SIC ICWC Policy brief

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Growing non-traditional crops in Central Asia

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Abstract

This policy brief highlights the research of non-traditional crops in Central Asia. Research and selective breeding of crops has identified potential crops that are recommended for cultivation. The recommended alternative crops have the potential to form a fodder base and to play an important role in providing food and medicines to the population, given their ability to grow on salinized land under conditions of more frequent extreme droughts caused by climate change.

Such crops include African millet, sorghum, amaranth, Kochia prostrata (L.) Schrad., quinoa (Chenopōdium quīnoa), bamia (Abelmoschus esculentus), sesame (Sesamum indicum) and others. Many alternative crops are halophytes. Halophytes are a valuable resource for reclamation of degraded land, particularly in arid zones because of desalination effect of halophytes through salt removal from the soil.

Introduction

Non-traditional crops for the region are crops that have not been previously used and are not a historically established tradition in crop production. This may include newly developed varieties of already known cultivated crops. The survey provides information on non-traditional crops that have not been extensively studied in the region.

However, these are crops that have recently got attention. Their adoption in local agricultural practices is seen as a way to increase the fodder stock and overcome the impact of climate change and soil salinization.

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Facts and analysis

1. Why non-traditional crops?

The reason for the interest to grow new non-traditional crops in the region is determined mainly by two factors: drought and salt tolerance.

1.1. Climate change

Climate change affects many aspects of life, including the most important one – food security. And here the most important factor is drought frequency.

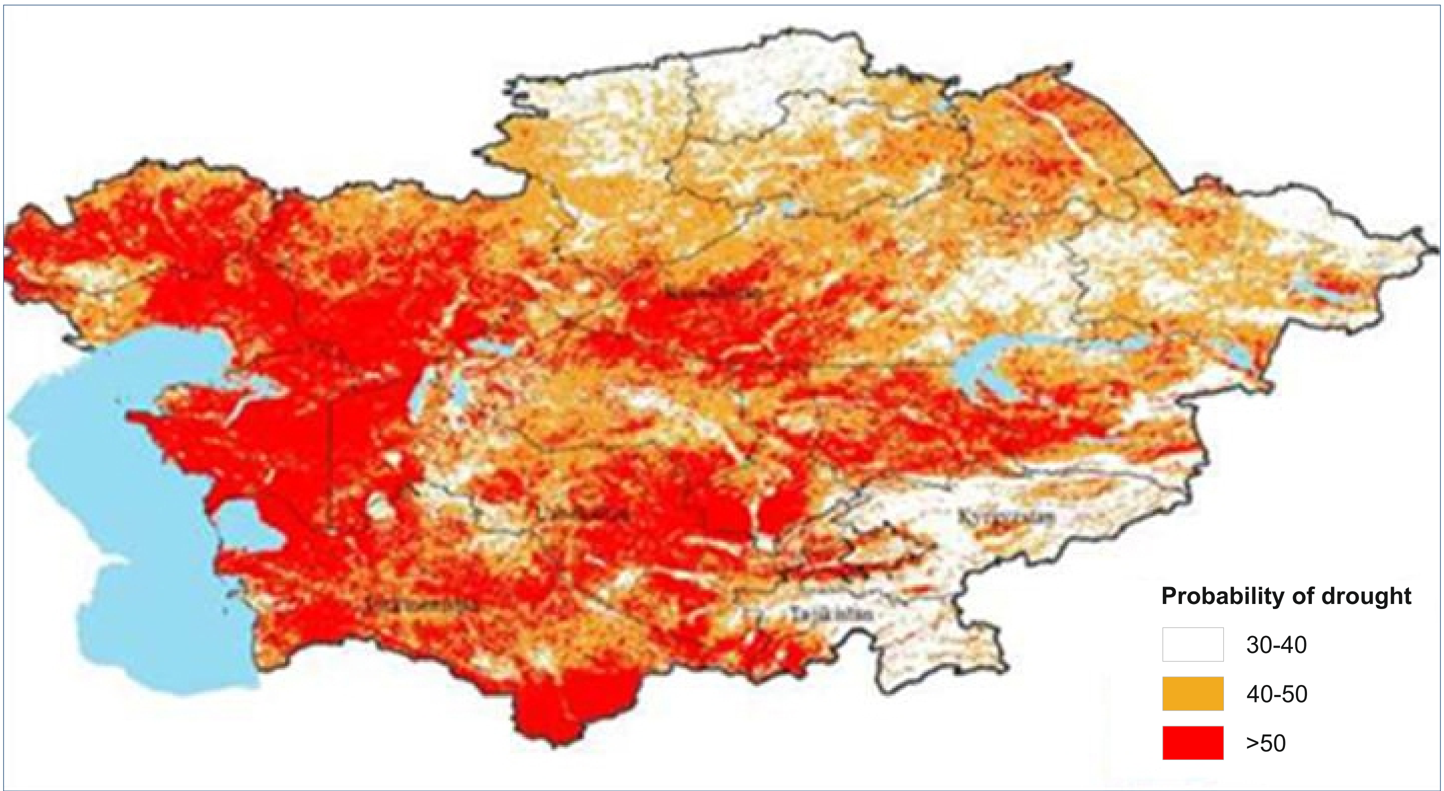
In case of drought, crops show suppressed growth and extended areas suffer from crop failure . This is especially true for the lower reaches of the Amu Darya River, where losses of grain made up 14-17% and 45% to 75% for other crops in the periods of severe drought (2000-2001) [1].

According to climatologists, the losses of food crops are expected to reach 35-50% by 2050, those of winter wheat, up to 4% (2030) and of fodder crops – up to 7-14% (2050) [2].

In rainfed farming, yields will decrease by 50% or more. Alternative crops can compensate the planted area and production volumes.

The Figure below shows the probability of drought if temperature grows 1-2ºC [3].

Probability of drought occurrence in Central Asia, % [3]



1.2. Soil salinity

Currently, up to 40-60% of irrigated soil in Central Asia is subjected to salinization and/or waterlogging [4]. The World Bank (2005) also emphasizes that over 69.4% of agricultural land in Central Asia is salt affected. Soil salinization substantially reduces crop production, thus having a negative effect on food security. Crop losses in arid zones due to salinization range from 18-26% to 43% [1]. Consequently, this reduces livelihoods and increases people's vulnerability. Annual losses in agricultural productivity are estimated at $31 million, while economic losses from land withdrawal due to soil salinization, poor infrastructure and lack of water for soil leaching are estimated at $12 million [1].

2. Non-traditional cereal fodder

Cultivation of traditional crops is often unprofitable in highly saline lands. In this context, it is more advisable to use alternative salt- and drought tolerant plants both to replace traditional crops and also as alternate crops. Salt-tolerant crops such as sorghum *(Sorghum bicolor)* and African millet *(Pennisetum glaucum)* are well suited to these conditions. Both crops consume relatively little water and are very tolerant to drought, heat and soil salinity. These crops would contribute to solution of two problems simultaneously: first, ensuring sustainability of the fodder and grain production system; second, preventing soil erosion and improving soil productivity. This makes sorghum and African millet particularly suitable for salt- and drought-prone regions.

For rainfed conditions of the Aral Sea region, plants in natural pastures are the main forage for livestock. Thin grass cover in degraded pastures leads to lower livestock productivity. This problem can be solved by sowing drought-tolerant annual crops on agricultural land.

African millet – *Pennisetum americanum (L.) Schumann* is an annual herbaceous plant of the *Pennisetum genus* in cereals family *(Poaceae)*. The subspecies of millet differ greatly from each other by morphological and biological features. The height is from 1 to 4 m. It has a fibrous root system going deep to 100-150 cm and extending wide to 100-120 cm, with the bulk of roots concentrating not deeper than 40 cm. Millet forms air roots that increase resistance to lodging and drought. The heat resistance of millet is very high. Millet is not demanding for soil conditions but the highest yields are reached in loose soil rich in organic matter. It is also tolerant to soil salinity.

Millet varieties that mature in 65-70 days have proven themselves in the region's context. Millet which matures in 85-90 days is recommended as a double crop for saline conditions African millet has traditionally been used for grain and fodder production; it helps to prevent soil erosion and improve its productivity.

Sorghum – *Sorghum bicolor (L.) Moench* is an annual or perennial herbaceous plant, which belongs to *Poaceae Barnhart* family, *Sorghum Moench* genus. Botanists have described 63 species of sorghum plants: 33 cultivated and 30 wild species, inhabitants of tropical, subtropical and middle latitudes. More than 3,000 different varieties have been cultivated. Sorghum is a spring and more drought- and salt-tolerant crop. It can be grown in all soil types. With its strong root system, this crop can give satisfactory and good yields for a number of years in depleted and exhausted soil. Sorghum is often used as a primary crop in the development of gullied slopes. It can grow in saline and alkali soils at salt concentrations reaching 0.6-0.8%. Depending on variety, sorghum removes 31 to 75 t/ha of salt from the soil. It tolerates soil and air-dry conditions well.

Sorghum is a universal crop producing the main types of fodder: grain, silage, green mass, hay and haylage. The most widespread sorghum species are: grain sorghum *(S.vulgare)*, joughara *(S.sernuum)*, durra *(S.durra)*, kaoliang *(S.japonicum)*, kaffir corn *(S.caffrorum)*, feterita sorghum *(S.caudatum)*, Chinese sugar cane *(S.dochna)* – grain sorghum; Chinese sugar cane (sugar sorghum) *(S.saccharatum)*, paniculate, or broom *(S.technicum)*, Sudan grass *(S.sudanense)*.

3. Alternative fodder crops representing a promising way for growing in Karakalpaksta

Amaranth (pigweed, Latin. *Amaránthus*) is a widespread genus of mostly annual herbaceous plants with small flowers gathered in dense spiked panicled inflorescences. It belongs to the Amaranthaceous *(Amaranthaceae)* family. 65 sorts and about 900 species growing in warm and temperate regions are well-known. The popular varieties of fodder amaranth are: Giant, Kizlyarets, Kinelskiy 254, Lera, Asctec, Kharkovskiy 1, Cherry Jam. Amaranth is resistant to summer drought.

Amaranth is one of the oldest cultivated plants. Currently, amaranth is widely spread in the north and south America, Asia (India and China), Africa and the US. It is recognized by UNESCO as the main food crop of XXI century. It is common to distinguish between fodder, vegetable, grain and ornamental amaranth.

Its grain is a valuable food product; amaranthine oil is considered a healing remedy. Amaranth is a valuable non-traditional fodder crop. It is a unique plant in terms of yield and nutrition in the livestock industry.

Amaranth exceeds traditional cereals and leguminous crops in terms of protein, amino acids, vitamins, macro- and microelements, and has a high potential as a silage crop.

Kochia prostrata (L.) Schrad. – kochia prostrata (synonyms – *Salsola prostrata L., Chenopodium angustatum All.*; kochia prostrata, prostrate summer cypress, red wormwood, prostrate summer cypress) – is the ecologically flexible species. It grows in dry-steppe, semi-desert and desert areas, from plains to the upper belt of mountains (at 3,800 m above sea level), on sands, solonetz, sometimes on solonchaks, where rainfall is 90-350 mm per year.

Kochia prostrata is extremely drought tolerant and bears medium salinity of soils. The plant is frost- and heat-tolerant. It grows on different types of soils - sandy, stony, solonetz and solonchaks. *Kochia prostrata* (L.) Schrad. refers to valuable desert fodder plants, is well eaten by all kinds of animals and characterized by high content of protein and vitamin C, promising for cultivation without irrigation in arid areas.

In recent years, the new local plant varieties of atriplex, kokhia (belvedere summer cypress), African millet (Khashaki and Tamiz), sorghum (Keshen, KazInd and KizInd) were developed and zoned in various agro-ecological conditions of Central Asia (Uzbek Research Institute of Karakul Sheep Breeding and Desert Ecology, Uzbek Maize Research Station, Kazakh Research Institute of Rice, Kazakh Research Institute of Water Management, Kazakh Institute of Agriculture and Plant Industry).

4. Examples of growing non-traditional crops in Central Asia

Non-traditional crops can be not only fodder crops but also medicinal plants.

(1) **Quinoa** (*Chenopōdium quīnoa* in Latin) is a highly nutritious crop that contains much protein compared to almost all plant foods. Improved quinoa lines were first tested in different agro-ecological zones: from Tashkent region, Syr Darya basin to sandy soils of Kyzylkum. Special attention was paid to the introduction of quinoa on marginal lands of the Aras Sea region as a region with low-yielding and highly saline lands. In conditions of Uzbekistan, quinoa matures in 95-110 days. A test of improved gerplasm from ICBA showed low costs in production of this crop. Its tolerance to soil salinity and low temperature allows it to be used as an alternate crop with grain-legume crops or in combination of crops

(2) **Gumbo (okra)**, *Abelmoschus esculentus* in Latin. In Uzbekistan, okra has been cultivated since 2018. 200 ha have been allocated for this crop in Samarkand, Andijan and Tashkent provinces. The plan for harvesting okra is 13-14 t per hectare.

This unique and promising crop will play an important role in supplying the population of the country with vitamin-rich vegetables, industrial raw materials and nutritious fodder for livestock. It is a valuable vegetable crop with a wide range of dietary, nutritional benefits and many other useful properties. The fruits and stems of okra contain crude fiber used in the paper industry. The mucilaginous matters contained in okra are used to glue paper, the fruit is used to produce a bio-absorbent for confectionery. Okra is widely used in medicine, nutrition, cosmetology, and cooking.

(3) **Sesame** *(Sesamum indicum)* is a plant of the Sesame family *(Pedaliaceae)* belonging to the *Sesamum* genus, which includes up to 10 wild species growing in tropical and southern Africa, except for one, cultivated since ancient times throughout warm and hot Asia, and now in America. Sesame is an annual herb growing to 60-150 cm high. Sesame is mainly grown for its oil. Cold pressed oil is characterized by high nutritional qualities (substitute for olive oil), it is used for food, as well as in the production of canned food, margarine, confectionery and in medicine.

The peeled and crushed seeds are used in making paste – tahini oil. Halva is made from tahini. Oil extracted by hot pressing is used for technical purposes.

Reasons for sesame cultivation:

- More profitable, with limited resources than other crops.
- More profits at lower cost (less risk) than other crops.
- Resistance to drought and pests.
- Sesame suppresses root-knot nematode and cotton root rot, clearing the field for the next crop yield.
- Sesame increases moisture retention and natural tilth and the following crops increase yields, with reduced production costs.

5. Halophytes

Many non-traditional crops are halophytes.

Halophyte resources are an important source and reserve for sustainable development of agriculture in arid (dryland) areas all over the world. Halophytes are important for production of fodder, medicinal and oilseed raw materials. Halophytes are able to finish their life cycle in highly saline habitat, with soil solution's conductivity of 8-10 dS/m. Halophytes considered as an object of crop farming and are a valuable resource to restore degraded land, especially in arid zones where there is an acute shortage of food. Halophytes can be watered by saline water (seawater, groundwater, drainage water). Thus, belvedere summer cypress can provide winter feeding for 1 million sheep on 10 thousand ha of marginal land [5].

Halophytes have already replaced native vegetation in many ways. Domestication of these salt-tolerant plants potentially can reduce or keep soil salinity of irrigated land at the same level. Unlike glycophytes, halophytes are able to grow in saline conditions and bear higher concentrations of salt.

Harvesting halophytic plants can remove salts stored in or on the plants and from the soil system, thereby improving agricultural production and environmental quality. Reducing the amount of salt in the soil can

Table. Halophyte yields [6]

Spartina alterniflora	40 t/ha of biomass
Spartina patens	14.4 t/ha of biomass
Salicornia bigelovii	12.7-24.6 t/ha of dry biomass and 1.39-2.46 t/ha of seeds
Salicornia europaea	non-irrigated 2.6-3.9 t/ha, irrigation with brackish water 7.5-9.6 of dry mass
Climacoptera lanata	0.3-0.6 t/ha (solonchak, Kyzylkum)
Atriplex spp.	12.6-20.9 t/ha of biomass
Belvedere summer cypress (Kochia scoparia)	7-14 t/ha of dry mass, seeds – 0.6-1.3 t/ha
Sea blite arcuate (Suaeda arcuata)	13.6 t/ha of dry matter
Sea blite cuspated (Suaeda acuminata)	non-irrigated 2.2 t/ha, irrigated 5.4-6.1 t/ha
Small-flowered orach (Atriplex micrantha)	non-irrigated 0.238 t/ha, irrigated – 5.56 t/ha
Ornated orach (A. ornata)	non-irrigated 0.256 t/ha irrigated – 3.52-4.25 t/ha
most productive halophyte species	13.6-17.9 t/ha of dry mass

also prevent salt intrusion into nearby freshwater sources. Halophytes can also be used for human and animal consumption and as biofuel.

Halophytes can be used for soil desalination and phyto-reclamation because many of them are able to accumulate salts in their aboveground biomass, extracting them from the soil or irrigation water. The desalination period is approximately 3-5 years and 6-7 years for very saline soil. As a result, these lands can be used for growing traditional crops. The desalination effect of halophytes is composed of the following elements: salt content in 1 meter layer of highly saline medium loamy soil of semi-deserts is 48 t/ha. Given the aboveground phytomass of 18-20 t/ha, halophytes remove 8-10 t of salt from 1 hectare of the soil per year. By shadowing the soil, halophytes prevent evaporation and the associated upward salt flux to the upper soil layers. The effect of green mulch is 2.5 t/ha of salt. As a result, the process of salt removal from the soil reaches 10-12.5 tons per year on an area covered by halophyte plantations [1, 7-11].

Conclusion

The recent research by ICBA and ICARDA on selection and choice of drought-tolerant crops already known and widespread in Central Asia have proved the effectiveness of non-traditional crops [12-14].

Cultivated in saline soil halophytes, as well as drought-tolerant non-traditional crops of sorghum, African millet, safflower, amaranth, topinambur, quinoa, sesame, flax, artichoke, atriplex, kokhia, chogon, licorice, indigofera, peas, mungbean, horse beans, clover, melilot, sainfoin, barley, magar, perennial sorghum, triticale, etc. as single crops or combined with forage shrubs and semi-shrubs produce almost 2.5 times more green biomass and grain than local fodder crops.

Sorghum and African millet are particularly suitable for salt- and drought-prone regions.

Recommendations

Considering the effectiveness of non-traditional crop production, it is necessary to conduct territorial zoning for their use. First of all, one should identify abandoned saline land not supplied with water. Depending on the conditions, they should be assessed for possibility to produce certain type of non-traditional crop.

Based on the results of a series of studies, the following list of non-traditional crops is recommended for testing:

- *Haloxylon ammodendron* (C.A. Mey) Bunge
- *Haloxylon aphyllum* (Minkw.) Iljin.
- *Salsola richteri* (Moq.) Кат. ex. Litv.
- *Salsola Paletzkiana* Litv.
- *Ammodendron karelinii var. conollyi* (Bunge)
- *Salsola orientalis* S.G. Gmel.
- *Halothamnus (Aellenia) subaphyltus* (C.A. Mey.) Botsch.
- *Atriplex cana* C.A. Mey
- *Atriplex nitens* Schkuhr
- *Eurotia ceratoides* Botsch ex Ikonn.
- *Kochia prostrata* (L.) Schrad.
- *Kochia scoparia* (L.) A.J. Scott.
- *Camphorosma lessingii* (Litv.) Aell.
- *Climacoptera lanata* (Biebl.) Botsch.
- *Suaeda arcuata* Bunge
- *Suaeda acuminata* (C.A. Mey.) Moq.
- *Halocharis hispida* (Schrenk.) Bunge
- *Tamarix ramosissima* Ledeb.
- *Tamarix hispida* Willd.
- *Glycyrrhiza glabra* L.
- *G. uralensis* Fisch.
- *Artemisia monogyna* Waldst. et Kit.
- *A. Diffusa* ex Poljak.
- *A. Halophila* Krasch.
- *A. turanica* Krasch.
- *Elytrigia elongata* (Host) Nevski.
- *Onobrychis viciifolia* Scop. и др.
- *Vignia radiata L.*
- *Vicia faba*
- *Vigna unguiculata* (L.) Walp.

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