IRRIGATION AND SOIL CONSERVATION INNOVATIONS

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Purpose of this document:
In this catalogue 17 innovations for improving irrigation technologies in Kyrgyzstan are presented. The ideas for the technologies come from farmers and specialists from Kyrgyzstan, and from other countries. This document gives an overview, what possibilities farmers have to improve irrigation practices, with the objective to use natural resources more sustainable and at the same time to increase economical profit. It is an instrument for advisors of RAS, for farmers and any other person interested to discuss and choose innovations that can be tested in the field.
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A. Furrow Irrigation

Furrow Irrigation is used for most crops (potatoes, maize, sugar beet) in the fields as well as in vegetable gardens. The main advantage of this method is the simple technology, which doesn’t need any investment and the time-saving method for irrigating big surfaces. Most farmers have experience in using the technology and the water supply, coming from channels, makes furrow irrigation possible on a large part of the arable land in Kyrgyzstan.

However, there are also problems related to that technology:

- The distribution of water in the field is often very uneven; the upper parts of the furrows get a lot of water, the lower parts not enough. Therefore big differences in growth and yield can be observed along the furrows.
- The risk of soil erosion is very big and can be observed in most of the fields. Soil is washed away from the upper part of the field and accumulates at the end of it. Precious fertile soil is lost like this. Once the upper layer of the soil is washed away, soil fertility will decrease. In long term, soil structure will also be damaged, which will reduce the productivity of the soil. Soil which is washed away and accumulated in other places also results in irregular flow of water in the furrows and a lot of additional labour is required to repair and maintain the furrows.
- Usually, big stream sizes are allowed to flow in the furrows, and this results in a lot of water run off at the end of the field. This water is not absorbed by plants and therefore not useful for the farmer. It is a waste of water which should be avoided.
- A second way of loosing water can not be observed on the soil surface: Big stream sizes bring a lot of water to the soil, which can not all be absorbed. Much water will therefore flow through the profile (percolation) and run off in deep soil layers. This water is lost for the crop.

The following technologies show possibilities to improve furrow irrigation. All of them have the objective to use water more economically and to avoid soil erosion. The main effects are higher yields and productive soils in long term. Besides water, which is scarce in Kyrgyzstan, can be saved. These topics will be explained in detail:

- **Making furrows in cereals**
  - will increase yields and reduce soil problems (loss of soil, loss of nutrients, damaged soil structure)

- **Assure a small stream size in furrows**
  - reduces the risk of soil erosion and leads to even growth and higher yields

- **Use of weirs to measure the amount of water applied to the field**
  - guarantees that the correct amount of water is applied and is an instrument to control water flow

- **Cut-back and impulse irrigation**
  - lead to better distribution of water in the soil, thus balanced growth along the furrows and an increase of yield
Making furrows along the contour lines
☞ prevents soil erosion and preserves a productive soil in long term

Short distance irrigation
☞ assures a better distribution of the water in the field, which leads to higher yields and saves time for irrigating a field

Irrigating every second furrow
☞ saves water and time
**Furrow Irrigation in Cereals**

**Short Description**

Furrows can be constructed in two ways:

1. Cereals are sown in broadcast. After sowing, furrows are made with a normal cultivator with distance of 60-70 cm between two furrows (Figures 1 and 2).

2. A traditional seeder is used, cereals are sown in rows. Behind the seeder shares are put, and the furrows are immediately made when sowing. In this case, seeds can be saved, because the outlets of the seeder can be closed, where furrows will be made.

Furrows are watered in the usual way, but it is recommended to follow the instructions for adjusting the stream size.

**Benefits / Results**

- Flooding the field in early growing stage may damage young plants, therefore the germination and tillering of cereals is better with furrows.
- Distribution of water in the field is much better than with wild flooding. Therefore growth of plants and yield will be more uniform; the total yield will increase. When flooding a field, the soil is often sealed: A crust is formed, which doesn’t allow to let water in (rain, next irrigation application); and the soil cannot breath well anymore. This also has a negative effect on growth and can be avoided with furrow irrigation.
- If furrow irrigation is additionally combined with control of stream size, soil erosion and runoff water at the end of the field can be avoided. The amount of water can be reduced and therefore nutrients are not leached from the soil.
- Once the furrows are installed and channels for irrigation are prepared, furrow irrigation requires less labour time than flooding and is easier for the farmer to control.

**Costs**

Furrows can be made with usual machines and no additional costs are required. The traditional seeder can be modified by putting shares behind the seeding machine.
Technical aspects for implementation

If furrows are made with a cultivator, they should be made after sowing the cereals, but before germination. Otherwise the plants will be damaged. In fields with steep slope contour furrows should be made. In fields with practically no slope furrows should be made shorter.

Where it is useful to apply the technology

Furrow irrigation in cereals is already practiced in the south of Kyrgyzstan. It can be introduced everywhere in the country.

Contacts

- Rayon Advisors
- ATC, Bishkek, Phone: 0312 68 20 27

Figure 2: Furrows are separated 60-70cm and 15-20cm high.
Short Description

There exist several possibilities to assure small and regular water flow in furrows:

- The simplest methods consists of using pieces of earth (piece of grass together with roots), which are put at the entrance of the furrows (figure 3).
- Stream sizes may be adjusted by using plastic film. They are installed at the entrance of the furrow: one end is buried slightly into the soil (towards the supplying channel), while the rest is left at the soil surface. Soil is hilled under the sheet to allow just for the stream size required. The amount of soil under the sheet may be increased/decreased to allow less/more water flow into the furrow (figure 4).
- Stream size may be adjusted by using plastic pipes, which allow for a quite accurate determination of water supply to the furrow (figure 5).
- The upper part of plastic bottles can be used. They are buried in the soil at the entrance of the furrow (figure 6).

When controlling the stream size with earth, plastic film, pipes or bottles, attention has to be paid to the supply channel. Usually small channels have to be cut, coming from the main channel in order to reduce the speed and the quantity of water flowing into the field (figure 7).

Benefits / Results

- These devices at the furrow entrances help to adjust stream size. Water will flow in small quantity and with low speed. The effects are less soil erosion, and less runoff water at the end of the field. Fertile soil and precious water are not lost for the farmer.
- Slowly flowing water can better be absorbed by the soil and is useful for plants. Plant growth is improved and yield is higher.
- In many cases time is short when irrigating; by putting the devices before starting the irrigation, stream sizes can better be controlled, even if the farmer is alone in the field.
Costs

All the described tools are cheap or free of charge. The individual pieces can be used subsequently for several furrows in the same field. The additional labour for installing the devices at the beginning of an irrigation application is practically compensated by easier adjustment of the flow into the furrows.

Figure 7: System of channels at the head of a field. The stream size has to be guided to different channels. This makes it easier to control the water flow.

Technical aspects for implementation

To use this method efficiently the farmer has to know some rules of thumb on how much water he should apply to the furrows, and he has to be able to estimate stream size by eye. In order to get the feeling for estimating stream flow, a farmer can use a V-notch (or Thomson weir). Farmer say the pipes improve uniform irrigation, especially when irrigating at night.

Where it is useful to apply the technology

Controlling the stream size is useful in all cases where the amount of water coming from the supply channel is too big or is flowing with high speed. In these cases, water can damage the furrows and therefore has to be controlled. A farmer who wants to use cut-back or impulse irrigation is obliged to control the stream size with these devices.

Contacts

- ICARDA Project demonstration site at the Research Farm of Kyrgyz Agrarian University, Sokuluk Rayon (25 km West of Bishkek)
- RAS Chui, Sokuluk Rayon
Short Description
This method is used on steep slopes. Water is applied by furrows, but the furrows are running almost horizontally along the hill, so that water has to flow slowly instead of running down the hill with high speed, taking soil with it. Contour furrows are curved to fit the land surface. They have just enough slope to carry the irrigation stream. Also the supply channels, which bring the water to the head of the furrows, have to run almost horizontally.

Benefits / Results
- Contour furrows make furrow irrigation possible in hilly areas.
- Water speed is reduced very much. Slowly flowing water can better be absorbed by the soil (the same is true for rainfall) and there is no soil erosion.

Costs
No costs are required, but the construction of the furrows needs some labour investment.

Technical aspects for implementation
Construction of furrows following the land contours may be a little bit difficult. A guide furrow must to be made first, which should have the same slope all the time. Guide furrows must be made every 5 to 10 meters (figure 8), and only afterwards the real furrows are made with a cultivator or a small plough, draught by a horse.
In short term, the practice does not influence yields; in long term yields are higher, because there is no soil erosion and cultivation is possible for many years without damaging soil fertility.

Where it is useful to apply the technology
Contour furrows can be used by farmers who have to cultivate steep land, and where a water source is available on top of the field for applying furrow irrigation. It can be used for row crops or for vegetables.
Where furrows are made straight down the hill nowadays, it is recommended to replace them by contour furrows.

Contacts
- Kazym Sabyrov, National Cotton Research Station, Karasuu, Osh Oblast
IMPROVING FURROW IRRIGATION – IRRIGATION OF EVERY OTHER FURROW

Short Description
With this technology, only every second furrow is watered when irrigating the field. Water moves below the surface to the root zone of the plants of both neighbouring rows (figure 9). There exist two possibilities:
- Always the same furrows are irrigated during the whole season.
- The furrows are watered alternated with every application.

Benefits / Results

✓ Usually, when irrigating only every-other furrow, irrigation is achieved more quickly.
✓ While irrigating, the farmer can weed the field easily, walking in the dry furrows. Thus time is used more effectively.
✓ Water use may be significantly reduced by irrigating only every other furrow, since evaporation from the soil surface and water use by weeds is reduced.
✓ If always the same furrows are watered, less weeds grow in the dry furrows.

Costs
There are no investments necessary.

Technical aspects for implementation
On soils with adequate infiltration rates, irrigate always the same furrows, since water moves down the field faster in these rows. For the same reason it is often advisable to irrigate the rows which are compacted by tractor wheel traffic.

Where it is useful to apply the technology
The technology should only be applied in soils, where water is absorbed quickly. This is the case in fields, where water reaches the end of the field only after a long time. Besides, the farmer can test the ridges: If the water moves quickly through the earth and reaches the root zone of the crop, the soil is suitable for the technology.
Furthermore, it is useful for crops with small spaces between rows and without deep roots (maize, vegetables), because water can move quickly to the whole root zone of these plants.
Every-other furrow irrigation should not be used on steep slopes or on soils with low infiltration rates.

Contacts
Kazym Sabyrov, National Cotton Research Station, Karasu, Osh Oblast
IMPROVING FURROW IRRIGATION – CUT-BACK IRRIGATION

Short Description
The objective of the technology is to get a uniform distribution of water along the whole length of the furrows. This shall be achieved with the following irrigation schedule:

1. A large amount of water is let in the furrows with the objective to push the water as quickly as possible towards the end of the furrow. Like this, the ground of the furrow gets wet and smooth, and water will flow regularly during the whole application along the whole furrow.

2. When the water in the furrow has reached ¾ of the way down, the amount of water is reduced (= cut back) by half. Water speed in the furrow becomes more slowly. Like this, more water can be absorbed and there are almost no losses from runoff water at the end of the field.

The effect of this method is that the whole length of the furrow gets wet in a very short time, and the water can be absorbed in the whole length of the furrow during a longer period of time.

Benefits / Results

- Cut-back irrigation greatly reduces runoff water losses. Due to the smaller stream size, also loss of fertile soil is significantly reduced.
- The risk of percolation (water that flows through the whole profile and is lost for plant roots) is reduced. Nutrients are not washed away with the water.
- The more efficient use of water and the prevention of soil erosion result in even growth of plants and increase the yield.

Costs

Cut-back irrigation does not require any additional investments. But it is recommended that stream size is controlled by using plastic film, plastic bottles or pipes, and/or that the stream size is measured with a weir.

Technical aspects for implementation

For doing cut-back irrigation, two persons should work together. One controls the water flow at the head of the field, the others stands ¾ down the furrows and makes sign, when the water reaches him; the person at the entrance of the furrows can then reduce the stream size (figure 10 and 11).
Cut-back irrigation is recommended for all situations where furrow irrigation is used. In fields where soil accumulation can be observed at the end of the furrows, cut-back irrigation may be a good option to test.

Contacts

- Kazym Sabyrov, National Cotton Research Station, Karasuu, Osh Oblast
Impulse irrigation means that water is given to the furrows in several impulses. The effect of this procedure is to get the most uniform distribution of water that is possible. The procedure is the following:

1. A small amount of water is given to the furrow, till it reaches 1/3 of the way. Then the water is stopped and a break of 20-30 minutes follows. The effect of this break is to make the ground of the furrow smooth, so that water will flow faster afterwards (figure 12, nr. 1).

2. A second impulse of water is given to the furrow; when it reaches 1/3 of the way the amount of water is reduced and is allowed to flow 2/3 down the field. Then again a break is made (figure 12, nr. 2).

3. A third impulse of water is given to the furrow; the amount of water is initially big and is reduced after 1/3 of the way and even more after 2/3 of the way down the furrow (figure 12, nr. 3).

4. When reaching the end of the field, the amount of water is once more cut back, and this small stream size is used for the rest of the irrigation application (figure 12, nr. 4).

It is recommended to irrigate every second furrow with that method and to use the breaks between the impulses for irrigating the neighbouring furrow. Like this, the method also saves time, because more furrows can be irrigated to the end in shorter time.

Figure 12: Procedure of impulse irrigation in four steps. The figures given for stream sizes are suggestions. In practice, stream sizes have to be adapted to local conditions such as crop, soil structure, length of furrows, slope, etc.

Figure 13: Profile of a soil, irrigated in impulses: Figures show the area of wet soil after each step. Compared to usual irrigation, water distribution is more uniform along the whole length of the furrow.
**Benefits / Results**

- Impulse irrigation improves the uniformity of water distribution (figure 13). Water is used most effectively with this method. Compared to other methods (40-60%) more than 80% of the water applied to the field can be absorbed by the soil. This leads to better growth of plants and higher yields.
- Soil erosion and runoff water at the end of the field can be prevented.
- More furrows can be watered to the end of the field in a shorter time.

**Costs**

Impulse irrigation does not require any additional investments. But it is recommended that stream size is controlled by using plastic film, pipes or plastic bottles, and that there are always two people monitoring the irrigation.

**Technical aspects for implementation**

It is highly recommended to use water measurement devices when doing impulse irrigation, because the stream size can be well controlled with it. The water supply has to be controlled with a good channel system at the beginning of the field (see figure 7). Small stream sizes must be possible, otherwise the technology doesn’t make sense.

**Where it is useful to apply the technology**

The technology is particularly useful on flat land or on fields with small slope. It is not useful for steeper slopes and slowly permeable soils. Impulse irrigation is a quite demanding technology. It is recommended to start first with cut back irrigation and to get some practice with this method. When the farmer has enough know-how about it, he can start to make impulse irrigation. Instead of 3 impulses also 2 impulses are possible.

**Contacts**

- Kazym Sabyrov, National Cotton Research Station, Karasuu, Osh Oblast
CONTROLLING THE WATER - MEASURING WATER IN THE FURROWS

Short Description

There exist small weirs, Thomson-weir or v-notch-weir they are called, which allow measuring the stream size in a very easy way. They consist of a metal plate, with a scale, where the amount of water flowing in the furrow can be read (figure 14). There exist different sizes of Thomson-weirs. Usually the smallest one (30x40 cm big) is put in the entrance of one furrow. To adjust the stream size, earth, plastics, bottles or earth can be used.

A bigger weir (40x50cm) is usually put in the supply channel to control the distribution of the water to several furrows (figure 15).

This simple technology makes it possible to verify, how much water is applied to the field. Farmers can irrigate their crops according to norms. Additionally cut-back irrigation and impulse irrigation are simplified, because the stream size can easier be defined and adjusted.

Benefits/Results

- The farmer can control the water flow in his field. This has several advantages: Farmers get used to judge stream sizes by eye and can therefore irrigate their field by using norms. If crops get the needed amount of water (not more and not less), yield will increase.
- Usually the stream size flowing through the weirs is small. Therefore soil erosion, water runoff and washing out of nutrients are prevented.
- Additionally, weirs allow to the farmers to control the water supply he gets from the WUA.

Costs

A weir consists of an iron plate, which can easily be constructed by farmers, if they have a model (ask RAS). The cost for a small weir may not exceed 30 Som. The big weir may cost 50-60 Soms. They can be used for many years. There is no need to have weirs for every furrow; they can be shifted within the field.

Technical Aspects for Implementation

The weirs have to be properly put in the entrance of the furrows. Before using them, the scale must carefully be written on the plate. Advisors can help with it. Recommended stream sizes are between 0.3 – 0.5 l/sec.

It is not necessary to put a weir in every furrow, the water flow in the neighbouring furrows can be judged by eye. But in all the furrows there should be a device to control the stream size: plastic film, plastic bottles or pipes.

Weirs give the possibility to apply recommended norms to a crop. With a defined water flow, the time needed for irrigating one furrow can be calculated. This calculation is not difficult, nevertheless an experienced person should support it at the first time.
Where it is useful to apply the technology

The measurement of water is especially useful, when farmers want to irrigate their crops according to norms, or when they want to do cut-back or impulse irrigation. It is best suitable in conditions, where the water coming to the field flows slowly and can easily be controlled. This is generally the case in fields with small slope.

For farmers who want to control the amount of water they get from WUA, weirs are a good possibility to check as well.

Contacts

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- SMS from Chui, Naryn, Issyk-Kul Kazym Sabyrov, National Cotton Research Station, Karasuu, Osh Oblast

Figure 15: Arrangement of big and small weirs at the beginning of a field.
Short Distance Irrigation

Short Description

The problem of uneven distribution of the water along the furrows can be solved by making shorter furrows. Instead of making furrows through the whole length of the field, several channels may be cut across the field. Beside the field a side channel must be cut to lead the water to the cross-channels (figure 16). Irrigation starts at the top of the field, and goes down to the lower sections. The runoff water from the upper sections may be used to irrigate the next section. The shorter furrows allow the water to reach the end more quickly and therefore the whole length of the field is uniformly watered.

Benefits/Results

- Short distance irrigation leads to better irrigation uniformity (figure 17). The crop is irrigated more regularly, which results in even growth and higher yield in the whole field.
- Short furrows are irrigated more quickly, the farmer can irrigate several sections at the same time and this accelerates the whole irrigation application.
- Short distance irrigation has similar effects as cut-back irrigation, but is easier to apply, mostly when the farmer is alone and when devices for measuring or adjusting the stream size are missing.
- The control of the whole water supply is easier because more furrows (= a bigger part of the field) can be irrigated at the same time.

Costs

There is no investment necessary for making short distance irrigation, except the cutting of the cross- and the side channels. The cross channels have to be remade before every application, since they will be destroyed after harrowing the field (which is usually done after every application).

Technical aspects for implementation

The length of the furrows should not exceed 80 meters, but the most appropriate length depends mostly on the slope and on the soil characteristics. In soils with low infiltration rates, furrows may be longer than in soils with high infiltration rate. In general short furrows are around 50 meters long. Since the whole length of the furrow is wet very quickly, the water will flow uniformly and the water can be absorbed in the whole furrow-length. Therefore a small stream size is more appropriate. Devices to control the water flow can be installed at the head of the furrows.
Where it is useful to apply the technology

Short distance irrigation is a must in all fields longer than 100 meters and in flat fields or in very permeable soils, where the water doesn’t reach the end of the furrow within one hour.

Short distance irrigation is the easy alternative to cut back irrigation. It is easy to manage and doesn’t require any investments.

Contacts

- Kazym Sabyrov, National Cotton Research Station, Karasu, Osh Oblast
- RAS Batken, Kadamjai Rayon

Figure 17: Comparison of wetted soil in profile with short distance irrigation (above) and normal irrigation (below).

Short distance irrigation results in better distribution and less loss of water.
B. Subsurface Irrigation

Usually, irrigation takes place from the surface, and there are always water losses by surface runoff or by evaporation. Subsurface Irrigation means that the water applied to the plants comes directly from underground, opposed to usual irrigation practices.

- The biggest advantage of subsurface irrigation is that big amounts of water can be saved. There are neither losses of water through percolation (water going deeper than plants are rooting), nor washing out of nutrients. Also evaporation is minimized, since there is no water on the surface.
- Fertilizer may be mixed with the irrigation water.

In the following chapters two technologies related to sub-surface irrigation are described:

- **Earthen Receptacles (pitchers) and plastic bottles for vegetables and fruits**
- **Fertigation, combined with subsurface irrigation (used in sugar beets, maize and sunflowers)**
PITCHERS (EARTHEN RECEPTACLES) AND PLASTIC BOTTLES

Short Description

Unglazed baked earthen pitchers are buried to their neck in the soil and filled with water. Time by time the water will flow out of the receptacle through the porous walls, supplying the root zone with necessary moisture (figure 18). Pitchers are refilled with water as needed; a continuous supply of water to the plant roots is therefore maintained. Similar effects have plastic bottles, buried in the soil. Small holes are made on the two opposite sides of the bottle, through which water will flow out slowly (figure 19).

Benefits/Results

- Compared to watering by hand, pitcher irrigation is time and water saving.
- Since the soil surface remains dry, the risk of rotting plants and fruit is reduced.
- Weeding needs are minimized as the water source below the surface does not allow for weeds to get out of control.
- Young plants may be raised from seeds instead of transporting seedlings from nurseries.
- Once installed, the system is not labour-intensive and easy to operate and maintain.

Costs

Pitchers are available at the bazaar. They can be used 3 to 6 years. Plastic bottles are free of charge. But the required labour time for burying the receptacles correctly and for filling them up regularly should not be underestimated.

Technical aspects for implementation

Pitchers: The pots should have a capacity of 7 to 10 litres, and usually four plants can be grown around one pot. Pots should be placed 1 to 2 meters apart, so that wet areas do not overlap. The holes dug in the soil should be filled with a half-soil/half-manure mixture completely surrounding the pot (figure 18).

Plastic bottles: The holes in the bottles should be kept small and not more than two on each side. Otherwise the water will flow out too quickly. When putting the bottles, a minimum distance of 10-15 cm to the plants should be maintained in order to prevent blocked holes, originating from roots growing into the bottles.

Where it is useful to apply the technology

Burying receptacles and filling them up requires quite some labour time. The technology is therefore only suitable where water is really scarce and has to be brought to the garden by hand. The simple method makes it possible for children to fill the bottles/pitchers. It is only useful for small plots, usually in vegetable gardens. It can also be applied for young fruit trees as additional irrigation. When using this method even brackish water or water containing salt can be used, because these ingredients will not affect the plants.

Contacts

- ATC, Bishkek (brochure)
FERTIGATION, COMBINED WITH SUBSURFACE IRRIGATION (USED IN SUGAR BEETS, MAIZE AND SUNFLOWERS)

Short Description

Another kind of subsurface irrigation has been developed by some farmers in Kyrgyzstan. The technology is very new and farmer who are using it praise the effect of it. It is not exactly an irrigation technology, more a fertigation technique (combination of irrigation and applying liquid fertilizer). But according to farmers it also reduces the need of at least one irrigation application. The farmers have constructed tools that harrow and apply liquid fertilizer at once; either pulled by a tractor or by horse. (Figures 20, 21).

Both systems consist a tank, which is filled with a mixture of water and fertilizer (both mineral and organic fertilizer can be used, but the effect of mineral fertilizer may be much better). The liquid is brought to the share by plastic hoses and inserted into the soil, while the field is harrowed (figure 22).

Figure 20: Mini tractor with a tank, put on top of a small cultivator for 2 rows. This technology was tested in sugar beets. A person behind the machine assures that plants are not damaged.

Figure 21: Horse-pulled technology: a 25 liter-tank with a cultivator for one row; tested in sunflowers.
Benefits/Results

- The technology brings water and fertilizer directly to the roots of the plants; there are neither evaporation nor percolation or runoff losses. Therefore both water and fertilizer are used most effectively.

Costs

According to the farmers the machines were built with material at hand, no expenses were needed. But constructing the machine needs time and knowledge. When harrowing the crop is done anyway, the fertigation can be combined without big additional effort.

Technical aspects for implementation

When constructing the machine, it must be borne in mind not to make the tank too big, it has to be pulled by the tractor or the horse. Organic fertilizer has to be filtered before filling in the tank in order to prevent logging of the plastic pipes. The effort for fertigation can be quite big when water has to be carried from far away. One or two applications per season may be enough.

Where it is useful to apply the technology

Fertigation may be used in most of the crops; but is more suitable for small fields that are harrowed anyway, otherwise the effort for preparing the mixture and filling the tank every time is too big.

Contacts

- RAS Osh, Karakulja Rayon

Figure 22: Detail of a “self made” cultivator: The amount of liquid can be controlled by two valves at the exit of the tank. The plastic hoses end in two short metal pipes, which insert the liquid into the soil.
C. Water Harvesting in (mainly) Rain fed Cropping

Short Description
Water Harvesting means that rainfall-water is collected ("harvested") in one place, is stored in certain places and later used by plants. Usually, the technology is used on fields with small slope where no irrigation is possible. First small bunds (2-3 meters long) with the shape of half moons (figure 24) have to be constructed everywhere on the field. They are made with stones, earth, straw… When it is raining, water flows down the slope and is stopped at the bund (= Harvesting). There, water is forced to infiltrate into the soil (= storage). Only in that area, where water is stored, plants are grown (figure 23). They can use the stored water even when the rest of the soil has already dried out.

Figure 23: Elements which are necessary for water harvesting: a small slope, water harvesting and water storage area, a bund for stopping water, and a crop, which is resistant to drought.

Benefits / Results

- Water harvesting makes it possible to get a profit from areas where no other crop production can be done because of lack of irrigation water.
- Water harvesting may also be used to collect water for livestock in special ponds.

Costs
The establishment of water harvesting structures is quite labour intensive, but generally does not require financial inputs. The bunds can usually be constructed by hand, and can be used for many years.
Technical aspects for implementation

The soil is the most important aspect, when applying the technology: The soil in the areas, where water is harvested can be compact, shallow and infertile; but the soil, where the water is stored and plants are grown should be deep and have a good structure. The exact arrangement of the bunds depends on the soil and on the amount of rainfall. In areas with only few rainfall the area for collecting water will be much bigger than the area for storing the water. That means that the space between the single bunds has to be bigger (figure 24).

Where it is useful to apply the technology

There are vast dry areas in Kyrgyzstan that cannot be irrigated and rainfall is not sufficient to produce crops. In such cases, water harvesting may be a promising option for farmers. Fruit trees (apples, apricots) are best suited for water harvesting.

Figure 24: Arrangement of bunds in a water harvesting area. The less rainfall there is, the more space has to be made between each row.
D. Drip Irrigation

**Short Description**

Drip Irrigation describes the method where irrigation takes place drop by drop. This technology uses water most effectively, since losses are reduced to a minimum. It also makes it possible to water the plants according to their needs.

In the past, drip irrigation was only possible in big farms and high investments were needed. In recent times cheap systems were developed in India and Nepal by IDE (International Development Enterprises), which are adapted for small vegetable plots of farmers.

These technologies include several systems for various field sizes, suitable mainly for kitchen gardens. Every system consists of a number of delivery pipes and drip lines. A bucket, where water is filled in, and filters are also parts of the system.

The drip-system is installed in the field, and vegetable seedlings are planted next to the holes in the pipes. The work for the farmer mainly consists of filling the bucket every day or every second day and cleaning the filter once a week.

The water flows in drops out of the small holes and is immediately absorbed by the soil around the plant. Most of the soil surface remains dry.

In Kyrgyzstan 3 systems have been tested so far. The one best suited to conditions in Kyrgyzstan is the Nepali system. It is designed for an area of 8x12 meters and for irrigating 240 plants (figure 25).

![Figure 25: Part of the drip irrigation system, produced in Nepal. The bucket contains 60l of water, and has to be put 1 meter above ground. The drip lines are put along the plant rows and are supplied by two main lines at head of the field.](image)

**Benefits / Results**

- The biggest advantage of low-cost drip irrigation system is that a lot of water can be saved compared to all other irrigation methods. There are practically no losses through evaporation or percolation to deeper soil layers, because the water is applied very economically.
- No soil erosion takes place.
✓ Labour can be reduced very much, compared to the time needed for watering plants by hand. The system is easy to maintain. Additionally, less weeds are growing because the soil is only wet around the crop.

✓ The drip irrigation system makes it possible to cultivate plots, which were not used before, because water had to be carried by hand from far away.

✓ Fertilizers may be added to the irrigation water.

Costs

Costs of the irrigation systems vary according to distance from the producers. In the production-country the price for the Nepali Kit was 18$ in summer 2004. The price after importation to Kyrgyzstan is unknown at the moment.

Technical aspects for implementation

Installation and operation of the systems require some explanations (RAS advisors know about it) to fully understand the use of the system. Afterwards, the operation is very easy. It is important to plant the seedlings according to the holes in the drip lines; otherwise irrigation will not be effectively. Compared to watering by hand, request of water can be reduced a lot. This is new for farmers and attention should be paid not to apply too much water and thus to waste it. Water used for irrigation should be as clean as possible to avoid blocking of filter and the drip-pipes.

Where it is useful to apply the technology

The system is only useful in places where no irrigation with channels and furrows is possible. It is recommended to put it in places which are well protected from thieves. The systems are particularly suitable for vegetable and fruit production, which can be sold at a high price on the market (cash crops, or early production).

Contacts

- Advisory Training Centre (ATC), Bishkek
- RAS Batken, Chui, Issyk-Kul, Jalalabad, Naryn, Osh
E. Improved Flooding using Corrugations

Short Description
Corrugation irrigation is a method of surface irrigation similar to furrow irrigation. It can be used for pastures, alfalfa, and esparsette, where it is not possible to make furrows. Corrugations are like small furrows (10 cm deep, but no raises) in the ground, with a space of 40-75 cm between each other. They are like guidelines, leading the water across the field that is flooded. Corrugations are usually pressed in the soil with a roller or can be made with a small plough (horse-pulled or hand-pulled). They have to run along the greatest slope of the field. The field is flooded with small amounts of water and the water will gently flow down along the corrugations, over the whole field.

Benefits / Results
- Corrugations help to guide the flooding water in the whole field. The technology leads to a better distribution of water, therefore to a more even growth of plants and in consequence to higher yields.
- Water is used more effectively, because there is less runoff water and infiltration is improved because of a better distribution. The soil is neither eroded nor sealed by too much water.
- Corrugations can also be used for other crops on slopes that are too steep for furrows (>3%), but they have to be short, otherwise there is risk of erosion.

Costs
There are no costs required expect labour for making the corrugations. In generally, corrugations have to be remade once in a season. If the field is used as pasture, they have to be restored after the utilisation by livestock.

Technical aspects for implementation
Irrigation efficiency can be up to 70% (as compared to <45% in uncontrolled flooding). Exact length and spacing of corrugations are dependent on slope and soil characteristics. The suitable amount of water that should flow down the corrugations also depends on slope and soils. Erosion should be avoided.

Where it is useful to apply the technology
Corrugations are normally used for broadcast or close-seeded crops (grain, alfalfa, pasture), or pastures. They are a good alternative to furrows in fields with a slope too steep for making furrows.
F. Water Supply

Water supply is a general problem in Kyrgyzstan. Though there are big water resources in the country, coming from the mountains, water can often not be used for the crops, because the water source is on lower altitude than the fields. Therefore water has to be lifted up. The following chapters present three possibilities, how water can be lifted with easy and relatively cheap devices. Electricity or engines are not needed for these technologies:

- Hydraulic Pump
- Waterwheel
- Coil-pump
**Short Description**

The hydraulic pump (hydraulic ram) has been designed to pump water from rivers or channels with the use of water power (energy). The pump has to be placed in a river or a channel with sufficient water supply and water speed. Due to two valves installed in the pump, water is forced to go in a cylinder, where enough pressure is created to pump the water up (figure 27). There are various pump sizes, with different possible pumping heights (from 0.3m to 20m) and various water delivery capacities (from 0.2 l/sec for a small pump up to more than 50l/sec for big pumps).

**Benefits / Results**

- The main advantage of the Hydraulic Ram is that water can be lifted up without using electricity. Land can therefore be irrigated that is located higher than the water source.
- The technology is very easy so that a farmer can do necessary repairs himself. Once the pump is installed, it can work for 20 years.

**Costs**

A pump costs 100-500 USD depending on its capacity (figure 29). These costs can be shared between several farmers if the delivered water is used for several fields. This is very well possible since the amount of water delivered by the pump is sufficient for a big area.

**Technical aspects for implementation**

The pump has a supply pipe attached to the pump. The end of the pipe is inserted into the water. The water flows to the supply pipe and closes the valve due to pressure. This pressure forces the water to flow in pulses into the pipe leading it to the field. Each pulse brings water with a time interval of 2-3 seconds.

The depth of water in front of the pump should be at least 0.3 m or the speed of the stream flow in a canal or river should be high to create enough water pressure (figure 28).
Where it is useful to apply the technology

Before ordering a hydraulic pump, the river/channel where it shall be installed, should be carefully examined. It is recommended to ask a specialist, because a certain amount of water and a certain water speed is necessary to make the pump work. The water, delivered from the pump, should be used for good, fertile soils where crops can be produced for the market. In that way, the costs for buying the pump can be reimbursed most quickly. It is recommended that a group of farmers buy and maintain the pump together in order to use it efficiently (the pump delivers water during 24 hours, during the whole irrigation season) and to guard it against thieves.

Contacts

- G.V. Rogozin, 4a, Toktonalieva street, Bishkek, Kyrgyz Republic. Tel.: (+996) 312 425128
- Talant Sydykbaev, Tel: 0312 45 04 35, Mobile: 0502 219 5 35

<table>
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<td>ГТ-500</td>
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</tbody>
</table>

Figure 29: Capacity and price of the most frequently used pumps.
Short Description

Waterwheels are the easiest method to lift up water. The wheel, made of metal, is put in a channel or river, and water is lifted up with receptacles and collected on top of the wheel in a small tank, from where it is transported in pipes or in an open channel to the gardens or fields (figure 31). Waterwheels can be found in many places in Kyrgyzstan. Farmers can make waterwheels themselves, and once installed they work for years. No engine or electricity is needed.

Benefits/Results

- Waterwheels are an easy technology which is understandable for every farmer.
- Farmers can build and maintain them themselves. Many waterwheels can be put in the same channel without somebody taking all the water.
- The wheels make it possible to grow vegetables in places, where cultivation would not be possible otherwise.

Costs

Usually the material for waterwheels is at hand, or can be procured at low costs. As farmers usually don’t have to pay for water from channels, water is for free.

Technical Aspects for Implementation

Before building the wheel, the farmer should know for which place he wants to use the water. The water must be lifted up higher than the field, because the water has to flow from top of the wheel with small slope to the field.

Where it is useful to apply the technology

With waterwheels only small amounts of water can be lifted up, therefore only small fields can be irrigated. The technology is especially useful for gardens, where a water source is close, but in lower altitude than the field. The water lifted up with the wheel is precious (consider the work for making the wheel), therefore valuable crops like vegetables should be irrigated with it.

Contacts

- RAS Batken (many waterwheels seen in Kadamjai)
**COIL-PUMP**

**Short Description**

The coil pump was developed by STLI (Scientific Technology and Language Institute) for farmers in Osh:
This pump looks like a normal waterwheel, but instead of receptacles a long hose is rolled in form of a coil on the wheel. The wheel is put into a channel or a river. Like a waterwheel it turns around because of the paddles. Water flows in the hose and through the whole coil till the end. There the water is leaded to the axis of the wheel. From there it flows in a hose up the hill (figure 30).
The coil on the wheel consists of a very long hose and when it is filled with water and is turning around all the time, with new water flowing in, a pressure is created, which is sufficient to push water up.

**Benefits/ Results**

- The coil-pump is easy to build and, compared with other pumps, very cheap.
- The main benefit is that places can be irrigated that lie higher than the water source and where other irrigation technologies are not possible.
- The coil-pump can work for years and can be maintained by the farmer himself.
Costs

Two things have to be bought: The hoses for the coil and for the delivery pipe and one device in the axis of the wheel (which is produced in Osh at the moment and costs around 500 Som). The wheel itself can be made of metal at hand. An average pump which pumps the water 10 meters (12 liters/minute) costs totally around 4500 soms (including a hose of 90 meters).

Technical Aspects for Implementation

For creating enough pressure, the following ratio is necessary: The hose for the coil must be four times as long as the required pumping height is. Example: To pump 10 meters up, 40 meters of pipe have to be rolled on the wheel.

Where it is useful to apply the technology

The technology is especially useful for gardens, where a water source is close, but in lower altitude than the field. The water lifted up with the wheel is precious (consider the work for making the wheel), therefore valuable crops like vegetables should be irrigated with it. Compared to ordinary waterwheels, bigger amounts of water are pumped up, therefore it could also be interesting for bigger vegetable-cropping areas.

Contacts

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