Final Project Report (to be submitted by 30th September 2016)

Instructions:

- Document length: maximum 10 pages, excluding this cover page and the last page on project tags.
- Start with an abstract (max 1 page).
- Final report text: Do not forget to mention your methodology; the people involved (who, how many, what organization they are from – if applicable); and the expected added value for biodiversity, society and the company. Finally, state whether the results of your project can be implemented at a later stage, and please mention the ideal timing and estimated costs of implementation.
- Annexes are allowed but will not be taken into account by the jury and must be sent separately.
- Word/PDF Final Report files must be less than 10 MB.
- If you choose to submit your final report in your local language, you are required to also upload your final report in English if you wish to take part in the international competition.
- To be validated, your file must be uploaded to the Quarry Life Award website before **30th September 2016** (midnight, Central European Time). To do so, please log in, click on 'My account'/ 'My Final report'.
- In case of questions, please liaise with your national coordinator.

1. Contestant profile

▪ Contestant name:	Lina Lebedeva
▪ Contestant occupation:	Lecturer, Junior Researcher
▪ University / Organisation	al-Farabi Kazakh National University
▪ E-mail:	
▪ Phone (incl. country code):	
▪ Number of people in your team:	2

2. Project overview

Title:	Usage of the Complex Method of Soil Enrichment
Contest:	Quarry Life Award
Quarry name:	Baltabay
Prize category: (select all appropriate)	☐ Education and Raising Awareness ☐ Habitat and Species Research ☐ Biodiversity Management ☐ Student Project ☐ Beyond Quarry Borders

Abstract (max 1 page)

Nowadays there are a lot of new, high-tech and expensive ways to renovate and restore infertile soils. If small areas might be used as experimental fields, the areas more than few hectares are in a need of another method, a cheaper but not less effective. The main aim of our project is to prove that this method really exists. Green beans play a role of test-objects because of their ability to grow up even in synthetic substrates. Being obligate symbionts with rhizobia, they enrich the ground with natural organic and mineral fertilizer. It means that the fertile top layer of the soil can be formed and prepared for the further activities in short period of time without any expensive techniques or equipment.

Blue green one cellular algae called Spirulina is also a very prospective object for practical investigations. Due to its characteristics it can be used as a solo component, so together with other objects. Adding a few ml of Spirulina to the soil can accelerate the processes of growth and improve plants quality.

Apart from the obvious benefits to the biocommunity, our project might have a very significant vague for local population. Planting of beans in wastelands (i.e. former quarries) can help to partially solve the problem of forage and nutritional product for people.

To make this research one student from al-Farabi National University was involved in all laboratory experiments.

Introduction

Baltabay, the crushed-stone quarry, is located in Almaty's suburb. It represents a zone, at first glance, totally unusable for any agricultural purposes because of arid climate, clay soils, loams and the almost complete absence of the plants (pic. 1).

Picture1. Baltabay quarry in February and May

Definitely, right now it is impossible to plant perennials or to construct a recreation zone, because of an absence of fertile soil layer enriched by organic and mineral compounds. But there are plants which can upgrade soil with all important substances, gradually turn a deteriorated ground into an arboretum. Being symbiotic organisms this group of plants in cooperation with the root nodula bacteria can fixate nitrogen from the air which is a natural mineral soil fertilizer and play significant role in forming humus and recovery of the soil.

The fact that the lower the total amount of nitrogen in the soil, the more intensive processes of its fixation from the atmosphere and, on contrary, the presence of nitrogen in large amounts in the soil causes that plants critically suppress its fixation. Obviously, Baltabay quarry is an ideal place for these plants. Thanks to rapid growth and massive biomass, they are able to prepare grounds for the further planting of trees and shrubs, constructing parks and resort areas in short period of time.

These plants are known to everyone. They are cheap, easy in cultivation and are one of the most popular and widespread agricultural crops in the whole world. We are talking about leguminous which belong to the legume order.

They can be divided into 5 groups:

1. Food and dietary (peas, beans, chickpeas);
2. Feed and forage (lupine, broad);
3. Oilseed and fiber crops (soybean);
4. Mix (lentils);
5. Green fertilizers (alkaloid lupine) .

As you can see in this list, legumes are almost universal. However, we made a decision to select the green beans, which are in great request in many countries. Beans have a lot of advantages:

a) cultivation does not demand any special and expensive tools, techniques and equipment;

b) green beans can grow in moderately arid climate in the foothill and mountains;

c) green beans is a source of cheap vegetable protein and dietary lectins which can be used both for animals and people (for example, beans contain approximately 22-26% of proteins, whereas meat has 20-22%, and fish only 18-19%);

d) being in symbiotic relationships with bacteria belonging to Rhizobium, green beans fixate nitrogen, which is a nitrate supplements and play a significant role in soil formation;

e) they have a taproot system with strong, well-developed main root, which penetrates the soil up to 1 meter and prevent the erosion processes and desertification;

f) as every normal plant beans have ground and underground parts like root, leaves, sprouts etc. which serve as natural and non-toxic source of soil fertilizer and gradually form humus or fertile top layer of soil;

g) vegetative period is 60-115 days per year, but the yield can approach 200 ctw per hectare or 600 g on 1000 of beans sees.

Seeds of beans and they mature pods have high nutritional and taste qualities. In addition to conservation, beans are used in the preparation of various dishes, soups, toppings, side dishes, pies and cold appetizers. Besides the high protein content the beans are rich in carbohydrates (mainly starch) - 55% fats - 1.8%, fiber, minerals (zinc, copper, potassium, iodine, iron, sulfur, magnesium) and vitamins (A, C, B1, B2, B6, E, PP).

To demonstrate the real benefits of nitrogen-fixing symbionts, there is a table by well-known french scientists Pochon and de Barjac:

Table 1. The total amount of fixated nitrogen in the roots of legumes.

Plant	Nitrogen (kg/hectare)
Alfalfa	217
Clover	105-200

Peas	100
Soybeans	65
Beans	44

Thus, using nitrogen-fixing symbionts within 2-5 years we can expect for the almost complete soil restoration in Baltabay quarry or anywhere else.

To empower growth processes of beans we used cyanobacteria Spirulina platensis belonging to Arthrospira. Nowadays these bacteria are actively cultured in many countries. People use them as dietary supplements with normal food, as contaminants drugs in the treatment of anemia, heart diseases, chronic bronchitis, etc. It is proved, that even small amount of spirulina introduced directly into the soil increases its fertility and significantly speeds up plants growth and development.

Taking into account all of these factors, we can say that planting of beans is one of the most effective and at the same time the cheapest ways to enrich infertile soils.

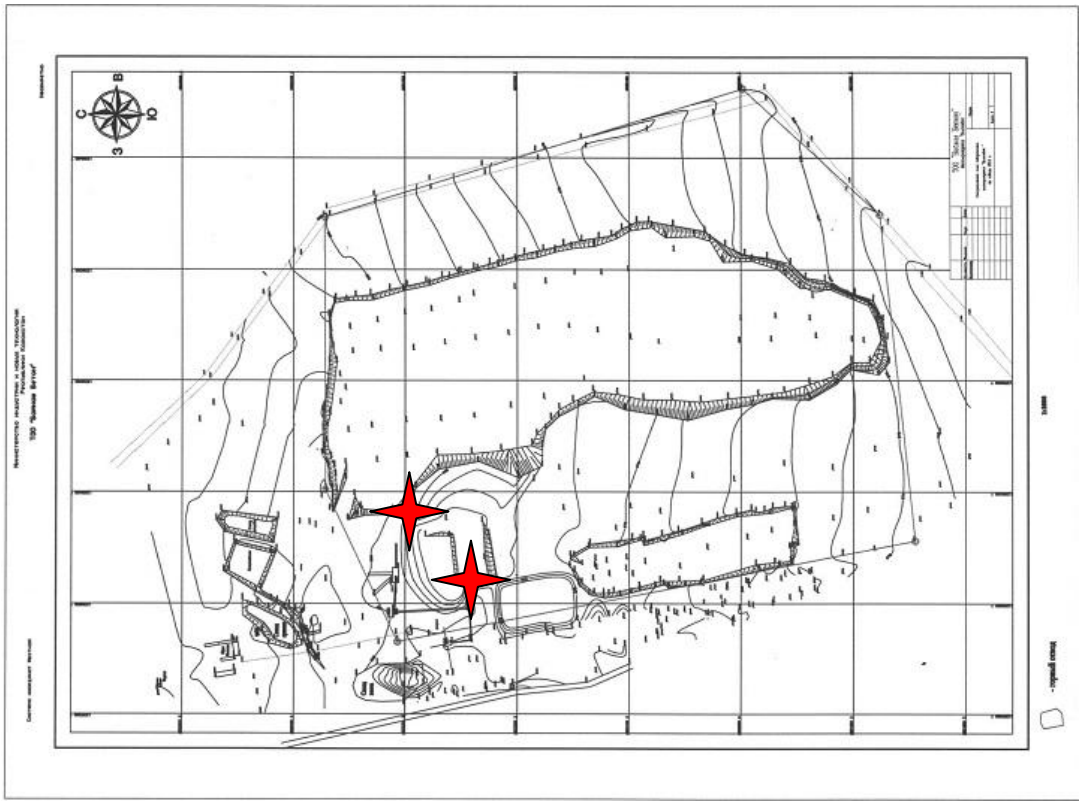
Materials and methods

The first stage of our experiment is a selection of seeds. Rotten, decayed, dry, withered seeds are not suitable for the planting. All of them must be smooth, identical in shape, size and colour, without any spots of mold or wormholes. To accelerate the process of germination, it is necessary to soak seeds in hot water (up to + 60 ° C) and leave them for a few hours. Thanks to this easy and cheap method we can speed the sprouting up and at the same time prevent some fungal diseases like anthracnose because majority of spores are not tolerate to high temperatures. Planting of germinated seeds should be done in open ground at an air temperature not less than +10-12° C, when spring frosts do not threaten anymore. The perfect time for green beans is in the third decade of May. The optimum temperature for them is equal to 20-25 ° C, but mature plants can resist high temperatures (30-35° C) for a short period of time.

We selected a local specimen called «Skorospelka» because of its visible advantages (pic. 2).

Picture 2. The seeds of the selected specimen

We checked two sites in Baltabay quarry and took samples of the soil (pic. 3). There was a complete absence of herbals, plants and trees and a lot of small stones.



Picture 3. The map of Baltabay quarry

Obtained samples were divided into 4 different pots. The 1st one represents clay soil, the 2nd and 3rd contain loams and the last one was filled up with humus. The depth of the wells was 4-5 cm, in each pot we planted 4-5 seeds of beans. As a control we used fertile soil made by company «Generous land».

In spite of the fact that usually breeders take care about plants, loosen the soil and remove all weeds, we decided to limit our influence and just irrigate them on time and add fertilizer spirulina directly to the soil for once in three weeks after the planting. Fortunately, spirulina is one of the easiest algae for cultivation and does not require any special skills, methods, reagents or laboratory equipment. 50 ml of suspension of algae diluted in the conic flasks and cultivated on a special media called Zarrouk. Temperature was never decreased less than 20-21°C during the whole period of cultivation. To help them grow faster we used a lamp for 24/7 and an aquarium oxygenator to aerate the algae within 10 hours (pic. 4).

50 ml of spirulina were added to 10 flasks (500 ml). Therefore we can calculate that the ratio between spirulina and cultural media is equal to 100 ml in 10 l.

Picture 4. Flasks with suspension of spirulina

In 10 days when the culture reached its peak we diluted 1 tea spoon of suspension in 200 ml of cultural media which helped us to maintain a culture in a viable state.

In this series of pictures you can see the development of seeds from small sprouts to immature pods. The totally controlled planting was done in June, 30, the last pictures were taken in August, 25. As we can notice, in less than two months common beans reached approximately 1.5 m in length and gave formed pods.

Picture 5. The second day after planting

As you can see, all sprouts were 15 cm in length in a week after germination. The fastest process was observed in red pods with humus and loams. The slowest (green pods) plants were in clay soil (picture 6).

Picture 6. Beans in 10 days after planting

In three weeks after the first sprouts had emerged we added some water with spirulina.

Picture 7. Plants after 45 days after planting

These pictures illustrate that before the end of vegetation all samples formed pods. Now the pods are in process of maturation (changing colour). As the beans are growing under stable conditions, we can suggest that by the end of vegetation 14 plants will give mature seeds.

Picture 8. Pods and flowers of the beans

Except visual observation we measured some parameters as length of stems, length and width of leaves, number of pods in every plant. These results are presented in the table 2.

Table 2. Measurement of beans

Soil	Length of stem, cm	Length of leave, cm	Width of leaves, cm	Number of pods per plant
Humus	153	5,5	3,1	6
Loams	149	5,3	3,4	7
Clay (1st pot)	147	5,3	3,0	5
Clay (2nd pot)	151	5,1	3,0	6

In the last picture you can observe roots of plants, which formed a dense tangle. They gum up the compartments of soil and prevent leaching, withering and degradation of restored zones.

Picture 9. Beans roots.

Conclusions

Our experiment demonstrates that infertile grounds which left after industrial activity, still have a potential to become an ideal substrate for legumes namely common beans. In the almost complete absence of mineral or organic fertilizers, beans' seeds do not only germinate, but also give pods with high nutritional value. The difference between experimental plants and the ones grown in fertile humus is now visible. In additions, it is necessary to notice that green mass of leftovers in cooperation with Rhizobacteria form natural harmless fertilizer, and root system can bond soil particles and prevent the processes of erosions, which are widespread in arid and semiarid zones.

To be kept and filled in at the end of your report

Project tags (select all appropriate):

This will be use to classify your project in the project archive (that is also available online)

Project focus:

- ☐Biodiversity management
- ☐Cooperation programmes
- ☐Education and Raising awareness
- ☐Endangered and protected species
- ☐Invasive species
- ☐Landscape management - rehabilitation
- ☐Rehabilitation
- ☐Scientific research
- ☐Soil management
- ☐Urban ecology
- ☐Water management

Flora:

- ☐Conifers and cycads
- ☐Ferns
- ☐Flowering plants
- ☐Fungi
- ☐Mosses and liverworts

Fauna:

- ☐Amphibians
- ☐Birds
- ☐Dragonflies & Butterflies
- ☐Fish
- ☐Mammals
- ☐Reptiles
- ☐Spiders
- ☐Other insects
- ☐Other species

Habitat:

- ☐Cave
- ☐Cliffs
- ☐Fields - crops/culture
- ☐Forest
- ☐Grassland
- ☐Human settlement
- ☐Open areas of rocky grounds
- ☐Recreational areas
- ☐Screes
- ☐Shrubs & groves
- ☐Soil
- ☐Wander biotopes
- ☐Water bodies (flowing, standing)
- ☐Wetland

Stakeholders:

- ☐Authorities
- ☐Local community
- ☐NGOs
- ☐Schools
- ☐Universities