# STATUS OF CROPPING SYSTEM IN KARAKALPAKSTAN

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## Introduction

The Aral Sea is located in the north-western part of Uzbekistan (Autonomous Republic of Karakalpakstan). Because the Aral Sea is shrinking this region has lots of environmental and health problems.

In the 1960s, the erstwhile USSR increased the area under cotton in Uzbekistan. To achieve this and because of Uzbekistan's continental climate, it became necessary to redirect water from the two main rivers, the Amudarya and the Sirdarya and, thus, their flow to the Aral Sea decreased. During the 1980s, the inflow was only 10 percent of what it used to be in the 1950s. The loss of inflow, combined with evaporation and little rainfall, caused the shoreline to recede, and, as a result, in 1987 the sea's southern and northern parts got separated, although they are still connected at times by a channel (Khakimov, 1989). By the end of 1996, the total area of Aral Sea had decreased by 57 percent, and the water level of the sea, which receives 80 percent of the inflow from the Amudarya, dropped 15-18 meters.

In the arid conditions of the Aral Sea basin, the depth of ground-water is a key issue. Above a certain critical level, intensive water evaporation begins, water transformation intensifies, and soil salinization occurs. In the Karakalpakstan, for example, the area of land with a critical groundwater situation increased from 72 per cent to 90 per cent during the period 1975-1989 (Khakimov, 1989).

The above problems have seriously affected agriculture and its production in the Republic. This is because of careless use and overexploitation of natural resources, commonly practiced same cropping systems and application of inadequate practices for management of soils and water that land and soil degradation is commonly observed in the Republic. This has had and continues to have detrimental effects on food production and is causing food shortages for the growing population of the Republic.

## Salinity

Planned and large-scale public programs on expansion of large areas with the simultaneous establishment of irrigation and drainage network throughout Karakalpakstan, including Karakalpakstan during 1960s to 1970s, were directed to strategical planning of the former USSR.

Simultaneous land-reclamation and irrigation of soils at the big territories, massively and heavily watering, and absence of well-operating and quality collector-drainage systems at the developed areas caused secondary salinity of soils universal for all irrigated areas, particularly in the arid regions. Imperfection of the hydraulic and reclamation constructions, and their underutilization as well as unfounded irrigation systems contributed to salinization in the arid regions.

Figure 1: See page salinity in Karakalpakistan

The area of saline irrigated lands in Uzbekistan amounts to 2,270,700 hectare, including low-saline lands of 1,267,700 hectare, medium-saline lands of 711,200 hectare, and strong-saline lands of 291,800 hectare (MAWR of Uzbekistan 2012).

In KK, about 80% of the irrigated land is saline land including 48% with high salinity. At present, share of salinized irrigated areas accounts for 100% in Mo'ynak district and 95% in Shumanay district while in Qorao'k district is about 85% where project site is located (Figure 1). The strong- and medium-saline areas increased for the last 24 years from 38.5% to 58.4 % against a background of ineffectively open shallow drainage network. However, against a background of progressive deep under-drainage in Sirdarya province high- and medium-saline areas increased for the same period from 25.7 % to 53.7 % as well. Considering this, if appraisal for salinity is not made for crops with strong salt resistance, then salinization intensity and its damage would be catastrophically unpredictable for the crops with weak-and medium-salt resistance.

## Drought

Moderate to extreme drought conditions extend across the southern part and much of the eastern and western part of Uzbekistan. At the height of the drought in 2007, more than half of the country was affected. According to data taken from the MAWR only the droughts of 2000 and 2001 affected a greater percentage of the country's land mass.

Figure 2: Drought in Karakalpakistan

After the 1999 drought, KK in 2000 and 2001 experienced the worst drought and water shortage in living memory. The area is naturally arid and, with an annual rainfall of only 110 mm, humans, animals and agriculture are almost entirely dependent on the residual flow in the Amudarya for survival. River flow fell dramatically and the consequent impact on the rural population, livestock and crop production was disastrous, with an emergency situation prevailing in many areas, particularly in northern districts.

The origins of this disaster were both man made and natural. The main cause is mismanagement of water resources in the river basin, compounded by diminishing snow and glacier melt, a declining trend in rainfall, and possible long-term climatic change. There is general consensus amongst scientists and farmers that water availability at the tail end of the Amudarya River is in decline. There are interventions underway in the river basin, aimed at improving efficiency in water management and utilization, and the Government has been providing assistance to vulnerable farmers repeatedly affected by drought in KK.

Drought can change many long-held convictions. Wheat in Qorao'zak is normally grown to help the following crops due to rotational benefits, weed control, and moisture accumulation.

The landowners and tenants should discuss how drought may affect production in a particular year and design a lease so that they share the opportunity and risk associated with drought. Discussion should include who decides when drought adversely affects the winter wheat production enough to apply nitrogen at the exact time in order to ensure sufficient moisture in the soil after winter.

Qorao'zak's climate is classified as severe continental with hot summers and cool winters. Summer temperatures are often surpass 45°C; winter temperature in January on average is about -8°C, with absolute minimum as low as -40°C. According to the data of the Karakalpak Research Institute of Farming (KRIF) located in Chimbay, the annual long-term precipitation is 110 mm, distributed as 18mm in fall (September- November), 60 mm in winter (December-March), 24 mm in spring (April-May) and 8 mm in summer (June-August).

## Current Cropping Systems

Rotation of crops taken up for a given piece of land, or sequence in which the crops are cultivated on piece of land over a fixed period and their interaction with farm resources and other farm enterprises. This term is not a new one, but it has been used more often in recent years in discussions about sustainability of our agricultural production systems. There are several options on different cropping systems and these are as follows:

a) Double cropping (also known as catch crop) is the practice of planting a second crop immediately following the harvest of a first crop, thus harvesting two crops from the same field in one year. This is a case of multiple cropping, which requires a season long enough and crops that mature quickly enough to allow two harvests in one year.

b) Intercropping is the presence of two or more crops in the same field at the same time, planted in an arrangement that results in the crops competing with one another.

c) Monocropping, or monoculture, refers to the presence of a single crop in a field. This term is often used to refer to growing the same crop year after year in the same field; this practice is better described as continuous cropping, or continuous monocropping.

Legume crops in the rotation have become more valuable with the increased cost of nitrogen.

Within a crop rotation, different root systems influence different soil horizons and improve the efficiency of the soil nutrient use.

The fibrous root systems of cereal and forage crops are excellent for building soil structure. Benefits of including wheat, and especially wheat plus mungbean, may persist beyond just the following year.

In choosing the crop to grow, one should be aware of any potential insect or disease problems that could affect crops later in the rotation. Table 1 shows various crop rotations and their potential impacts (Nurbekov 2008).

The basic rule of crop rotation is that a crop should preferably not follow itself. Continuous cropping (monocropping) of any crop will result in the build-up of diseases and insects specific to that crop, and cause a reduction in crop yields. The more often a crop has been grown in the field in the past, the greater this impact will be. For example, the practice of growing two or more years of cotton and wheat is becoming increasingly common. Perhaps, the greatest impact of back-to-back years of cotton has been the accelerated spread of cotton boll weevils. The increased number of years of cotton in the rotation is also increasing the susceptibility of Qorao’zak's soils to erosion. In fact, the structure of soils in cotton-wheat rotations is actually poorer than that of soils that were previously in cotton-alfalfa crop rotations.

**Table 1: Possible crop rotations and their potential impacts**

| Crop to be grown | Preceding crop in sequence | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Cotton** | **Wheat** | **Sorghum** | **millet** | **Sunflower** | **Sesame** | **Legumes** |
| **Cotton** | **NR**<br>• yield depression<br>• vascular wilt and other root diseases | **C**<br>• slugs may cause damage in no-till | **R** | **R** | **C**<br>• yield depression | **R** | **R** |
| **Winter Wheat** | **R** | **NR**<br>• yield depression<br>• root diseases | **C**<br>• yield depression<br>• weed escapes may be difficult to control | **R** | **C**<br>• yield depression | **R** | **R** |
| **Sorghum** | **R** | **R** | **NR**<br>• yield depression | **R** | **C**<br>• yield depression | **R** | **R** |
| **Proso millet** | **R** | **R** | **R**<br>• wireworms | **NR**<br>• yield depression | **C**<br>• leaf diseases<br>• yield depression | **R** | **R** |
| **Sunflower** | **NR**<br>• increased risk of Fusarium head blight | **C**<br>• yield depression | **R** | **NR**<br>• take-all<br>• leaf diseases | **NR**<br>• take-all<br>• leaf diseases<br>• yield depression | **R** | **C** |
| **Sesame** | **R** | **R**<br>• slugs may cause damage in no-till | **R** | **R**<br>• slugs may cause damage in no-till | **R** | **NR**<br>• yield depression<br>• root rots | **R** |
| **Legumes** | **C**<br>• slugs may cause damage in no-till<br>• check for herbicide carryover | **R**<br>• check for herbicide carryover | **R** | **R** | **R**<br>• slugs may cause damage in no-till | **C**<br>• white mould | **NR**<br>• white mould<br>• blackleg<br>• root rots<br>• yield depression<br>• check for herbicide carryover |
| Legend: | (**R**) Recommended | | | (**C**) Caution | | (**NR**) Not Recommended | |

Farmers who diversify by growing at least three type of crop are in a better position to tolerate soil-climate conditions or crop failures. By combining cereal and legume crops that yield multiple products and profits at different times, a farmer can use available space, time and resources more effectively and can get additional food and feed resources.

Within a crop rotation, different root systems influence different soil horizons and improve the efficiency of the soil nutrient use. In general, the soil structure becomes more stable (Bot & Benites, 2005).

During the Soviet era, the agricultural production system focused on maximizing the output using high-input monocultures of often non-adapted crops. Following land reforms, the former state-owned kolkhoz and sovkhoz farms were disbanded and the land was privatized. Yet, the majority of the newly established small private farmers were little prepared for this role and had difficulties in coping with the drastic change in farming operations. Their experience as employees on large, state-run farms was insufficient for private farming in a market-driven economy resulting in the current state of the agricultural and rural sector.

The main crop grown in the target area is wheat, barley, maize, potato, vegetables, and fruits. However, winter wheat and barley occupies 80% of the total arable area. In order to attain food security, wheat became the most important crop in Uzbekistan; the area under irrigation increased substantially, including rainfed production.

There were no crop rotations in the target area. The absence of alfalfa in present crop rotations has diminished humus in the soil and considerable micronutrients. In the time of former Soviet Union, area was planted to wheat in rotation with alfalfa. Crop diversification will be a new issue. A major feature of the planning system is the categorization of agricultural land productivity based on a range of variables that relate to soil characteristics and fertility. Consideration may be given to expanding the land use system to include variables on water availability and drainage characteristics.

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Research and experience have shown that good crop rotation will provide more consistent yields, build soil structure and increase profit potential (Nurbekov, 2008). Crop rotations for target areas were developed taking into account soil and climatic conditions and also marketability of the selected crops of the project in the project countries.

Qorao'zak district is distinguished by climate, which is prone to adverse natural phenomena that can drastically reduce the productivity of agricultural crops. These include air and soil droughts, hot dry winds, designated as "capture" or "igniting fuse". These phenomena occur due to long dry periods without precipitation and high air temperatures, with each of them reducing yield of agricultural crops. In order to manage these negative weather phenomena, it is important to know about the nature and times of drought and the onset of hot dry winds and associated effects on the specific crops to decide which crop management practice(s) to apply.

There is, thus, ample scope to increase yields for instance using bed planting methods. There is also potential for diversifying from cereals to higher value commodities such as fruits and vegetables. Furthermore, the target area can be competitive in a number of agricultural crops such as winter wheat and barley, legumes, vegetables and fruits products and in processed agricultural products.

Today in Karakalpakstan, most farmers do not have enough experience and knowledge about improved water management and irrigation technologies. Poor condition of irrigation system also constraints appropriate irrigation and consequently crop yields. There is a lack of information on improved agronomy, in particular crop rotation, the use of legumes, reduced tillage and crop residue retention, designed to counter these problems. In 2015 an experiment was carried out in Qorao'zak district to test the effect of tillage methods on productivity of different agricultural crops.

## Proposed crop rotations

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In irrigated agriculture, winter wheat should be cultivated with legume crops in specialized cereal crop rotation. Developed and recommended crop rotation options for soil and climatic zones in the target areas are also characterized to soil fertility rehabilitation.

## Proposed short-term cereal-legume crop rotations

***Option I***

1. Winter wheat + Alfalfa 1st year
2. Alfalfa, 2d year
3. Alfalfa, 3d year
4. Winter wheat
5. Winter wheat
6. Grain maize

***Option I***

1. Winter barley + Alfalfa 1st year
2. Alfalfa, 2d year
3. Alfalfa, 3d year
4. Winter wheat+
5. Winter wheat+maize
6. Winter pea

***Option III***

1. Maize
2. Winter wheat
3. Kidney bean
4. Oilseed rape
5. Winter wheat
6. Soybean

***Option IV***

1. Winter wheat
2. Maize
3. Forage pea
4. Sunflower
5. Winter wheat
6. Forage pea

Crop rotation with fodder legumes or pulses is extremely important for soil health and management of plant diseases.

## Proposed fodder crop rotation for irrigated production

***Option I***

1. Alfalfa, 1st year of life
2. Alfalfa, 2nd year of life
3. Alfalfa, 3rd year of life
4. Maize
5. Co-sowing Maize &Sorghum
6. Winter Rye + Winter Field Pea, Second crop+ co-sowing Maize and Sunflower

***Option II***

1. Winter wheat+maize
2. Winter field pea+Sorghum
3. Winter barley+fodder bean
4. Winter Triticale+maize
5. Winter Rye+Sorghum
6. Winter barley+Alfalfa

There is, thus, ample scope to increase yields for instance using bed planting methods. There is also potential for diversifying from cereals to higher value commodities such as fruits and vegetables. Furthermore, the target area can be competitive in a number of agricultural crops such as winter wheat and barley, legumes, vegetables and fruits products and in processed agricultural products.

## Proposed Cereal crops for CA

### Winter wheat

Winter wheat (*Triticum aestivum*) are strains of wheat that are planted in the autumn to germinate and develop into young plants that remain in the vegetative phase during the winter and resume growth in early spring (Figure 3). Classification into spring or winter wheat is common and traditionally refers to the season during which the crop is grown in the Northern Hemisphere. For winter wheat, the physiological stage of heading is delayed until the plant experiences vernalization, a period of 30 to 60 days of cold winter temperatures (0° to 5 °C).

Figure 3: Winter wheat field in Karakalpakistan

Winter wheat usually planted from September to November in Uzbekistan and harvested in the summer of the next year.

### Winter barley

Barley (Hordeum vulgare L.), a member of the grass family, is a major cereal grain. It was one of the first cultivated grains and is now grown widely (Figure 4). Barley can be distinguished by differences in head type and growth habits. In a six-rowed barley, three kernels are formed at each node of the head while in a two-rowed type, only a single kernel forms at each node.

Barley is also classed by its requirement for cold temperatures. Winter barley must be planted so that seedlings will be exposed to cold (vernalized), which enables it to later produce heads and grain normally. Winter barley is usually sown in the fall for exposure to low temperatures during the winter and then development is completed during the following spring and summer. Spring barley does not require exposure to winter temperatures and can be sown in spring. Winter types usually mature somewhat earlier than spring types. Growth and development of the six-rowed spring barley commonly grown in Uzbekistan will be considered here.

Barley production has become more intense and complex in recent years. Crop managers must understand barley development and be able to recognize growth stages because of the increased use of growth stage sensitive production inputs such as chemical fertilizers, pesticides, and growth regulators.

Figure 4: Winter barley in Uzbekistan

## Winter rye

Cereal rye is an excellent winter cover crop because it rapidly produces a ground cover that holds soil in place against the forces of wind and water. Rye's deep roots help prevent compaction in annually tilled fields, and because its roots are quite extensive, rye also has a positive effect on soil tilth.

Rye for No-Till. Because it leaves a lot of residue on the soil surface, no-till rye can be an effective way to avoid erosion and help control weeds. Mowing or using a burn-down herbicide are two common methods of killing a rye cover crop for no-till plantings. To kill rye by mowing, it should be done at flowering when the anthers are extended, and pollen falls from the seed heads when shaken. If mowing is done earlier, the rye simply grows back. Studies are underway looking at rolling instead of mowing as a means of physically killing winter rye.

## Maize

Maize (Zea mays L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions (Figure 5). Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. Maize can be grown successfully in variety of soils ranging from loamy sand to clay loam. However, soils with good organic matter content having high water holding capacity with neutral pH are considered good for higher productivity. Being a sensitive crop to moisture stress particularly excess soil moisture and salinity stresses; it is desirable to avoid low lying fields having poor drainage and also the field having higher salinity. Therefore, the fields having provision of proper drainage should be selected for cultivation of maize.

Figure 5: No-till maize in Uzbekistan

## Sorghum

Sorghum [*Sorghum bicolor (L.) Moench*] are a warm season annual grasses that is best known in the U.S. and India as a forage crop. Singh B.R. and Singh D.P. (1995) reported that sorghum should be grown as fodder crop under inadequate and irregular water supply in semi-arid regions. Sorghum is considered stable food crops in climatic risk situations, whereas corn is a high yield crop. Recent studies analyzing the climatic potential of the northern Sebungwe region, Zimbabwe indicate that rainfall in some parts is high enough to ensure stable crop production (Chiduza 2001). The crop have high water-use efficiency, and are highly tolerant to drought and soil salinity. These features make pearl millet and sorghum especially suitable for crop diversification and crop-livestock productivity enhancement in Uzbekistan (Figure 6).

Figure 6: No-till Sorghum in Karakalpakistan

## Pearl millet

Pearl millet [*Pennisetum glaucum*] has a long history of use as a summer grazing and hay crop. The recent development of new, adaptable and productive grain pearl millet hybrids in the southeast gives crop producers a suitable alternative feed grain for dryland production. Pearl millet is one of the most drought resistant grains in commercial production. It is able to grow in areas that experience frequent periods of dry weather during either the vegetative or reproductive phases. Pearl millet appears to be more tolerant of sandy and acidic soils than other summer grain crops. It is deep-rooted and can use residual nitrogen, phosphorus and potassium and, therefore, may not need the levels of fertility required by other summer grains (Figure 7).

Figure 7: No-till Pearl millet in Karakalpakistan

These characteristics enhance pearl millet's desirability in lower input, dryland production systems. The grain can be used in poultry, cattle and swine rations without adversely affecting feed efficiency or weight gain. Total metabolizable energy of pearl millet is similar to corn. Crude protein levels in pearl millet range from 12 to 14 percent.

## Proposed legumes for CA

There is a need for crop diversification with legumes to improve sustainability as well as to provide protein-rich grains. Technologies to save seed, water, fertilizer, etc. should be identified and disseminated to the farmers on a large scale. Food legumes enrich the soil with nitrogen and are very important for sustainable production intensification. In addition to providing nitrogen, legume crops also improve soil quality, thus positively affecting the performance of the ensuing crop. Nitrogen fertilizer requirement for the succeeding crop is reduced in a cropping system that includes legumes, which results in lower cost of production.

Legumes - chickpeas, peas and beans - in Karakalpakstan are produced for grain and green biomass. Great interest in the production of leguminous crops in the project countries is due to the volatility in grain prices and demand for pulse crops in foreign markets. As it is known, modern varieties of leguminous crops grow well both on fertile and on poor soils having a pH from 5.0 to 7.5. In addition, legume crops are high-performance bio-plants for the fixation of atmospheric nitrogen.

Legumes improve soil fertility and, accordingly, are excellent as preceding crops to many other crops in rotations. Additionally, leguminous grain crops produce more protein per unit area, and its quality and digestibility is much higher.

The rising cost of mineral nitrogen fertilizers has revived interest in nitrogen-fixing legumes. Organic growers often include this type of cover crop in order to produce nitrogen for the rest of the crop rotation. Deep-rooted cover crops can bring nutrients up from deeper layer in the soil profile and contribute to the development of a network of soil biopores which improves aeration, drainage and moisture holding capacity.

## Soybean (*Glycine max*)

Soybean pods, stems and leaves are covered with fine brown or grey hairs. The leaves are trifoliolate, having three to four leaflets per leaf, and the leaflets are 6–15 cm long and 2–7 cm broad. The leaves fall before the seeds are mature. The inconspicuous, self-fertile flowers are borne in the axil of the leaf and are white, pink or purple. Modern crop varieties generally reach a height of around 1 m, and take 80–120 days from sowing to harvest (Figure ).

**Figure 8: Bed-planted soybean field in Uzbekistan and no-till soybean at full maturity stage in Uzbekistan**

Nurbekov and Ziyadullayev (2012) studied effect of Rhizobium with combination of Potassium and Phosphorus on productivity bed-planted soybean in irrigated conditions of Kashkadarya province. Significant findings of this study were: soybean appeared to have high response to Rizobium application in all treatments, especially Control + Rizobium + K60+P120; the response was lowest in treatments where Rizobium was not applied.

Soybean consists of more than 36% protein, 30% carbohydrates, and excellent amounts of dietary fiber, vitamins, and minerals. It also consists of 20% oil, which makes it the most important crop for producing edible oil http://www.iita.org/soybean.

The USA, Argentina, Brazil, China and India are the world's largest soybean producers and represent more than 90% of global soybean production (FAOSTAT, 2013). Soybean can be used for human food and animal nutrition and will increase soil fertility for the succeeding crop in the crop rotation and wider adaptability across different climatic zones. Despite the above-mentioned characters and its ability to grow well with no added N fertilizer, soybean production in Karakalpakstan has not been substantial and the crop is not widely grown in Uzbekistan because cotton and winter wheat are the important crops. However, demand for soybean is growing in the region.

## Kidney bean (*Phaseolus vulgaris*)

Beans are one of the most important legume crops used for food supply. According to FAOSTAT (2013), sown area under beans has been growing year by year and in the world it now accounts for 19-20 million hectares. The main producers of beans are India, China, Brazil, USA, and Mexico. The lion's share is the growing of vegetable beans.

In the CIS, vegetable beans are grown primarily in Ukraine, Moldova and the Caucasus. In countries such as Portugal, Bulgaria, Romania beans are grown in large quantities for export only. Despite the advantages in growing vegetable beans, they are not as yet widely distributed in the CIS. However, there is no doubt about its development potential in the future.

**Figure 9: Bed-planted kidney bean in Karakalpakstan**

In terms of the nutritional qualities, vegetable beans take one of the top spots among other plant foods. In practice, they are used as seeds (as dry grain) as well as immature beans and unripe seeds (as green vegetable).

Vegetable bean contains (in %) 90.0 of water, proteins - 4.0, 4.3 of carbohydrates, including sugar 1.0, 0.25 of fat, dietary fiber 1.0, 0.7 of ash. Bean protein is one of the full plant proteins contained in vegetables. In the bean there are also carotene and vitamin C, B1, B2, K. In terms of minerals, green beans are rich in phosphorus (44 mg %) and iron (1.1 mg %). Double cropped kidney beans can help solve food security challenges in Central Asian countries (Figure 9).

## Mung bean (*Vigna radiata*)

The Mung bean, *Wilczek* has been grown in India since ancient times. Mung bean originates from South West Asia, where it was introduced into agriculture of 5-6 thousands years ago. It is still widely grown in southeast India, Pakistan, Afghanistan, Iran, Burma, China, Vietnam, Japan, and African countries, South American countries and also in Australia. The crop is also grown in Karakalpakstan, Turkmenistan, Tajikistan, the Caucasus and south Karakalpakstan (in small areas) as main crop or second crop after winter wheat. The most common mung bean varieties are Oltin don, Orzu in Uzbekistan. Mung bean grain can be used as food while its stem can be used as fodder to feed animals. The crop can also be used as green manure cover crop to improve soil fertility.

Place in the rotation: Mung bean in the rotation can be grown as main crop in the spring as well as second crop in the summer period of sowing after cereal crops, vegetables, oil crops in rotation. Mung bean is a perfect preceding crop for many crops.

Mung bean is a warmer season crop requiring 90–120 days of frost free conditions from planting to maturity (depending on variety). Adequate rainfall and available soil moisture is required from flowering to late pod filling stage in order to ensure good yields.

Mung bean does best on fertile sandy, loam soils with good internal drainage. They do poorly on heavy clay soils with poor drainage and low carbon content. Performance is best on soils with a pH between 6.2 and 7.2. Mung bean plants can show severe iron chlorosis symptoms and certain micronutrient deficiencies on more alkaline soils. Mung bean has phosphorus, potassium, calcium,magnesium and sulfur requirements similar to other legumes which must be met by mineral and/or organic fertilizer additions if the soil is deficient in these elements.

Seeds should be planted 3-4 cm deep into the soil with good moisture content. If the surface layers are dry this depth can be increased to 5 cm, if the soil does not crust easily. The seeds of Mung bean can have a hard time breaking through a thick crust and stands will be reduced and uneven. Crusting and soil surface sealing is the result of low soil organic matter content and mechanical destructuring. Under no-till/CA system, soil crusting reduces as soil health builds over time. Planting dates of mung bean are as follows: in the spring, in the beginning of May, in the summer,in the 1$^{st}$ and 2$^{nd}$ ten days of July, after the harvest of cereal crops and early vegetables. Sowing is carried out by no-till direct seeders such as FANKHAUSER 2115 and other modified seed drills designed for direct sowing in no-till soils.

Seed rate should be 16-20 kg ha$^{-1}$, corresponding to plant density of 150,000-200,000 plants ha$^{-1}$. Sowing should be on beds 70 cm in width, at row spacing of 17-20 cm, and 10-20 cm between plants within the rows.

Irrigation: Pre-sowing irrigation is very important to obtain even seed germination of mung bean and the rate of water application is 800-1000 m$^3$ ha$^{-1}$. The second irrigation of mung bean crop should be done during the flowering period at the application rate of 800-900 m$^3$ ha$^{-1}$.

Fertilizers: Sowing is followed by the application of 60-70 kg ha$^{-1}$ of phosphorus and 40 kg ha$^{-1}$ of potash fertilizers in active substances. Application of nitrogen fertilizer during the growing season of mung bean is not recommended, as legumes with Rhizobium bacteria are able to fix atmospheric nitrogen.

There are many herbicides available for control of later emerging weeds in mung bean field in the irrigated conditions. After field emergence of seedlings at 2-3 trifoliate leaf stage, mung bean crops should be treated with herbicides Pivolt - 0.6-0.8 l ha$^{-1}$ and Pivot -0.8-1.0 l ha$^{-1}$.

**Figure 10: Pod maturity in mung bean in different stages as the plants flower over an extended period**

Pod maturity in mung bean is not uniform because the vine type plants flower over an extended period (**Figure** ). This makes it difficult to decide when to harvest. Generally harvest should begin when one half to two-thirds of the pods are mature. Seeds might be between 13% and 15% moist at this time. Some growers swath the plants to allow further maturity of the pods and then combine using a pick-up header on a small grain combine. This is a especially useful harvest system for the vine type varieties or when there is delayed maturity or when problem weeds are present. Swathing should be done earlier in the day to prevent severe shattering losses.

## Double cropping

There is an urgent need to increase cropping intensity. More needs to be produced from less land. It is time for growing two crops in a year as against the current practice of growing either cotton or winter wheat in a year. Many crops can be used for double cropping after wheat harvest in the irrigated conditions of Central Asia and Karakalpakstan. In this context maize, mung bean, pearl millet, kidney bean, and sorghum are used as summer crops after the wheat harvest in the project demonstration sites.

In Karakalpakstan corn, sunflower, soybean, pearl millet, sorghum, forage pea, mungbean, sudan grass, sesame, were studied under two different tillage methods no-till and traditional tillage systems.

Multiple cropping (growing two or more crops in sequence in one growing season) offers an opportunity to provide additional output from the same land. Multiple cropping may be the most important of today's modern agricultural developments.

No-till system, herbicides and residue management leads to increase in the possibility of double-cropping;

- Two crops can be planted with the same fuel required for one conventional crop;
- Output is increased, while the overall cost of production is reduced;
- Equipment is used more fully and labour requirements are spread more evenly through the year.

In double-cropping, timing of planting the second crop becomes limited along with pressures of harvesting the mature crop. No-till system reduces the time element while retaining soil moisture that is already present, and reducing run-off, soil erosion and soil evaporation.

In no-till system, herbicides and residue management offer an opportunity to increase double-cropping. Fuel for producing agricultural products has become expensive and no longer is available in unlimited supply. By using no-tillage and multiple cropping technique, two crops can be planted with the same fuel required for one conventional crop. Fuel for harvest, processing and transportation would be higher than in single crop production owing to increased production and extra harvest. Farmers and researchers agree that double cropping can add grain or forage production in the project countries.

### Conclusions

Both types of crop diversification as single crops and double cropping systems will be essential to improve sustainability of farming and income generation at the local, regional and national levels. Prepare a project proposal on crop diversification under CA for each country in the region.

Also this short term crop rotation can improve land use efficiency in the irrigated areas which is extremely important in the country. Short term wheat-legume crop rotation under no-till practices can be recommended to the farms of the country. Many aspects of crop rotation and second cropping are compatible with current crop rotation in the country and could become more accessible to farmers if government policies are restructured to reflect the true environmental costs of agricultural production.

The results confirmed the findings from the experiment testing winter wheat and maize yield’s depending on preceding crops in Karakalpakstan. The winter wheat and maize provided more yields in cereal-legume crop rotation.

The introduction of cereal-legume crop rotation in the no-till practices could help to improve soil fertility and increase crop productivity. This beneficial aspect of crop rotation should be further investigated in the Aral Sea region.

## References

Bot, A. and J. Benites. 2005. The importance of soil organic matter: the key to drought resistant soil, sustained food and production. FAO Soils Bulletin 80. http://www.fao.org/docrep/009/a0100e/a0100e00.htm

Chiduza C. (2001). Comparative performance of corn, sorghum and pearl millet under high input management in a dry region of Zimbabwe. (2001) *Res. on Crops* 2 (1), pp. 8-16.

FAOSTAT, 2013

http://www.iita.org/soybean

Khakimov, I. 1989. Pochvenno-meliorativnye usloviyapustynivahyuschikhshya del't: Tendentsii izmenii prostrant'svennaya *differentsiatsia* [Soil reclamation conditions of delta desertification: Tendencies of transformation and spatial differentiation]. Pushchino: Nauchoyi Tsentr biologicheskikh isseldovaniy AN SSSR.

Ministry of Agriculture and Water Resources of Uzbekistan, 2012.

Nurbekov A.I. Manual on Conservation Agriculture Practices in Uzbekistan. Tashkent-2008. pp 40.

Nurbekov A., Z.Ziyadullaev. Adoption of no-till technology for sustainable agriculture in the drought-affected regions of Karakalpakistan. International Conference on improving soil fertility through adoption of resource saving technologies in agriculture. 5-6 December, 2012. Tashkent, Uzbekistan. Pp101-105.

Singh B.R., Singh D.P. 1995. Agronomic and physiological responses of sorghum, corn, and pearl millet to irrigation. *Field Crops Research*, 42 (2-3), pp. 57-67.

# Annex

Field trials in Qorao'zak district under CRP 1.1.

No-till mungbean in Kzrakalpakistan

No-till sesame in Qorao'zak district