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Potato in Kyrgyzstan: The Second Bread

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Abstract

Kyrgyzstan is the first country for potato consumption in Central Asia and the second in the world after Belorussia. Potato is, after wheat, the second most important food security crop in this country. The production is however facing many challenges like small size of farms, poor soil fertility, high occurrence of pests and diseases, limited mechanization, unavailability and expense of fertilizers, use of non-adapted varieties and non-certified seeds, lack of storing facilities, seasonality of the market and weakness of the research and extension system.

Keywords: *Kyrgyzstan, Potato (Solanum tuberosum L.), varieties, crop management, value chain;*

Абстракт

По потреблению картофеля Кыргызстан занимает первое место среди стран Центральной Азии и второе место в мире после Белоруссии. Картофель, после пшеницы, является второй наиболее важной культурой для обеспечения продовольственной безопасности этой страны. Однако производство картофеля в Кыргызстане сталкивается со многими проблемами, такими как небольшой размер фермерских хозяйств, низкое плодородие почв, высокая плотность вредителей и болезней, ограниченная механизация, отсутствие или труднодоступность удобрений , использование неадаптированных сортов и несертифицированного семенного материала, отсутствие условий хранения, сезонность рынка, слабость исследований и расширение системы производства.

Ключевые слова: *Кыргызстан, картофель* (*Solanum tuberosum L.), сорта, управление растениеводством, цепочка создания стоимости;*

Özet

Kırgızistan patates tüketiminde Orta Asya da birinci, dünya sıralamasında ise Beyaz Rusya nın ardından ikinci sıradadır. Patates, buğdayın ardından bu ülkedeki en önemli gıda güvenliği ekinidir. Buna mukabil patates üretimi, küçük tarla ebadi, düşük toprak verimliliği, yüksek haşere ve hastalık oranı, kısıtlı mekanizasyon, kısıtlı ve pahalı gübre, uygun olmayan ve tescilsiz tohum kullanımı, yetersiz saklama tesisleri, pazarın mevsimselliği ve araştıma ile uygulama sistemlerinin zayıflığı gibi bir çok sıkıntı ile karşı karşıyadır.

Anahtar kelimeler: *Kırgızistan, Patates (Solanum tuberosum L.), çeşitler, ekin yönetimi, değer zinciri;*

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1. INTRODUCTION

Potato was introduced in Kyrgyzstan during the 19th century. The new crop flourished in the temperate climate of the northern foothills. By head of population, Kyrgyzstan ranks as the world's 10th largest potato producer. With 143 kg per capita, it is the first consumer of potato in Central Asia and the second in the world after Belorussia [1]. Potato is considered in this country as "the second bread" [1]. Kyrgyzstan is, together with some limited areas of Eastern Europe and the Yunnan province in China, a region where the importance of potato in the cropping system is the highest [2]. Environmental and socio-economic conditions prevailing in the country however considerably impact yield and production of the crop.

1.1. Environmental conditions

1.1.1. Geography
Kyrgyzstan is a small (198,000 km^2), mountainous, landlocked country lying between 39° and 43° North and 69° and 80° East. It is bounded to the North by Kazakhstan, to the South by China and Tajikistan and to the West by Uzbekistan. The Tien Shan Mountains divide the country into three main zones [3]. The northern zone includes the Talas and Chu river valleys at the southern limit of the great Kazakh steppe, and the upland basin in which lies the Issyk-Kul Lake. The central zone comprises a vast area of rugged mountain ranges, glaciers, snow fields, high river valleys, upland steppe and alpine and sub-alpine pastures and meadows. The southern zone is marked by a bang of rich agricultural lowlands in the Fergana valley, centred on the towns of Osh and Jalalabad. 94% of the country is above 1,000 m and more than 40% over 3,000 m. Only 7% of the land area (mainly located in the northern and southern zones) is suitable for agriculture [3].

2.1.2. Climate
The climate is continental, with cold winters and hot summers and great local variations depending on altitude. In winter, frost occurs in all regions. In July, average temperatures at lower elevations exceed 40° C. Precipitation is highest in the mountains, falling mainly as snow, with a maximum of 1,000 mm along the fringe of the Fergana valley. In the Talas valley in the north-west, precipitation varies from 250 mm to 500 mm. Rain and snow occur mainly in the autumn and winter. Summers are generally dry but storms of heavy rain, hail and even snow can occur. Evaporation in key irrigated areas can vary between 1,200 mm and 1,600 mm, exceeding average precipitation [3].

2.1.3. Soils
According to FAO/UNESCO classification the soils of the Fergana valley in the South are calcic xerosols, those of the Chui valley are calcaric gleysols and those of Naryn Oblast in the central highlands are humic cambisols. In the mountains lithosols and outcrops of rock debris occur while the plateau-like surfaces are characterized by yermosols, especially takyric yermosols [3].

1.2. Socio-economic context

1.2.1. Population
The population of Kyrgyzstan is around 5.6 million, with a growth rate of about 1.32% [4]. The Kyrgyz, who represent about 64.9% of the population, have a long tradition as nomad herdsmen and horsemen and speak a Turkic tongue. Other ethnic groups are the Uzbek (13.8%), Russian (12.5%), Dungan (1.1%), Ukrainian (1%) and Uighur (1%) [3]. The capital Bishkek (former Frunze) has a population of about 900,000 inhabitants. About 65 % of the population lives in rural areas [4]. Agriculture contributes 20% of the GDP and 30.7% of labour and the field crop sub-sector accounts for about 50% of agricultural GDP [5].

1.2.2. Land and Agrarian Reform

In 1993, the government started the privatization of land and breakup of collectives. Land and livestock were divided between all the members of the old collectives [6]. Due to the collapse of industrial and service sectors, many people shifted their efforts to agriculture to ensure food security, home consumption, and physical survival. As a consequence, more than one million of smallholder households are involved today in agriculture [7], representing 75% of the cultivated area [8]. The arable land is parcelled out in very small units (0.4 hectare per capita in the South) and many of these smallholders do not have access to agricultural machinery [4]. The privatization also left the new farmers without technical support despite of efforts to develop a Rural Advisory and Development Service (RADS) with donor assistance. Crops yields fall considerably due to unavailability and expense of fertilizer, herbicide and good seeds associated to the lack of cash in the rural economy. Labour productivity also declined, due to the large increase in the agricultural labour force and lack of farming know-how among the newly privatized farmers [4].

The total cultivated area is estimated today at about 12,200 km^2 of which 7,300 km^2 (59%) are irrigated. The potential for irrigation is however not fully used due to the deterioration of irrigation dams, breakdown of irrigation and drainage systems and lack of pumps. The clogging of drainage systems is leading to increased water logging and soil salinization [6].

1.2.3. Main cultivated crops

The main crops are wheat, maize (for grain and silage), potato, barley, melon, oilseed crops, vegetables, and fodder (lucerne and sainfoin) [3]. Driven by local demand, the wheat acreage greatly increased at the expense of fodder crops and barley. Average wheat yield however fall to an average of 2.0 tons, near to the average of rainfed wheat in the 80's. Oil seed crops (sunflower and safflower) area increased from 7,801 ha in 1990, mainly on irrigated land, to 68,488 ha in 1990 [3]. Reflecting the increasingly subsistence nature of Kyrgyz agriculture, the area cultivated for growing domestic crops raised substantially. Since the end of collectivization, farmers tried to diversify their cropping systems [6]. Sugar beet is an important cash crop in Chui oblast and cotton and tobacco in the southern Fergana oblasts. Commercial vegetable production is often in the hands of certain ethnic groups as the Uzbeks in the Fergana oblast, and the Dungans and Koreans in the Chui oblast [3].

1.2.4. Economic indicators

Kyrgyzstan is today categorized as a low-income food-deficit country. Average growth rate in 2000 (1.5%) is the lowest of the Central Asia countries [9]. Poverty rate (less than 2.15 USD per day) was 36% in 2011, compared to 41.6% in Tajikistan and 27.5% in Uzbekistan [5]. More than 300,000 persons (5.7% of the total population) are undernourished [8]. The average per capita food consumption was only 2,300 kcal in 2011 [5]. Moreover, recent improvements in food security statistics are less the result of significant changes in food or agricultural policy than the help provided by the United Nations World Food Program, which began in 2010 [10].

2. POTATO CULTİVATİON

2.1. Importance of the potato crop

Potato is the second most important food security crop after wheat and the dominant vegetable crop, covering about 7% of cultivated land [4]. Roughly 25% of farmers produce potatoes as a main crop (mainly in Issyk-kul, Naryn, Osh and Talas) but potato is cultivated almost everywhere as an important "kitchen garden" or domestic crop.

Potato yield in Kyrgyzstan is less than 16 t ha^{-1} [9]. Attainable yield is limited by the relatively short growing season due to the long winter and by high temperatures in spring and summer leading to higher development rates of insects including aphids and reduced tuber dry matter content [2].

About 97% of farmers producing potato are smallholders [4] and potato highly contributes to stabilize their income [11]. Potato was the crop with the highest self-sufficiency ratio with 123.5% in 2012 (compared to 108.2% for milk and dairy products, 93.2% for meat, 87.0% for eggs, 78.4% for wheat, 29.6% for oil and 15.9% for sugar) [5].

Potato market is characterized by its seasonality [6]. Some regions of the Osh and Jalalabad oblast have two growing seasons. Early potatoes, as well as tomatoes, onions, cucumbers and watermelons harvested after the first growing season are cash crops. Income realized from the first harvest is used for purchasing the seeds and inputs and servicing credit necessary for the second planting. The autumn harvest of the second planting includes heartier, thicker-skinned potatoes that are stored in household root cellars and consumed over the course of the winter [6].

2.2. Potato varieties

The potato research and development system in the region has been neglected since 1990 [12]. With the collapse of USSR and consequent break down of former seed supplies (Russia and contiguous soviet republics), seed potatoes started to be imported from Europe. During the last decades, new potato varieties have been introduced from these countries like Albina (Potato Research Institute Bonin, Poland), Daifla (Germicopa, France), Rosanna (Germicopa, France), Pamela (Germicopa, France), Aïda (Germicopa, France), Appoline (Germicopa, France), Santé (Vechter, Netherlands), Agave (Norika, Germany), Mondial (Biemond, Netherlands), Picasso (Holstein, Netherlands), Nevskiy, Molli (Norika, Germany), Draga (Hettema Zonen BV, Netherlands), Pirol (Norika, Germany) and Molli (Norika, Germany) [11].

They generally lack tolerance to stressful conditions (high temperatures, erratic moisture) and make farmers more dependent on expensive imported seeds. Consumers also regret the Russian varieties that had appreciated organoleptic characteristics (mainly cooking texture) [12]. The list of varieties approved in 2014 by the State Center for Testing of Varieties and Genetic Resources of the Kyrgyz Republic is given on Table 1. More details about main varieties cultivated by farmers is given on Table 2.

Table 1. List of potato varieties approved by the State Center for Testing of Varieties and Genetic Resources of Kyrgyzstan in 2014

Name	Year of registration	Origin of variety	Maturity
Agave*	2010	Germany (Norika)	medium early
Alegria*	2011	Germany (Norika)	middle late
Aida	2009	France (Germicopa)	mid
Appolina	2009	France (Germicopa)	mid
Asterix*	2005	Netherlands (HZPC)	early
Borvina*	2011	Germany (Norika)	medium early
Vineta	2007	Germany (Europlant)	mid
Daifla	2009	France (Hermicopa)	mid
Delicat*	2006	Germany (Norika)	mid

Jelly*	2006	Germany (Europlant)	medium early
Dgara	2002	Netherlands (HZPC)	mid
Jetigen	2012	MSDSPG	late maturity
Innovator*	2003	Netherlands (HZPC)	early
Concurent	2003	Netherlands (HZPC)	early
Latona*	2002	Netherlands (HZPC)	medium early
Liseta*	2007	Netherlands (HZPC)	mid
Marabell	2007	Germany (Europlant)	early
Marlen	2014	Netherlands (Agrico)	
Mira	2012	MSDSPG	late maturity
Molly*	2004	Germany (Norika)	medium early
Mondial*	2002	Netherlands (HZPC)	late maturity
Nevsky	1990	Russia	mid
Pamella	2010	France (Germicopa)	mid
Picasso	2000	Netherlands (Agrico)	mid
Redanna	2012	Germany (Norika)	middle late
Rivera	2014		
Romano	1998	Netherlands (Agrico)	mid
Sante*	1998	Netherlands (Agrico)	mid
Symbol	1992	Ukraine	late maturity
Symphony*	2002	Netherlands (HZPC)	middle late
Talent	2014		
Troya	2012	Germany (Norika)	medium early
Felsina*	2006	Netherlands (HZPC)	mid
Chelpek	1999	Kyrgyzstan	early

***Potato varieties that are resistant to nematodes**

Table 2. Main potato varieties used by farmers in Kyrgyzstan (2011-2013) and their characteristics

Varieties	Breeder agent	Year of release	Pedigree	Main characteristics	Percentage of farmers	Percentage of land area	Yield (t ha^{-1})
Picasso	Gebr. Holstein	1994	Cara x Ausonia	Creamy skin, striking bright red eyes, waxy fleshed tubers. High productivity, good disease resistance and drought tolerance, susceptible to slugs.	24.7%	23.2%	16,72
Jelly	Europlant (Germany)	2002	Marabel x 173/92/921	Smooth shinny yellow skin and yellow flesh color. Productive, fresh market and processing variety. Long storage capabilities and high resistance to discoloration.	19.1%	30.5%	23,76
Sante	J. Vegter	1983	WY 66-13-636 x AM 66-42	Smooth yellow skin, rather shallow eyes, pale yellow flesh. Suitable for pre-pack, processing	15.1%	19.2%	33,96

				and general ware, most commonly grown organic variety.			
Daifla	Germicopo (France)	2004	-	Smooth yellow skin, moderately deep eyes, white flesh.	4.5%	3.8%	22,6
Agave	Norika (Germany)	1995	Solta x 6.357203-74 N		3.4%	5.2%	17,1
Nevskyi	USSR	1982	Veselovskij x Kandidat	Smooth white to yellow skin, shallow to medium eyes, white flesh.	1.4%	1.3%	13,3
Draga	Hettema Zonen BV	1970	SVP 50-2017 x MPI 19268	Yellow and smooth skin, moderately deep eyes, yellowish-white flesh. Fresh market.	0.6%	0. 8%	18,1
Others	-	-	-		31.1%	16.0%	14,5

State Variety Testing carried out in 2008-2010 in Ak-Suy (Issyk-Kul Oblast) allowed a better knowledge of the potentialities of the different varieties (Table 3).

Table 3. Yield and agronomical characteristics of 24 varieties tested in the State Variety Testing in 2008-2010

Varieties	**Yield of grocery-ware tubers (t ha^{-1})**	**% of standard**	**Maximum yield (t ha^{-1})**	**Tuber weight (g)**	**Starch content (%)**	**Resistance to virus**
Early						
Innovator	38.3	100.0	44.1	126.0	19.0	not resistant
Molly	36.8	98.7	45.7	156.0	14.8	medium
Asterix	35.9	103.4	52.3	159.0	18.2	resistant
Concurrent	31.3	104.1	49.9	138.0	16.9	medium
Marabell	39.6	106.8	53.7	148.0	14.9	resistant
Borvina	40.8	105.1	42.6	110.0	14.1	high resistant
Troya	43.5	106.4	43.5	96.0	17.8	high resistant
Moderately early						
Nevsky	32.9	97.1	42.5	118.0	17.7	not resistant
Picasso	35.9	99.2	41.0	168.0	14.4	not resistant
Latona	36.2	103.9	41.8	134.0	14.3	resistant
Draga	35.9	104.8	45.9	121.0	13.9	medium
Sante	45.2	105.3	48.4	109.0	14.9	high resistant
Felsina	35.3	105.7	41.7	150.0	18.9	medium
Jelly	48.9	119.1	58.7	180.0	13.9	resistant
Appolina	46.3	112.6	51.6	142.0	15.3	medium
Daifla	49.1	119.5	58.8	146.0	15.5	medium
Aida	48.2	125.7	53.2	150.0	19.6	resistant
Agave	43.5	108.1	47.9	100.0	13.0	medium
Pamella	49.9	127.4	58.4	115.0	14.6	resistant
Moderately late						
Redanna	57.4	130.8	57.4	115.0	13.5	resistant
Symbol	41.1	100.0	43.4	144.0	19.2	resistant
Mondial	47.7	116.0	53.0	168.0	18.7	not resistant
Symphony	42.1	106.5	53.0	142.0	17.8	high resistant
Alegria	45.4	110.5	49.7	106.0	14.6	medium

In 2010, five varieties originated from CIP (International Potato Center) germplam were released in Kyrgyzstan (Table 4).

Table 4. Varieties originated from CIP clones released in 2010 in Kyrgyzstan

CIP number	Official name	Main attributes	Pedigree
302313.105	Mira	Virus and Heat	801011 x 393613.2
302312.104	Bereke	Virus and Heat	801011 x 392820.1
302312.106	Alay	Virus and Heat	801011 x 392820.1
302331.103	Tien Shan	Virus and Heat	800048 x 392820.1
302089.108	Jetigen	Virus and Heat	397036.7 x 392820.1

2.3. Potato based cropping systems

In the lowlands, potato is cultivated in a dual cropping system often practiced under irrigated conditions and, therefore, highly dependent on regular water supply. In the first cropping season, with planting between February and March, and harvesting in May-June, only early maturing varieties are cultivated. During the second cropping season, potatoes are cultivated immediately after wheat, with mid-early maturing varieties planted at the end of June-beginning of July, and early maturing varieties planted towards mid-July. Generally, markets offer prime prices for early crops harvested in May-June, for which special varieties are grown (ie, Impala, Agata, Agave, Nevskyi). In the highlands, mid-late and late maturing varieties are cultivated with planting between April-June and harvest between September-October. Monoculture of potato is frequent, particularly in the highlands. Yield gaps range from 45.4% to 74.8% [4].

Potato is the most labor intensive crop in the country, with a high degree of dependence on labour during planting and harvesting [4]. Workers are hired on a short term basis for harvesting and for planting periods. The harvest of early potatoes takes 4-6 days, depending on the size of the plot and the number of workers employed. In the South of Kyrgyzstan, the majority of the labour used during this period is composed by Uzbek workers coming from across the border [6].

2.4. Potato crop management

2.4.1. Fertilization

Fertilization of potato crop in Kyrgyzstan has been extensively studied [4]. Because the soil in most areas is exhausted, farmers have to use large amounts of fertilizers in order to obtain satisfying yields [6]. Fertilizers (organic or inorganic) are used on 88.3% of the potato area. About 31.6% and 24.4% of potato area applied with inorganic nitrogen and phosphoric fertilizers. Potato shows the highest value-cost ratio of fertilizer use on yields (4.99) among the crops cultivated in Kyrgyzstan. Small stakeholders use twice more nitrogen and phosphoric nutrients compared to large farms. However, the yields are by about 50% lower [4].

2.4.2. Pest and diseases

The following diseases and pests have been observed on potato in Kyrgyzstan: PLRV (potato leaf roll virus), PVY, PVX, PVA (mosaic viruses), blackleg (*Erwinia carotovora* ssp. *atroseptica*) and soft rot (*Erwinia carotovora* ssp. *carotovora*), *Rhizoctonia* root decay and top rolling, early blight (*Alternaria solani*) and late blight (*Phytophthora*

infestans) [11]. Infections with viruses, blackleg and *Rhizoctonia solani* have been quite frequent in seed production fields. In table potatoes fields, often more than 70 % of all plants were affected [11]. Colorado beetle could be seen everywhere while wireworms (larvae of the click-beetle) and cutworms have been found occasionally [11]. Brown slimy bacteriosis of potatoes (bacterial wilt, or wilt) caused by *Ralstonia solanacearum* is a relatively a new disease in Kyrgyzstan [13].

2.4.3. Seed systems

Generally, seed potato tubers are not certified and do not match the demand on seed quality. No standardized varietal catalogue has been created yet. It is needed to convince potato growers that eradication of diseased potato plants is important to reduce viruses, intensify the knowledge on diagnosing disease symptoms and supply farmers and agronomists with suitable extension material. Healthy locations for seed potato growing can be found 1,500 m asl. Colorado beetle does not occur if altitude is more than 2,000 m asl [7].

2.5. Potato value chains

The mechanisms for producers to sell to markets in Kyrgyzstan are underdeveloped, allowing middlemen who purchase and distribute the crops to the local, regional and external markets to keep prices high. Potatoes from the first cropping cycle have to be sold off or consumed right away since early potatoes do not store for more than a few weeks. They rely (much more than the second potato harvest in the autumn) on demand in the export market. They are loaded onto local trucks and exported to Kazakhstan, Russia and Uzbekistan. Kyrgyz middlemen bring the produce to the border where it is then exported by traders [6].

Potato research

The capacity of existing laboratories is insufficient. Because of lack of funds furnishing is inadequate and became outdated. The development of a central laboratory for virus detection e.g. with ELISA-Test or/and PCR techniques is needed to match the demand on virus-free meristems plants and microtubers. Development of facilities to produce entomophages and pheromones would be useful to reduce pesticide application in future. There is finally a need for training specialists and farmers in the area of plant protection (diagnosis of diseases and pests) [11].

3. CONCLUSION and PERSPECTIVES

The stability of food supply in Kyrgyzstan is threatened by climate change [14, 15, 16], degradation of natural resources [17] and increase of food prices. The country is already facing warmer temperatures and a changing hydrology, and has already seen an increase in extreme weather events, such as droughts and floods. This trend is expected to persist. Kyrgyzstan is among the top ten countries in the ECA region that are likely to experience the greatest changes in climate extremes by the end of this century [14]. Poor management of soil erosion, water resources, pest control, and nutrient conservation are already constraining agricultural productivity and threatening the food security of poor rural communities. For example, 12 % in Kyrgyzstan of the irrigated area is affected by salinization [17]. Another risk related to the food stability in Central Asia countries is their dependency on food imports which makes them susceptible to price fluctuations on world commodity markets, as demonstrated during the price spikes in 2007-08 and 2010-11. As a result of both the sharp increases of global commodity prices and wheat export restrictions implemented by Russia, Ukraine and Kazakhstan, Kyrgyzstan experienced in 2010 a 35% increase of wheat flour price and the poorest households, which spent large shares of their income on food, were disproportionately affected [8].

In this context, potato appears as a priority crop for the country which can play an increasing role in food security and income. Most varieties, of European origin, are however not really adapted to the heat- and drought-prone conditions of Kyrgyzstan and their organoleptic characteristics are poorly appreciated by the consumers. Finally, they make farmers more dependent on expensive imported seeds. There is a strong demand for early maturing particularly for cultivation during the first cropping season, for heat and drought tolerant varieties for the second cropping season and for varieties resistant to biotic stresses particularly in the highlands, were monoculture increases the diseases pressure. A more rational use of mineral and organic fertilizers is needed together with a standardized varietal catalogue, a procedure of seed certification in order to improve seed quality and a better organization of the farmers to ensure better market price. Improving infrastructure and capacity of the national research institutions would help them to play a more active role in the development of potato production through identification and dissemination of better adapted varieties and improvement of crop management and seed systems.

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