Promotion of Underutilized Vegetables in Central Asia and the Caucasus (CAC) to Improve the Household Nutrition

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Central Asia and the Caucasus region

Boundary: 39–48° N and 43–75° E
Area: 4.2 million km²
Population - over 76 mln.
Annual growth rate - 0.9%.
Population living below poverty line - 43.9%

Source: The World Fact Book

Middle Asia Center of Origin of Cultivated Crops

Northwest India (Punjab, the Northwest Boundary province, Kashmir), whole Afghanistan, Tajikistan, Uzbekistan and Western Tian-Shan

Cucumis melo L	**Secondary center**
Lagenaria vulgaris Ser	**Secondary center**
Daucus carota L.	**Primary center**
Brassica campestris L., ssp. Rapifera Sinsk,	**Primary center**
Raphanus sativus L.	**Secondary center**
Allium cepa l.(sensu lato)	**Primary center, wild relatives exist**
Allium. sativum L	**Primary center, wild relatives exist**
Spinacia oleracea L.	**Primary center, wild relatives exist**
Portulaca oleracea L.	**Secondary center**
Ocimum basilicum l.	**Main center**




West Asian Center of Origin of Cultivated Crops

Area: West Asia, internal Minor Asia, whole Caucasus, Iran and Mountain Turkmenistan

Lepidium sativum L.	**Secondary center**
Brassica campestris ssp. Rapifera Sinsk.	**Secondary center**
Beta vulgaris L	**Secondary center**
Daucus carota L	**Species diversity in Anatolia**
Brassica olearacea L	**Endemic species in Anatolia**
Eruca sativa Lam	**One of centers**
Allium cepa L.	**Secondary center**
A. porrum L., A. ampeloprasum L.	**Wild relatives exist**
Petroselenium hortense Huffm.	**Secondary center**
Lactuca sativa L.	**Wild relatives exist**
Portulaca oleracea L.	**One of centers)**
Cucumis melo L.	**Diversity exists**
C. agrestis Pang. And Microcarpus (Alef.) Pang (Wild forms)	**All principal melon diversity is concentrated in the Asia Front**
C. flexuosum L.	**Main center**
C. sativus L. ssp. Antasiaticus Gabaev	**Anatolia cucumber (specific geographic race)**
Cucurbita pepo L.	**Diversity exists**
Crocus sativus L.	**One of centers**

Vegetable crops in the CAC region

- **Average consumption of vegetables and fruits is 4.61% among 10 significant food items***

- **Vegetable crops play a significant role in ensuring the food security for the CAC population**

- **Most popular crops in CAC region:**

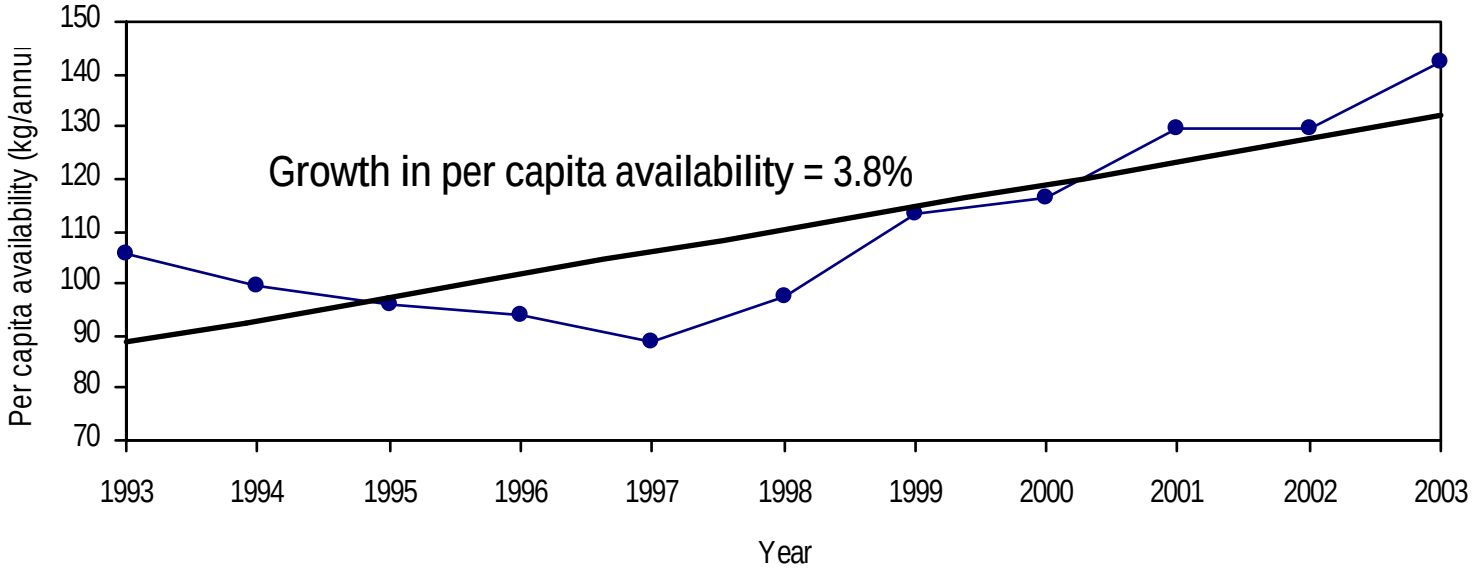
  onion, carrot, head cabbage, table beet, melon, tomato, cucumber & water melon that occupy 4/5 of total vegetables cultivated area

- **Many underutilized crops are important for balanced nutrition and health!**

***Source: FAOSTAT**

Vegetables consumption in CAC region

Total vegetables cultivating area - 550 thousand ha
Vegetable gross output - over 9.5 mln. tons



Root causes for vegetable crop underutilization in CAC region

- changing ecological conditions
- narrowing habitat of some species
- lack of awareness on the importance of vegetable for human health
- lack of knowledge on utilization, culinary recipes
- lack of vegetable cultivation skills amongst the farmers, especially poor rural communities and younger generation
- insufficient market demand
- lack of infrastructure for the products sale, processing and export

Main Strategies for Future Promotion:

- Ex-situ and in-situ crop diversity conservation
- Cultivation of the wild edible species, alliaceous, greens, legumes and root crops in farms and householders gardens
- Seed multiplication, seed quality Control and storage
- Establishment of the output market
- Trainings of farmers and householders
- National and international partnerships




World collections evaluation in CAC

Global Vegetable Diversity is underutilized in CAC

Germplazm sources:

- **All – Russian Research Institute of Plant Industry (Vavilov's Institute, VIR)**
- **AVRDC – The World Vegetable Center**

Global vegetable germplazm evaluation in CAC

- 19 conventional and non-traditional species
- 65 botanical varieties
- 1440 accessions/cultivars
- from 87 countries
- VIR and AVRDC global collection
- VIR and AVRDC Methodological Guidelines

Root and green vegetable species evaluation

Our Investigation was conducted on species/subspecies and varieties levels

Biological characteristics of crops in CAC

Crop	Species, variety	Vegetation period, days	
		flowering	Seeds ripening
Carrot	*Ssp. occidentalis (Rubasch.) Setch*	65 -75	110 -115
	Ssp. orientalis (Rubasch.) Setch	65 -75	110 -115
Garden radish	*Ssp. sativus*	40 -45	85 -100
	Ssp. sinensis (Mill.) Sazon.	45 -60	95 -110
Winter radish	*Ssp. Sativus canvar. sativus*	35 -45	90 -95
	Ssp. Sativus convar. hybernus (Alef.)Sazon	50 -65	125 -135
	Ssp. sinensis (Mill.) Sazon.	45 -50	85 -110
	Ssp. acanthiformis (Blanch.) Stankev.	40 -45	75 -90
Turnip	*Ssp. rapa (Sinsk.) Scheb.*	45 -55	110 -120
	Ssp. indoafghanica Scheb.	45 -55	110 -120
Table beet	*Ssp. europaea Krassochk.*	65 -75	115 -125
Celery	*convar. secalimum Alef. and convar .rapaceum (Mill) Alef.*	65 -85	130 -145
Parsley	*Petroselinum radicosum (Alef.)*	65 -85	130 -145

The share of the bolting plants in CAC conditions

Species	Ssp,, convar.	Bolting plants,%
Raphanus sativus L Garden radish	S*sp. sativus convar. radicula (D.C.Pers.) Sazon.*	40 - 100
	S*sp. sinensis (Mill.) Sazon. convar. sinensis*	100
Raphanus sativus L Winter radish	S*sp. Sativus canvar. Sativus and convar. hybernus (Alef.)Sazon*	2,3 - 15
	Ssp. sinensis (Mill.) Sazon. convar. lobo Sazon. et Stankev	4,0 - 100
	S*sp. acanthiformi s (Blanch.) Stankev.*)	4,3 - 100
Daucus carota L. Carrot	*Ssp. occidentalis (Rubasch.) Setch*	1,0 - 23
	(s*sp. orientalis (Rubasch.) Setch*	3,1 - 100

The self-incompatibility level of Raphanus sativus L.. in CAC conditions

Ssp,, convar.	starveling seeds, %
S*sp. sativus convar. radicula (D.C.Pers.) Sazon.*	100
S*sp. sinensis (Mill.) Sazon. convar. sinensis*	100
S*sp. Sativus canvar. Sativus*	11 - 46
Ssp. sinensis (Mill.) Sazon. convar. lobo Sazon. et Stankev	7 - 49
S*sp. acanthiformi s (Blanch.) Stankev.*)	100

Variability of yield potential for root crops in Uzbekistan

Significant phenotypic yield variation (CV= 36-96%) and root vegetable mass (CV= 24-52%)

Crop	Standard yield, kg/m^2	Indices of surveyed varieties		
		$\bar{x}$	limits, kg/m^2	CV, %
Carrot (spring)	2,1	1,0	0,1 - 3,6	36
Carrot (summer)	2,4	1,1	0,2 - 3,6	43
Garden radish (s*sp. sativus)*)	0,4	0,5	0,1 - 1,1	42
Garden radish (s*sp. sinensis (Mill.) Sazon*.)	1,7	1,4	0,9 - 3,2	36
Radish	3,7	3,8	0,1 - 9,0	38
Turnip	2,1	1,7	0,1 - 3,0	36
Table beet	2,2	1,5	0,4 - 5,2	80

Specific variation of crops' yield in Uzbekistan

Crop	Standard yield, kg/m^2	Indices of surveyed varieties		
		$\bar{x}$	limits, kg/m^2	CV, %
Celery (leaves)	0,9	0,7	0,1 - 2,6	96
Celery (root vegetable)	1,1	0,7	0,1 - 2,6	74
Parsley (leaves)	0,6	0,5	0,1 - 1,2	60
Parsley (root vegetable)	0,5	0,4	0,1 - 1,1	68
Parsnip (root vegetable)	-	0,5	0,1 - 2,0	92

Criteria for the initial breeding material selection:

I. selection on a yield

- a) with low value of the trait – with indices below the average statistical (x);
- b) with mean value of the trait – average statistical considering the LSD ($x+-LSD_{0.05}$);
- c) with the high value of the trait – with indices over +- $LSD_{0.05}$.

Criteria for the initial material selection on a yield

- **With its traits stability at least 60%**
- **The yield exceeding the standard one – garden radish (s*sp. sinensis (Mill.) Sazon*. *convar. sinensis*), all surveyed carrot subspecies and varieties (for the summer sowing), celery, parsley, dill, leaf and crisp-head lettuce;**
- **Over average statistical indices – for the garden radish (*ssp. sativus convar. radicula (D. C. Pers.) Sazon.)*, turnip and parsnip;**
- **Over the standard or the average statistical depending on the variety – for the carrot (for the spring sowing), radish and beet.**
- **When selection varieties with the large root vegetables the initial material of the carrot, Chinese garden radish, turnip, beet, celery and parsley has to have the indices exceeding the standard, and of the European garden radish, winter radish and parsnip – over the average statistical indices.**

Phenotypic variation of chemical composition

- **The dry matter content: the slight - for the carrot (CV=9.4%), the average – for the garden radish, turnip, table beet, celery, parsnip and dill (CV= 11.2-- 19.7%)**
- **The ascorbic acid and sugar sum: the average – for parsley and parsnip (CV = 15.7--19.8%)**
- **The sugar sum: average - for carrot and table beet (CV =12.4--19.8%)**
- **Phenotypic variation of the other components for crops is significant (CV = 20.8 -- 60.9%)**

Variation of chemical composition of the root vegetable crops

Crop	Dry matter, %			Sugar sum, %			Ascorbic acid, mg/%		
	standard	$\bar{x}$	limits	Stan dard	$\bar{x}$	limits	Stan dard	$\bar{x}$	limits
Carrot (spring)	14,0	14,1	9,1 -21,0	4,6	5,0	2,6 -7,5	7,9	4,9	1,0 -15,0
Carrot (summer)	12,5	12,0	9,1 -16,0	5,1	5,1	3,1 -7,5	3,2	4,1	1,0 -11,0
Garden radish	6,2	6,1	4,1 -9,0	2,8	2,2	1,1 -4,0	26,7	23,3	6,0 -45,0
Radish	9,2	7,7	3,1 -13,0	3,2	2,3	0,1 -5,0	29,8	26,0	6,0 -60,0
Turnip	11,6	10,2	8,1 -16,0	3,3	3,5	1,6 -6,0	30,6	27,5	11,0 -50,0
Beet	15,0	15,8	8,1 -24,0	7,2	7,8	2,1-11,0	24,7	19,2	8,0 -36,0

Variation of chemical composition of root vegetable crops

Crop	Dry matter, %			Sugar sum, %			Ascorbic acid, mg/%		
	standard		limits	standard	$\bar{x}$	limits	standard	$\bar{x}$	limits
Celery (root vegetables)	18,9	19,8	10,1 -24,0	0,2	0,4	0,1 -0,8	5,8	4,7	0,1 -10,0
Parsley (root vegetables)	20,0	18,7	16,0 -25,0	3,1	3,0	2,1 -6,0	51,3	27,0	1,0 -60,0
Parsley (leaves)	22,3	16,5	11,0 -30,0	2,0	1,9	0,1 -0,4	280,2	207	101 -400
Parsnip	-	25,0	20,0 -30,0	-	5,1	4,0 -6,0	-	22,1	15,0 -30,0

Criteria for the initial breeding material selection on chemical composition

- a) with low value of the trait – with indices below the average statistical ($\bar{x}$);
- b) with mean value of the trait – average statistical considering the LSD ($\bar{x}$+-$LSD_{0.05}$);
- c) with the high value of the trait – with indices over +- $LSD_{0.05}$.

Criteria for the initial breeding material selection on chemical composition

- When selection for the excessive content of the dry matter, sugar sum and ascorbic acid in the radish (s*sp. sativus* and s*sp. sinensis (Mill.) Sazon*) as well as in surveyed varieties of the parsley, lettuce and carrot the standard index should be considered as the selection criteria
- Selection for content of the sugar sum and ascorbic acid in the garden radish, carotene in the lettuce and ascorbic acid in the dill as for standard index
- Regarding other chemical composition traits for all root crops selection indices exceeding the average statistical data is recommended

Co-variation yield structure elements

Crop, subspecies	Yield--- average mass of the root vegetable	Yield-- number of plants, pieces/m^2	Average mass of the root vegetable -- number of plants/m^2	Correlation multiple coefficient
Carrot	+0,55	+0,67	-0,10	+0,72
Garden radish, (s*sp. sativus*)	+0,68	+0,83	+0,22	+0,97
Garden radish (s*sp. sinensis (Mill.) Sazon*.)	+0,69	+0,65	-0,04	+0,96
Radish (s*sp. sativus*)	+0,59	+0,27	-0,38	+0,69
Radish (s*sp. sinensis (Mill.) Sazon*)	+0,01	+0,35	-0,70	+0,25
Radish (s*sp. acanthiformis (Blanch.) Stankev.*)	+0,28	+0,58	-0,37	+0,79
Turnip	-0,50	+0,43	-0,08	+0,63
Table Beet	+0,12	+0,92	-0,11	+0,92

High overall combining ability in terms of the yield

Crops	Species	Cultivar	Origin
Carrot	*Ssp. orientalis (Rubasch.) Setch - convar. afganicus Setch.*	Mirzoi Krasnaya, Mestnaya 1 and Mestnaya 2	Uzbekistan
Garden radish	*Ssp. sinensis (Mill.) Sazon. convar. sinensis*	Koreyskiy Mestnii and Dunganskiy 12/8	Kazakhstan
	Ssp. sinensis (Mill.) Sazon. convar. sinensis	Krasnii Velican	Russia
Radish	*Ssp. sinensis (Mill.) Sazon. convar. lobo Sazon. et Stankev*	Chin-Yan-Tsin	China

High overall combining ability in terms of chemical composition

the sucrose content	**carrot**	***Ssp. orientalis (Rubasch.) Setch - convar. afganicus Setch.***	**Mestnaya 1, Uzbekistan**
		Ssp. occidentalis (Rubasch.) Setch convar. sativus (Hoffm.) Setch.	**Shantene, Russia**
ascorbic acid	**carrot**	***Ssp. orientalis (Rubasch.) Setch - convar. afganicus Setch.***	**Mirzoi Krasnaya, Uzbekistan**
	radish	***Ssp. sinensis (Mill.) Sazon. convar. lobo Sazon. et Stankev***	**Khuan chjou, China**
the sugar sum, sucrose and carotene content	**carrot**	***Ssp. occidentalis (Rubasch.) Setch convar. sativus (Hoffm.) Setch.***	**Gauzes, Lithuania**

The Global collection of the World Vegetable Centre comprises the valuable germplasm of vegetable crops

- **15 vegetable species 830 accessions, including non-traditional crops (vegetable soybean, pak-choi, pai-tsai, long yard bean and asparagus) was introduced in the CAC region in 2005-2007**





Utilization of the new vegetable crop varieties in CAC

- As results diversity of initial material selected by us in terms of the ripening period, consumption duration and shelf-life we defined more precisely the cultivation schedule for the non-traditional varieties of root vegetables and green crops.

- This schedule includes new cultivars of these crops that are supposed to diversify assortment and obtain the output all year round. Among them, carotene carrot of European subspecies, European early-ripening garden radish, different varieties of radish and turnip, dill, celery, leaf and crisp-head lettuce, Chinese cabbage (pak-choi and pai-tsai), and long yard bean.

Developed new cultivars in CAC

Released cultivars:

- **Dill Orom, lettuce Kok-shokh, daykon Kuz khadiyasi, sweet corn Jakhongir, carrot Baraka, green pea Surprise, soybean Ilkhom and Universal, mungbean Zilola and Marjon**

- **New cultivars of the hot pepper, pak-choi, pai-tsai and long yard bean are currently under the state variety trial**








Future Research Activities for Promotion of underutilized valuable crops for CAC

Artichoke	**Cynara scolymus L.**
Asparagus	**Asparagus officinalis L.**
Broccoli	**Brassica oleracea L. var. italica Plenck.**
Brussels sprouts	**Brassica gemmifera Lizg**
Chinese cabbage	**Brassica chinensis L.**
Groundcherry	**Phisalis L.**
Head lettuce	**Lactuca sativa L.**
Hyssop	**Hyssopus officinalis L.**
Kohlrabi	**Brassica oleracea L. var gongyloides L.**
Leek	**Allium porrum**
Lettuce	**Lactuca sativa L.**

List of underutilized vegetable crops

(continued)

Lima bean, lima	Phaseolus lunatus L.
Marrow squash	Cucurbita pepo L. var.giraumons Duch.
Marrow-stem kale	Brassica oleracea L. var acephala (DC.) Alef.
Okra	Hibiscus esculentus L.
Parsnip	Pastinaca sativa L.
Pattypan	Cucurbita pepo L. var. melopepo (L.) Filov.
Parsley	Petroselinum Hill.
Red cabbage	Brassica oleracea L. var. capitata L.f. rubra (L.) Duch.
Spinach	Spinacia oleracea L.
Shallot	Allium ascalonicum L.
Sweet potato	Ipomoea batatas (L.) Lam.

Conclusions

Evaluation and further adoption of new germplasm from Global Gene Banks (e.g. AVRDC and VIR) stimulate:

- **Developing of new cultivars with commercial valuable traits that could be easy introduced (in large scale) under different agro-ecological zones in CAC;**
- **Promotion of underutilized vegetables should be taken place at all levels, including scientific, farmers and policy markers communities in order to develop an appropriate and sustainable vegetable production system;**
- **Involvement of farmers in participatory varietals selection;**
- **Enhancement of underutilized crop diversity into vegetable system will improve nutritional diet benefits, farmers income for their better livelihoods**

Thank you very much!