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Multifunctional Orchard Model For Synergistic Production

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Abstract. **The world's growing population requires increased crop yields for their feeding. In food consumption, fruit is relied upon as one of the sources of vitamins. This necessitates an increase in perennial fruit plantations. Another important product is the consumption of animal foods and products. On the other hand, a growing population is in dire need of electrical energy to meet its needs. This also requires an increase in the production of this type of energy. Worldwide, in order to protect the environment and reduce the consumption of raw materials, it is necessary to produce electricity from RES.**

This article discusses a model of complex production of plant production from an orchard, animal production and energy from a photovoltaic plant in a unit of arable area.

In practice, these are three separate productions to meet the needs of the population, which, however, have the same area and are located in the same place. Using the specifics of the individual productions, an attempt was made for the joint use of the areas, in which case it is possible to eliminate part of the various technological operations or serve as a basis for the other type of production. Such can be the irrigation of the plantation, the presence of shade from photovoltaics, fertilization of the plum plantation by the animals, fresh food for the animals, etc. The interrelations and the main points in the symbiotic production are given. The model can also be used in other types of joint "green" proceedings, after clarifying their specifics.

Keywords: symbiosis, res, model, plant production, fruit plantation

I. INTRODUCTION

Links between individual ecosystems are the subject of an increasing number of studies [1] as understanding them is essential for designing societal practices and management strategies to promote sustainability of ecosystem products and services provided [2-6].

Non-productive agroecosystems provide many non-market services such as improving soil structure, fertility, water quantity and quality, biological pest control, pollinators and combating climate change through carbon sequestration and greenhouse gas (GHG) mitigation. [7-9]. Links between agroecosystem services are strongly influenced by agricultural practices [9-12].

Relationships predetermine positive (synergies) and negative (trade-offs) interactions between different ecosystems. From them the main management activities are differentiated [13].

Orchards are interesting to study because of the impact of their perennial nature on biogeochemical cycles, their productive potential and the importance of their management practices [14,15].

This article discusses a model for synergistic production several types of production from one production area, which aims to improve the condition of employees and serve as an idea for deeper study. The model will serve to study the relationships between its main elements in obtaining plant production from plum plantation, animal production in the form of dairy products and meat, biomass and electricity production from a photovoltaic plant.

II. MATERIALS AND METHODS

Synergistic orchard production is understood as an approach in which different types of produce are produced. They are grown together by positively interacting with each other. This method of farming aims to improve crop yields and protect the ecosystem.

The multifunctional model refers to an intelligent system for growing and selling production from plum plantations and its adjacent production of products from different industries. Suitable for this purpose is the area of the city Troyan.

The municipality is located in the southern and south-eastern part of Lovech region. With an area of 888,839 km^2, it occupies the 2nd place among the 8 municipalities of the district, which accounts for 21,53% of the district's

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territory. The relief of the municipality is high and medium and low mountainous, and its territory falls entirely within the Central Stara Planina and the Middle Fore-Balkan. The climate is temperate continental with a pronounced mountain influence, with four seasons, no fog and strong winds. Rainfall is above the national average. The snow cover lasts about 50 days a year.

The area is famous for its plum plantations of prunes and the famous "Troyan plum brandy".

III. Results and Discussion

The model includes the following key points:

1. Cultivation of plant production from plums
2. Growing animal production.
3. Obtaining green electricity.
4. Obtaining biomass.
5. Obtaining organic products from the plant and animal farm.

Suitable terrain for the realization of the model is the land of the village of Debnevo with an array of 800 ha. Typical for it is the relatively mild climate. The good soil and climatic conditions the region have given a good livelihood to the population for years. The model (Figure 1) is part of the so-called circular bioeconomy giving high added value to products.

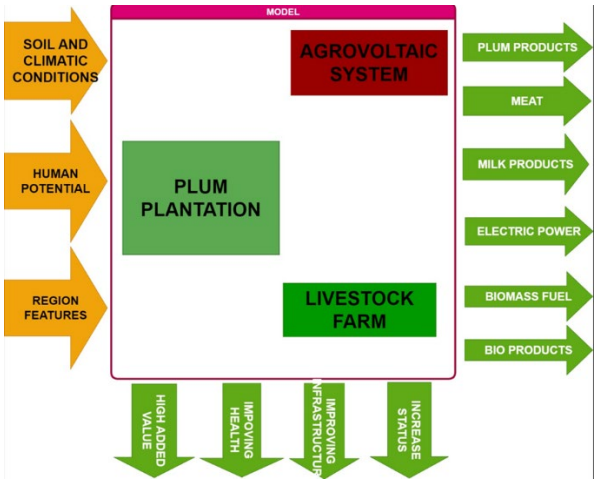

Fig. 1. General appearance of the model structure

The organization of the model implies the establishment of one plant and one animal farm, factories for the processing of organic products from the plant and animal farm, as well as an energy holding (Fig. 2).

At the heart of the model is the plant farm for growing plums. In the area over the centuries have grown plantations of gray plum in high yield. Currently, low-stemmed prunes plantations are relied upon. The plantations are low-stemmed with a small crown. This allows the free space above the crown and between the rows to be used for another type of production.

The change in the soil-climatic conditions of the farm environment is taken care of by a network of sensors that show the vital parameters in the cultivation of plum plantations. With the help of a developed algorithm and artificial intelligence that takes into account all factors of the environment, a dynamic technological map for growing the crop is made, and all operations for the cultivation of the plantations are performed, depending on the change in environmental conditions. The ultimate goal of these measures is to obtain the maximum yield from the plum plantation. With the fulfilment of the technological conditions, a yield of 30 t/ha or 24 000 t is planned.

In the cultivation of plum plantations, pruning operation is vital for obtaining high yields. In this regard, it releases a biomass product (about 1000 kg / ha or for the 800 t array), which can be processed into pellets or chips from the energy holding.

Since the plant farm is located in the field, it is necessary to provide an energy source for the monitoring and implementation of the tasks of the technological map. A suitable energy source is a photovoltaic system made up of agrovoltaics [16]. The characteristic of them is that they are located above the plum plantations and are vertical. Thus, the penetration of direct sunlight, which is vital for plant growth, will not be interfered with. The surplus of the electricity produced is envisaged to be sold by the energy holding.

The livestock farm is also located in the plum plantation. It will be located in the interrow space of the plum plantation. Pair-hoofed mammals can be raised. To avoid scattering the herd, it is planned to breed in special pens, which will move in the interrow. In turn, the crib gives safety to the herd from raids of wild animals (this is semi-mountainous terrain).

Symbiotic cultivation of plant and animal production has its advantages. Production areas are in one place and monitored simultaneously. No further processing of the inter-row space is needed, because the animals graze the grass and take care of its maintenance within certain limits. This reduces the cost of servicing the plantation. Another advantage is obtaining natural manure from animals. It feeds crops to increase yields. Again, the cost of growing plant products is reduced. Apart from this, the irrigation system of the plantations also feeds the lawn for animal feed. In this way, fresh feed for animals is obtained all year round. The cost of obtaining food for animals is eliminated.

In order for this system to work well, it is necessary to monitor the condition of the plantation and lawns in the inter-rows. The right watering mode also requires some power consumption. All the energy for servicing the plant and animal farm is obtained from the agrovoltaic system above the plantations. This energy cost is also eliminated. Part of the feces from the animals can serve to make pellets or for liquid fertilizers from the energy holding. They are collected by special devices at the end of the pen.

Processing factories have the obligation to process all production. In these factories, organic products of a plant or animal nature are obtained. They are again in the land of the model. The energy to operate these factories is supplied by the energy holding, at fixed prices suitable for both parties. This energy can be thermal or electric.

In the plant processing factory, the raw material was obtained from the tenants. Plums are targeted, dried and dried plums are obtained as a final product from one assembly line. The model provides a packing line for dried fruits. A shock freeze line is also planned. The other end product is the preparation of oil from the plum's pit. This is the third assembly line in the factory for processing. It is suitable for making medicines and the cosmetic industry.

The waste from the plum processing factory will be handed over to the energy holding to make biofertilizer or biomass for energy.

The animal production processing factory processes the products of the animal farm. Production lines for processing milk, yellow cheese, cheese and local products are envisaged. The products are organic because the animals are grown in a natural environment without the use of synthesized feed mixtures. A packing line for finished products is again envisaged in the factory.

The waste is again handed over to the energy holding.

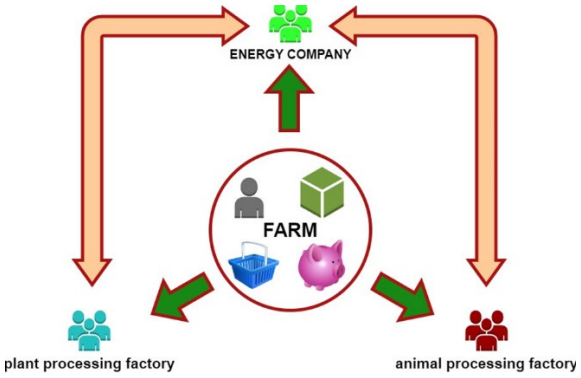

Fig. 2. Interaction between the main elements of the model

The energy holding aims to control and redistribute the energy obtained from the agrovoltaic systems, from the biofertilizer from the animal farm, from the excess hay from produced from the inter-row space of the plum plantation and from the waste from the various industries such as pruning branches, plum pits, etc. Once the needs of individual consumers in the model are satisfied, surplus energy will be sold on the free energy market or used to meet the energy need of households involved in the processes.

As a result of the produced organic products and the consumption of such, it is assumed that the health of the population will improve. Due to the increased trade turnover, it is assumed that this will lead to improved infrastructure to allow production to reach the markets. The profit made will improve the situation of all stakeholders and involved in the process. A well-functioning structure will be built, in which everyone will have an interest in developing it and improving the well-being of those involved.

This will lead to increased interest in involving new tenants or process actors, resulting in population growth in the region. New structures such as a school, a medical centre and other adjacent units will be built.

As elements of the circular economy, they will all lead to the high added value of manufactured products.

The model relies exclusively on human potential, on the soil-climatic conditions of the environment and on the peculiarities of the region. It is located in the centre of Bulgaria and can be a key centre for the preservation and development of the livelihood of the population.

IV. Conclusions

A model of symbiotic cultivation of plant and animal production, as well as the receipt of electricity and energy from biomass, has been developed. The developed model will allow to increase the living status of its participants through sustainable development. Lifestyle and infrastructure will be improved. The developed model can serve as an example of symbiotic sustainable development of society.

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