoman municipality traditionally has dry summers, but in recent years these dry periods have become longer and more severe, as seen in the minimum annual rainfall in 2022. Such prolonged droughts can have devastating impacts on agriculture, especially in areas that lack irrigation conditions, and agricultural production is based on natural rainfall.

Temperature fluctuations: Like many places in the world, the municipality of Rosoman is exposed to unpredictable temperature changes. In the region, the occurrences of temperature extremes in summer and winter are characteristic, which are somewhat expected, since they are constantly present. However, the occurrence of unpredictable temperature variations, especially during transitional seasons such as spring and autumn, significantly disrupt the natural cycle of flora and fauna.

Changing rainfall patterns: In addition to prolonged dry periods without rainfall, there are more and more recorded cases of unseasonal rainfall, which often result in torrential rains and floods. Such unpredictability of rainfall can impair soil quality and harm crops.



Percentage representation of precipitation by month for the period 2018-2022
Source Directorate for Hydrometeorological Affairs, https://uhmr.gov.mk/

HIGHLIGHTING THE KEY FINDINGS OF THE INITIAL ASSESSMENT OF THE SOCIAL IMPACT

The agricultural sector of Rosoman Municipality, intertwined with its rich history, traditions and community spirit, stands at a crossroads facing concrete challenges. As climate change is felt more and more, reshaping ecosystems and altering long-standing practices, the need for proactive adaptation and building resilience is becoming more pronounced. The assessment undertaken to measure the social impact of climate change on agriculture in the municipality of Rosoman was derived from the need to locate the impact of climate change at a specific local level. Through a precise combination of structured questionnaires, in-depth interviews and comprehensive literature reviews, a multidimensional picture of the current scenario of climate change in Rosoman municipality emerged. This assessment, rich in its information and data, offers insight into the perceptions, challenges, opportunities and knowledge gaps that define the agricultural sector in Rosoman Municipality today. Key findings highlight the tangible changes in weather conditions, the resulting effects on crop yields, and the wider socio-economic implications these changes introduce with the unpredictability and challenges of climate change. Their narratives, echoing both resilience and concern, underscore the need for targeted interventions. The assessment identifies the adaptive spirit of the community, their willingness to learn and their aspirations for a sustainable and prosperous future. This optimism, coupled with the right resources, knowledge and support, can be the foundation on which the sustainable future of Rosoman Municipality is built. The recommendations and action items, which are rooted in the findings from the assessment, serve as the direction in which the municipality of Rosoman will move in the coming period. They emphasize the importance of community engagement, education, infrastructure development and continuous monitoring. Furthermore, the emphasis on crafting a comprehensive strategy underscores the need for a structured and long-term approach to overcoming the challenges ahead. Local stories, individual narratives of farmers, stories of fields and crops and aspirations of the community will define the actions of the municipality of Rosoman in dealing with the negative effects of climate change. the way forward. It is expected that the municipality of Rosoman will not only successfully deal with the challenges of climate change, but also show resilience, ensure innovation and sustainable growth.

VISION AND DEVELOPMENT GOALS

Vision statement

Preservation, protection and improvement of the quality of the environment and the quality of life of citizens, in order to enable sustainable growth that will contribute to the achievement of global environmental goals.

The long-term vision of creating a sustainable, resilient and prosperous agricultural sector capable of adapting to the challenges of climate change.

Strategic goals

1. Improving agricultural resilience and sustainability

Goal 1.1: Promote the adoption of climate-resilient crop varieties and sustainable agricultural practices to reduce vulnerability to climate variability.

Objective 1.2: Implement advanced water management practices, including efficient irrigation and rainwater harvesting systems, to combat water scarcity.

Goal 1.3: Increase soil health through conservation practices, reduce erosion risk and improve agricultural productivity.

2. Protection and management of natural resources

Goal 2.1: Strengthen efforts to conserve biodiversity in agricultural systems, supporting ecosystem services.

Objective 2.2: Develop and promote green infrastructure projects to mitigate the carbon footprint of the agricultural sector and improve resilience against climate change.

Objective 2.3: Create and implement disaster risk reduction measures to protect agricultural assets, livelihoods and infrastructure from climate-induced hazards.

3. Encouraging knowledge, engagement and capacity building

Objective 3.1: Create targeted educational programs and workshops for farmers on climate adaptation strategies and technologies.

Goal 3.2: Increase community participation in climate change resilience projects, such as tree planting, community gardens and local conservation efforts.

Objective 3.3: Facilitate access to climate and weather information, enabling farmers to make informed decisions about crop management and planting schedules.

4. Strengthening policy support and institutional frameworks

Objective 4.1: Update agricultural and environmental policies to integrate climate change adaptation measures and sustainability principles.

Objective 4.2: Cooperation with national and international entities for harmonizing strategies and obtaining access to technical and financial support

STRATEGIC DEVELOPMENT OBJECTIVES

1. Improving agricultural resilience and sustainability

Goal 1.1: Promote the adoption of climate-resilient crop varieties and sustainable agricultural practices to reduce vulnerability to climate variability.

Vulnerability assessment of existing crop plant varieties to climate change

Постоечки сорти на културни растенија		
Function	**Agricultural production**	
Concrete purpose	Promoting the adoption of climate-resilient crop varieties and sustainable agricultural practices to reduce vulnerability to climate variability	
Resources	Input resources: Land/soil, water, existing crop plant varieties	Enabling conditions: Traditional habits and behaviors, market demands, trade, access to information, knowledge, technologies
	Climatic: Change in amount and period of precipitation, increase in temperature, floods, droughts, extreme weather events	Unclimatic Poor governance, overuse of resources, low awareness, lack of information
Exposure	Creating conditions that are intolerable for existing varieties	Diminishing returns and income exploitation
Consequences	A small flow of new varieties	

Efforts for rational and sustainable use of all the proposed measures in the system for analyzing the vulnerability of fruits, vegetables and table grapes to climate change, in the region of Rosoman Municipality, will represent a great input, a challenge and a real chance for this segment of agriculture to be sustainable, labor intensive, profitable and export oriented. Due to the specificities of the perennial fruit and grape plantations, semi-agricultural and horticultural production which are characteristic of this agricultural region and which gravitate to the Municipality of Rosoman, the action of the natural elements has a negative impact not only on the current vegetation season, but also on the next vegetation season, so and in the next few years.

For this purpose, in order to reduce the vulnerability of climate variability in fruit growing as a characteristic region for the Municipality of Rosoman, the following adaptive measures are taken, which are aimed at dealing with climate change:

- ✓ echnologies and adaptive systems for growing fruit crops, which are less susceptible to climate change,
- ✓ compatible management of diseases and pests
- ✓ opening the possibility for production and introduction of new fruit crops..

Choice of fruit type

The choice of the fruit type when raising fruit plantations mostly depends on the natural conditions in the respective region, taking into account the requirements of the fruit plants towards them. In the central part of our country or in the Municipality of Rosoman, preference should be given to heat-loving fruit species such as peach, apricot, almond, walnut, summer and autumn varieties of pears, early varieties of cherries and strawberries, cherries, etc. Also, in conditions where there is a deficit of water for irrigation and a lack of precipitation, crops that require wetter conditions should not be planted. While in drier or arid regions preference is given to crops that ripen early even before the beginning of summer, and late ripening crops should be avoided.

The correct choice of fruit species depends on the natural conditions in a given region

Selection of varieties when raising fruit plantations

The correct choice of varieties when raising fruit plantations is a key element for increasing productivity, the quality of fruits with the same or reduced production costs. The variety represents a significant element in the creation of greater profit in the cultivation of plantations.
When choosing varieties, in addition to biological, production and quality characteristics, the requirements for specific environmental conditions are also very important. Individual varieties of different fruit species give solid results in some environmental conditions, and behave completely differently in areas with other environmental conditions.
In arid or drier conditions, where there is no possibility of irrigation, it is recommended to raise plantations of early maturing varieties that are harvested before the onset of summer droughts. The lack of water in the soil, fruits without fruits, tolerate it more easily.
Early ripening varieties are raised and planted in more southern regions, and early ripening in warmer regions comes to the fore, the fruits reach the market at a time when there is no fruit and competition from other regions. It is also very important to know that in more southern and also warmer regions it is recommended to plant varieties with very long vegetation, so that in such conditions they can achieve their specific varietal characteristics.
If there are regions dominated by wind, then varieties with stronger stems are planted that hold the fruits as firmly as possible to the branches. In microlocations, along rivers, lakes, depressed terrains, where later spring frosts occur more often, early flowering varieties, which are usually sensitive to low temperatures and which have a high possibility of freezing, should also be avoided. But even here there is a deviation if the varietal specificity for resistance to low temperatures comes to the fore.
In addition, certain varieties of peaches characteristic of the Rossoman region show resistance to low temperatures, i.e. the percentage (%) of damage to the buds during the winter period and to the flowers is lower in the following varieties: Nectarina setans, Fair Haven, Red Haven, Crest haven, Nectared - 5, Spring Time, Faet, Early Red Haven, Sun Crest, Glo Haven, Independence, Fantasia, Spring Gold, etc..

Correct selection of varieties resistant to specific environmental conditions

Selection of substrates when raising fruit plantations

When raising fruit plantations, one of the most important decisions is the selection of a suitable substrate. The substrate must have the biological properties that must be in accordance with the specific soil conditions in the given region and with the planned cultivation technology. Each fruit substrate has its own advantages and disadvantages, so it is necessary to choose a substrate that shows the least negatives.
The main requirements in fruit production when choosing a substrate are:

- ✓ the exuberance
- ✓ adaptability to soil-climate conditions,
- ✓ resistance to diseases and pests,
- ✓ tolerance to low temperatures,
- ✓ good rooting,
- ✓ longevity,
- ✓ suitability for the introduction of intensive cultivation systems,
- ✓ ensuring quality fertility.

In this primarily fruit-growing region, characteristic of Rosoman Municipality, there is a great need to use fruit substrates that have a high tolerance to the lack of soil moisture, i.e. it is necessary to be resistant to drought.
In modern fruit growing production, preference is given to weakly lush substrates, when raising intensive fruit plantations, due to easier control of the lushness of fruit trees and raising dense plantations, easier management, they are lower and are characterized by high and regular productivity per unit area, they produce better quality fruits compared to more lush rootstocks. As a negative side of poorly lush substrates, their poorly developed and shallow root system is prescribed. Therefore, these substrates are more sensitive to the lack of moisture in the surface layers of the soil. And that is why the question arises, whether these substrates need to be constantly represented in intensive fruit plantations. When choosing the substrate, it is necessary to pay attention to other biological properties, namely pH, adaptability to environmental conditions, tolerance to drought and humidity. , resistance to high temperature and to diseases and pests. On carbonate soils, the peach with a high pH needs to be grafted onto almond or peach x almond hybrids. The most famous substrates of carbonate soils through which the peach stem develops are: nemagard, vine peach, peach and GF 677.

Selection of fruit substrates when raising plantations

ACTION to achieve the goal
✓ Raising public awareness of the need to adopt climate-resilient crop varieties and sustainable agricultural practices to reduce vulnerability to climate variability.
✓ Promoting technologies and adaptive systems for the cultivation of fruit crops, which are less susceptible to climate change.
✓ Educating on integrated management of diseases and pests.
✓ Creation of opportunities for production and introduction of new varieties of agricultural crops.
✓ Promotion of adaptive measures in crop production

Goal 1.2: Implement advanced water management practices, including efficient irrigation and rainwater harvesting systems, to combat water scarcity

Vulnerability assessment of water resources from climate change

Crna Reka River and its tributaries		
Function	Water supply	
Concrete purpose	Implement advanced water management practices, including efficient irrigation systems and rainwater harvesting, to combat water scarcity	
Resources	Input resources: Water, water basin, soil, flora and fauna, infrastructure	Enabling conditions: Political will, understanding, international, national and local policies, access to information, knowledge and technologies
	Climatic: Change in amount and period of precipitation, increase in temperature, floods, droughts, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Exposure	Overflow of the river Drying up of the river	Pollution of the river with agricultural, construction and industrial waste Uncontrolled reduction of the river fund Disappearance of endemic species
Consequences	Arrangement of a part of the river bed	

Lake Tikvesh		
Function	Water supply	
Concrete purpose	Implement advanced water management practices, including efficient irrigation systems and rainwater harvesting, to combat water scarcity	
Resources	Input resources: Water, infrastructure, flora and fauna (natural resources and natural wealth) ecosystems	Enabling conditions: Political will, understanding, international, national and local policies, access to information, knowledge and technologies
	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Exposure	A spill Drying out Destruction of flora and fauna	Pollution of the lake with agricultural, construction and industrial waste It occurs on large amounts of nutrients, especially phosphates of agricultural origin from vineyards Appearance of heavy metals, cadmium, copper and lead. Uncontrolled reduction of the fish stock Disappearance of endemic bird species
Consequences	Ruined irrigation water supply system	

Good water-related practices are those that increase water permeability and reduce non-productive surface water runoff from rivers, surface and groundwater management through proper use and avoidance of drainage where unnecessary, improvement of soil structure and increasing the level of humus, investments in production including waste or recycled products, through technology that avoids the pollution of water resources, applying techniques that monitor the water status of plants and soil.

Although one of the main goals of the artificial accumulation of Lake Tikvesh was to irrigate arable agricultural land and produce electricity, today, due to the specific geographical location, climatic conditions, location and natural beauty, the potential of this area is being developed through the animal and plant life of most of which are also endemic species.

The water from Lake Tikvesh is used for irrigation and for obtaining electricity. Irrigation is carried out through the "Tikvesh" hydrosystem, and the "Tikvesh" hydropower plant was built near the dam. The total projected gross area for irrigation in H.M.S. Tikvesh was 17,760 hectares, and the total gross possible irrigated area is 13,258 hectares. It was built in the period (1969-1971) and put into operation at the end of 1971. HMS "Tikvesh" distributes water through a system of mains and distribution channels in the geographical area that includes the areas and users from the municipalities of Kavadarci, Rosoman, Gradsko, Negotino and DemirKapija. Of the total irrigated areas (75-85 percent) are vineyards and orchards.

Lake Tikvesh is one of the few in the world with fresh water that is used for irrigation, and in recent years it has been below the biological minimum. All this affects the quality of the water in the lake and we are faced with endangered aquatic flora and fauna, and the consequences caused by the pollution itself when irrigating the agricultural areas on which large quantities of food are produced for the population and endangering the quality of the produced food, the health of the population in our country is generally deteriorating.

Tikvesh Lake – artificial reservoir

In the Rossoman region, most of the areas are not under the irrigation system. In this region, the irrigation of agricultural crops is mainly done in a conventional way, through open systems (canals), from which a large amount of water is lost due to the irregular maintenance of the canals. In addition to this type of irrigation, other irrigation practices are used, namely: open furrows, flooding and sprinkler irrigation. The application of these practices has a number of disadvantages, both in terms of loss of irrigation water, and in terms of disruption of water physical properties and soil structure..

Impact of climate change on the artificial reservoir Tikveshko Ezero

To overcome the side effects of conventional practices, there is a need to introduce a strategy for the introduction of new, modern practices such as efficient irrigation systems and rainwater collection. Modern irrigation systems offer solutions that reduce water consumption, the appearance of weeds, increase the quantity of production and guarantee constant quality and reliable pinos.

One of the most effective practices is irrigation using the "drop by drop" system. Drip irrigation consists in adding water in small quantities, directly in the active rhizosphere zone in order to maintain optimal humidity. When using this method of field irrigation, extremely good results were obtained, with the yield increasing up to 30%, and at the same time the quality improving up to 20%.

This system has many advantages, the most significant of which are::

- high water utilization efficiency, less water is consumed because only the active rhizosphere is irrigated
- low labor cost
- saving water
- the structure of the soil is not destroyed
- it can be irrigated on any terrain
- irrigation of soil types with different properties
- soil erosion is reduced
- during irrigation, various types of fertilizers and plant protection agents can be added through the system, which are directly delivered to the root system
- irrigation can also be performed at low water pressure
- possibility to carry out agrotechnical measures during irrigation.

- weather conditions are generally not a factor during application so
- can be done in windy or rainy conditions or when fields are too soft for farm machinery to operate without getting stuck
- when using the drop-by-drop system, nutrients, feeding, insecticides can be injected directly through the droppers, which avoids compaction of the soil by heavy machinery
- Drippers can be on the surface (above ground) or buried in the soil (underground).

Modern irrigation systems as a solution to climate change mitigation

Another modern practice for rational use of water is micro irrigation. This method of irrigation is carried out through drippers, sprinklers, foggers and other emitters on the surface or subsurface of the land. It is used for the preparation of nurseries and lawns, in soils with low water holding capacity. These practices are mostly applied to the preparation of nurseries, lawns and light soils, with low water capacity that require frequent watering.

Micro irrigation

Part of the agricultural areas in the Rosoman production area are irrigated with water from the artificial reservoir of Lake Tikvesh, and the areas that are not covered by this system are used artesian wells and subartesian wells. Here it should be pointed out that something that is least or not at all applied is the collection of water from rains and water from melting snow and other watercourses. This water would be of particular importance for smaller agricultural farms, irrigation of smaller greenhouses, lawns, family gardens or to be used as technical water in households. Individual residential buildings can accumulate rainwater in cisterns that can be surface or buried with a capacity of 1000 to 3000 liters of water. Small investments are necessary for the construction of small artificial reservoirs or the purchase of tanks for this purpose.

Collecting rainwater in dug cisterns to deal with water shortages

ACTION to achieve the goal
✓ Raising the awareness of the population about the need for rational use of the available water resources.
✓ Rehabilitation and maintenance of the old infrastructure/construction of a new one
✓ Construction of water purification stations
✓ Using alternative sources of water supply and irrigation
✓ Campaign for rational use of water
✓ Sanctioning of illegally built industrial facilities-separations
✓ Campaign for the construction and use of rainwater collection facilities
✓ Revitalization and rehabilitation of the Tikvesh Lake irrigation system
✓ Construction of arterial and sub-arterial wells
✓ Rational use of water from Crna Reka
✓ Construction of small artificial reservoirs or purchase of tanks for this purpose

Goal 1.3: Increase soil health through conservation practices, reduce erosion risk and improve agricultural productivity

Assessment of soil vulnerability to climate change

Soil health		
Function	Agricultural production	
Concrete purpose	Increasing soil health through conservation practices, reducing the risk of erosion and improving agricultural productivity	
Resources	Input resources: Soil, pesticides, agricultural machinery, water resources	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Exposure	Changing soil structure, increased erosion, reduction of organic matter and reduction of microbial activity	Excessive consumption of natural resources Contaminated soil, water and air Loss of biodiversity
Consequences	Very few new technologies are applied	

Adaptation measures should primarily be aimed at solving the basic problems caused by climate change, such as: erosion and reduction of organic matter. Fertile soil is necessary for productive agriculture, so the sustainable management of this natural resource is of particular importance.

Tillage of the soil

Accelerated soil cultivation changes its natural structure, causes erosion, reduction of organic matter and reduction of microbiological activity. For this purpose, reduced soil cultivation or so-called protective plowing is recommended. This means leaving a third of the plant residues on the field, which contributes to the reduction of erosion processes and conservation of moisture. According to certain expert researches, this method of processing is suitable and has success in the production of fruit, vine, garden and grain crops. For conservation on the soil, the elimination of plowing (no-till) is also recommended, which implies leaving the plant residues from the previous year and applying direct sowing on them or applying other agrotechnical, agrotechnical and ampelotechnical operations on the plantations. In this way, the pressure from fast-growing weeds is also reduced. The application of these techniques reduces production costs (fuel, depreciation) on the one hand, and on the other hand reduces the consequences of drought due to reduction of erosion and ensuring conservation of moisture in the soil. In addition, the biological activity of the soil and its fertility are stimulated. Mulching is a widely known practice of artificially covering the soil surface. The materials used for mulching can be of organic or inorganic origin. If organic material is used, it should be applied in thinner layers, otherwise anaerobic processes are created, which release poisons for plants and soil microorganisms. The most widespread of inorganic materials is plastic film, which is offered in different thicknesses and different colors. The advantages of applying mulching are multiple:

- ✓ the appearance of weeds is prevented
- ✓ the soil is protected from drying and hardening,
- ✓ and the capacity to preserve humidity increases
- ✓ the biological activity of soil microorganisms is retained and increased
- ✓ temperature oscillations are mitigated
- ✓ the soil structure is maintained and erosion is prevented, and thus the leaching of nutrients
- ✓ saving of irrigation water is ensured

Cover crops

This measure also protects the soil from water erosion, i.e. reduces the impact of raindrops.The same thus, when the soil is covered with a plant cover, the surface flow of rainwater slows down and the degree of infiltration increases. The temperature of the soil in the summer period decreases as a result of the cover crops, and the content of organic matter in the surface soil also increases. layer. Cover crops can also be sown on empty areas, due to the effect of green manure and enrichment of the soil with organic matter. The selection of plants should be done carefully. First of all, they should develop well in the climatic conditions suitable for the region, and the plants should not demand too much from the soil and accumulate more biomass in a short time..

Cover crops in an orchard

An increase in the degree of infiltration and the capacity to hold water - is a very important principle that enables:

- ✓ reducing the lack of water for plants,
- ✓ increase in the yield and production of green mass,
- ✓ reduction of surface water runoff (rivers)

Measures to increase soil infiltration and water retention capacity are:

- ✓ reduction of water losses through evaporation by raising wind protection belts and reducing wind speed,
- ✓ continuous processing of the plantations between the rows of the plantation so as not to form a cover or a permeable surface layer,
- ✓ creation of small barriers so that there is no surface runoff (processing and placement of plants according to isohypses),
- ✓ deep plowing in order to improve the permeability of heavier soil types, which hinder the penetration of water into the deeper layers,
- ✓ use of organic fertilizers to increase soil infiltration and the ability to retain water,
- ✓ reduction of land slope to have more time for water infiltration.

Degradation, erosion and compaction of the soil

ACTION to achieve the goal
✓ Raising the awareness of the population about the need for rational use of the soil.
✓ Application of adequate tillage of the soil
✓ Use of cover crops
✓ Campaign for rational use of soil

2. Protection and management of natural resources

Goal 2.1: Strengthen efforts to conserve biodiversity in agricultural systems, supporting ecosystem services

Biodiversity Vulnerability Assessment of Climate Change

Biodiversity		
Function	Economic benefit	
Concrete purpose	Strengthen efforts to conserve biodiversity in agricultural systems, supporting ecosystem services	
Resources	Input resources: Earth/Soil, Water, Wildlife, Birds, Fish, Medicinal Plants, Teas, Snails, Mushrooms, Butterflies, Forests	Enabling conditions: Traditional habits behaviors, market demands, trade, access to information, knowledge, technologies
Exposure	Climatic: Change in amount and period of precipitation, increase in temperature, floods, droughts, extreme weather events	Unclimatic Poor governance, overuse of pesticides, overuse of resources, low awareness, poaching, fishing
Consequences	Destruction of plant and animal stock	Excessive consumption of natural resources Loss of biodiversity
Instant adaptive capacity	It doesn't exist	

The term biodiversity as it relates to food in agriculture encompasses all the plants and animals - domestic and wild - that provide human food, fodder and fuel.
But the FAO reports are very worrying in view of the fact that biodiversity - which is a major support of our food systems - is disappearing, putting the future of our food, health and environment under great threat.

Biodiversity in the region of Rosoman municipality

Rosoman is a municipality located in the central part of Macedonia, along the lower course of Crna Reka, at an altitude of 140 meters. It is distinguished by a moderate-continental climate and a significant influence of the Mediterranean Sea. Therefore, the biological diversity of Rossoman and its wider environment is distinguished by the richness and heterogeneity of ecosystem species.

Flora and Fauna

Forests are not very abundant and are mainly deciduous and low-shrubs, which cannot be used for industrial purposes. The following species are most represented: oak, hornbeam, yew, wild foya, gripa, spruce. A variety of game is encountered: wild boar, roe deer, wolf, fox and rabbit. Smaller animals include: hedgehog, mole, forest mouse, marten, badger, turtles and bats. Typical birds for the municipality of Rosoman are: jay, tern, golden hornbill, scotch warbler. With the construction of the reservoir, various species of lake birds have settled on the entire coast, the most numerous of which are: cormorant, gray heron, wild white seagulls, falcon, bald eagle. Fifty-seven species of birds are represented in the territory of the protected area of Lake Tikvesh and are included in Annex I of the Birds Directive. Three species of birds with a relatively large population are included in the endangered category: the Egyptian vulture, the Imperial eagle and the kestrel. In Crna Reka and Tikveshko Lake, several types of fish have been identified, of which the following are the subject of economic exploitation: carp, crucian carp, largemouth bass, redfin, chub, scobel, whiting, tench, barbel, bream and catfish. Vardar pradica, scobalot, Vardar clove and popadika are Balkan endemics. All these species are vulnerable to extinction due to their limited distribution range. It is necessary to take into account the annual catch, which is over 200 t of fish, mostly redfin, carp, catfish and plaice, and less scobul and popadica.

Hunting and gathering animals, plants and fungi

Snails and butterflies are mainly collected. The forest snail (**Helix lucorum**) is collected for personal and commercial purposes. In the municipality of Rosoman there is a buying station where snails intended for processing are bought. Rare, endemic and relict species are also collected by collectors engaged in trade in floristic rarities. It must be noted that hunting and poaching of wild animals poses a large-scale threat to the Tikva region and requires active management and monitoring. Also, poaching and cage farming of fish have a significant impact on biodiversity and on the reduction of the fish stock. Some species of butterflies, as well as the shrimp (**Austropotamobius torrentium macedonicus)** are collected for scientific purposes and collecting. Also, there are negative anthropogenic activities in the region, which are manifested through the collection of eggs and chicks from birds, there is destruction of places where birds nest or stay, as well as poaching with traps. There is illegal hunting, i.e. poaching of wild boar, roe deer, rabbit and marten. From the mushrooms of the Tikvesh region and its surroundings, common and black boletus, chanterelle, Polish champignon, etc. are mostly collected. types of fungi. Collecting medicinal plants or teas such as St. John's wort and thyme does not pose a threat

ACTION to achieve the goal

- ✓ Monitoring of the impact of climate change on plants and animals
- ✓ Preservation of seed plants affected by climate change

- ✓ Mapping of zones affected by climate change
- ✓ Controlled collection of wild plants
- ✓ Construction of feeding points and drinking fountains for life during dry periods
- ✓ Afforestation and prevention of erosion
- ✓ Proclamation of protected areas

Objective 2.2: Develop and promote green infrastructure projects to mitigate the carbon footprint of the agricultural sector and improve resilience against climate change

Assessment of infrastructure vulnerability to climate change

Infrastructure		
Function	Utility	
Concrete purpose	Developing and promoting green infrastructure projects to mitigate the carbon footprint of the agricultural sector and improve resilience against climate change	
Resources	Input resources: Roads, means of transport, cars, urban infrastructure, communal infrastructure	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
Exposure	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Consequences	Damage to infrastructure, destruction of infrastructure	Excessive consumption of natural resources Contaminated soil, water and air Loss of biodiversity
Current adaptive capacity	Insufficiently functional infrastructure	

The carbon footprint is a measure of the total amount of greenhouse gases that are released into the atmosphere as a result of the activities of an individual, organization or country. It is usually measured in tons of CO2 (carbon dioxide).

According to the European Environment Agency, agriculture uses 70% of the world's drinking water resources, causes 78% of water pollution and contributes 24% of global greenhouse gas emissions..

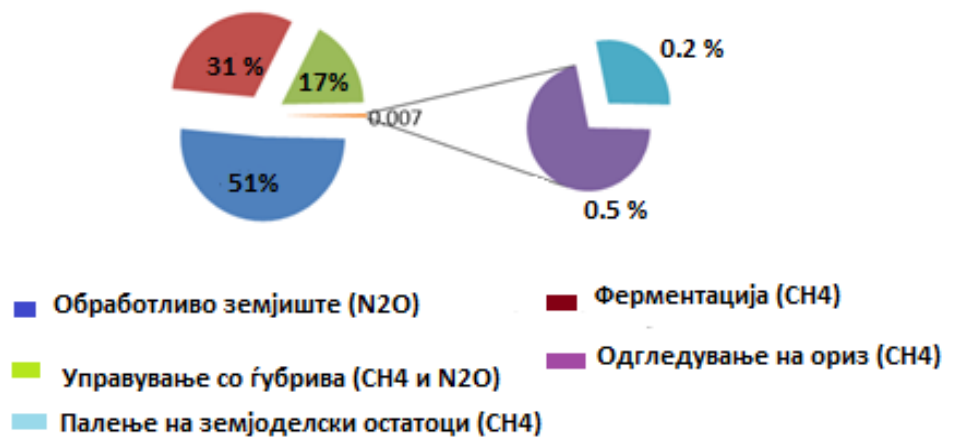
Some of the reasons for creating a carbon footprint:

- Conventional tillage
- Poor fertilizer management

- Burning of agricultural residues
- Fermentation in cattle
- Cultivation of rice

Consequences:

- Excessive consumption of natural resources
- Contaminated soil, water and air
- • Loss of biodiversity

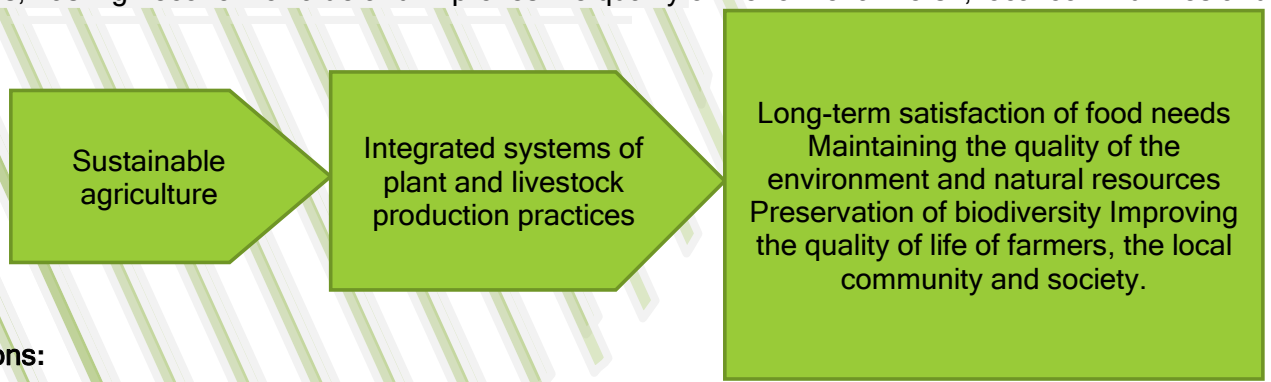


Participation in the creation of a carbon footprint in the agricultural sector
Source: **European Environment Agency database , 2015**

The constant increase in the concentration of greenhouse gases in the atmosphere causes changes in the climate worldwide, which is expected to have a strong impact on agro-ecological and production conditions. It will be a big challenge for agriculture, in conditions of limited and already degraded natural resources (soil and water), and in the face of pronounced negative impacts of climate change, to meet the food needs of the growing world population. Developing and promoting green infrastructure projects to mitigate climate change through the creation of sustainable agriculture and integrated agricultural systems.

Sustainable agriculture provides a potential solution to enable agricultural systems to provide food for growing populations in changing environmental conditions. In doing so, efforts are made to integrate three main aspects to be as efficient as possible and cause less damage to the environment. These are: economic, environmental and social.

Sustainable agricultural production originates as a need to develop methods of agricultural production that do not degrade natural resources, and which at the same time bring high yields. The concept of sustainable agriculture can be defined as an integrated system of crop and livestock production practices that meets people's food needs in the long term, preserves the quality of the environment and natural resources, has high economic value and improves the quality of life to the farmers. , local communities and society at large (FAO).



Recommendations:

- The carbon footprint can be neutralized.

Carbon generation and reduction or so-called offsetting can also be bought, sold or traded in carbon markets. An example of that is carbon offsetting is the **Single.Earth** platform where individuals and companies can compensate for their carbon footprint, by financing environmental protection activities or by "storing" carbon in sinks or reservoirs. As we are on the brink of rapid self-destruction, humanity realizes that nature is the most valuable asset on this planet. It can be self-renewing because nature itself is the most efficient way to remove CO2 from the atmosphere! The UN's ground-breaking decision to add natural resources to economic reports combined with the work of **Single.Earth** gives hope for a better future.

The future is in the land, which will be worth more if it is left natural, with healthy and intact ecosystems, instead of under plantations, with cut forests or with mines. Other examples of carbon offsetting projects are:

Renewable energy projects made 2020 the first year in the US that in 7 months out of 12, renewable sources were used more for energy production than coal. An example of the use of renewable sources is the Empire State Building, which is powered by wind-generated electricity. Growing white clover has a lower carbon footprint because it is not treated with additional nitrogen from inorganic fertilizers. This

not only avoids the emissions associated with the application of nitrogen fertilizers, but also those associated with its production.McAuliffe (2018)

However, to date, no artificial sink or store of carbon dioxide can be removed enough from the atmosphere to reduce climate change!

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ACTION to achieve the goal

- ✓ Raising the awareness of the population about the carbon footprint
- ✓ Rational spending of resources
- ✓ Reduction of soil, water and air pollution
- ✓ Restoration of biodiversity

Objective 2.3: Create and implement disaster risk reduction measures to protect agricultural assets, livelihoods and infrastructure from climate-induced hazards

Assessment of infrastructure vulnerability to climate changes

Infrastructure		
Function	Utility	
Concrete purpose	Creating and implementing disaster risk reduction measures to protect agricultural assets, livelihoods and infrastructure from climate-induced hazards	
Resources	Input resources: Farms, family buildings, vehicles, cars, infrastructure	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
Exposure	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Consequences	Collapse of agricultural holdings, damage to infrastructure, destruction of infrastructure	Excessive consumption of natural resources Contaminated soil, water and air Increased risk of disasters
Current adaptive capacity	There is no adaptive capacity	

Community disaster resilience is closely related to the risk of natural disasters such as climate change and extreme climatic events such as soil erosion, air pollution, floods, drought, lack of adaptable crop varieties, unfavorable sales market and low purchase prices. A community that has better resources, communication, information or renewable energy sources has less exposure to these disasters.

Every participant, from asset suppliers and agricultural machinery manufacturers to traders, logistics companies and the food industry is at high risk in the event of extreme weather conditions resulting in crop losses.

Effective agricultural risk management begins with an adequate understanding of the broad categories of risk that affect the agricultural sector, as well as identifying the best ways to manage them..

Weather events in Rosoman municipality such as extended dry periods lasting months, minimum annual rainfall (2022), unpredictable temperature changes and variations, torrential rains and floods are likely to become more frequent in the region. Agricultural producers will have to face a possible loss in production due to failure of agricultural equipment, lack of irrigation conditions, disturbed natural cycle of flora and fauna, impaired soil quality and crop damage. Promoting climate-smart agriculture can address important issues of climate vulnerability, rural poverty and degradation of modest agricultural assets and effective strategies to deal with climate change..

Preparedness for sudden weather variability

Changing weather has gradually become a constant threat to agriculture. Farmers need to be prepared for sudden and frequent weather changes in order to ensure yield and manage possible risks. Online tools for such weather features are a great help when it comes to climate change and agriculture. In relation to the type of agriculture in the municipality of Rosoman such as viticulture, fruit growing and vegetable production in elementary protected areas as well as the climate changes that are evident, it is considered that the following techniques and practices will prove to be potentially useful in reducing the risk of disasters for the protection of agricultural assets, livelihoods and infrastructure from climate-induced hazards.

Installing an automatic meteorological station in the municipality that will conduct meteorological measurements according to the standards of the World Meteorological Organization will mean more precise monitoring of the local climate, analysis of the effects of climate change, creation and implementation of effective strategies for adaptation and mitigation of environmental challenges..

Online farming software like EOSDA Crop Monitoring

This software helps in careful and frugal management. It will allow farmers to accurately calculate the necessary costs, which actually reduces costs in the short term and protects nature in the long term. Of course, the adaptation and mitigation of climate changes in agriculture are not comprehensive solutions and should be adapted in each specific case depending on the microclimatic specifics of the given area, agricultural potential and needs, as well as the profitability of the applied methods. Daily forecasts for up to 14 days with air temperature, amount of precipitation, wind direction and strength, air and soil humidity, cloudiness are data that, if available, farmers will be aware of the upcoming conditions, so they will schedule and carry out agricultural activities in a timely manner. activities such as sowing or harvesting, application of fertilizers or application of herbicides. Weather data such as accumulated precipitation, daily precipitation, daily temperatures, fluctuation of minimum and maximum temperatures will allow predicting the general tendencies of weather changes in this region such as temperature jumps ie high or excessively low temperatures stress. So, farmers will be aware of the threat and will be able to solve it in time.

Drainage with ecosystem care

Proper water infiltration will not lead to flooding and clogging of channels and will avoid unwanted leakage of chemicals into the groundwater. Thus, farmers will reduce the use of water resources and it will be easier deal with soil erosion. However, this technique of climate adaptation in agriculture needs a careful approach in order not to disturb the biodiversity of the ecosystem, enough water must remain for the plants and of course, the drainage must not contribute to excessive runoff of herbicides or fertilizers.

Irrigation efficiency

Irrigation is vital for vegetation in agriculture in the absence of rainfall, and the water supply should be sufficient to ensure stable plant development. Drip or strip irrigation helps farmers provide the moisture they need with less water. Mulching and crop residues also contribute to reducing evaporation from the soil and less water consumption for irrigation.

Rainwater harvesting

Rainfall harvesting is an economical method of water supply for drought-prone areas and conserving water resources. However, the disadvantage is that long-term collected rainwater can cause a drop in the groundwater level and thus affect the balance of the ecosystem.

Precision farming

Smart or precision agriculture is based on the management of agricultural production that is specific to the location, in the specific case of the municipality of Rosoman. It saves farmers' resources and reduces environmental pollution.

This type of advanced farming uses advanced technologies and data obtained from drone and satellite observations, as well as online data processing and interpretation software. *Example: These agricultural tools allow farmers to locate critical areas with a disease or pest and focus only on them, instead of treating the entire field with pesticides*.

Cover crops

To prevent soil erosion, retain water and fix nitrogen in the soil, cover crops such as legumes, which are known as nitrogen-fixing crops and participate in the conversion of atmospheric nitrogen, should be planted as organic manure or forage material and cattle grazing.

No or minimal tillage

No-till farming is a land management practice with no or minimal soil disturbance. No-till farming prevents soil erosion and promotes carbon sequestration, or soil sequestration, which is particularly beneficial in the climate change-agriculture nexus. This method reduces the depletion of the soil, improves its natural environment, as well as reduces the costs of cultivated soil or equipment maintenance.

Adaptable varieties and species

Varieties and types of vegetables, fruits and vines that are more resistant to unfavorable climatic conditions are needed. They should be healthy and more resistant to drought. The reduced use of chemicals contributes to the protection of nature, and thus to climate change in agriculture.

Diversification and crop rotation

Crop rotation is an old and effective agricultural method that has proven successful in managing weeds and

pests, as well as in the application of chemicals. Crop diversification is beneficial for biodiversity.

Climate change and agriculture are closely related. Although agriculture is not the only anthropogenic factor that drives it, however, the effect of agriculture on climate change is huge. The climate affects agriculture, but agriculture also causes climate change, especially overgrazing, fermentation of farmyard manure, stubble burning, gas emissions during fertilization. , cutting down the forest and turning it into agricultural land. from greenhouses and greenhouses. As calculated by the EPA, agriculture contributed 9.3% of total US greenhouse gas emissions in 2018.

ACTION to achieve the goal

- ✓ Raising the awareness of the population about the risk of disasters and dangers caused by the climate

- ✓ Rational spending of resources
- ✓ Monitoring of weather conditions and application of adequate measures
- ✓ Measures to protect agricultural assets, livelihoods and infrastructure from climate change

3. Encouraging knowledge, engagement and capacity building Objective

3.1: Create targeted educational programs and workshops for farmers on climate adaptation strategies and technologies

Assessment of vulnerability of agriculture to climate change due to lack of educational programs

Education		
Function	Educational	
Concrete purpose	Creating targeted educational programs and workshops for farmers on climate adaptation strategies and technologies	
Resources	Input resources: Agricultural holdings, curricula, literature sources	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
Exposure	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Consequences	Inadequate response to climate change Collapse of agricultural holdings	Excessive consumption of natural resources Application of outdated technologies
Current adaptive capacity	Low representation in the education system	

Agricultural production and the impact of climate change on it is inseparably connected with a certain system of knowledge and current information, which refer to the various strategies and technologies for adapting agricultural production to the climate in order to overcome and deal with all climate changes that affect agricultural production. . Improving such knowledge and increasing its availability is essential for the successful implementation of climate adaptation strategies and technologies.

The awareness of the population in our country that is engaged in agricultural activity in terms of strategies and technology for climate change adaptation is at a very low level. A survey was conducted in 48 municipalities in RSM by the Ministry of Education and Culture, and according to this survey, the most common view is that dealing with climate change is not the duty of farmers, but of the Government, industry and companies. Also in this survey, it was determined that farmers do not have enough information about climate change and how to deal with it.

From here we come to the key problems that arise among the agricultural population:

- insufficient information in rural areas about climate change
- insufficiently developed awareness of the impact of climate and the consequences of climate change
- lack of education of the rural population to recognize the consequences of climate change, but also how to deal with them

We are witnessing intensively rapid technological-technical and socio-economic changes in all spheres of society, which are also happening in the agricultural sector. Farmers perform their work in changing economic, technical and natural conditions, decreasing resources for work, population migration, changes in society, rapid development of technology as well as the increasing impact of climate change on the entire production cycle. In such conditions, it is necessary for farmers to familiarize themselves with new knowledge, skills, technologies and new ideas for managing agricultural production, but also how they can more easily cope with and adapt agricultural production to climate change. Natural conditions, especially climate changes, affect agricultural production, and therefore agricultural producers should be promptly informed of all changes. The educational system in agriculture consists of secondary vocational agricultural schools and higher educational institutions. Informal education is not institutionalized and is implemented irregularly, within the framework of national and international projects. The educational structure in agriculture according to research from 2016 is that the majority of farmers have completed or not completed primary education (44.5% or 80,269 persons) and secondary education (43.3% or 77,996 persons). Only 9,359 of them, or 5.2%, have formal education in agricultural sciences. Henceit follows that the majority of the agricultural workforce lacks formal agricultural education, training and managerial and business skills. The analyzes that have been made for the specific problems with the impact of climate change and the existing conditions of agricultural production indicated a lack of connection between agricultural producers and the educational sector. Therefore, it is necessary to strengthen the ties between these two subjects and to find solutions for the problems that farmers encounter as a result of the impact of climate change, but also adaptation to the climate. A large part of agricultural producers do not know how to deal with the negative impact of climate changes on agricultural production, how to apply certain measures and technologies for climate adaptation to agricultural production. From here arises the need to create targeted educational programs and workshops that will enable the improvement of the knowledge and qualifications of agricultural producers and they will be presented at continuous trainings. The trainings it is necessary to organize them with a fixed number of hours depending on the needs of agricultural producers as well as the type of agricultural production. In the course of educational trainings and workshops, agricultural subjects should first be informed about the impact of climate change from various aspects, about the impact of climate on plantations and crops, about ways to prevent damage due to climate change, choosing varieties resistant to climate change, awareness of useful products/resources in agriculture, knowledge of agricultural technologies to mitigate negative impacts, adaptation of local agricultural practices to climate change. It is also necessary to determine the knowledge and awareness of farmers about the effects of climate change,

the application of adaptation measures, as well as the importance of education in dealing with climate change. The aim of the educational workshops is to improve the level of awareness of farmers about adaptation to climate, as well as to raise awareness among farmers about the impact of climate, to encourage further activities for climate adaptation. Better awareness of agricultural producers will enable mutual cooperation and exchange of experiences, sharing of best practices and research results, it will be possible to present the results to farmers for adaptation.

ACTION to achieve the goa
✓ I Training of personnel who will provide education and maintenance of trainings and workshops for farmers
✓ Development of targeted educational programs for farmers on climate adaptation strategies and technologies
✓ Increasing the flow of knowledge and strengthening the links between research and practice
✓ Organizing group discussions, surveys and consultations to exchange opinions from farmers and experts
✓ Continuous monitoring of the implemented activities of the farmers
✓ Subsidization of educational training by municipal and national institutions

Goal 3.2: Increase community participation in climate change resilience projects such as tree planting, community gardens and local conservation efforts

Assessment of vulnerability of agriculture to climate change due to lack of climate change resilience projects

Climate Change Resilience Projects		
Function	Economic and environmental benefit	
Concrete purpose	Increasing community participation in climate change resilience projects such as tree planting, community gardens and local conservation efforts	
Resources	Input resources:: Agricultural holdings	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
Exposure	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Consequences	Inadequate response to climate change Collapse of agricultural holdings	Excessive consumption of natural resources Application of outdated technologies
Current adaptive capacity	Low representation of existing projects	

Inadequate use of natural resources often leads to their reduction and represents a direct threat to their survival. The ecosystem approach to the use of natural resources is not yet sufficiently understood and accepted. The appearance of inappropriate use of mineral resources leads to the degradation of the landscape, the destruction of natural habitats and wild species. In agriculture, traditional practices are abandoned and inappropriate practices and use of herbicides, hormones and chemicals are applied, while in forestry, illegal cutting is observed in some places. There is also a phenomenon of inappropriate collection of medicinal plants, fungi and animals. Hence, the need to eliminate such conditions and establish a sustainable use of natural resources emerges as a priority issue. In that regard, in the Republic of North Macedonia in the last few years, various incentives have been provided through various forms of support, especially in agriculture.

To fulfill this priority, the interventions that should be implemented are based on:

- protection of waters from negative impacts on agriculture;
- greater application of agricultural practices favorable to the environment;
- establishing and promoting integrated production systems;
- improvement of systems for organic production, control, certification and supervision in organic production;
- raising awareness of the importance of using renewable energy sources and producing energy crops;
- controlled management of waste from primary agricultural production;
- development and improvement of the by-products management system in the food industry;
- preservation and sustainable management of genetic resources of plants and animals;
- preservation of landscapes, agricultural areas of high natural value and their resources.

The management of natural resources in a sustainable way is a guarantee for ensuring the long-term development of agriculture and the rural areas themselves. Agricultural holdings in the next period should more significantly implement the concept of "green" agriculture as a logical and natural way of performing their agricultural activities. In that direction, they will be stimulated through the measures of several types of interventions from agricultural policies, such as the conditionality of direct payments with the fulfillment of cross-compliance requirements, agro-ecological measures including organic production, support for the protection of bidiversity, i.e. genetic diversity of indigenous plants and livestock breeds and the introduction of direct payments to support practices beneficial to the climate and the environment (eco schemes) which will be expanded according to progress in the definition of protected zones. Agricultural activities and rural environments are under pressure from the negative effects of increased climate change. Hence, it is necessary to reorganize the management of natural resources in a way adapted to the new conditions for mitigating the negative effects of changes in the course of agricultural activity and of course with as much as possible ensuring their long-term sustainability. The fact that we are increasingly exposed

to the influence of climate change in some form, a climate cataclysm is looming and we are ill-prepared for what it could mean. If climate change is not controlled, it will undo much of the development progress achieved in the past years. With the increase in greenhouse gas emissions, the climate changes happen much faster than expected. Its impacts can be devastating and include extreme and changing weather patterns and rising sea levels. Climate change is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable. The most important thing we as a civilization can do is to start using renewable energy sources as soon as possible and stop burning fossil fuels IMMEDIATELY. That means, as soon as possible, we should stop burning, first of all COAL, as a fossil fuel for obtaining electricity, and start producing it from the sun, wind and water.

Also, as far as transportation is concerned, we need to start using electric vehicles as soon as possible, instead of those that move with the help of internal combustion engines and use engines that run on oil or gasoline. Of course, we should charge the batteries of electric vehicles with renewable energy sources.

Fossil fuels also still find enormous use in industrial production processes. So it is necessary to find new technologies that will enable us to supply the necessary energy for industrial production processes in other, alternative ways.

As we can conclude FOSSIL FUELS are by far the "most important" part of this story, but they are not the only one.

To tackle climate change, we must greatly raise our ambitions at all levels. There is a lot going on in the world as investment in renewable energy sources has increased. But more needs to be done. The world must transform its energy, industry, transport, food, agriculture and forestry systems to ensure that we can limit the rise in global temperature. In December 2015, the world took a significant first step by adopting the Paris Agreement, in which all countries committed to taking action to tackle climate change. However, more action is critically needed to achieve the goals.

Should we be concerned about global warming and the enhanced Greenhouse effect? The answer is of course, yes.

We must do something to reduce the greenhouse gases we produce. We can achieve this by:

- ✓ less use of means of transport,
- ✓ planting of new trees
- ✓ rational use of energy
- ✓ waste collection, i.e. recycling of bottles (plastic)
- ✓ using canvas bags instead of plastic bags etc.

The greater presence of greenhouse gases in the atmosphere leads to the so-called an intensified greenhouse effect that is already becoming a danger to life on the planet. Even small increases in temperature can be very dangerous, not only for humans but also for all other living organisms.

We also have to find ways to make more use of arable agricultural areas and produce food in sustainable ways, and it is especially important that we use less meat in our diet in the future, because livestock also has a significant impact in the emission of greenhouse gases..

The Human Impact of Global Warming Today, for the first time in Earth's history, humans have, perhaps, a decisive role in the future of climate change. A warmer future may result from human activities today that release large amounts of heat-trapping gases. These gases are part of the reasons for increasing the temperature. by 0.5 degrees for the last 100 years. Today, for each of the more than 6 billion people on the planet, nearly 6 tons of CO2 are emitted annually. As a result of our activities conc. of CO2 has increased by 30% in the last 250 years. Industrialized countries today release the most CO2, while CO2 emissions in developing countries are on the rise. Since the biggest consequence of climate change will be drought and water scarcity, we should unite towards solving this problem.

It is also very important to protect and preserve FORESTS, because they help us a lot to extract carbon dioxide from the atmosphere. It is no coincidence that it is said that trees and forests are the "lungs" of the planet Earth and we should not only preserve them but also intensively restore them. The government can initiate an afforestation drive. It could also provide mass transit. The government can set standards for air cleanliness and chimney filters. To help prevent global warming the government can ban the cutting of nature and can also invest in fluorescent lighting and use solar energy instead of nuclear and thermal power plants.

Planting trees is the best, easiest and cheapest way to combat climate change, according to scientists, who have calculated how many trees could be planted without endangering current agricultural lands and urban areas.

As they grow, trees absorb and store carbon dioxide, which contributes to global warming. A worldwide tree-planting program could eliminate two-thirds of the emissions released into the atmosphere by human activities, according to new scientific estimates. Climate change has a serious impact on Macedonian agriculture through lack of water, reduced yields, damage to agricultural production, all of which affects food security and the livelihood of the rural population that depends on agriculture.

Limited access and high prices of agricultural raw materials, such as high-quality seed material, as well as facilities for their production, storage and application, further affect the efficiency of agricultural production and resistance to climate change, especially among small farmers..

To respond to the increasing domestic demand for high-quality seed material that is resistant to climate change, the Food and Agriculture Organization of the United Nations (FAO) is supporting the Government of North Macedonia to improve the national seed system by improving the domestic production of high-quality and climate tolerant seeds of strategic crops and strengthening national capacities to ensure adequate seed supply to farmers.

FAO is helping assess national seed systems by reviewing seed production, certification, distribution and quality, ex-situ conservation and plant breeding, which will provide guidance for improving climate-resilient seed production policies..

Climate change has a serious impact on Macedonian agriculture through lack of water, reduced yields, damage to agricultural production, all of which affects food security and the livelihood of the rural population that depends on agriculture. The limited access and high prices of agricultural raw materials, such as high quality seed material, but also facilities for their production, storage and application, additionally affect the efficiency of agricultural production and resistance to climate change, especially among small farmers. To respond to the increasing domestic demand for high-quality seed material that is resistant to climate change , the Food and Agriculture Organization of the United Nations (FAO) is supporting the Government of North Macedonia to improve the national seed system by improving domestic production of high-quality and climate-tolerant seeds of strategic crops and strengthening national capacities to ensure adequate supply with seeds for farmers.

FAO is helping assess the national seed system by reviewing seed production, certification, distribution and quality, ex-situ conservation and plant breeding, which will provide guidance for improving climate-resilient seed production policies.

ACTION to achieve the goal

- ✓ Raising the awareness of the population about the preservation of the environment
- ✓ Encouraging the population to participate in projects in the field of "Green financing - planting of green areas"
- ✓ Preparation of greening projects to reduce the impacts of climate change and include the rear in the same
- ✓ Reduction of the greenhouse effect through education of the population
- ✓ Analyzing the vulnerability of municipalities in relation to climate change based on a previously prepared questionnaire on the occurrence of extreme weather events (floods, hail, snow drifts and forest fires).

- ✓ A special focus will be placed on the promotion of project activities and results at the local level (in the municipality where the specific activity is implemented), PR texts published on electronic media and TV and radio promotions that are related to climate resilience, the consequences of climate change, such as and the urgent need for adaptation and mitigation measures and activities.
- ✓ The activity of planting plants and afforestation has the greatest impact on reducing climate change
- ✓ Waste selection/recycling is the activity that has the most impact on reducing climate change and reducing and reusing waste
- ✓ Installation of solar panels for hot water in the city and its surroundings, reduction of consumption of products in plastic packaging, rational use of drinking water, installation of solar panels for houses and buildings for the production of electricity, use of energy-efficient devices in the household, collection waste from public areas, using energy-efficient lamps and cycling.

Objective 3.3: Facilitate access to climate and weather information, enabling farmers to make informed decisions about crop management and planting schedules

Assessment of vulnerability of agriculture to climate change due to lack of climate and weather information

Climate and weather information		
Function	Economic and environmental benefit	
Concrete purpose	Facilitating access to climate and weather information, enabling farmers to make informed decisions about crop management and planting schedules	
Resources	Input resources: Agricultural holdings, digital resources, institutions, mobile applications	Enabling conditions: Political will and understanding, international, national and local policies, access to information, knowledge and technologies
Exposure	Climatic: Change in the amount and period of precipitation, increase in temperature, extreme weather events	Unclimatic Poor governance, irrational use of resources, low awareness, lack of information
Consequences	Inadequate response to climate change Collapse of agricultural holdings	Excessive consumption of natural resources Application of outdated technologies Untimely reaction to climate change

Current adaptive capacity	Underutilization of existing digital resources

Agriculture is inextricably linked to external weather influences, which makes agricultural production the most sensitive to climate change. The risks of adverse impacts such as increasing temperatures, changes in the amount and distribution of precipitation and weather events for the agricultural sector are becoming a particularly sensitive issue for our country, which is located in a zone where significant climate change is expected..

When it comes to climate and weather, agricultural producers have little or no control. How should they plan and implement their production in the face of climate change, while achieving the planned results?

Would you agree that the answer lies in the digitization of agriculture?

New global trends show that technologies are key in the development of many activities, including in the development and improvement of agriculture. Digital literacy in rural areas and additional digital transformation in agriculture is one of the most important prerequisites for further development.

According to certain surveys among farmers, regarding the use of electronic services (e.g. electronic issuance of title deeds or filling out applications for subsidies), the majority of them (82.5%) declared that they do not use them services, also a large part (54%) that they do not use digital technology at all.

Today's modernization of economic activities, including in agriculture, is inextricably linked to digital technology. Digital transformation in agriculture needs to be asserted as an important factor in the development and improvement of the competitiveness of the sector..

Our experts agree that the digital transformation of agriculture should be started as soon as possible through all available means, which would increase the economic and environmental efficiency and progress of agriculture. It is also expected that the application of new, digital technologies will significantly affect environmental sustainability and help agriculture become greener. One of the positive results would be increasing the competitiveness of production, improving working conditions, increasing transparency along the supply chain, and more. In addition to the positive things, in rural areas, farmers often face certain problems:

¬ limited access to internet and digital infrastructures,

¬ low awareness of the benefits of introducing these technologies among producers,

¬ the age structure and the reduced level of skills of farmers

Digital technologies have the potential to significantly improve agriculture and can help farmers work more precisely, efficiently and

sustainably, thereby significantly increasing their productivity. Based on digital technologies and data, agricultural producers can improve decision-making in crop management and planting time.

Through digital technology, farmers can receive timely information about the conditions that will follow in the future period and thus be able to plan their activities, be able to carry out timely protection from adverse external influences, and reduce the impact of external conditions. Meanwhile, digital agricultural technologies give farmers the opportunity to increase decision-making efficiency and returns to factors they directly control. Such as:

- - what types of crops to grow
- -according to what schedule the crops should be planted
- -how to rotate crops for best results
- -when and how much water to use for precise irrigation
- -when, how much and what nutrients to apply
- -when and with which protective agents to treat the plants
- -what type of tillage works best with a given type of soil

Whether we are ready for it or not, digitization is increasingly present in agriculture as well. It is estimated that by 2025, profits due to digitalization will increase to 330 billion dollars, and as a result, food production will increase by as much as 25 percent. Countries around the world are currently discussing how to improve the quality and quantity of food produced, and digitalization seems to be an irreplaceable solution for all new issues, and the basis for its implementation by agricultural organizations and companies should be additional education, starting with small farmers. The digitization of

agricultural production aims to make agriculture more efficient and sustainable and to improve rural life.

ACTION to achieve the goal

⁾ Identification of the level of knowledge of farmers on the use of digital technology

⁾ Ensuring full access to broadband internet in rural areas

⁾ Creation of a unique digital platform for farmers and which would provide monitoring of external conditions, where farmers' experiences will be exchanged and climate changes in the region will be monitored, decision-making based on real data. Such a platform for managing processes in agricultural production would allow open access to every farmer, enable more efficient data collection and all results would be stored in one safe place and would be easily accessible.

⁾ Sectoral interventions to purchase digital technologies at any stage of the supply chain, including knowledge sharing and product quality monitoring.

⁾ Farm advisory services on digital aspects in agriculture and rural areas.

⁾ Introduction of educational curricula aimed at increasing the digital skills of farmers and residents in rural areas, but also to prepare easily understandable and accessible applications with detailed instructions for the use of e-services.

4. Strengthening policy support and institutional frameworks

Objective 4.1: Update agricultural and environmental policies to integrate climate change adaptation measures and sustainability principles

"Climate change is in many ways different from other problems facing humanity today and the consequences for life on earth could be

catastrophic if we allow it to continue unchecked. In that sense, political measures at all levels – local, national and international – can have a decisive impact on reducing climate change and global warming."

Settlements are vulnerable to climate change due to the concentration of population and material goods, as well as due to the connection with infrastructure systems, and as such, settlements are the biggest generators of climate change. Strengthening support for climate change policies and institutions is crucial to successfully addressing this challenge. This includes various aspects:

Policy development, implementation and alignment

Creating policies that reduce greenhouse gas emissions, support the transition to renewable energy sources, and improve communities' resilience to climate change. It is also essential to ensure that these policies are implemented appropriately. It is important to ensure alignment between different levels of governance (local, national, international) and sectors (government, private sector, civil society) to support climate change policies. This includes harmonization of laws, rules and initiatives to stimulate accountability and innovation:

- Environmental Law
- Law on protection and promotion of the environment and nature
- Nature Protection Law - Ambient air quality law
- Law on waste management

Creation of regulatory frameworks

Adopting clear and strong regulatory frameworks to protect the environment and reduce greenhouse gas emissions can encourage investments in clean energy and sustainable development. These frameworks should be flexible and adapt to changing circumstances and the needs of communities.

Institutional capacities

Building and strengthening institutions capable of implementing climate change policies and programs is essential. This includes the capacity to transition to clean energy sources, emissions monitoring and reporting, and the ability to predict and address climate risks. Institutions that formulate and implement climate change policies need to be well trained and equipped with the necessary resources to deal with these challenges. By providing training, technical support and financial assistance, institutions can be helped to become more efficient in their efforts.

Institutions that can and should be actively involved in the implementation of climate change policies:

- o Ministry of Environment and Spatial Planning o MANU
- o Secretariat for European Affairs
- o Ministry of Economy
- o Ministry of Agriculture, Forestry and Water Management
- o Ministry of Transport and Communications
- o Ministry of Culture
- o Ministry of Health
- o Ministry of Education and Science
- o Ministry of Finance
- o Institute of Public Health
- o Center for crisis management
- o Administration for hydrometeorological affairs
- o State Statistics Office
- o Directorate for Economic Diplomacy
- o Institute of Occupational Medicine
- o Chamber of Commerce of RSM
- o ZELS o RSM Red Cross
- o Climate Response Networko Regional Center for Environment

Financial support

Investing in projects and programs that minimize climate risks and increase them is essential the influence of communities. This includes financial support for the development of clean energy infrastructure, biodiversity protection and measures to adapt communities to climate change.

Education and awareness of citizens

Informing and educating people about the impact of climate change and the ways in which it can be prevented or weakened is essential for the successful implementation of policies and measures to combat climate change. An educated citizen can influence political processes. Citizens should be aware of the impact of climate change and how their activities can contribute to solving this problem. Information campaigns, educational programs and mobilization of communities can improve their knowledge and engagement in this area.

ACTION to achieve the goal

- Building and strengthening institutions capable of implementing climate change policies and programs
- Building capacities for information on climate change
- Educational programs and mobilization of communities can improve their knowledge and engagement in this area
- Creating educational programs and mobilizing communities can improve their knowledge and engagement in this area

Objective 4.2: Cooperation with national and international entities for harmonizing strategies and gaining access to technical and financial support

Global problems require global solutions. Strengthening international cooperation to reduce climate change, such as the United Nations Sustainable Development Goals (UNSDGs) and the Paris Agreement, is key.

Only with an integrated and coordinated approach between different actors and cooperation between different levels of government, the private sector, civil society and the international community can significant progress be made in the fight against climate change..

The Ministry of Environmental Protection should make a special contribution to the Strategy for the fight against climate change with an action plan, which will establish a strategic framework in accordance with the international obligations of the Republic of Macedonia and the EU accession process. The climate change strategy aims to identify opportunities for reducing greenhouse gas emissions.

Current climate scenarios indicate that our country is extremely sensitive to the impact of climate change, especially droughts and forest fires.

The strategic fight against climate change will not only be aimed at reducing the emission of gases with the greenhouse effect, but will pay special attention to the negative impacts of climate change and will propose priority adaptation measures. The purpose of the Strategy is to identify new opportunities for industry and sustainable development, as well as consideration of energy security and harmonization of national policies with the EU framework.

For the agricultural sector, with a special focus on food production, the following adjustment measures can be identified: construction of new and efficient irrigation systems, construction of new multi-purpose storage lakes and reservoirs for water supply and irrigation. For the forestry sector, with a special reference towards the production of bioenergy, the following measures can be identified: afforestation of new areas with species adaptable to climate change, changing the existing forest management practice in accordance with the "close to nature" concept and introducing the "smart forestry" approach, which optimally uses the locations in order to increase the areas under forests. For the water management sector, with reference to the production of energy from hydroelectric power plants, the following adjustment measures can be identified: raising protective green belts and additional measures along the river courses, improving the system for monitoring and data collection for early recognition of extreme climatic and hydrological events and increasing water storage capacities. It is necessary to establish an Adaptation Framework, which can be used as an instrument for risk assessment through the identification of adaptation measures of climate change, both for smaller investments and for larger development program initiatives.

ACTION to achieve the goal

- Building and strengthening institutions for cooperation with national and international subjects

IMPLEMENTATION PLAN

Agriculture is the main economic activity in the municipality of Rosoman. This activity faces all challenges and opportunities, including the ever-evident climate changes.

The interaction of socio-economic dynamics, agricultural practices and environmental changes create a complex situation that requires identified interventions.

Proposals for the action of the municipality of Rosoman

1. Comprehensive climate change education

Contextual Curriculum

Developing an educational program that will combine a global understanding of climate change with the specific challenges and experiences of farmers in Rossoman. This would ensure that the knowledge imparted is correlated with the lived experiences of the local community.

Regular updates

Because climate science is a rapidly evolving field, periodic curriculum reviews and updates are essential for farmers to keep abreast of the latest findings and best practices.

1. Promotion of adaptive technologies

Exhibition sessions

Organizing regular exhibition sessions where service providers can introduce farmers to the latest adaptive technologies. These sessions can serve as a platform for knowledge exchange, questions and practical demonstrations.

Subsidized access

Partnering with technology providers to offer these solutions at subsidized rates or through easy installment plans, ensuring financial accessibility.

3. Enhanced community engagement

Feedback platforms

Establishing digital and other platforms where farmers can provide real-time feedback on interventions, policies and training programmes. This feedback-driven approach ensures that interventions remain aligned with current realities.

Promotion of local practices

Documenting and promoting local agricultural practices that have historically demonstrated resilience. Organizing workshops/study circles in the community where older farmers can share their knowledge with the younger generation.

2. Mechanisms for socio-economic support

Targeted programs

Developing specialized programs that offer support to the most vulnerable groups in the farming community, ensuring that they have the resources and knowledge to adapt effectively.

Migration support

Establish support centers that provide resources, counseling and training to those affected by climate change-induced migration, ensuring their smooth transition and adaptation.

3. Improvement of infrastructure

Focused investments

Direct investments towards infrastructure projects that directly strengthen climate resilience, such as water conservation systems, sustainable irrigation and agricultural storage facilities.

Public-private partnership

Inclusion of private entities for co-financing and co-development of infrastructure projects, taking advantage of their expertise and resources.

ACTION ITEMS

Insights into the consequences and challenges of climate change point to the need for the municipality of Rosoman to develop a structured action plan.

This section describes the immediate next steps and concrete action items, including the key task of developing a climate change strategy.

Action plan

Step	Action	Purpose	Carrier	Included	Realization time
Development of a comprehensive strategy	Initiating a series of brainstorming sessions, workshops and consultations to develop a comprehensive climate adaptation strategy tailored for the agricultural sector of Rosoman Municipality	A well-defined strategy will serve as a blueprint for all subsequent interventions, ensuring alignment with the overarching goals and vision for an adapted agricultural region.	Rosoman municipality	Residents of Rosoman municipality Institutions NGO Business sector	June – October 2024
Formation of the Municipal Council for Climate Change	Formation of a special council that will oversee the development of the strategy and its subsequent execution. This body should consist of local agricultural experts, community leaders, agricultural community representatives and other relevant stakeholders.	The Council will be instrumental in guiding the formulation of the strategy, ensuring that it reflects the unique challenges, aspirations and resources of Rossoman Municipality.	Rosoman municipality	Residents of Rosoman municipality Institutions NGO Business sector	June – October 2024
	Organizing focus group discussions, surveys	Grounding the strategy in field	Municipal	Farmers,Experts	June –

	and consultations to gather opinions from farmers, experts and community members	knowledge ensures its relevance, acceptance and effectiveness	Council on Climate Change	Community members	October 2024
	Documenting the strategy in a comprehensive yet accessible way and distributing it widely through community meetings, digital platforms and local media.	Ensure that the community is well informed about the strategy that encourages collective ownership and cooperation in its implementation	Municipal Council on Climate Change	Farmers,Experts Community members	June – October 2024
Pilot programs	Implementing pilot programs to test new initiatives. Organizing educational workshops, introducing adaptive technologies	To provide a safe environment for testing interventions, gathering feedback and refining approaches before wider roll-out	Rosoman municipality	Residents of Rosoman municipality Institutions NGO Business sector	Ongoing from 2025
Infrastructure assessment	A thorough assessment of the existing agricultural infrastructure in the municipality of Rosoman	To identify critical areas that need immediate attention and investment, ensuring that resources are channeled effectively	Rosoman municipality	Residents of Rosoman municipality Institutions NGO Business sector	First half of 2025
Feedback systems from the community	Developing digital and offline systems where farmers and community members can provide continuous feedback on various initiatives	Development of a feedback-oriented approach that will ensure that interventions remain agile and responsive to evolving community needs	Rosoman municipality	Residents of Rosoman municipality Institutions NGO Business sector	Ongoing from 2025
Resource allocation and fundraising	Initiating efforts to allocate the necessary funds for the proposed interventions	Ensuring financial readiness is for smooth implementation of the recommendations	Municipal Council on Climate Change	FarmersExperts Community members	Ongoing from 2025
	Reallocation of municipal funds and seeking external grants or partnerships		Municipal Council on Climate Change	FarmersExperts Community members	Ongoing from 2025
Cooperation with research institutions	Forming partnerships with academic and research institutions that focus on climate change science and sustainable agriculture	Delivering scientific rigor, research insights and technological innovation, ensuring Rossoman remains at the forefront of adaptive agricultural practices	Municipal Council on Climate Change	FarmersExperts Community members	Ongoing from 2025
Continuous monitoring and reporting	Establishing mechanisms for continuous monitoring of implemented initiatives.	Providing accountability, and insight into progress and future improvements	Rosoman municipality	Residents of Rosoman municipality Institutions, NGOs Business sector Municipal Council on Climate Change	Ongoing from 2025

	Regular reporting of findings, challenges and successes to the community and stakeholders.		Rosoman municipality	Residents of Rosoman municipality Institutions, NGOs Business sector Municipal Council on Climate Change	Ongoing from 2025
Public awareness campaigns	Launching public awareness campaigns, using local media, community meetings and digital platforms, to keep the community informed about climate change and ongoing interventions	Increased active community participation in adaptation measures	Municipal Council on Climate Change	Farmers Experts Community members	Ongoing from 2025
Periodic review meetings	Review meetings with council, community representatives and other stakeholders	Stakeholders to assess progress, address any emerging challenges and recalibrate the approach if necessary	Rosoman municipality	Rosoman Municipality Council, Community representatives and other stakeholders Municipal Council on Climate Change	Ongoing from 2025

MONITORING

Monitoring provides an opportunity to examine and analyze the implementation phase after the completion of the planning phase. As a means of measuring success, it opens up the possibility of dealing with uncertainties, taking corrective measures as well as support for updating and adapting the plan.

Monitoring is also an important tool for implementing measures and evaluating their effectiveness and determining which goal and action should be given appropriate priority in the future.

Another very important aspect of monitoring is that it can provide a basis for obtaining information, which would be implemented in planning processes in the future.

Plan for monitoring the implementation of the strategy

Purpose	Indicator	Monitoring period	Responsible
Promoting the adoption of climate-resilient crop varieties and sustainable agricultural practices to reduce vulnerability to climate variability	Introduced new varieties in production New technologies applied	Annually	Municipal Council on Climate Change
Implement advanced water management practices, including efficient irrigation systems and rainwater harvesting, to combat water scarcity	Efficiency of existing irrigation systems Built facilities for collecting rainwater New irrigation systems applied	Semi-annually	Municipal Council on Climate Change
Increasing soil health through conservation practices, reducing the risk of erosion and improving agricultural productivity	Improved soil structure New technologies applied	Semi-annually	Municipal Council on Climate Change
Strengthen efforts to conserve biodiversity in agricultural systems, supporting ecosystem services	Monitoring the impact of climate change on plants and animals Control of collection of wild plants Built feeding facilities and watering holes for life during dry periods Afforestation carried out	Quarterly	Municipal Council on Climate Change

Developing and promoting green infrastructure projects to mitigate the carbon footprint of the agricultural sector and improve resilience against climate change	Developed green infrastructure projects	Quarterly	Municipal Council on Climate Change
Creating and implementing disaster risk reduction measures to protect agricultural assets, livelihoods and infrastructure from climate-induced hazards	Monitoring the application of adequate measures for the protection of agricultural assets, livelihoods and infrastructure from climate change	Annually	Municipal Council on Climate Change
Creating targeted educational programs and workshops for farmers on strategies and technologies for climate adaptation	Developed educational programs and held workshops for farmers on climate adaptation strategies and technologies	Quarterly	Municipal Council on Climate Change
Increasing community participation in climate change resilience projects such as tree planting, community gardens and local conservation efforts	Developed climate change resilience projects such as tree planting, community gardens and local conservation efforts	Quarterly	Municipal Council on Climate Change
Facilitating access to climate and weather information, enabling farmers to make informed decisions about crop management and planting schedules	Availability of climate and weather information	Monthly	Municipal Council on Climate Change
Updating agricultural and environmental policies to integrate climate change adaptation measures and sustainability principles	Proposals for integrating climate change adaptation measures and sustainability principles	Annually	Municipal Council on Climate Change
Cooperation with national and international entities for harmonizing strategies and obtaining access to technical and financial support	Developed cooperation with national and international entities and specific technical and financial support	Annually	Rosoman municipality

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