United Nations
Educational, Scientific and
Cultural Organization

GEF

SGP The GEF Small Grants Programme

UNDP Uzbekistan

URGENCH STATE UNIVERSITY named after AL KHOREZMI
The Khorezm regional representative office of the Association of farmers of RUz
"INDIGO JONIBEK" PRIVATE COMPANY

Cultivation of Indigo plant, biotechnology of natural dyes and improving the soil's ecology

Teaching-practical manual for farmers

Tashkent-Urgench, 2009

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The mother who loves you – the Earth,
The one who suffers in illness – the Earth.
The only one you have – the Earth..” (E. Vahidov)

“Do not be the Sky, but be the Earth, a brother.
Be the son of the fatherland, a brother”.. (I. Yuldash)

The native land, the soil being forgotten,
The looks were turned towards the Sky”.. (F.Afruz)

The present manual contains information regarding the areas of distribution of indigo plant, the history of applying the Indigo natural dye, expertise on its cultivation in the saline soil and climatic conditions of Uzbekistan, methods of treatment of this culture, harvesting of high yield of biomass out of it, as well as the simplest methods of extracting of the paint base under the field conditions.

The present manual is intended to be used by farmers, and it mainly simply describes the methods of seeding of Indigo plant into the soil, activities on amelioration of the soil, as well as methods of extracting the paint base from the upper biomass in our degraded lands, i.e. those exposed to the decrease of productivity and annual salinization.

We hope that the given pamphlet will be also useful for the interested readers, for those working in this area, for scientific researchers and specialists. We thank you in advance for your proposals, opinions and shortcomings ascertained by you.

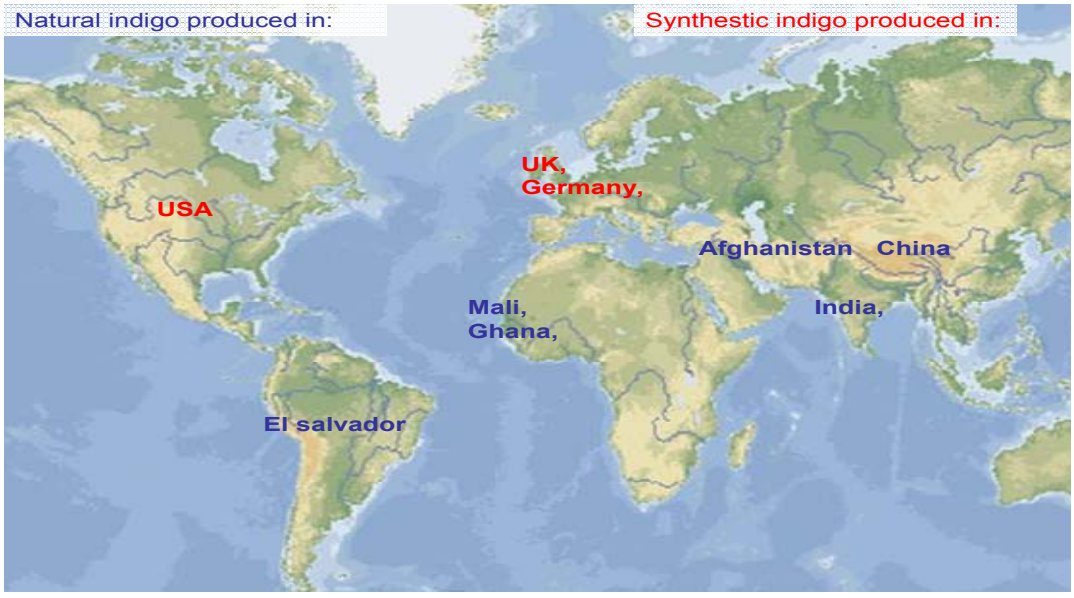
The appearance of half-moon and morning star on the blue sky

Introduction

When taking a good look at the history of our development we will pay attention to the stupendous importance of natural colors in it. Within several periods of history we can observe that human beings even tried to deify the colors, turning them into the symbols of their idols. For instance, the ancient Egyptians believed their main deity was of the sky-blue color, and so did Indians and representatives of Turkish nationalities imagining their main gods Krishna and Tangri, and there is chance that this served a reason for only Pharaohs, sultans, emperors and the members of their families to have the right to wear the clothes which were of sky-blue color. Definitely, these traditions came to the end by passing of time.

"Indigo plant" is the plant of the tropical zones, out of leaves of which the world known paint named "Indigo" is extracted, and it is a paint of sky-blue color which is titled to be the "king" of all paints. The history of the practical usage of the natural paint ""Indigo" extracted from the plant, which have the blue color and does not fade, counts for many centuries and thousands years. But regardless of this fact, several aspects of cultivating of this plant and extracting of the paint from this culture still remain to be a secret, and in the countries like India, China and Japan, usage of Indigo paint is peculiar secret art of the famous craftsman, which is passed only from fathers to sons.

Up to this moment the home for Indigo was considered to be India, and there is a chance that even no one considered that it can be cultivated for industrial purposes in the near Aral sea region. In Uzbekistan, the "Indigo" paint is mostly imported from a broad at the expenses of the foreign currency reserves, and if the paint paste costs in average 60-70 thousand soums per kilo in our country, in the markets of Europe it is priced at the level of 240-250 euro.



Picture 1. Regions of the world, where the natural indigo is produced (countries, where it is extracted using chemical synthesis are marked in red).

Presently, within the textile industry of our country, the artificial paints

are mostly being used. The extracting of such paints from the economical point of view does not cost a lot and the colours are beautiful, but it is notorious fact that artificial substances are harmful for human being organism. Nowadays the need for qualitative and non-perishable natural paints is increasing. The natural paints are considered to be ecologically clean product and fabrics, which are being painted, using them, do not fade under the sun and do not lose their qualities even after many years. It is a well known fact according to the history, that the clothing of ancient Pharaoh king of Egypt Tutanhamon, painted in indigo, almost did not lose its color and after 3, 5 thousand years.

Picture 2-3. Painted fabrics and carpets using indigo in Uzbekistan.

Due to this reason, during the past several years the need for the Indigo paint increases. But it should be mentioned that indigo plant was never cultivated before within the soil-climate conditions if our Republic for broad industry usage purposes. And we cannot find any information in the historical sources, that it has been cultivated in the Central Asia area for industrial purposes with the aim of extracting the natural paint out of it.

Based on this, and by the initiative of the UNESCO representative office

in Uzbekistan, the project named “Uzindigo” was organized during 2005-2007 there in Uzbekistan. Within the frames of this project, the experiments were carried out in Karakalpak, Khorezm, Syrdarya and Tashkent regions on planting and cultivation of Indigo. During the last years there in our Republic, as well as in Khorezm district, number of private and joint companies were established started their operation, which are involved in the activities on processing of cotton, wool and silk, where currently the ready-made goods are produced. Such companies as “Nurtob”, “Khiva carpet”, “Gultekis”, “Bogot tekstil” are working on their full capacity and they are sending their gods for export. These companies mainly use the artificial paints. Such types of paints have the tendency to fade by passage o time. Besides, foreign tourists are mostly interested in the products of local craftsman which are painted using natural paints.

Starting from 2005, a team of scientists under the head of the group professor A. Ergashev and with the assistance of the UNESCO/CEF Bonn/UrSU project have started the studying of the agricultural methods for cultivation of Indigo plant plant, the method for extracting of the paint base out of it and the issues related to seed farming and marketing. For these purposes, number of experiments on a preliminary basis was conducted in 2006 for its cultivation in a form of the major culture on the soils which were not used for 3-4 years, on the saline and low yield soils of the educational-experimental farm of UrSU, and in a form of secondary culture after harvesting winter wheat. During 2006-2007 some experiments were conducted within the territory of UrSU and Academy after Mamun on the possibility of cultivation of Indigo plant and yielding the harvest of biomass from two mows. In addition to this, some simple methods for extracting paint base from the green and dry biomass of the plant were developed. In 2008 some experiments were carried out on the fields of farmers association named after «M.Kuvakov» located in Bagat district on the possibility of applying fertilizers for the purpose of identifying its effects on the harvest of biomass. Some consequent recommendations were developed based on the results of these experiments.

This manual summarizes and describes the main results of these experiments in the way applicable to farmers.

1. Biological characteristics of plant

“Indigo plant tinctoria L.” relates to the leguminous family and it is a annotinous shrub plant with the height of 1-1,5 meters, which is grows in the cultivated form. The plant does not have any wild forms, thus it is grown only in cultivated form. The leaves have the extended shape, and are complex odd-pinnate. Its flowers are of red color, and they are located in the shape of cyst on the bud protruded from the source.

Picture 4. The flowers and the appearance of the plant.

The bearings, i..e beans have the length from 2 up to 3 centimeters and are of red-yellow color. Each bean contains on average from 3 to 4 mellow seeds inside. The mellow bean has the brown tincture. The seeds are small in size and are of brown color. The side branches are mainly arise in the bottom part of the footstalk during the period of growing and reach up to the height of the main body. Every single bush has up to 10-15 side branches depending on the planting density.

The other biological feature of the plant, which should be given with the special attention, is that up to period of beans' and seed's maturity, the growing upwards and formation of leaves takes place in an active form. After the beginning of the maturity period of beans, the formation of leaves sharply decreases. After the maturity of the beans, the leaves turn into yellow and shed. The given feature of the plant is very important depending on the aims for its cultivation (for the purpose of receiving the seeds or biomass of the leaves).

The root of the indigo plant has the straight shape, and after the shoot appears from the seed, the growth of the root is activated, and during the period when the leaves are formed, subsequent to the growth of 6 to 8 leaves, the length of the root part exceeds the length of upper part of the plant by three times. During the period of plant's development the growth of the root slows down, it becomes wider and side roots start to appear. Until the end of the period for plant's growth, the length of the root equals to 15-20 centimeters.

Picture 5-6. The appearance of the completely mature Indigo plant and the seed beans and the location of seed inside of it.

The external appearance of the plant reminds of shirin miya (buyon) growing in our region within the natural conditions in the prairie next to the canals and ditches.

Considering the fact that the plant is tropical, its seeds start to shoot only if the temperature of soil is high, i.e. when it reaches the level of 18-20 ^{o}C. In the southern regions of the country, this periods falls on the first decade, in the central zones, on the second decade, and in northern zones on the end of April and the first decade of May. The full period of the plant's growth (the full maturity of the seeds) compounds of 100-110 days.

2. Land treatment

The filed chosen for Indigo was degraded, as it shown in the Picture 7, it was not sowed during 4 years, and the content of humus in soil was not big, as in topsoil its content was equal to 0.60-0.65%. Additionally the saturation of soil with fertilizing elements was weak. The total content of nitrogen in soil was equal to 0.043-0.046%, of active phosphorus to 306 mg/kg^{-1} and of potassium to 80-102 mg/kg^{-1}.

According to the level of salinity the soil was classified as strongly saline. In accordance with several year's standing data, the quantity of chlorine was high and was equal on average to 1.27-1.89 mg in 100 grams of soil. And of the ion of sulphate was equal to 2.52-5.08 mg.

To the point, it should be mentioned, that around 65% of irrigated areas in our country are saline, and the level of salinity in them increases on yearly basis by 1.7-2.0% (based on the data of Uzbek state republican committee for land, MX, 2002).

Picture 7. Planting of seedlings into the saline soil, and three years later. (Experiments within the project of UNESCO/ZEF Bonn/UrSU)

For the reason the salt was not washed out during 4 years period of time and the high evaporation of the large volume of groundwater through the layers of soil, the ratio of the dry soil was high and was equal to 0,57%. Excessive amount of harmful salts in the soil affected its environment as well, i.e. on the reaction of dissolution. The environment of dissolution was alkalotic, the level of pH was equal to 7.67-8.10, and when correlating the quantity of ions in the soil, one could notice the superiority of chlorine ions. Due to this, this type of soil salinity was considered to be as chlorine.

Depending on the salinity of the soil, the sown area for Indigo plant is washed through 1-2 times. Each washing procedure requires on average 1000 m^3/hec of water. When the soil is ready, each hectare of the land is fertilized using 15-20 tons of dung and 200 kg of phosphorus, the depths of plowing of soils equals to 30-35 cm, the beds are constructed in the distance of 90 cm from each other. The beds are additionally handled and after the readiness of soil, the mixed with sand seeds of indigo plant are planted by hand into the depths of 1-1,5 cm, on the account of 6 kg per one hectare of land.

The present activity is similar to the inoculation of seeds of carrot, but the seeds of the indigo plant are inoculated in the upper part of the bed in one line.

Picture 8. Preparation of soil and inoculation of seeds

One of the most important land treatment measures while growing Indigo plant is applying the measures of control against weeds. As it is know, sufficiency of natural humidity in is soil will result in breeding of annotinous and perennial weeds.

In particular, such annotinous weeds as yantoq, sassiq o't, chuchik miya (buyon) and perennial weeds such as sho'ra, olaputa and sigir kuyruk are growing in big quantities. For the reason that young shoots of Indigo plant have the tendency to be very weak and its surface base part grows slower that under surface part, the weeds negatively affect on the growth of the plant. There is a risk that perennial weeds are growing together up to the end of the growth period, that negatively enough influences the sowings. Considering this, it will be reasonable to apply preventive and land treatment measure to fight against weeds. For this reason, it is necessary to carry out the removal of weeds 2-3 times in the period of early growth of the plant. In the case of excessive dangerous breeding of weeds for the sowings, it is necessary to apply chemical methods of fight against them. However, the scientific sources do not provide with exact recommendations on this matter. That is why it is considered to be reasonable to conduct a research on chemical methods of fighting against weeds and develop specific recommendations.

Picture 9. Growth, development and seed of the plant

During the period of the growth and appearance of 4-5 leaves on average the sowings are fertilized with the mineral fertilizers for the first time applying the ratio of 100-110 kg of nitrogen (ammonia saltpeter) per hectare of soil. Due the fact of lack of information on the methods, quantity and deadlines for fertilizing during the first year, we only limited us with the above mentioned quantity. The necessary quantity and methods of applying mineral fertilizers were studied deeply in 2007-2008.

It is necessary to pay a special attention on the methods of irrigation of indigo plant. In particular, during the the early stages of the plant's development, the beds should be constantly irrigated with small amount of water. The water should not reach the level of plant's height, i.e. up to the very top of the bed. That is because the weak leaves could stick to the soil, or the sowings could be spoiled. Due to this reason, it is necessary to observe that the level of water does not goes upper than the level of the middle of the bed. During the active development, and when the side branches start to appear, the sowings are irrigated 2-3 times. After appearance of seed beans and during the period of plant's maturity, the plant already requires a lot of water. The cultivation of soil between the beds after each session of irrigation let the humidity remain in the soil, which ensures the condition for exchange of air which in its turn accelerates the growth of the plant and the process for development of leaf mass. The normal growth and development of the plant can be determined based on its external appearance. The leaves of the plant which is developing well have the dark green color and the flowers are of red-yellow color. The process of appearance of the side branches is accelerated.

Picture 10. The period for development of Indigo plant

In the beginning periods of Indigo plant's growth it is necessary to pay a special attention on application of land treatment methods of fight against plant pests. From the moment of appearance of the first leaves, the plant louse, the

representative of plant sucking pests, creates a particular danger. The plant louse which appears on the plants growing in the prairie locations moves to the plant. To fight against them, the sowings are twice processed with the preparation of "Cypermetrin" in the amount of 10 g dissolved in 10 liters of water, after which they disappear. Other pests and rodents do no not create the danger for the sowings. But at the end of the growth period (in August), the sowing could be repeatedly affected by "Acacia louse". The spring method of control is applied against it, which let the sowing be protected from the pests.

3. Conditions for auxesis and development of plant

The plant starts to develop actively beginning from the second half of July up to first half of August. That is the hot temperature accelerates its growth top wards. Simultaneously, the appearance of side branches continues. During this period, the flowers of the plant are being pollinated, and the development of beans accelerates. After this, the development of the plant decelerates, which continues until the end of the period of its development. The height of the plant at the end of the period for its development could reach the height from 14 to 150 cm. As Indigo plant is classified as bunch-shaped plant, the side branches of the plant are mostly develop in the bottom part of its footstalk. These branches appear when the height of the plant reaches 20-30 cm and grow top-wards together with the footstalk. In the beginning, these branches continue to grow until reaching the height of the footstalk, and some seed beans develop and mature on them. This period falls on the beginning of July. Around up to 10-15 side branches appear on every plant on average. The attribute feature of the development of branches is that side branches first appear in the lower part of the bush, and then they start to appear on the top. This process continues until the end of August. The first branches reach the height of the footstalk, and in some cases they become higher than footstalk itself. Nonetheless, the leaves of the side branches are of the same size as the leaves of the main footstalk. But the leaves of later side branches usually are of a smaller size and seed beans on them do not mature completely.

Picture 11. Growth and development of the plant (A/f M. Kuvakov).

The height of the plant and quantity of side branches mainly depends on density of seeding. Under dense seeding of planting stock, the quantity of side branches does not exceed 3-4, they are developed not completely, and the main footstalk grows higher. And contrariwise, under not very dense seeding, the bushes do not become high and the quantity of side branches increases. On the beds, the distance between which should be 90 cm, it is advisable the presence of 20-25 bushes on average within one running meter. Under such density, there will be 220-250 thousand pieces of bushes on average within one hectare. During the experiments carried out in 2007, the first mass of yield form the sowings seeded in April was harvested in the end of August, after which the irrigation works, cultivation and fertilizing continued until the middle of October, and footstalks mowed at the height of 12 cm, developed the side branches again and the leaf mass appeared. Such branches can reach the height up to 20-40 cm.

4. Crop for the green biomass of plant

It is of a high importance to harvest the biomass of indigo plant seeded in spring as the main crop on timely basis, i.e. to identify correctly the time frame for harvesting the leaf mass only in which case the high yield of crop can be guaranteed. The incorrect identification of harvesting time may lead to the loose of the crop. As it was mentioned above, the process for the development of biomass of indigo plant's leaves is continuing till the time of bean's maturing. After this the process intercepts, and the appeared leaves start to fall. The period of mowing the mass of the leaves falls on the third decade of the August. However, it is important to mention, that before the harvesting the biomass, the sowings must be completely cleaned off weeds, as weeds affect very negatively on the quality of the extracted paint.

The mowed biomass cannot be left on the field, but should be transferred to the clean paved area, and when there is a possibility, it should be dried under the shade. For extracting the pigment of paint, it is placed inside of the sacks. As the paint is extracted only from the leaves, it is appropriate to store the leaves separately. However in many cases, the footstalks also contain the determined quantity of paint thus the footstalks can also be mixed for extracting the paint.

The volume of the biomass for the indigo plant, which is extracted from its terrestrial part in many cases, depends on the soil, land treatment and on-time harvesting. Thus, the biomass seeded in spring with the purpose of extracting indigo plant paint should be harvested at the end of August, beginning of September. In a case the aim is to extract the seeds, the crops is remained on the field without harvesting until the middle of October. The harvesting for the purpose of extracting the seeds is carried out when the maturity of beans reaches 90 %. The indigo plant is referred to the fabaceous family and though it accumulates the certain amount of nitrogen through the roots bacteria named tuganak, the crop yield of the biomass en masse depends from its fertilizing by nutrients. The fertilizing nutrition pattern of the plant on the soil with average crop yield was studied in 2008 within the territory of farmer's association named

after M. Kuvakov in Bagat district. Prior to sawing of seeds the soil was fertilized with 100 kg of phosphate and 30kg of potassium in the ratio for one hectare of area, and during the period of growing the soil was fertilized with 100-130-150 kg of nitrogen. As the result of this, the fields fertilized with 150 kg of nitrogen produced the biggest volume of crop.

During the period of indigo plant's growing it is of high importance to detect correctly the deadlines for fertilizing the soil. The most rational approach is to fertilize the soil when the side branches appear. Due to this, during this period, there is a necessity for better nutrition for maintaining the growth of the main footstalk and the side branches.

Up to this moment we only limited ourselves by studying the deadlines for fertilizing the soil and quantity of fertilizers in the field conditions. It is expedient to thoroughly study further the fertilizing nutrition conditions of the plant in the future.

Picture 12. Growth and development of the plant under the different fertilizing conditions.

Within the small fields the crop is harvested by hand. On big fields, the crop can be mowed using mowing-machine. During the harvesting of the crop it is not recommended to admit the loose of biomass. For this purpose, the mowing should be started from the edge of the filed using the certain pattern and the biomass should be removed from the field on the same day. While removing the biomass, it is necessary to collect and keep in separate sacks the leaves fallen on the beds.

Picture 13. Harvesting of biomass of indigo plant of “Feruz-1” sort.

The crop yield of the plant’s biomass on the degraded and saline soil reaches up to 120-180 centner from each hectare. This is equal on average to 12-18 tons of green biomass. After drying is undergone, it is possible to prepare 4-6 tons of dry mass for extracting the paint. This means, that 60-100 kg of paint base can be extracted from each hectare of law capacity soil, and besides the crop yield of the used soil can be renewed during 1-2 years.

Medium and high fertility lands provide high crop yield. Necessary regime of irrigation and nutrition may result in producing of 250 and even 350 centners of crop yield.

5. **Cultivation of indigo plant by secondary sowing after harvest of wheat in winter**

The experiment was conducted in 2006 on the sown area of ZEF /UNESCO within the territory of Urgench State University on sowing the seeds of indigo plant after harvesting the winter wheat. The winter wheat was harvested on the 6th of June, and on the 7th of June the field was ploughed up and sowed by the seeds of indigo plant, after which the growth and development of the culture was studied. All land treatment was carried out in the same manner as in the case of spring sowing in the form of the main culture. I.e. the field was cleaned off weeds 3-4 times, it was fertilized once and once it was processed with the preparation of “Cypermetrin” against Acacia louse. As the outside temperature was hot during this period of time, the seeds grew very fast, the growth of the plant was very active. Due to this, the sowings were fertilized with the nitrogen in the ratio of 100 kg for hectare of soil at the end of July. The biomass was completely formed on the fields sowed with secondary culture at

the end of September, i.e. its harvest fell to the first decade of October. By this time the seed beans usually do not mature. Although, when sawing is done in a form of secondary culture the crop yield of biomass is usually a bit lower, compared to indigo plant cultivated as the primary culture, it is not inferior to the first based on quality comparison. 100-120 centners of crop can be harvested on average from each secondly sowed hectare of area.

There are number of advantages of cultivating the indigo plant in a form of secondary culture. Among them is that there is no need for additional fields of land, land treatment is improved and the profit can be increased at the expense of single land area.

Due to this reason the indigo plant should be sowed in a form of secondary culture in the lands which are intended to be used for extracting the paint base. In a case if the aim is to extract the seeds, it should be sowed in spring as a primary culture on the minor not sowed areas around the ground area of farmers.

6. Methods for extracting of pigment dye

The method for extracting a pigment dye from the indigo plant is very simple. One of the ancient ways is to collect the leaves of indigo plant in the hole and to press it using foot.

The chemical structure of indigo plant was firstly defined in 1887 by scientist chemist Bayner. The indigo is congregated within the leaves of the plant in the form of substance called indigan. In order to extract it, it is necessary to press the leaves in water. While doing so, the substance contained in leaves in a form of indigan coalesced with water turn into indocsile. By passage of time, indocsyl, extracted during the pressing process in the water environmente, under the influence of oxygen in atmosphere air gradually turns into Indigo pigment in the form of sediment.

To accelerate this process, the compressed air flasks are used. The simple atmosphere air can also be used, in which case the air is supplied using compressor during pressing. However, the pressing time for extracting pigment using atmosphere air and compressed air from flasks differs. I.e. the atmosphere air is supplied for longer period of time.

For the first time the possibility of extracting indigo under the field conditions using oxygen technology proposed by A. Ergashev was demonstrated in 2006 in Botanic garden of Karakalpakistan named after Amir Temur (Picture 14-16).

Picture 14. The process for extracting Indigo pigment

The sowings are cleaned off the weeds before being mowed, and then they are moved and collected to extract the pigment. The mowed mass of leaves is washed in clean water and then dried in the shadow. The pigment can be extracted directly and from the green mass. However, after drying the process is accelerated and it becomes more compact. As the result of drying, the mass of the leaves reduces by 2,5-3,0 times compared to the green mass. The leaves need to be kept in a very clean place. Different dirt and dust worsen the quality of pigment. Because of this, the mowed mass of the plant should be dried in a clean place and stored in clean sacks in the enclosed space.

The extract the paint base, the following means are necessary:

- Flask with the filled oxygen;
- Pipe with the length of 4-5 meters to supply the oxygen;
- Synthetic net for piling biomass in pile (2-3 m);
- Container with the capacity of 50-60 liters of water with wide neck;
- Water thermometer;
- 10 liters water buckets, 2-3 pc.;
- Decanoic fabric for filtering of liquid with crust;
- Polyethylene film for drying of crust in the shadow;
- Containers for storing the pigments and other necessary means.

For extracting the pigment in in-house and on-field conditions it is necessary to pile together on average 5-6 kg of dried mass of leaves in Decanoic net. The piles then placed into the container with the capacity of 50-60 l of water

and flooded with hot water which has the temperature of 70^0C. If the temperature of water is hotter than 70^0C, the paint base may burn out. After this, the net of the piled mass should be carefully pressed using stick. While doing this, the oxygen is supplied through the pipe dropped into the water from the oxygen flask. The end of the pipe is dropped until it reaches the very end of the mass. Only under this condition, the oxygen is evenly distributed reaching all part of the mass in the net. The supply of the oxygen should be even, while careful pressing of biomass is not stopped.

The process in this described ways continues for about 20-25 minutes. As it was mentioned above, the appearance of the colourful bubbles on the surface of water implies the beginning of the reaction. In other words, the inter-connection of indoclile with the oxygen during the process of indigo formation gives the bubbles a blue tint and glitter under light. After the completion of the process, the mass in the Synthetic nets if firmly pressed and deposition formed are left in the containers. Afterwards, the container with the depositions is left in non-movable positions for 4-5 hours. After full deposition, the water from the containers poured out using the pipe. When doing this operation, it is necessary to ensure, that the container is kept in non-movable condition all the time.

After the transparent water is poured out from the container, liquid with deposition is poured on the placed polyethylene films and is smoothed out. The deposition should be dried out in the shadow under low wind speed during 1-2 days. After this, the pigment is moved from the film into glass containers.

Picture 15. Extracting of pigment from the biomass and dyeing of yarn.

When the pigment is collected it is necessary to pay a special attention that it is completely dried, otherwise, if there will be moisture in its content, the pigment could become spoilt during its storage and some mould could appear and it will lose its paint qualities.

Picture 16. The ready paint base.

The paint base recovered in 2006 was used to dye silk, wool and cotton yarns, and some fabric was made out of it. The industry experts gave their high evaluation for this fabric and noted that its quality is not inferior to those indigo paint imported from abroad.

Picture 17. Director General for UNESCO, Mr. Koitiro Matsuuro personally got aquatinted with the experiments on Indigo carried out in Aral Sea Basin and separately underlined their scientific, practical and economic significance.

7. Approximate calculation of expenditure for cultivating the biomass of indigo plant for one hectare

(based on the information Ministry for agriculture and water administration of RUz for

Khorezm region)

№	*Type of activity*	***Expenses (soum)***
1	Land treatment for flushing of salt	3 700
2	Turning up of item (chela) by hand	2 000
3	Flushing of salt (3 times)	9 000
4	Collection of item (chela)	5 300
5	Plough up of soil using plow	20 000
6	Smoothing out of soil using dlinabaz device (2 times)	26 000
7	Harrowing (2 times)	25 000
8	Making beds on traces of sowing machine	10 000
9	Hand treatment of beds	9 000
10	Hand sowing of seeds	12 000
11	Works and irrigation (7-8 times)	50 000
12	Hand removal of weeds (4-5 times)	75 000
13	Cultivation (4-5 times)	33 000
14	Thinning	18 000
15	Fertilizing with mineral fertilizers (2 times)	29 000
16	Using of "Cypermetrin" medicine against louse (2 times)	32 000
17	Mowing of biomass using mower	7000
18	Collection, drying and transportation of biomass	25 000
	Total:	391 000

Additional expenses (per 1 hectare)

1.	Purchase of seeds (10-12 kg/hectare)		1 200 000
2.	Mineral fertilizers:	Nitrogen	115 000
		Phosphor	400 000
		Potassium	70 000
3.	Fuels and lubricants		228 000
4.	Chemical processing		40 000
	Total additional expenses:		212 3000
	Total expenses:		2 514 000 soum/hectare

Before making any conclusions we would like to draw your attention to interesting fact.

In 2001 the group of scientists from European countries (Spain, Italy, Germany England and Finland) carried out the mutual pan-European scientific-practical project named SPINDIGO with budget of 3,6 millions of euro. The aim of this project was identification of possibilities for cultivation of Indigo plant in the climatic conditions of European countries and satisfaction of the demand for this product at least by 5% by extracting the valued natural Indigo paint out of it.

The carrying out of this project with involvement of huge capital resources, famous scientists and specialist did not go in vain. The results of this project were not bad as some interesting from the scientific point of view discoveries were done. But the analysis of the received results pointed out that production of natural Indigo paint in Europe is very expensive. For example the results of the experiments carried out in Italy in 2003 revealed the following:

- Recovering of biomass of leaves from 1 hectare — 40 000 kg/hectare
- Quantity of extracted pigment — 100 kg/hectare
- On field expenses (in E=euro) — 22 E/kg
- Total expenses — 72 E/kg
- Real selling price — 150 E/kg
- Income received from Indigo — 78 E/kg
- **Net effective income from each hectare — 78 000 E**

These indicators of course could be different depending on place, but it should be mentioned in here that the buying price of natural Indigo for customer companies is 10-12 times higher than the price of synthetic indigo.

The selling price of Indigo on world markets (E=euro)

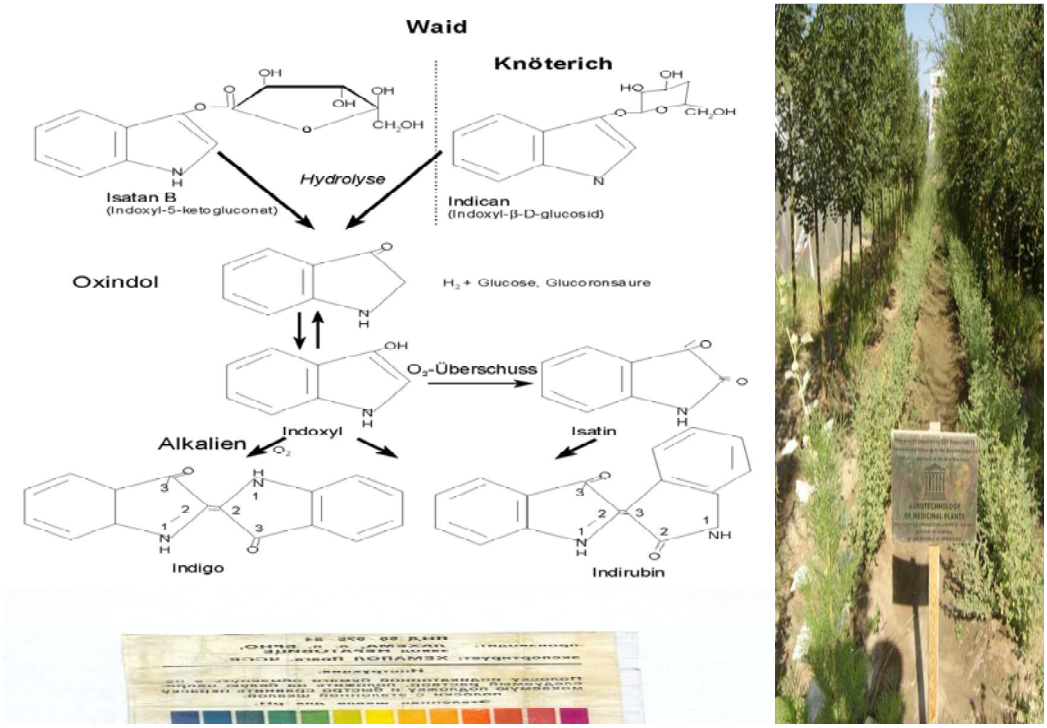
Country	Company name	%	Price, E/kg
Germany	Synthetic	100	20
India	Satish Trading	28	60
Germany	Thuringer Landesanstal (TLL)	20-30	80
Italy	La Campana	20-30	150
El-Salvador	Maple S.A.	60	220
France	Pastel	5	240

As seen from the above mentioned information, the natural indigo pigment has a big demand on the world markets and it is considered to be a profitable commodity. In order to produce it, we have to study well and develop the biology of indigo plant, the land treatment for its cultivation, its extraction methods, its biotechnology and the issues related to marketing.

In the far history, when the methods for chemical synthesis were not yet discovered, our ancestors probably, widely used natural paints in weaving, construction and ceramics. Such opinion and prepositions were very close to be true from logical point of view and gave us strength and believe during our experiments. Why the century-old sky colored tones on our historical monument do not stop to surprise us?

For full understanding of the meaning, secret and value of all this, the new approach is required!

The development of industries for processing of cotton, silk, and wool and weaving industry on yearly bases and application of natural paints in them becomes issue of the day. We hope that this work will help the country to economize the foreign currency resources, create new job places, and help farmers to revivify the crop yield of the saline lands and increase their incomes by some proportion received from every single span of the land.



Picture 18. Biosyntheses of Indigo and appearance of Indigo in it (left) and rink indirubin (right) depending on Ph factor.

Picture 19. Countries of world, where different types of Indigo plants are cultivated.

Picture 20. Elevation part if Allakulikhon madrasah in Khiva.

Picture 21. The blue tile being tore off from the elevation part in Khiva

Picture 22. Fabrics painted using Indigo in the craftsman center of UNESCO (Allakulikhon madrasah in Khiva).

Picture 23. Drying of fabric painted using indigo (India)

Picture 24. And in our pottery, the sky - blue colors prevail.

Picture 25. Old bricks painted suing indigo (St-Petersburg, 2008).

Picture 26. The minaret directed towards the sky, Khiva

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