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CROSS-BORDER ALLIANCE FOR CLIMATE-SMART AND GREEN AGRICULTURE IN THE BLACK SEA BASIN

Subsidy Contract No. BSB 1135

CROP MODEL

ORGANIC WHEAT GROWING MODEL

Common borders. Common solutions.

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CROP MODEL

ORGANIC WHEAT GROWING MODEL

Climate-smart crop models, adapted to the environmental, social and economic conditions in the BSB region

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Contents

A. Choice of crop and method of experiment implementation

The effects of climate change - global warming, intense periods of heavy rain and longer dry periods, highly challenge the productivity of the agricultural sector. Farmers and farm communities around the world experience frequent loses due to altered meteorological conditions, floods, droughts, as well as weed & pests' outbreaks brought about by the climate change. Farmers need to choose crop varieties well adapt to local conditions and resistant to drastic environmental changes. Organic production system in combination with use of heritage wheat species can be a solution for stable harvests and food security for smallholder farmers from dry areas affected by the climate change.

The model proposes use of cover crop - an ancient well-known method, in order to suppress weeds, reduce water consumption and increase soil nitrogen. Researchers at the University of Michigan in the United States estimate that 1 acre (0.404686 ha) of soil under 1.8 tons of clover will be enriched with about 150 lbs (68 kg) of nitrogen in plant assimilated form, half of which will be used by the plants in the area and half (under proper soil management) will remain in the soil for the next cropping season. Benefits of cover crop use are the following:

- weed control without using herbicides;
- no need to use nitrogen fertilizers - rhizobium bacteria inhabiting clover root nodules will enrich the soil with nitrogen, increasing thus the yield and quality of grain;
- the soil protected from erosion;
- the soil looseness maintained; the content of organic matter in it and the ability to retain moisture increased (the frequency of watering and water consumption reduced);
- in addition, it is possible to use clover hay for animal feed.

According to the model, it is planned to sow clover as a cover crop in the fields with cereals, in particular, heritage wheat. The aboriginal variety of autumn soft wheat - "Akhaltsikis Tsiteli (red) Doli" and endemic species of spring wheat - "Dika" are selected for this model. These ancient wheat species are known for their high nutritive qualities; they are highly adapted to local soils and changing weather conditions, are resistant to pests and disease and give stable harvests in low input systems and, therefore, have a potential to significantly contribute to food security of smallholders.

This model to be implemented for the first time in Georgia. Clover will be sown in autumn and spring wheat fields. In parallel control fields will be also sown. The observations and results will be documented, compared with control crops, analysed and, based on the conclusions, recommendations for Georgian farmers will be developed.

Georgian farmers will have the opportunity to see, get acquainted, study and introduce proposed production system in their fields. The model will be implemented on Elkana conservation farm -

"Seed Ark" located in village Tsnisi, Akhaltsikhe municipality, Samtskhe-Javakheti region. This is a land of 4.2 ha, used for multiplication of heritage wheat and other indigenous varieties of crops.

The region Samtskhe-Javakheti is located in southern Georgia. It stretches over area of 6,413 km^2 with a population of 151.110. Samtskhe-Javakheti is a strictly agrarian region where the share of agriculture in total value added is largest in the country - 32%. Most of the human resources (about 64%) are employed in agriculture. The region's agriculture is made up of family farms and commercial farms. Over 90% of production is accounted for by family farms. 73% of family farms produce agricultural products for own use, and for the remaining 27% - agriculture is a source of income. Irrigation is rather problematic and most of the farmers practice rain-fed agriculture in the region. In most of the region the summers are cool (+15 + 20 ℃), with little precipitation and cloudiness, with not much rains. The winters are cold and snowy.

Implementation of the model will give a possibility to Georgian farmers to see the model in Elkana "Seed Ark" farm and get acquainted with the obtained results and conclusions of the experiment. This will give them possibility to introduce this model in their farming systems.

B. Objectives and tasks of the experiment

The main objective of the experiment is to introduce heritage wheat and the organic wheat growing model to farmers in Samtskhe-Javakheti.

This objective implies the following tasks:

- To arrange organic wheat growing model on Elkana "Seed Ark" farm with use of clover as a cover crop and heritage wheat – as a main crop;
- To observe and record performance of the main crop on experimental and control fields;
- To develop information package on heritage wheat and use of cover crop in organic production system and introduce it to local farmers.

C. Materials and methods

C1. Area selected for model implementation

The model will be implemented on Elkana conservation farm "Seed Ark" located in village Tsnisi, Akhaltsikhe municipality, Samtskhe-Javakheti region. This is a land of 4.2 ha, used for multiplication of heritage wheat and other indigenous varieties of crops. Since the establishment the "Seed Ark" farm is managed based on organic farming principles.

Model area on Elkana "Seed Ark" farm:

i. 0.25 hectares (2,500 m^2), sown on October 29, 2021 with the autumn wheat variety "Akhaltsikis Tsiteli Doli";

ii. one hectare (10,000 m^2) to be sown with the endemic species of spring wheat – Dika, before March 10, 2022.

C2. Description of the plot selected for the model (orchard)

The model area shall be managed using only organic methods and organic means.

i. On an area of 0.25 ha, in the spring of 2021, corn was sown; after harvesting the plot was cleaned from stubble remains, tilled to 20-cm depth, cultivated (loosened) and on October 29 was sown to 60 kg Akhaltsikhe red wheat seeds; for spring 2022 the crop condition is satisfactory;

ii. On an area of 1 ha, in the spring of 2021, grain legumes (cowpea, grass pea, chickpea, and broad beans) were sown; after harvesting the plot was cleaned from stubble remains, tilled to 20-cm depth, cultivated (loosened) and will be sown to the spring wheat "Dika" before March 10. 2022.

According to the laboratory analysis of the soil, in the area selected for the implementation of the model, the soil type is brown-carbonate; pH of the alkaline reaction (8.05); organic matter content is low (2.83%); the nitrogen content available to the plant is very low (25.16 mg/kg); phosphorus content is low (15.96 mg/kg); potassium content is very high (438.26 mg/kg).

C3. Project importance and design

3.1. Soil Fertility

Up to 80% of Georgia's agricultural lands are poor in nutrients, therefore models that work on soil improvement are very important in Georgian context. The project aims establishment of an organic wheat growing model, where clover will be used as a cover crop to improve soil fertility, control weeds and reduce use of water. Along with saving water resources, farmers will get additional benefits through animal feed production (clover), increased crop yields, and from cutting costs for use of herbicides, nitrogen fertilizers and irrigation. The main goal of the project is to maintain soil fertility, harvest high-quality crop of cereals and at the same time retain loose soil, increase organic matter as well as amount of minerals and living organisms therein.

The main "element" that creates soil fertility is edaphon (a combination of organisms living in the soil) or life in the soil and not the soil itself (without living organisms living in the soil, or non-living part, there is no soil).

The upper layer of the soil should maintain optimal conditions for the survival of microorganisms and beneficial organisms; only in such conditions, as a result of decomposition and transformation of organic matter, complexes of substances necessary for plant growth and development are formed.

Since soil and plants are components of a single whole system, in our case, wheat plants will have optimal conditions for good growth (light, heat, moisture, Rhizobium bacteria living on clover roots will enrich the soil with nitrogen). Plants grown in such conditions will have high immunity and will be able to adapt to adverse environmental conditions (e.g. drought).

3.2. Maintaining soil fertility

To maintain the soil fertility it is important to restore nutrients "lost" during harvest by rotating the stubble remains into the soil. Recycling of plant and animal waste is important in organic farming.

When the crop and vegetation are removed from the cropland, the soil loses energy and nutrients. Therefore, the main mass of plants grown in the given area, after harvesting, must be returned to the same soil. This retuned mass is the food for the organisms living in the soil and as a result of their metabolism substances like carbon dioxide, amino acids, phytoncides, vitamins, phytohormones, etc., are released, which condition the normal growth and development of crops. Rotating the post-harvest stubble remains into the soil serves for this purpose.

In addition, the root nodule bacteria (Rhizobium) transforms nitrogen from the air into a form assimilable by plants (e.g., in the alfalfa area, the soil is enriched with about 300 kg of nitrogen in 3 years). Researchers at the University of Michigan in the United States estimate that 1 acre (0.4 ha) of soil under 1.8 tonnes of clover will be enriched with about 150 lbs (68.0389 kg) of nitrogen in plant assimilated form, half of which will be used by the plants in the area and another half (under proper soil management) will remain in the soil for the next cropping period.

D. Activities

D1. Soil preparation (cultivation)

The main purpose of soil cultivation (loosening) is to create favorable conditions for the normal growth and development of agricultural crops (improvement of physical, chemical and biological properties of topsoil, water and air regimes), i.e. existence in soil of solid, liquid and gaseous components at the volumetric ratio (1:1:1), for which loose soil is necessary.

When there is air between the clogs and they are saturated with moisture, the plant root system develops well, the number of microorganisms grows and their vitality is activated, the processes of converting organic matter and mineral salts into plant food are activated, the roots are better propagated both wide and deep, absorbing nutrients from more area.

In the case of deep tillage, the movement of the topsoil downwards and of the bottom soil layer upwards, their loosening and stirring took place concurrently. In loose soil, the root system of plants grows well, but the use of this method of soil cultivation has negative consequences:

- the structure and biological cycle of the soil are disturbed,
- the content of organic matter is reduced,
- different microorganisms (aerobic, anaerobic) live at different depths of the soil, and their number decreases when the clog is turned over.

Subsoiling (rototilling) is a better method (if the soil structure and the crop allow it), because the top, fertile layer (where good conditions for soil microorganisms are already created) does not move down, the soil structure is not disturbed, and earthworms are active; the soil is rich in humus, water easily penetrates into the soil, moisture evaporates gradually and not all at once; the root system develops well; soil self-renewal processes are active, etc. Therefore, when this is possible, soil loosening should be done lightly, without turning the clog.

The use of the zero (no-till) tillage method (sowing of agricultural crops on uncultivated, untilled soil) is effective only on light soils and when the biological and mechanical methods used against weeds are effective.

For the model the surface tillage or minimum cultivation method will be used. The soil loosening on 0.25 ha area and 1 ha area occurred in October 2021 to 15-17- cm deapth, without turning the clog to be followed by cultivation (clog loosening) and sowing of fall wheat on an area of 0.25 ha on October 29, 2021, also sowing of spring wheat seeds on an area of 1 ha before March 10, 2022.

These operations to be performed using the rotary tiller “Meccanica Benassi RL328-Kohler 7,0”.

1. Clover sowing (03.2022)
The clover seeds will be sown by hand, by oversowing in wheat crop fields.

2. Mulching effect of clover crops for wheat field
Mulching with organic matter will facilitate:

inhibition of weeds and improvement of soil structure;
protection of soil from erosion and prevention of nutrient leaching;
protection of soil from sharp changes in temperature;
development of a strong plant root system;
protecting the soil from drying out, retaining moisture, producing dew and reducing irrigation frequency;
generating more carbon dioxide and dew;
inhibition the development of fungal diseases;
activating the process of photosynthesis, getting an early harvest, increasing the vegetation period and yield;
getting a quality crop.
Organic matter is food for microorganisms, fungi, and worms living in the soil and promotes their reproduction and vitality activation. This method shows the effect of one of the best organic mulches - live mulch - made for the wheat crop in the form of clover (low-growing and drought-resistant leguminous crop). Clover develops quickly, covers the soil like a carpet, inhibits the emergence of weeds, prevents soil overheating, moisture evaporation, crust formation, attracts beneficial insects, enriches the soil with nitrogen (with Rhizobium bacteria), indirectly creates crop rotation effect. Using this method is especially effective in hot (low humidity) regions, where much less water would be required for irrigation in fields with cover crop than without it.

3. Measures against the spread of pests of agricultural crops
Agricultural pests are species of insects, mites, nematodes, mollusks and animals that are harmful to plants and are one of the major problems in agriculture. They damage the plant, transmit viral and fungal diseases, reduce yields.
Organic way of farm management considers regenerative methods of pest control by which the processes that organically take place in nature are enhanced. For example, it is possible to reduce the number of pests in the area significantly by beneficial parasites and predatory insects. The predatory insects are spiders, predatory flies, ground beetles, bombardier beetles, mites, odonata (dragonflies and damselflies), green lacewings, bugs, wasps, mantises, ladybugs (one ladybug worm destroys 100 aphids a day, and one pair during sexual activity destroys 1600 aphids a month). Beneficial parasites are parasites of the body of pests, for example, aphid parasite ichneumonid wasps lay eggs in the body of aphids (one aphid parasite destroys 200 - 1,000 pests).
During the model implementation, it is planned to attract entomophagi (beneficial insects) in the farm and promote their reproduction. For this purpose, a “guesthouse” for beneficial insects will be set up in the farm. For this purpose organic materials, like straw, cones, broken bricks, finely chopped pieces of large tree branches will be used. Insects live and stay permanently in this "guesthouse", feeding or parasitizing on pests and their eggs, and significantly reducing their number.
4. Wheat harvesting-handling-sale (07-10.2022)
The wheat will be harvested with a special small combine, owned by Elkana. Harvested wheat will be cleaned, sorted for seed and grain and placed in warehouse on the “Seed Ark” farm.
5. Required materials

Clover seeds - 12 kg;
Construction and arrangement of a shelter for beneficial insects ("Guesthouse") in the plot, GEL 1,200.
The heritage wheat seeds to be used for the model are from Elkana “Seed Ark” farm.

6. Number of workers required (man-day)
Tillage (rototiller) – 2;
Cultivation (rototiller) - 2;
Rotary tilling (rototiller) - 2;
Wheat sowing (tractor, sower) - 2;
Clover sowing (by hand) – 1;
Irrigation – 2;
Harvesting (small-size harvester) – 2;
Harvest grain drying-warehousing-sorting – 6;
Cultivation in the area, mulching and turning stubble remains into the soil – 2.
In total, 21 man-days are required.

E. Expected results and impact

The model will demonstrate to local farmers

- heritage wheat species adapted to changing climatic conditions;
- organic management practices of wheat growing;
- the benefits of use of clover as a cover crop in wheat fields;
- organic pest management practices

Introduction of this model gives local farmers possibility to get stable harvests & income through use of non-irrigated fields, where other crops usually fail.

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