



Best practices for soil conservation and soil fertility management

for smallholder farmers in the mountainous regions of Tajikistan



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Netherlands



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geres

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FOREWORD

In 2011, ASDP Nau and GERES launched a project to promote sustainable land management practices in Sughd province, in Northern Tajikistan; 2 jamoats were involved: Fon Dario jamoat (Ayni district) and Oshoba jamoat (Asht district).



Both jamoats are confronting increased pressure on land resources: more and more trees and shrubs are being cut to face fuel demand which directly affects the villagers' livelihood. At the same time, climate change is producing negative effects on local water resources: summer scarcity, more intense rainfalls, and snow precipitations turning more and more into rain precipitations.

The project ended in 2013 and has experimented with 4 techniques (compost, winter cover, drip irrigation, and roofwater harvesting) with the farmers of each jamoat and determined the best practices to be replicated. This brochure takes into account the results of the experiments to present the most adapted techniques.

100 farmers of which 80% were women were trained on sustainable land management practices during the project.

This brochure proposes a few ideas and techniques to improve agricultural practices for households and smallholder farmers so as to increase yields and benefits from the land while maintaining the land's balance.



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Sheet 1

LAND DEGRADATION IN TAJIKISTAN AND ADOPTION OF NEW PRACTICES

Land degradation, which can be a natural process or caused by humans, can take several forms:

Different examples of land degradation encompass:

- erosion of land
- decreased fertility
- water runoff

Land degradation is mostly linked with a decrease of the soil quality.

When the soil quality decreases, the soil cannot sustain anymore plant and animal productivity, maintain or enhance water and air quality, or support human health and settlement.

The main factors of land degradation are the following:

- deforestation and overcutting of vegetation: cutting the trees on steep slopes degrades the first layer of soil that helps with absorbing water; this leads to water erosion which washes off the layers of soil.



- overgrazing: when big numbers of livestock graze the same pastures repeatedly, the quantity and quality of the vegetation decreases. The soil of pastures becomes more sensitive to wind and water erosion and the quality of the soil decreases.



- improper crop rotation: when farmers always grow the same crops on the same fields (for example potatoes or wheat) instead of using beans or alfalfa in turn, the soil quality becomes poor, since less organic matter is released back into the soil.

- Unbalanced fertilizer use: when farmers use a lot of chemical fertilizers to obtain high yields, it unbalances the makeup of the soil and as a result the soil will not work properly afterwards.

- over-irrigation: deep drainage may result in rising water tables and then lead to problems of soil salinity.

Furthermore, climate change can worsen the process of land degradation by increasing the irregularities of precipitations and changing the ecosystem through temperature changes.

In Tajikistan, erosion is the most significant cause of land degradation.



By understanding what land degradation is and adopting new practices, significant changes can be achieved for the soil quality at the farmers' level.

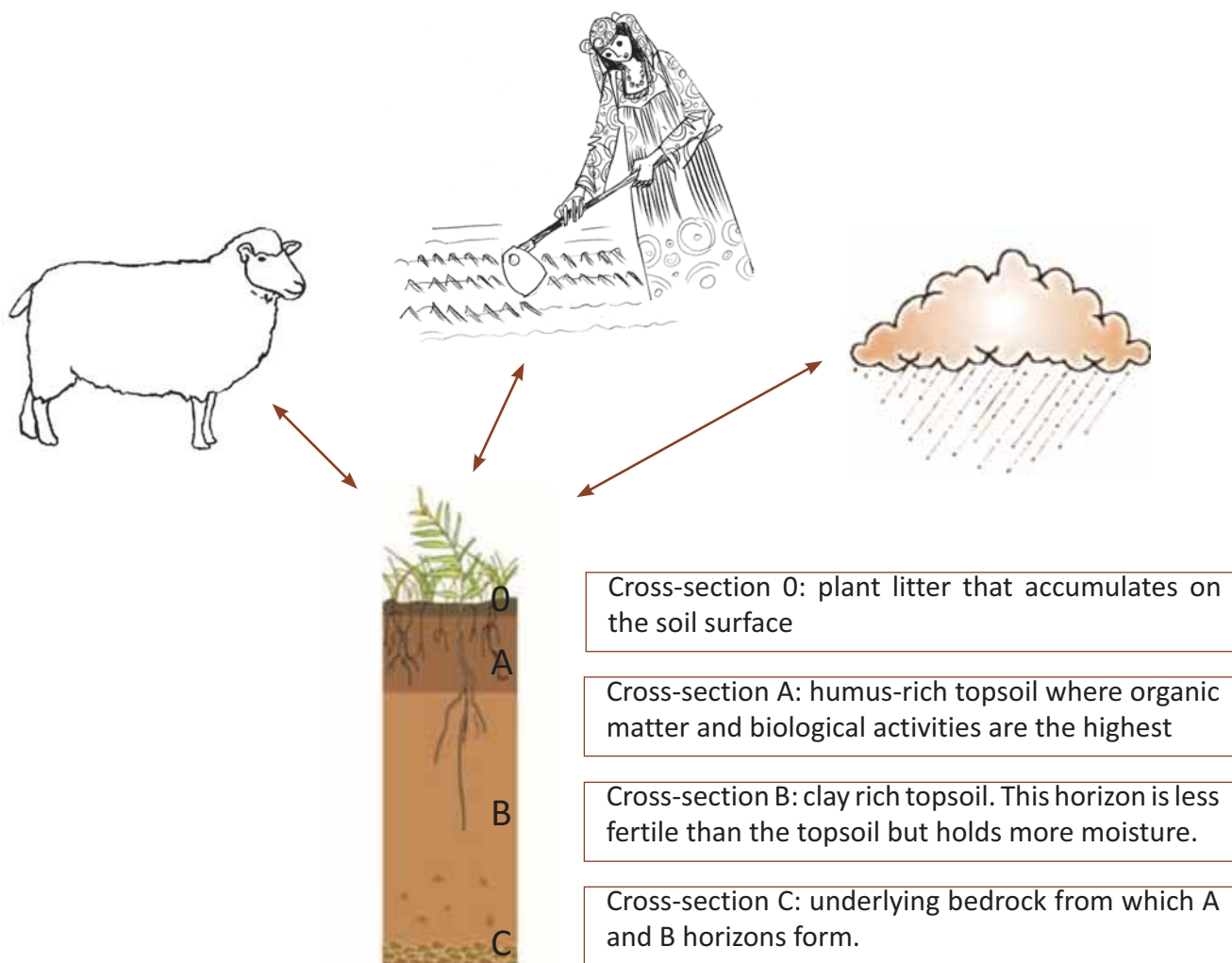
Healthy soil brings numerous benefits:

- yields of the crops increase,
- the soil ecosystem is healthier: it means that there are less weeds, diseases and pests,
- it absorbs efficiently and stores more rainwater, which means a reduced need for irrigation,
- it absorbs excess nutrients, filtrates the sediments, decomposes pollutants, and moderates extreme temperatures,
- it increases the water quality of the river and streams which generates benefits for the general environment.

Sheet 2

SOIL CONSTITUENTS AND ITS FUNCTIONS

The soil results from the transformation of the bedrock through the action of climate, living organisms (fauna, plants roots,..) and human beings.



The soil is constituted of:

- mineral constituents of different sizes (rocks, gravels, sand, silt, clay),
- organic matter (leftovers of crops, manure, compost, roots, humus, micro-organisms that live in the soil),
- liquids and gases.

A soil fulfills 3 functions:

- it holds the plant,
- it takes part in feeding the plant,
- it brings oxygen, heat, water, and nutrients to the plant.

Sheet 3

CONTOUR CULTIVATION WITH A-FRAME TECHNIQUE AND TERRACING

Contour cultivation is when crops are planted along the contour lines. This helps to prevent soil erosion on sloping land.

To determine the contour line, you can use the A-frame technique.

The A-frame is an accurate and simple tool for measuring and marking level contours on a hillside field.

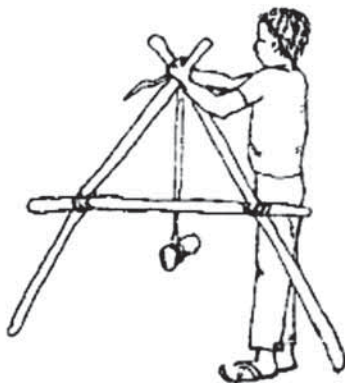
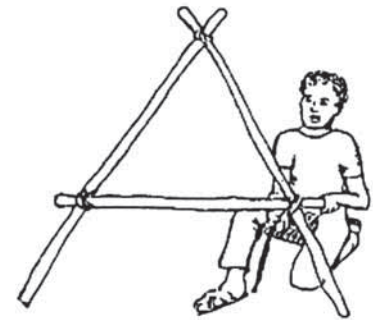
You need the following materials:

- 2 wooden sticks about 2 meters long,
- 1 shorter stick about 1 meter long,
- some string,
- a stone.

Building the A-frame:

Make the frame:

Nail the two long sticks together at one end with a single nail. Leave the nail sticking out about half a centimeter so the string can be tied to it. Next nail the shorter stick to the other two to make an «A».



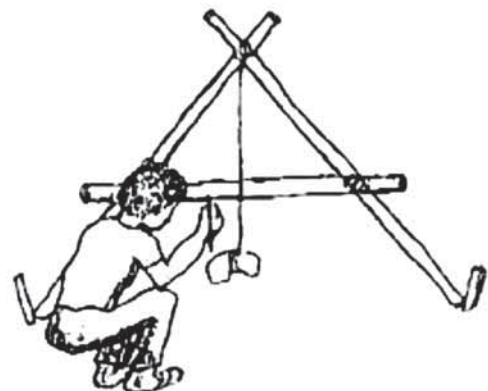
Tie the level:

Tie the string onto the nail and hang the stone at the other end of the string so that it will swing freely, but below the horizontal stick.

Mark the level:

If you are certain that you have a level spot you can just make the mark where the string is resting. Rotate the A-frame 180 degrees and set it back on exactly the same spot.

If the string is not on the same mark the location was not level.



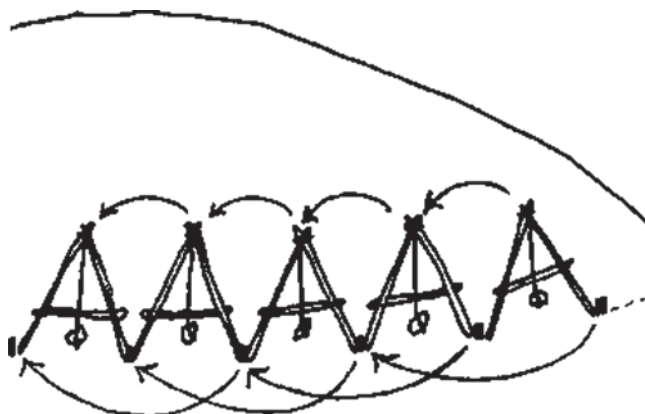


Mark the contour line

1. Collect a lot of small sticks about 30 cm long to act as markers.

2. Push one stick into the soil at the edge of the field at the level where you want to mark the contour line.

3. Place one leg of the 'A' Frame so that it is touching the first stick, on the uphill side of the stick. Now move the other leg, rotating the frame, until the string touches the level mark on the cross bar.



Terracing is also a useful technique to prevent water and soil erosion. It is made by building barriers or steps along the contours of the land with the purpose of preventing the rapid flow of water down the slope and eases agricultural work.

Cultivation along steep slopes may cause severe soil erosion.



One technique to make terraces is to start by making contour lines, dig ditches on these contour lines and plant trees in the lines, then, year by year, build up the terrace.

Sheet 4

CROP ROTATION

Crop rotation has 3 goals:

- increase yield
- get rid of pests
- get rid of weeds

The principles of crop rotation include the following rules:

Make sure that 2 vegetables of the same family don't follow each other,

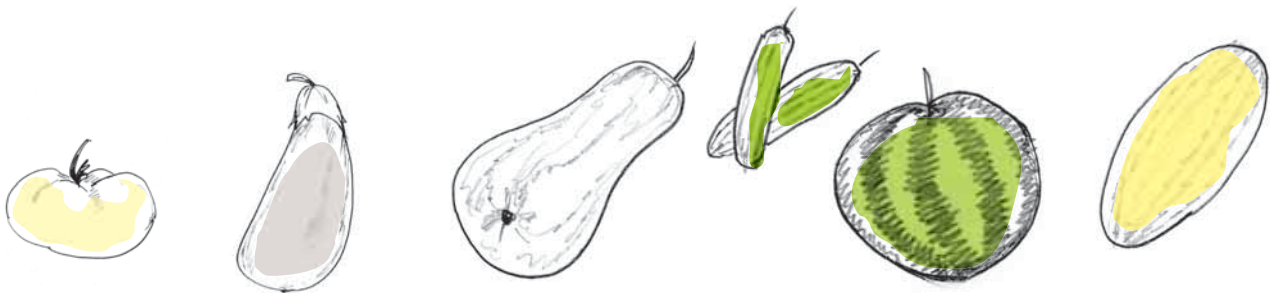
Look at the part of the vegetable that is harvested: don't grow two root vegetables or two fruit vegetables after one other,

Avoid growing 2 families of vegetables that have high fertilization needs one after the other. The families that have high fertilization needs are the Solanaceae and the Cucurbitaceae.

Solanaceae: tomato, bell pepper, chili pepper, potato, eggplant.

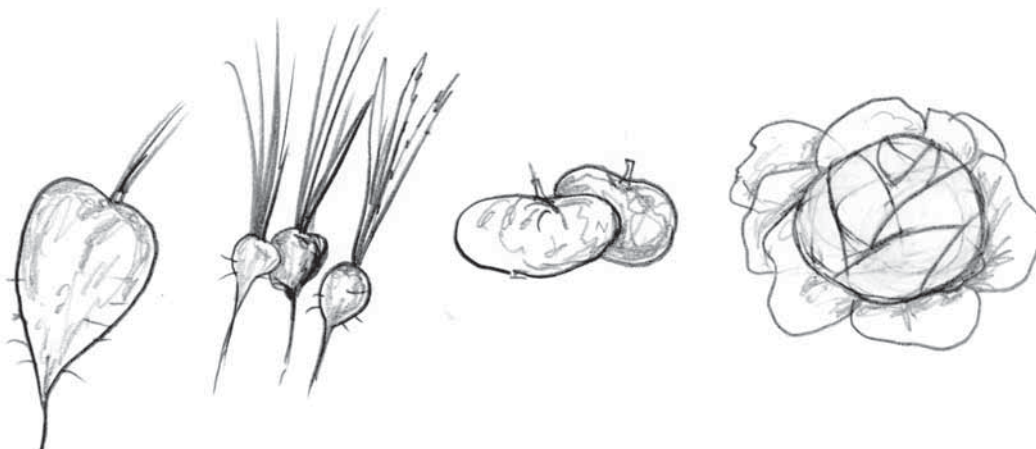


Cucurbitaceae: cucumber, pumpkin, watermelon, melon.





Brassicaceae: cabbage, green radish (turp), red radish, rape, turnip.



Chenopodiaceae: beet, spinach.



Apiaceae: carrot.

Amaryllidaceae: onion, garlic.

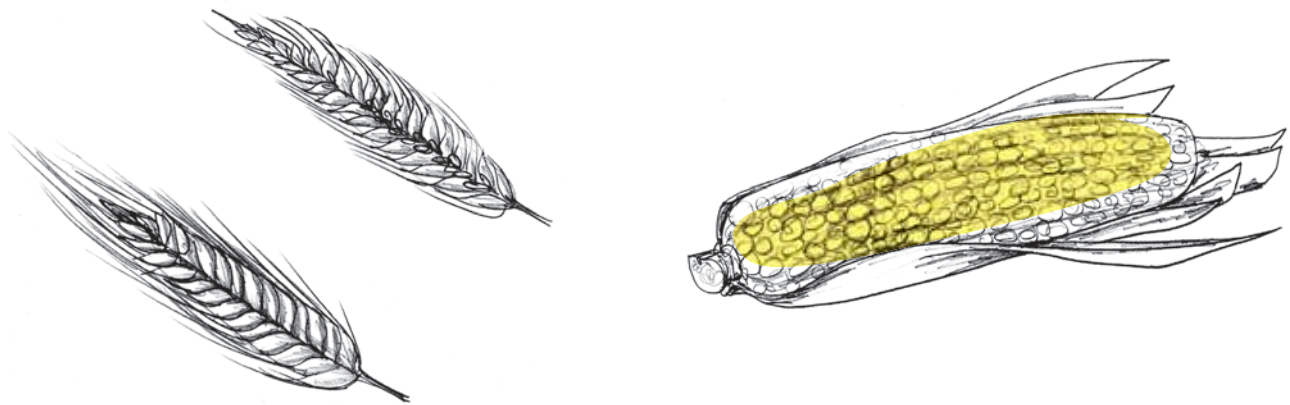




Fabaceae: bean, broad bean, mung bean, chickpea.



Poaceae: wheat, barley, maize



Proposition of crop rotation over one plot

Example of crop planning for a low elevation area (400 m, possible to do 2 harvests a year)
The plot is divided into 6 parts for which a different crop will be grown.

	1	2	3	4	5	6
Year 1						
First crop	tomato	cabbage	carrot	cucumber	eggplant/sweet pepper	barley
Second crop	green radish	carrot	wheat	cabbage/maize		onion
Year 2						
First crop	cucumber	tomato	melon	eggplant/sweet pepper	spring cabbage	onion
Second crop	wheat	Green radish	onion		bean	cabbage
year 3						
First crop	carrot	cucumber	onion	barley	melon	tomato
Second crop	garlic	sorgho (green manure)	cabbage	red beet	wheat	bean

Example of crop planning for a high elevation area (1500m)
The plot is divided into 6 parts for which a different crop will be grown.

	1	2	3	4	5	6
Year 1						
Crop 1	tomato	tomato	carrot	cucumber + bean	cabbage/ green radish/ red beet	barley/wheat
Year 2						
Crop 2	cabbage/ green radish/ red beet	barley/wheat	tomato	tomato	carrot	cucumber + bean
year 3						
Crop 3	carrot	cucumber + bean	cabbage/ green radish/ red beet	barley/wheat	tomato	tomato



For small mountain plots where potatoes cover most of the field every year, try and rotate the vegetables that are not potatoes every year on a different place.

For potato growing:

before sowing, manure (1 to 2 year old manure) should be added in a quantity of up to 20-30 t for 1 ha.

A possible crop rotation with potatoes is:

Year 1	Year 2
potato	wheat
Potato	cabbage/ broad bean
potato	barley
potato	carrot

If you do a rotation with beans, it is possible after having grown beans to sow a crop that needs a lot of fertilization, since thanks to the effect of beans on the soil, you will need to add only a little bit of compost before sowing.

Sheet 5 SALT TOLERANT CROPS

Some land was desalinized during the Soviet time due to yearly heavy irrigation that used to wash away the salt. It also contributed to raising the water table and increased the salinization of the soil.

For farmers who aren't able to irrigate yearly to wash out the salt, it is recommended to plant crops or trees that can grow even when the soil is salty.

CROPS

Low salt tolerant crops	Middle salt-tolerant crops	High salt-tolerant plants
wheat, sorghum, buckwheat, radish, beans, cucumber, lemon.	oats, millet, corn, sunflower, alfalfa, potatoes, onions, carrots, tomatoes	barley, mustard, clover, cabbage, sugar beets, spinach, cotton

TREES

not salt-tolerant trees	salt-tolerant trees
All the fruit trees	Russian Silverberry (<i>Elaeagnus angustifolia</i>) Plane (Платан)

Sheet 6

AGROFORESTRY: INTERCROPPING FRUIT TREES AND ANOTHER CROP

Agroforestry is the combination on one plot of two plant species, which influence each other biologically: one plant species is a shrub or tree, the other plant species is used as fodder or food plant.

Agroforestry presents many advantages:

- tree planting on a steep slope and on the contour lines controls erosion,
- weed control,
- wind protection for the crops (if the trees are placed so as to create a windbreak),
- soil improvement,
- trees keep moisture in the soil.



But can also present a few disadvantages:

- shading of the crop prevents its growth,
- Tree root development can hamper the development of the crops,
- Drying of trees because of competition from crops.

Before choosing the crops and trees, it is necessary to think about some points

- Look at the different lengths of the roots of the plants you want to grow.

If the trees and plant roots are at the same depth, there will be competition for water and soil nutrients between both species and they will not develop well.

- look at which density is necessary to plant the trees:

a wider stand density facilitates a sufficient aeration inside the tree crowns.

Dense planting is ok for peach, cherry, and plum, which are shallow rooters.

Good examples of agroforestry in Tajikistan are:

1/ alfalfa and orchard:

Mixing alfalfa and fruit trees allows for a better growth of trees through increased soil fertility and leads to an increased farm production of good quality fodder. It also prevents soil erosion through an intact ground cover throughout the year.

Fruit trees should be planted with six meters of space between rows and 4 meters of space between trees in the same row.

2/ orchard and vegetable crops

It is possible to grow vegetables (tomatoes, cucumbers, eggplants, cabbage) under fruit trees.

Keep 6 meters between the rows of trees as well as between the trees.

It is not recommended to grow rice in paddy fields intercropped with trees because such activity reduces the oxygen availability for the roots of all crops and trees other than rice.

It is necessary to take good care of the field by pruning the trees. It will allow crops to have more light.

More information can be found on the internet:

http://www.camp.tj/images/materials/2005/Agroforestry_ENG.pdf

Sheet 7

DRIP IRRIGATION

Drip irrigation is an irrigation method in which water is supplied directly to the root zone of plants.

Advantages of drip irrigation:

It saves water and labour, prevents soil erosion, reduces diseases and weeds

It can be used for open field and greenhouses.



Put the water tank at 1m to 1,5m above the ground to ensure constant flow of water.

Connect the water tank to the drip irrigation system with a main pipe and a tap.

Bring this pipe to the beginning of the crop rows.

Add the diversion secondary pipes in front of each row and connect the main pipe with the secondary pipes, which have holes or dripperlines.

You should use an independent system for each crop type, if they

don't have the same water needs:

A pipe that waters only the cucumbers and another one only for tomatoes for example.



You should be present during the irrigation to check the quantity of water given for each crop and to check if the drippers work well.

Water needs increase with temperature:

In summer, irrigation can happen every two days.

Sheet 8

ROOFWATER HARVESTING



ROOF WATER HARVESTING consists of gutters or pipes that drive the rainwater falling on the roof into water tank.

3 basic elements:

- Collection area = ROOF,
- A conveying system = PIPES, GUTTERS,
- Storage facilities = TANK.

The efficiency of collection is influenced by the roof area, and the material used to construct the roof and the gutter.

A roof made with metal sheet is the more efficient: 85% of the rain falling on the roof can be collected.

Advantages :

Simple to build, adjustable according to available material and income

- Running costs are low
- Construction, operation, and maintenance are not labor-intensive
- Costs to buy irrigation water and time spent to collect it can be saved
- It provides water in situ, at the consumption point

Tips for the tank:

- it is possible to buy a plastic watertank
- it is also possible to build a watertank with mud bricks and polyethylene.

To build the water tank with bricks:

- 1 - dig the pond (1,5 m depth, 1 meter diameter)
- 2 - plaster the inside walls with a fine soil and water mixture to smooth them,
- 3 - line the pond's walls with double polyethylene layer,
- 4 - connect the inside polyethylene sheets with the pond coverage through a piece of cord, so that it can be taken out of the pond any time to be cleaned of sediments,
- 5 - cover the pond with any available material such as a soil, water and straw mixture, reinforced by several poles, leaving an opening of 0.25 x 0.25m to extract water, you can cover the opening with a metal sheet or wooden planks.
- 6 - finally connect the roof to the pond with a plastic pipe.

To avoid dirty water flowing from the roof into the pond, the pipe should only be connected to the pond some time after the rainfall has started.

For more information, see: WOCAT QTTAJ104 Roofwater harvesting: https://qt.wocat.net/qt_summary.php?lang=English&qt_id=578

Sheet 9

WHAT IS FERTILIZATION?

Soil fertilization is the process of bringing essential minerals into the ground, necessary for plant growth.

If Carbon (C) and Oxygen (O) are available in the air and fixed by the leaves, Nitrogen (N), Phosphorus (P), Potassium (K) and water are taken from the soil through the roots.

NITROGEN (N) is the main nutrient that constitutes protein for plant growth.

PHOSPHORUS (P) is essential for the flowering, quick maturation, and enlargement of the fruits and seeds maturation.

POTASSIUM (K) plays a key role in water regulation within the tissues of the plant. It also supports drought, frost and disease resistant properties of plants.

Those 3 essential elements can be found in different organic fertilizers.

Organic fertilizers are usually cheaper than chemical fertilizers and easily available on a farm.

Examples of organic fertilizers

manure, peat, liquid manure, bird droppings, faeces, compost and green manure.

Organic fertilizers contain nitrogen, potassium, phosphorus, calcium, magnesium, sulfur and other microelements and organic substances which play a very important role in the nutrition of crops and a positive effect on soil structure.

Sheet 10

HOW TO USE MANURE

Manure should be used in autumn time. It can be spread on the field and then turned over in the soil while ploughing.

It is not recommended to use fresh manure in spring since it has not decomposed into the soil and does not provide available nutrients for the plants.

It is good to mix manure from all types of animals (cow, sheep, donkey, goat).

- for cereals: 25 t/h, which means 2,5 kg/m².

- for vegetables: 30 to 35 kg/h, which means 3 to 3,5 kg/m².

For chicken manure, only a little should be used (5t/ha or 0,5kg/m²)



Don't put raw manure in or on soil. Raw manure generally releases highly soluble nitrogen compounds and ammonia, which can burn plant roots and interfere with seed germination. Also, don't incorporate raw manure into unplanted garden beds. Raw manure often is filled with weed seeds, so spreading it on soil can create serious weed and disease problems.

DIRECT USE OF ANIMAL MANURE ON YOUR SOIL Nutrient quantity (%)			
Animal	N	P	K
Cow	1.0	0.4	0.5
Sheep and goat	2.0	0.4	0.5
Horse	0.7	0.4	0.5
Chicken	2.0	2.0	1.0

Manure is a prime source of nitrogen, potassium, and phosphorus, and is rich in bacteria. Manure is important in a rapid composting method that requires a high-nitrogen, high-bacteria heat-up material.

The best way to use manure as a fertilizer is to compost it.

Sheet 11

HOW TO MAKE COMPOST



Advantages:

Compost is a fertilizer which provides ready nutrients for the plants while providing long effects on the soil. It helps giving a good soil structure, it retains water in the soil. The process of composting kills disease, pest and weed seeds in the manure.

How does it work?

Compost is the decomposition by fungus and micro organisms of organic matter to create humus. Compost is used as a main fertilizer for all crops and as humus to start seedlings.

To make compost:

Dig a pit: depth 1 m, width 1m, length 1,5m

Use:

- manure (cow dung, sheep and goat dung, donkey dung, even mixed with straw from the shed)
- vegetable waste of small size : fallen leaves from trees, old hay, twigs, sawdust, kitchen waste (peeling from vegetables).

Vegetable waste should represent between 20 and 40% of the total volume of compost, it may vary according to the total amount of straw in the manure.

Lay down one layer of manure, add a layer of small vegetable waste, add another layer of manure, Water and cover with polyethylene

Let it ripen from March to October, it is good if you can take everything out once and mix it.

Compost is ready when:

- it does not smell any more.
- it looks like dark crumbly soil.

If more materials are available to make compost in autumn, it is possible to empty the pit and store the ready compost in bags and store in a cool and not too dry place.

Then prepare some new compost that will be ready in spring.

How to use compost efficiently

Use finished compost in a layer on top of your soil to nourish the plants underneath. Water will carry nutrients down, into the soil.

Compost also makes an excellent layer in anyno tilled soil. In this kind of use, especially in araised bed, you can make the layer as thick as you like.

Dig it into soil. As you dig soil, add as much compost as you like and mix it with the soil as you put it back. It's a great amendment for both sandy and clay soils.

Put compost during the transplanting of seedlings

Sheet 12

HOW TO MAKE A MULCH



Mulch is simply a protective layer of a material that is spread on top of the soil when a crop is grown.

Examples of organic mulches	Examples of inorganic mulches
grass clippings, straw, bark chips, compost, well rotted manure and similar materials	stones, brick chips, and plastic, woodboard

Both organic and inorganic mulches have numerous benefits. Organic mulches also improve the condition of the soil. As these mulches slowly decompose, they provide organic matter which helps keep the soil loose.

Advantages of the use of mulch:

- Protects the soil from erosion,
- Reduces compaction from the impact of heavy rains,
- Conserves moisture, reducing the need for frequent irrigation,
- Moderates soil temperature,
- Prevents weed growth,
- Brings organic matters to the soil (If organic).

Time of mulching

Mulches are best applied from mid to late spring and autumn, when the soil is moist and warm. It is best to avoid applying mulches in winter and early spring as the soil is too cold, and in summer, when it will be dry. They can be applied around new plantings or to already established crops.

To be effective, organic mulches need to be between at least 5cm and ideally 15cm thick.

Implementation

- Lay the mulch over moist soil, after removing weeds, including their roots.
- When creating new beds, planting through mulch sheets is effective.

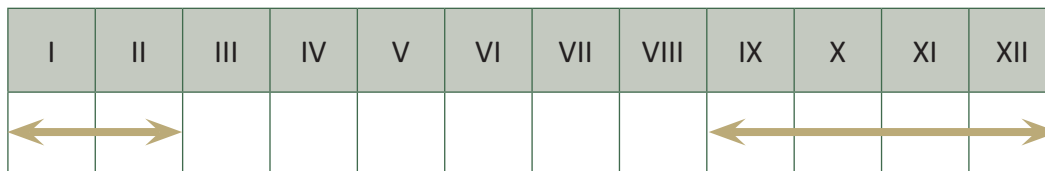
Sheet 13

WINTER COVER AND GREEN MANURE

Green manure is a crop that will be destroyed on the spot in the field and that will be mixed into the soil directly.

The incorporation of the winter green manure prevents the soil from being barren which provides these benefits. In addition, mixing it into the soil acts as an organic fertilizer and improves the soil fertility:

- avoiding erosion,
- keeping nitrogen in the soil,
- acting as a fertilizer,
- loosening the soil,
- avoiding weeds dissemination.



Implementation

Prepare the soil to sow the chosen crop (green manure),
Sow in August or the beginning of September and let it grow.
But never let the cover crop grow to seed! Don't let them grow too much.

At the beginning of spring, before the starting of the growth of the vegetation, mix it in the soil by ploughing when you prepare the soil for the next crop.
Wait 15 days before sowing a new crop.
It might be necessary to work again the soil in surface.

Choices of crops to use

The poaceae (wheat, barley, oat, rye..) are good to ensure good crop rotation. These crops are also resistant to trampling.
Clover and pea are also good cover crops as they bring nitrogen in the soil.
Mustard is good for disinfecting the soil.
In case of early winter They should be sown under the vegetable that is already growing so as to grow enough before the winter rest.

Sheet 14

SOLARIZATION

In case of severe disease of the soil, the farmer can try solarization of the soil. It allows keeps the soil healthy without disturbing its structure.

What is solarization?

It is in an increase of the soil temperature higher than 80°C, which destroys different disease agents (fungi, bacteria, pest) and weeds, but also other good micro-organisms.



Implementation:

During the summer (you have to make sure to have 3 consecutive days of sunshine for this technique to work):

- Prepare the soil as if you were going to sow it.
- Water the soil generously.
- Place a transparent tarpaulin without holes directly on the soil surface immediately after watering.
- Cover the sides of the tarpaulin with soil to seal it hermetically.
- Do not walk on the covered tarpaulin.
- Leave the tarpaulin for a minimum of 5 weeks

For the next crop, sow without working the soil too deeply (maximum 10cm).

Thanks to this technique, the soil fertility is preserved, which is not the case when all the soil is replaced.



Sheet 15 TO LEARN DIFFERENT TECHNIQUES AND SEE EXAMPLES IN TAJIKISTAN: WOCAT WEBSITE

WOCAT is an international platform that gathers experiences, examples and concrete ideas of sustainable land management practices.

It is available on the internet, but also exists as a book.

Available in English on:
<https://www.wocat.net/>

Available in Tajik on:
https://qt.wocat.net/index.php?goto_page=index

The database for Tajikistan gathers 110 examples of adapted practices. It describes which practice was used, how to implement them, the costs to implement. It also gives the contact information of the person who implemented it in case the farmer wants more information.

Go and check it out: it is very useful!

Sheet 16 POLYETHYLENE, SEEDS SUPPLIERS, DRIP IRRIGATION

These people can order good quality polyethylene, seeds and drip irrigation materials, they have them available in their shops for you.

Don't hesitate to call them:

In Fon Dario Jamoat (Ayni district)

Kosimov Shodimurod

927575133

902403845

Sarvoda Bazaar, Store «Farzona»

In Oshoba Jamoat (Asht district)

Yuldoshev Sherzod

928098087

High Appon



GERES - TAJIKISTAN

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ASDP - AGENCY FOR SUPPORTING OF DEVELOPMENT PROCESSES

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Web: www.agencynau.tj