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The Legacy of the Soviet Agricultural Research System for the Republics of Central Asia and Caucasus

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1. Introduction

Historically, Russia and then the Soviet Union, were largely agricultural countries, at least up to the 1950s. The majority of the population lived in the countryside and was involved in crop cultivation and animal husbandry. Agriculture progressed as the society progressed and, at a certain stage of its development, agricultural science became an integral part of its evolution. The beginning of agricultural science in Russia is probably associated with the establishment of the Russian Academy of Sciences by Peter the Great in 1724. A notable scientist of the time, Mikhail Lomonosov (1711-1765), was the first to establish a separate structure within the Academy with the responsibility for assistance to agriculture. The first scientist in Russia who conducted experiments and published a number of books on agriculture was Andrey Bolotov (1738-1833), military officer and a land owner (Nikonov, 1995).

In 1765, Katherine II issued a decree establishing the Imperial Liberal Economic Society with the major objective to assist in the development of agriculture in Russia. The Society conducted experiments and published books and journals on a number of agricultural subjects such as soil science, bee-keeping, veterinary, agronomy, animal husbandry and others. The activity of the Society was stopped in 1915 because some of its members were suspected of socialist activities. Agricultural science in the 19th century was mainly concentrated in universities in Moscow, St. Petersburg and other large cities. In the second part of the 19th century, specialized agricultural universities and colleges were established. The first two were Gorygoretsk Agricultural College established in 1848 (now Belorussian Agricultural Academy) and Petrovskaya Agricultural Academy established in 1865 (now Timiryazev Moscow Agricultural Academy). By the beginning of the 20th century, very detailed knowledge was accumulated on farming systems, crop rotations, mineral nutrition, soil fertility, cropping in dry environments and many other subjects. According to the 1897 census data, 85% of the population in Russia lived in the countryside and 74% depended entirely on production from their farms (Nikonov, 1995, page 74). At the same time, the country exported 33% of its wheat and 41% of its barley production (Nikonov, 1995, page 72).

The end of the 19th century and the beginning of the 20th (period of 1890-1915) witnessed a large increase in the number of agricultural research and educational institutions. This was influenced by several factors such as a favorable economic situation before World War I, a rapid increase in agricultural production as a result of the liberal reforms conducted by the government in 1906-1911, and the high priority given by the government to agricultural production. This change was reflected in the increase of the total budget of the Department (Ministry) of Agriculture from 2.4 million rubles in 1895 to 29.4 million rubles in 1913. Also, in 1910 there were 239 agricultural educational institutions (courses of all levels, schools, colleges, universities) and by 1915 the number was 341. At the same time, the government share of funding for these institutions increased from 42% to 60%.

By January 1, 1915, the country had a network of state agricultural experimental institutions totaling 287 (Nikonov, 1995, page 112). The following types of the research institutions existed at that time:

- experimental stations (general and specialized) which were involved in research and conducted experiments on the application of fertilizers, soil tillage, forage crops, and breeding;
- experimental fields to conduct research adapted to particular environment;
- experimental farms to conduct field experiments on a larger scale;
- laboratories for analysis; and
- nurseries for multiplication of horticultural crops.

Experimental fields were more common in Russia than in Western countries where experimental stations dominated. These institutions could belong to the Department of Agriculture, local authorities of gouberniya (region) and uezd (county), agricultural societies, city departments, industrial or scientific societies, groups of land owners and private persons. The majority, however, belonged to the government. (Nikonov, 1995, page 118)

The following experimental stations, established during this period, illustrate how both government and progressive land owners were interested in the development of agricultural science. Shatilov Agricultural Experiment Station was established in 1896 on the premises of the landowner Shatilov in Central Russia by the gouberniya authorities. The Moscow Breeding Station was established using funds from the Department of Agriculture. Rostov-Nakhichevan Experiment Station in Southern Russia was set up in 1908 using funds of the regional agricultural society. The Kamenno-Stepnaya Experimental Station was established in Central Russia in 1911 using funds entirely from the Department of Agriculture (Nikonov, 1995, page 120). Summarizing the development of the agricultural science just before the revolution, Viner (Nikonov, 1995, page 120) came to the following conclusions: (1) the initiative and the funds of private people, societies and the government were used to establish agricultural research enterprises; (2) the network of research institutions expanded very fast after 1910 due to agrarian and market reforms; and (3) there were efforts to study different aspects of crop production using the newly established experimental stations and fields.

This brief description of the history and the status of agricultural research prior to 1917 is necessary to demonstrate the type of system of agricultural research that existed before the revolution. In summary, scientists working mainly on basic problems related to agriculture were concentrated in universities and colleges. Applied science was done in the experimental stations and fields targeting the adaptation of agricultural methods to local conditions.

The October revolution of 1917, and the events which followed, caused major changes in society as a whole and in agricultural science in particular. The following chapters address the major developments in agricultural science during the period of the USSR and its evolution in the post-Soviet period. Some general comments and observations are now provided to highlight several important issues relating to this paper.

First, the development of agricultural science (as well as science as a whole) in the Soviet Union was a reflection of societal development. Since the latter was highly politicized, science was politicized as well. There are many examples of shifts in agricultural science strategy which were determined purely by political decisions. This definitely affected the behavior of scientists and science administrators from top to bottom. In the first place, only members of the communist party and those supporting the official ideology had chances for promotion or rewards, such as trips abroad. During Stalin's rule, scientists also learned that disagreement with the official viewpoint could be a serious mistake leading to imprisonment or worse. This pressure on scientists resulted in their dependence on politics which is still present in the older generation of researchers. Though the relationship between politics and science was one of the most important factors influencing many aspects of agricultural research, this is not the focus of this paper. Instead, the paper concentrates more on the technical details of the structure and management of agricultural science using an analytical approach.

Second, there were many entities in the Soviet Union involved in agricultural research. This paper will focus primarily on the institutions within the Academy of Agricultural Sciences which was the major structure responsible for scientific support of agricultural production. Agricultural research was also conducted in the institutes and stations which belonged directly to the Ministry of Agriculture. Some investigations were made in the agricultural colleges and universities across the country. In this paper, these institutions are described briefly in relation to the Academy of agricultural sciences for the following reasons: (1) the institutes in the MOA system had essentially the same organizational structure and management system as the institutes of the Academy; (2) eventually, many of the institutes were transferred from the MOA to the Academy; and (3) educational institutes and universities played a very minor role in agricultural research per se and are mentioned only in the context of the broad issues of agricultural knowledge development and the education system of the country.

Third, the agricultural research system of the USSR was very large and had a very interesting history. It would take a full book to adequately reflect the details of its development. For such details, the readers attention is drawn to a book by A.A. Nikonov entitled, "The Spiral of a Centuries Long Drama: Agrarian Science and Politics in Russia from the 18th through the 20th Centuries." This paper, however, is intended to provide only a short review and by no means can be considered as a comprehensive document.

2. Agricultural Research in the Academy of Agricultural Sciences in the Soviet Union (1918-1991)

The Academy of Agricultural Sciences of the USSR had a long and very interesting history. It evolved from an association of a few elite institutes into a giant establishment uniting almost all the agricultural research institutions in the country. This chapter primarily describes the evolution of the agricultural research system in the USSR. It also includes some detailed information about the structure, management and linkages of the agricultural research system up through the 1980s. Knowledge about the USSR system during this period is very important to understand with respect to the CAC republics since it was the basis or starting point for establishing the agricultural research systems in these newly independent countries of the former Soviet Union.

2.1 Historical Development

The establishment of the Academy The civil war which followed the 1917 Revolution did not allow the Bolshevik government to rebuild agricultural research infrastructure; although, in 1918, the establishment of the Russian Institute of Agricultural Science was approved at the meeting of Sovnarkom (the Council of the Peoples' Commissars or Deputies which functioned as the government). Several new institutes were also opened at that time including: the Institute of Experimental Veterinary (1918), the Fertilizer Institute (1919), and the Institute of Applied Zoology and Phytopathology (1922). In 1922, the 1st Congress of Soviets of the USSR adopted a resolution to set up a central body which would unite agricultural research institutions and help to increase agricultural production. The follow-up action by the government was a resolution adopted on August 8, 1924 to establish an All-Union Academy of Agricultural Sciences and, as a first step, to establish the Institute of Applied Botany and New Crops, now called the Vavilov Institute of Crop Industry (P. Vavilov, 1979).

In the mean time, the process of revitalization of the network of experimental stations continued and some new organizations were created. The economic situation in general and the agricultural situation in particular was very favorable due to the so called New Economic Policy (NEP) which liberalized production and trade. Starting from 1925, grain production exceeded 70 million tons compared to 50 million tons in 1922 and 45 million tons in 1920 (Nikonov, 1995, page 150). On June 25, 1929, Sovnarkom issued its decree establishing the All-Union Academy of Agricultural Sciences named after V.I. Lenin (VASKHNIL), hereafter also called the Academy. The same decree ordered VASKHNIL to establish 10 new institutes for major subjects of agricultural science and a specialized library (P. Vavilov, 1979). The objective of the Academy at the time was to provide both a theoretical and practical basis for the increase of agricultural production and the overall reconstruction of agriculture.

The history of VASKHNIL can be divided into several time periods which coincide with the important stages of the development of Soviet society. These time periods are normally marked by changes either in the country or in VASKHNIL leadership.

VASKHNIL in 1929-1937 A world famous scientist, Nikolai Vavilov, was the first President of the Academy, combining this position with the directorship (1925-1940) of the Institute of Applied Botany and New Crops in Leningrad. The first action of the Academy was to implement the Sovnarkom decree and, by January 1, 1930, ten new institutes were established. These new institutes were: the Institute of Agricultural Economics, the Institute of Organization of Large Farming, the Pest and Disease Protection Institute, the Drought Institute, the Amelioration Institute, the Cropping System Institute, the Animal Husbandry Institute, the Institute of Fisheries, and the Maize Institute. In addition to these mandated institutes, a number of other new institutes were opened in 1930-1931 such as the Microbiology Institute, the Institute of Oil Crops, the Bee-Keeping Institute and others (Nikonov, 1995, page 200-201).

For a short initial period, VASKHNIL reported directly to the government – Sovnarkom; but, in January 1930, it was transferred to the Ministry of Agriculture. The President and Vice Presidents of the Academy, however, were appointed by the government. There were no personal memberships in the Academy until 1935 when Sovnarkom approved 42 scientists as members or academicians of VASKHNIL. At that point, the Academy became not only the association of agricultural research institutes, but also, an association of individual scientists.

Until 1956, however, the academicians (members of the Academy) and corresponding members were not elected, but were appointed by the government. The first 42 members of the Academy included the best agriculturists and biologists of the time. Unfortunately, fourteen of them died later in the Stalin camps. The first few years of the Academy were characterized by uncontrollable growth of the network of research institutions in Russia and its regions as well as in the Republics.

On July 16, 1934, as part of the VASKHNIL review, the President of the Academy, Nikolai Vavilov, gave a report to Sovnarkom about the results of Academy activities and their impact. The subsequent results of the government review were largely negative. The Academy was blamed for insufficient linkage with the producers, poor results in wheat and cotton breeding, and inadequate research on fertilizer application. The structure and management of the Academy was also criticized for: (1) lack of coordination of the research activities; (2) very narrow specialization which resulted in the establishment of many institutes devoted to minor problems; and (3) inadequate scientific summarization of the advanced methods utilized in the best farms. As a result of the review, Sovnarkom decided to reorganize VASKHNIL on the following basis: (1) the Academy is the highest body in the USSR involved in agricultural research and it consists of full members (academicians), honorary members and corresponding members; (2) the sessions of the Academy are conducted regularly to discuss the most important issues of agricultural development, plan the research agenda and review high priority projects; (3) the leadership of the Academy consists of a President, two Vice Presidents and a Scientific Secretary, all appointed by the government; and (4) the outreach branches of the Academy in the Republics are closed (Nikonov, 1995, page 202).

The 1934 review had very important consequences for agricultural science in the USSR. Only a few major institutes with their networks were left within VASKHNIL. The remaining institute and stations were transferred either to the All-Union Ministry of Agriculture or to the respective structures in the Republics. Some of them were closed or transformed to conduct different activities. As a result, by the mid-30s, VASKHNIL consisted of the following institutes: All-Union Institute of Crop Industry (VIR, Leningrad), Plant Breeding and Genetics Institute (Odessa), All-Union Institute of Fertilizers and Agro-Chemistry (Moscow), Agro-Physical Institute (Leningrad), Institute of Microbiology (Leningrad), Central Genetics Horticultural Laboratory (Michurinsk), Animal Husbandry Institute, Institute of Acclimatization and Animal Hybridization, Institute of Hydraulic Engineering and Melioration, Institute of Electrification of Agriculture, Institute of Marsh Farming (Minsk), Central Scientific Agricultural Library (Moscow) (Nikonov, 1995, page 203). The government decision to leave only a few elite institutes within VASKHNIL clearly indicates that the priority of the Academy was more toward basic rather than applied science.

It is difficult to judge to what extent the changes in the Academy were determined by some logical reasons and to what extent by political struggle. By 1935, a group opposed to President N. Vavilov had developed and became influential largely due to support from academician Trofim Lysenko who promised to do wonders in agriculture using his new methods and approaches. On June 21, 1935 Nikolai Vavilov was replaced as President of VASKHNIL by Alexander Muralov who was Deputy Minister of Agriculture at the time. In June 1937, he was arrested and executed under the suspicion of treason. For a short period of time, the Acting President was Georgiy Meister, Vice President of VASKHNIL and a noted wheat breeder. His fate was the same as he was arrested in the end of 1937 and later executed (Nikonov, 1995, page 213).

In summary, VASKHNIL experienced unprecedented growth in the first eight years of its existence. This was followed by a major reorganization which determined its structure, organization and management for many years.

VASKHNIL in 1938-1953 This period of the history of the Academy is associated with the name of Trofim Lysenko who was its President from 1938 to 1956 and again from 1961 to 1962. Three to four years before the War (1941-1945), agricultural science, as well as society as a whole, were particularly shaken by Stalin's repressions which killed millions of innocent people. It was in this period that the first President of VASKHNIL, Nikolai Vavilov, was imprisoned and died in a Saratov jail in 1943.

On June 22, 1941, Germany invaded the USSR and the Great Patriotic War started and lasted until 1945. VASKHNIL had several objectives during this period. Direct assistance to military industry was provided by the institutes which had experimental industrial facilities, such as those at the Institute of Mechanization and Electrification. Genetic resources collected by Nikolai Vavilov were conserved and maintained in his institute in Leningrad despite the famine. Occupation of the European part of the USSR required a substantial increase of agricultural production in the East. This was achieved using new methods developed by VASKHNIL scientists. The major research institutes were evacuated. VASKHNIL itself and the All-Union Institute of Animal Husbandry moved to Omsk, Siberia; the Plant Breeding and Genetics Institute moved to Tashkent, Uzbekistan; Timiryazev Moscow Agricultural Academy moved to Samarkand, Uzbekistan. Accordingly, the war related evacuation from the European areas had a positive effect on the establishment of agricultural research centers in the Eastern part of Russia and Central Asia.

Scientific discussion about key issues in agricultural science calmed down during the war, but appeared with new vigor in 1946-1948. The President of VASKHNIL, Trofim Lysenko, and his followers were against genetics and the basics of biological science. They claimed that a human being can alter nature the way he likes and, in this way, dramatically increase agricultural production. This opinion was attractive for Stalin and he gave unlimited support to Lysenko. However, many scientists were against Lysenko's ideas and did not follow his methodology. In August 1948, VASKHNIL conducted a session attended by some 700 participants; all were leading agriculturists and professors from agricultural universities. Lysenko made an opening speech titled "About the status of biological science" which was against geneticists and all those who followed real science. The speech was concluded by the statement that the Central Committee of the Communist Party approved his approach. The 1948 session of VASKHNIL had extremely negative consequences for a generation of researchers. From that time on, the institutes were not able to openly conduct experiments based on real scientific knowledge. At the same time, a huge amount of resources were wasted on experimentation in line with Lysenko's theories. Generations of students graduated from universities without any knowledge of genetics. There were no books published which would reflect the real status of biology. Only supporters of Lysenko were appointed as academicians of VASKHNIL (Nikonov, 1995, page 289) and the structure and the management of VASKHNIL under Lysenko remained largely unchanged.

VASKHNIL in 1953-1965 Though Lysenko remained the President of VASKHNIL, its strategy and activity, to a large extent, depended on the policy developed by Nikita Khrushev, the first secretary of the Communist Party. By the beginning of the 1950s, grain production reached pre-war level or 80-85 million tons. However, it was not sufficient for the fast

growing population. So, in 1954, the government decided to bring into cultivation the virgin lands of Eastern Siberia and Northern Kazakstan. Within three years, an additional 42 million hectares of land were plowed (25 million hectares in Kazakstan and 15.9 million hectares in Siberia) and planted with cereals. Grain production increased by 30-40 million tons. The small institutes and experimental stations in the regions of virgin lands cultivation were soon transformed into major scientific centers. In 1956, a station in Shortandy (Northern Kazakstan) was transformed into the All-Union Research Institute of Cereal Production. The institute had tremendous impact on production in the region by developing a soil-conservation cropping system. In Western Siberia, the Altai Agricultural Research Institute (Barnaul) and the Siberian Agricultural Research Institute (Omsk) were strengthened and became important regional scientific centers. Later the Siberian branch of VASKHNIL was established in Novosibirsk indicating the priority given to the region.

The leadership of the country under Nikita Khrushev paid considerable attention to the development of agriculture. In 1956, the Council of Ministers issued a decree "About the improvement of the work of the agricultural research institutions." Agricultural science was criticized for being isolated from producers, lack of coordination, poor impact on farmer's fields, poor research on regional farming systems, and the concentration of research institutes in a few major cities (Moscow, Leningrad, Kiev, Tashkent). The practical outcome of the decree was increased funding for agricultural science. Another significant change was that research institutes were given large farms for on-farm trials and production.

During this period, the agricultural research network became a multi-level structure:

- State agricultural research stations reported to the *regional (oblast) departments of agriculture* and were responsible for support of regional agriculture by consulting and the provision of high generation seed.

- Zonal agricultural research institutes were established in large economic zones of Russia, Ukraine and Kazakstan. They reported to *the Ministry of Agriculture of the respective Republics* and were responsible for the development of scientific recommendations as well as for breeding new varieties for the whole zone. In Russia, the institutes were in the Central Zone, North-West Zone, North-East Zone, Central Black Soil Zone, Western Siberia and others.

- The specialized or commodity institutes with an all-union mandate remained within *VASKHNIL*. Most of them were in Moscow and Leningrad, but a few were in Ukraine and one was in Kazakstan.

- The *Academies of Agricultural Sciences of the Republics* were established in Ukraine, Belorussia, Uzbekistan, Kazakstan and Georgia. Previously the agricultural research institutes in the Republics were within the Academies of Sciences which were established in all the Republics. During this period of reforms, they were transferred either to the newly established Academies of Agricultural Sciences or to the respective Ministries of Agriculture. Later the Academies of Agricultural Sciences in the Republics were closed and all the Institutes were transferred to the Ministries of Agriculture.

Despite the positive changes in agriculture and science during 1953-1965, VASKHNIL was still headed by Lysenko and his follower, M. Olshanskiy (1962-1965), and they did not allow experimentation and publication which was not in line with their theories.

VASKHNIL in 1965-1985 This period of Soviet society is frequently referred to as one of stagnation. The leader of the country for 18 of the 20 years was Leonid Brezhnev. The yield of cereals for 15 years in this period (1970- VASKHNIL in 1965-1985 This period of Soviet society is frequently referred to as one of stagnation. 1985) remained basically the same at 1.4-1.5 tons/hectare (Nikonov, 1995, page 330). At that time, VASKHNIL was headed by Presidents P. Lobanov and P. Vavilov.

The Great Soviet Encyclopedia published in 1970 reflected the official view on many subjects. It defined the objectives of VASKHNIL as follows (Lobanov, 1970):

- the development of theoretical research for major agricultural subjects;
- the identification of new ways of making technical progress in agriculture;
- the improvement of research methods to increase the efficiency and level of science;
- the study and summary of global science; and
- assistance in the utilization of research achievements in practice.

In order to implement the objectives, VASKHNIL was involved in the following:

- planning and coordination of research;
- methodological leadership for major research issues;
- human resources development by graduate study;
- training; and
- dissemination of the scientific knowledge.

There were still only about 30 leading specialized institutes within VASKHNIL at the end of the 60s. At the beginning of this period, VASKHNIL expanded and, in 1969, it had three regional branches: Southern in Kiev, Central Asian in Tashkent and Siberian in Novosibirsk.

During 1965-1985, agricultural science readily responded to a number of mega-projects developed and pursued by the Central Committee of the Communist Party. Many of these projects were based on political consideration and frequently failed to deliver the product. For instance, the project on concentration of agricultural production resulted in huge animal farms which did not have enough locally produced feed. Huge investments in the agriculture of the Non-Black Soil Zone (Central Russia) did not result in doubling of the production in 10-15 years, but just sustained it. The Food Program proclaimed in 1980 and designed to provide enough food for the population by 1990 also failed. For all the projects and programs, agricultural science was requested to provide support and tried to do it despite the highly politicized environment. One of the achievements of agricultural science during this period was the development of the farming systems for each region based on long-term experiments and economical analysis. These were published and served as good guidelines for agricultural production in specific areas.

The 1970s witnessed the further expansion of VASKHNIL, once again following Communist Party directives. In 1974, the Non-Black Soil Zone branch of VASKHNIL was established in Leningrad. A number of research institutions and farms were essentially transferred from the Ministry of Agriculture to form the new branch. This decision united 34 research units including several large institutes and 53 farms (Nikonov, 1995, page 364). The same thing happened with the establishment of the Siberian branch of VASKHNIL which united a number of institutions and was responsible for research that targeted the whole of Siberia and the Far East of the USSR. In the beginning of the 80s, several other regional branches were established: All-Russian, Far-Eastern, Western, Transcaucasian and Eastern. As a result, VASKHNIL rose from a relatively small organization to become a giant uniting almost all the agricultural research institutions of the country.

VASKHNIL in 1985-1991 Perestroika started with the appointment of M. Gorbachev as a party leader. Soviet society gradually became more open. In agriculture, the highest priority was given to the introduction of new forms of property and work organization, more efficient economic mechanisms, and land reform. VASKHNIL actively participated in the development of recommendations for new production methods as well as contributed to the preparation of the new laws. Another high priority issue of the Academy during this period was farming under drought environment. Efforts of several institutes and production units concentrated on more efficient production methods under moisture stress. Sessions of VASKHNIL, held in 1985 and 1987, were specifically devoted to this problem. They resulted in detailed recommendations which were successfully applied in several drought prone regions.

In the late 80's, regional branches of VASKHNIL were transformed into the Republican Academies of Agricultural Sciences in Ukraine, Belorussia, Kazakstan, Uzbekistan, Georgia and Turkmenistan. In 1990, the Russian Academy of Agricultural Sciences was established based on the four VASKHNIL branches situated in Russia.

The general opinion in the Republics was to establish their own agricultural research structures. In 1991, VASKHNIL decided to transfer to the Republics 80% of the institutes and leave within its structure only specialized more basic science oriented centers such as the Vavilov Institute. The State Council chaired by M. Gorbachev supported this initiative. However, in practice, the Republics were taking over the institutes which were thought to remain within VASKHNIL. By the end of 1991, it was realized that VASKHNIL may cease to exist unless urgent measures were taken. The scientific community viewed its roles as coordinating and uniting the new sovereign countries, as a center of human resource development, and as a center for basic agriculture-oriented research. Accordingly, the heads of the Academies of Agricultural Sciences from ten republics (Azerbaijan, Belorussia, Georgia, Kazakstan, Kyrgyzstan, Moldova, Russia, Turkmenistan, Uzbekistan and Ukraine) signed a letter to M. Gorbachev and the heads of the sovereign Republics recommending to transform VASKHNIL into the Academy of Agricultural Sciences of the Sovereign States. This new Academy was anticipated to consist of major inter-governmental scientific centers with funding from participating countries (Nikonov, 1995, page 412). However, nobody answered the letter and in December 1991, the USSR broke up. On January 30, 1992, President Borus Yeltsin signed a decree establishing the Russian Academy of Agricultural Sciences on the basis of the All-Russian Academy of Agricultural Sciences and VASKHNIL. VASKHNIL had its last session on February 4, 1992. The last president of VASKHNIL was

the noted economist, A. A. Nikonov, author of the book which provides the history described in this paper.

Historical Summary

The history of the organization of agricultural research in the Soviet Union demonstrates a close link to the politics of the times and a continuous shifting of control of the system between scientists (VASKHNIL) and the Ministries of Agriculture. Many of the changes that took place had a significant influence on the structure of agriculture in the republics and this legacy remains as an important factor during the current period of reforms. Table 1 presents a summary of the changes that took place in the agricultural research structure in the republics from the 1950s to the late 1980s. These changes reflect, on one hand, the higher priority that was given to agriculture in the republics by the central government and, on the other hand, the tendency to decentralize research and make it more impact oriented at the republic level. Unfortunately, the reorganization which took place in the 70s and 80s subordinated many agricultural research institutes of the republics to VASHKNIL through regional branches.

2.2 National Structure and Resources

Since 1935, the Academy of Agricultural Sciences in the USSR (VASKHNIL) had a dual character as both (1) an association of research institutions and (2) an association of individual scientists.

As an association of research institutions - As demonstrated above, the structure of the Academy, and agricultural research itself for that matter, was constantly changing. Over time, however, there were two distinct patterns of research organization. The first one reflects the Academy, as a union of a few specialized institutes, with the rest of the research conducted within the Ministry of Agriculture. This was the dominating pattern in the 1960s. The second pattern shows the Academy as a giant organization managing almost all the agricultural research in the USSR. This was VASKHNIL of the 1980s.

The structure of VASKHNIL in the 60s was described by Lobanov (1970). He indicates that the division of the Academy was both subject and region oriented. During this period, the Academy had three regional branches (Southern, Central Asian and Siberian) and was divided into eight departments plus the Library.

- *Department of Cropping Systems and Chemicalization* (Agro-Physical Institute, Institute of Crop Protection, Institute of Crop Protection of the South-Western Region, Institute of Crop Protection in Tashkent, Institute of Cotton, Soil Institute, Microbiology Institute, Institute of Fertilizers and Soil Science, and Institute of Cereals Production)

- *Department of Crop Science and Breeding* (Institute of Maize, Institute of Oil Crops, Institute of Plant Industry, Plant Breeding and Genetics Institute, Institute of Legumes, Institute of Cotton Breeding, Institute of Vegetables Breeding, Genetic Laboratory of Horticultural Crops, and Nikitskiy Botanical Garden)

- *Department of Animal Husbandry* (Institute of Animal Husbandry, Institute of Animal Physiology and Biochemistry, Institute of Animal Breeding)

- *Department of Veterinary* (Institute of Helmintology, Institute of Experimental Veterinary)

- *Department of Mechanization and Electrification* (Institute of Mechanization, Institute of Electrification, Institute of Mechanization and Electrification of the Southern Regions, Institute of Equipment and Precision Measurements)

- *Department of Hydraulics and Melioration*

- *Department of Forestry and Agroforestry* (Institute of Agroforestry)

- *Department of Economics and Organization*

- *Central Scientific Agricultural Library*

The majority of the regional Agricultural Research Institutes (ARIs) and experimental stations belonged to and were funded through the Department of Science in the Ministry of Agriculture of the respective Republics. The Ministry research network had a two-level structure. Research institutes had a network of research stations and farms which were used for testing new technologies and for extension services. The institutes would be mostly region oriented though there were some which worked on a particular subject. The institutes of the Ministry of Agriculture (MOA) would use the newest methodology from the VASKHNIL institutes and their scientists would be sent there for training. The agricultural research conducted in agricultural colleges and universities was isolated from both VASKHNIL and the network of research of the Departments of Science from MOA. It was mainly targeted to address local problems and to demonstrate to students how research is done. Of course, the level of science was high in a few major institutions like Timiryazev Moscow Agricultural Academy and Leningrad Agricultural College. The overall organizational structure of agricultural research in this period can be seen in Figure 1.

The essence of the changes in the organization of agricultural research during the following 20 years was a gradual transfer of the research institutions from the Ministry of Agriculture to VASKHNIL and mainly to its regional branches. By the mid 80s, there were nine regional branches of VASKHNIL:

- All-Russian, Moscow

- Siberian, Novosibirsk

- Non-Black Soil Zone, Leningrad

- Far Eastern, Khabarovsk

- Western, Minsk

- Southern, Kiev

- Transcaucasian, Tbilisi

- Eastern, Almaty

- Central Asian, Tashkent

The all-union commodity institutes reported directly to their respective departments at VASKHNIL headquarters. The other institutes reported to regional branches. While passing through these changes, the majority of the experimental stations were upgraded to institutes. They no longer reported to the zonal ARI, but directly to a VASKHNIL branch. As an example of the structure of a regional VASKHNIL branch, the Non-Black Soil Zone Branch headquartered in Leningrad had 42 research institutes with 1660 scientists (Nikonov, 1995, page 364). The other branches were of similar size.

Similar transformations took place in the republics. The research institutes which belonged to the respective Ministries of Agriculture were transferred to the regional VASKHNIL branches. In general, the expansion of VASHKNIL and changes in the regional structure had negative consequences. Previously, the regional (oblast) experimental stations were directly responsible for scientific support of a region and reported to regional authorities and a zonal research institute which, in turn, reported to the MOA. After restructuring, the regional experimental stations became the institutes and reported directly to VASKHNIL branches. Their activities changed to a certain extent and sometimes local regional problems were ignored. The regional departments of agriculture and MOAs could only indirectly influence the agenda of the ARIs via VASKHNIL branches, not directly as was the case in the past.

A.A. Nikonov (1995) notes that there were no common criteria to explain why some institutes belonged to VASKHNIL and others to MOA. Theoretically, MOA was supposed to keep very specialized institutes which were needed for its departments (like the Plant Quarantine Institute). In practice, this rule was not followed. It is difficult to explain why, for instance, the Institute of Maize belonged to VASKHNIL and the Institute of Rice belonged to MOA.

ARIs belonging to VASKHNIL or MOAs in the 70s and the beginning of the 80s enjoyed full funding for their activities. The government invested in the construction of new facilities, new equipment and machinery. Physical resources were sufficient for effective research. New institutes were easily established following political decisions by the Communist Party leadership. Figure 2 presents the structure of a typical zonal ARI. Commodity research institutes would have a similar size or be even bigger. They would have more research programs and less extension activities. By Western standards, it may be considered a luxury to have a regular breeding program supported by such departments as genetics, wide crosses, plant physiology, quality control, and green houses. However, in the time of the USSR, this was considered normal. At that time, there were qualified scientists and resources sufficient to run the programs.

Table 2 presents the agricultural research resources in the USSR including VASKHNIL. This table demonstrates the relative importance of research of the Academy of Agricultural Sciences versus that conducted within MOA. VASKHNIL alone had 573 experimental farms with total area of 3.5 million ha (Nikonov, 1990).

An evaluation of the system in the early 1990s, and its comparison with the Western countries (Pray & Anderson, 1997), demonstrated that there was an over investment in agricultural research in the USSR. This was coupled with the low efficiency of scientists due to lack of motivation, poor work environments, lack of labor and a number of other factors. The transformation of agricultural science from a privileged structure with unlimited resources

into one with efficient impact-oriented programs is one of the major current challenges of the newly independent states of the former USSR.

As an association of individual scientists. There were several levels of membership in the Academy of Agricultural Sciences.

- *Full members or academicians.* Scientists were elected by secret votes of academicians at the annual general assembly of the Academy according to the quotas for the subject departments or regional branches of the Academy. Research institutes had the right to make nominations for full membership in the Academy. Academicians were members of the council of their respective subject department or a regional branch of the Academy. Additional payment was made to academicians. By the end of the 80s there were some 120 academicians.

- *Corresponding members.* The procedure for election and their responsibilities were similar as for academicians. Corresponding members did not have the right to vote in elections for new academy members. The number of corresponding members was more or less equal to the number of academicians.

- *Foreign members.* The procedure for election was the same. For nomination, the support of at least three Academy members was needed. There were some 80 foreign members in VASKHNIL at the end of the 1980s. Nobel Prize winner Dr. N. Borlaug was among the foreign members of VASKHNIL.

- *Honorary members.* The election and nomination procedure was the same as for foreign members. This level of membership was designed to honor outstanding national personalities who contributed to agriculture development. A famous honorary member was T. Maltsev who never graduated from a school, but made a major contribution as an agronomist to the development of a soil conservation tillage system in the Ural region. There were just a few honorary members in VASKHNIL.

Regardless of type of membership, it was offered for the recipient's lifetime. Scientists from any institution (not only the VASKHNIL network) were eligible for membership. When VASKHNIL stopped its activities in early 1992, all its members automatically became members of Russian Academy of Agricultural Sciences. Membership in the Academy was considered as recognition of achievements in science. It gave additional responsibility and was financially rewarded. The system of secret voting did not allow the use of Academy membership for political purposes. In fact, there were many cases of high ranking officials who wanted an academician title, but, were not elected.

The two functions of the Academy (association of research institutions and association of individual scientists) were interrelated. Once members of the Academy were elected, they usually played an active role in Academy management and the coordination of its activities.

2.3 Management of Agricultural Research

Governance of the Academy. The highest decision-making body of the Academy was its general assembly. It elected the Presidium of the Academy to manage day-to-day activities. The Presidium consisted of President, Vice-Presidents (3), Chief Scientific Secretary, heads of the Academy regional branches and several famous scientists. Though the procedure of

appointment of Presidium members was democratic, its implementation resulted in a very low rotation. Since the same individuals were in charge for 10-20 years, there was obvious conservatism in Academy leadership.

The general structure of VASKHNIL headquarters is represented in Figure 3. Each subject department and regional branch of the Academy was headed by an academician-secretary who was appointed by the Presidium. Each department also had its bureau consisting of academicians and corresponding members (15-20 persons). This bureau was responsible for developing a strategy for research on the subject, research program planning and coordination of activities. Each subject department was further divided into sections or councils which addressed a particular narrow problem. A section normally consisted of a chairman, deputy chairman and a secretary. The responsibility of the section was to coordinate the research efforts on a particular subject. Only the academician-secretary of the department was based in headquarters and had administrative responsibilities. The members of the bureaus and section chairmen were all active scientists and the most advanced and recognized in their fields. A section chairman automatically became a national coordinator for a particular research agenda. As an example, Figure 4 provides structure of the Department of Cropping System of the Academy.

At the research institute level, the management structure included the director, deputy directors (science, administration, production), heads of research departments and administrative units.

Employment of research and administrative staff. The directors of the research institutes were elected by secret ballots cast by members of the Academy departments. In the late 80s, the procedure was changed and the directors were elected by the secret votes of the institute staff on a competitive basis. The elected candidate, however, still had to be approved by the Presidium of the Academy. The director of the institute appointed its deputies and other administrative staff after approval by the Academy. The positions of the heads of the research programs and senior scientists were advertised and a five-year appointment was made by the director following the recommendation of the selection committees. After five years, the scientist had to prepare a report for review in order to continue employment. Once again, the procedure sounds very democratic and logical. However, in many cases, it was a formality to get reappointed or a position was given to a favorable candidate without advertising.

University graduates were hired for junior positions, according to requests from the Department of Education of MOA. The rotation of research staff was very low. The typical pattern would be graduation from the agricultural college, Ph.D. degree study in one of the research institutes, and employment in a junior position in the same or another institute. Then, there would be a gradual advance to senior scientist and possibly head of the program. It was not uncommon that a lifetime of activity of a scientist was associated with only one institution. One of the reasons for low rotation was difficulty in moving and obtaining new housing. In fact, the system encouraged employment in one institution. For example, a person employed more than 10-15 years at one institution had significant advantages in obtaining social privileges which were distributed by the administration.

Priority setting and client identification. The procedure of priority setting as it is used in the West (consultation with the participation of stakeholders) was unknown within the agricultural scientific community of the USSR. The process of priority setting was highly

politicized, as one would expect, and it was from top to bottom (Cross, 1995). The general directions for society development were given by the Communist Party. Whether they were based on scientific knowledge or the personal ambitions of the leadership is an open question. The scientific community was often consulted, but was not always heard. The decrees of the Communist Party congresses or plenums were interpreted by the government to shape its current policy and determine investments. The fact that VASHKNIL reported to MOA, and was not an independent structure, clearly indicates that its objective was essentially to assist the Ministry to increase agricultural production.

The mechanism of transformation of the overall priorities set by the government into the priorities of a particular research program is difficult to describe. Partly it was done through research planning as described below. In many cases, the leaders of the programs set their priorities themselves based on what they saw as necessary. Sometimes government regulations set up the priorities. In the case of plant breeding, for example, if the MOA decided not to accept varieties susceptible to a certain disease, the breeders had to emphasize breeding for resistance to that pathogen. However, the major factor which changed priorities was increased funding for the involved institutes and programs. The introduction into cultivation of the virgin lands of Siberia and Kazakstan witnessed a tremendous increase in the funding of agricultural research in and for the region.

Unfortunately, the scientific interests of the President of the Academy also influenced priorities. The economist would expand the Economics Department and establish a few new institutes. The agronomist would shift the priorities to his area of research. In fact, the opinion of the producers was hardly counted in establishing priorities. The Academy did not, in fact, have a formal, structured way of priority setting.

Client identification and participation, as known in Western management culture, was not known in the USSR. The uniformity of agricultural enterprises in the country did not allow for a differentiated approach. The kolkhozes and sovkhozes were very similar in their farming methods and level of agriculture. There were no private farmers or strong farmer associations which would request science to address particular research issues. At present, the situation is definitely different.

Research planning, funding and reporting. A five-year period was the basis for planning nearly all the activities in the USSR, including agricultural science. One year prior to the start of the implementation period, the respective subject departments of VASKHNIL or its regional branches would ask the institutes to identify proposed activities for the next five years. Each research program had to compile a detailed plan describing what would be done, what output was expected, what would be the impact on the output for producers, and what funding would be needed to implement the objectives. The plans from each institute would then be combined and reviewed, first in the respective section and then in the bureau of the respective subject department. In case the problem addressed had local importance, it would be reviewed and included in the plan of research of the regional VASKHNIL branch. The Presidium of VASKHNIL would take the compiled plan to the Ministry and eventually to the government for approval and subsequent funding. The whole procedure of planning, coordination and reporting was monitored and supervised by the department of agricultural sciences of the Central Committee of the Communist Party. This Committee consisted of scientists-administrators and was the final authority.

The planning procedure described was, to a certain degree, a formality for several reasons. First, the personal relations between the institute director and the superiors from the Academy counted for funding much more than a plan of research work. Second, many research programs were highly conservative in planning their research agenda and would continue to concentrate on the same problem for many years. For the Academy, it was sometimes easier to establish a new institute to address new problems rather than re-orient existing programs. Third, nobody questioned the cost of research and its impact. The bigger the institution the more of additional funding could be asked for research expansion and social needs. Fourth, there were no uniform criteria to judge the results of the work of the research program and often no criteria at all. For example, a crop breeding program which did not release any variety for a number of years would still be funded as much as another more successful program.

In rare cases, the government gave 100% of the funds requested. The institutes had their experimental farms with land which was used for production. The profit from experimental farms was partly used to invest in science. Contract research was obligatory for the majority of the research programs. Producers contracted a research unit to produce high generation seeds or adapt new technology to their environment or to make recommendations for soil improvement, etc. The portion of funds received through contract research varied from program to program, but in the mid 80s, accounted for some 5-10%. As the economic situation deteriorated at the end of 80s, the share of contract research in overall funding increased. Normally the money earned by contract research was pooled together and used by the administration to support those programs which were not able to earn funds through contract research. This negatively affected the motivation of scientists to conduct contract research.

The funding of agricultural science was also characterized by very strict rules on how to spend the money. Funds allocated to one budget item by no means could be used for different purposes. As a result, program leaders did not have the flexibility needed to effectively manage their budgets.

The word "grant" was not known to agricultural researchers until the late 80s when the State Committee for Science and Technology started to announce competitive projects, including some related to agriculture. Those grants were small and did not have any significant impact on agricultural research.

Research reporting was done on an annual basis and at the end of the five year planning period. Each research institute had a Scientific-Technical Council. In December each year, the research programs would publicly report to the council what was accomplished during the year. The council critically reviewed the work accomplished and gave suggestions as necessary. A brief written version of the report would be compiled into the overall institute report. Depending on the institute, the director would publicly present the annual report either to the bureau of the subject department or at the meeting of the regional branch of the Academy. The bureaus and the regional Academy branches compiled the institute reports and presented the overall reports at the general assembly of VASKHNIL. Then the Presidium of the Academy provided a final report to the government. Normally, the reports concentrated on what was achieved in science and, to lesser degree, on what impact the program and/or institute made on agricultural production. Very few reports were accompanied by solid impact studies.

Additional reporting was done by the subject coordinators. Though research coordination was one of the prime objectives of the Academy, the way it functioned was always confusing. The chairman of the subject section in the subject department of the Academy was the country coordinator for the problem. The institute where the chairman of the section worked became the coordinating institute. The functions of coordinator were to combine the overall plan of work, compile an annual report from all participating programs and conduct the annual coordination meeting. This was all done in a better or worse fashion depending on the coordinator. At the same time, however, funding was channeled through the subject department of the Academy or regional branch depending on the institute. Only in the late 80s were some minor amounts of money given to coordinating institutes to support the activities of the participating programs. The bulk of the money came to the institutes directly from the Academy.

Since coordinators did not have the financial mechanisms to influence the research agenda, their activity was once again a formality to a great degree. There were a few examples of successful coordinated efforts to address a particular problem, however. The program "North" successfully united several institutions to breed early maturing maize. The program "DIAS" had concerted efforts in Siberia to study the genetics of spring wheat and breed new varieties. However, these programs were the result of individual efforts of the interested scientists rather than the coordinating system of the Academy. *Very little, if any, cooperation and coordination existed between the institutes belonging to Academy, the MOA and the agricultural colleges*. The rare examples of cooperation were based on personal contacts of the scientists.

Review processes and evaluation of research programs. The research institutes were reviewed on a regular basis by a commission consisting of a representative from VASKHNIL headquarters, scientists from other institutes and professional auditors. In some cases, the directors of the institutes were dismissed if irregularities with money were found. These commissions had limited influence on the research structure and agenda.

As mentioned above, there was no uniform criteria to evaluate the research programs. Some authorities (mainly the Communist Party) used the production figures in the region to evaluate the impact of the institute or a research program. The Academy administration was satisfied with the proper reporting and implementation of the five-year plan. The number of publications was taken into account when the promotion of a scientist was considered. There was no formal system of research program evaluation which would be applied to the VASKHNIL institutes.

2.4 National and International Linkages

Figure 5 schematically represents the linkages between the Academy and other organizations. The following is a brief discussion of the linkages of VASKHNIL with the Academy of Science, agricultural colleges and universities, the State Committee for Science and Technology, the Ministry of Agriculture of the USSR, the Ministries of Agriculture of the Republics, scientific societies, agricultural science institutions of socialist countries (e.g., COMECON), and the scientific community of the West.

Certain research conducted within the Academy of Science had application in agriculture. Accordingly, the government always encouraged closer collaboration between VASKHNIL

and the Academy of Sciences. Joint sessions of the two Academies were conducted once in a while. In order to build a bridge, several academicians of VASKHNIL were elected as members of the Academy of Sciences and visa versa. Despite these efforts, cooperation and coordination between the two Academies was insufficient or, as Holderbaum (1993) describes, practically nonexistent. Again, there were a few joint projects despite the high potential of such collaboration. Some very attractive joint programs could have been developed with the Department of Biology and specifically with the institutes which worked on plant biotechnology. This area of research was given high priority in the 80s, however, the investments and the expertise within the agricultural research community was not sufficient to develop the technology. Successful cooperation did take place between the Institute of Physical Chemistry of the Academy of Sciences and many breeding programs from VASKHNIL which were involved in mutation research. The Institutes of Genetics and Cytology in Minsk (Belarus) and Novosibirsk (Russia) enjoyed very close and fruitful collaboration with several breeding programs. Unfortunately, these positive examples were primarily the result of communication and collaboration at the scientist level rather than as structured coordination approaches.

Agricultural colleges and universities prepared human resources for employment in the Academy of Agricultural Sciences. Unfortunately, the relationship between agricultural science and education was very weak. The most important reason was that they were separate structures with weak linkages between their leadership, even though the objectives of the two organizations overlapped. Most educational institutions prepared M.Sc. degree equivalent specialists. Research institutes belonging to VASKHNIL prepared the Ph.D. equivalent specialists (candidates of science). Normally, the bright M.Sc. students would be kept after graduation in the same college or university as assistant professors. However, the Ph.D. degree was required in order to advance to higher levels. The choice was either to enter a three year Ph.D. study program in one of the research institutes or to have it by distance learning and continue teaching. So some professors were exposed to research environment in the institutes and others were not.

Most of the teaching positions allowed only 10% of the time for research. Since the facilities for research in educational institutions were inferior to those in the VASKHNIL system, the scientific level of the professors was by far lower compared to scientists in research institutes. Only elite universities (like those in Moscow and Leningrad) maintained a high level of research for the benefit of the students. Scientists were very rarely invited to give lectures to students or to have a part-time teaching position. Furthermore, there was a low level of rotation within educational institutions and interchange of staff between the Academy institutes and colleges. Again, a key reason was that people were attached to their housing.

The *State Committee for Science and Technology* was responsible for securing a coherent national science and technology policy in accordance with party and government directives (Cooper, 1994, page 291). Its main counterpart was the Academy of Sciences. VASKHNIL was involved in some biology related grants in the end of 80s. However, the areas of interest of the two organizations was quite different.

The relationship between VASKHNIL and *MOA of the USSR* has been mentioned already. The All-Union MOA was essentially the client of the Academy. With the evolution of VASKHNIL, when more and more institutes were transferred from the Ministry to the Academy, the importance of this linkage increased dramatically. However, because of the

conservatism of the Academy, it did not readily respond to new priorities and directions of MOA.

The *Ministries of Agriculture of the republics* had their own research institutes which were gradually transferred to the regional branches of the Academy. By the end of the 80s, the republic's MOAs heavily depended on the Academy and its regional branches. The complex structure of the Academy made it possible for institutes situated in one republic to report to different organizations. One would report directly to Moscow if it belonged to the VASKHNIL subject department. Another would report to a VASKHNIL regional branch situated in another republic. Still other would report to the local MOA. This structure sometimes resulted in ignoring important local problems. The contribution of an institute to the republic where it was situated frequently depended on how strong the MOA lobbying was or how close the relations were between the leadership of MOA and the respective institutes. The republic which hosted a regional VASKHNIL branch often had definite advantages since these institutes would concentrate their efforts on this republic first.

Contrary to the situation in Western countries, *scientific societies* played a minor role in the USSR. The activity of the All-Union Society of Geneticists and Breeders was limited to the organization of meetings every 4-5 years and the publication of their proceedings. There was no regular publication and communication between the members. While the leadership of the society consisted of the academicians of VASKHNIL and the Academy of Sciences, there were no formal linkages between these societies and the Academies.

In the international arena, the highest priority of the Academy was cooperation with the *Academies of Agricultural Sciences of COMECON and other socialist countries.* Most of them copied VASKHNIL in their structure. There were several mechanisms for cooperation. First, one of the most important mechanisms was the establishment of joint research programs addressing common problems. For example, a successful program that focused on winter wheat breeding united plant breeders from Russia, Ukraine, Hungary, Romania, Bulgaria and other countries. This program was coordinated by the Plant Breeding and Genetics Institute and resulted in a number of advanced varieties. Second, cooperation at the institute level was encouraged. This involved both joint research activities and the exchange of scientists. It seems that cooperation and coordination of agricultural research at this international level (COMECON) was much better than at the national level. Third, reciprocal membership in the Academy was one of the mechanisms to maintain communication. In this case, the leaders of an Academy of Agricultural Sciences in a friendly country were elected as foreign members of VASKHNIL and vise versa.

The relationship with the scientific community of the Western countries could be characterized as one of isolation. This isolation was determined by two major factors: the lack of language skills and the very limited exchange of people. As a rule, trips abroad were undertaken by the Academy bureaucrats and rarely by scientists. Some researchers who were invited to attend scientific conferences were not allowed to go due to political reasons. Very few scientists were trained abroad. While they may have learned the languages and knew very well the research system abroad, they were hardly able to apply their knowledge and experience due to the conservative environment in the institutes. This was ironic since the system of agricultural education encouraged and required knowledge of foreign languages. In graduate study, in fact, everybody had to pass a language exam. While many scientists were able to read and understand a foreign language, there was no motivation to learn to speak it.

Most importantly, there were very few joint research programs with institutions from the West.

The Academy realized that physical isolation from the West should not undermine information exchanges. Accordingly, all important scientific journals published globally were received by the Central Agricultural Library and were available to scientists. They were also abstracted in Russian and published on a monthly basis. The libraries of the institutes and individual scientists could easily subscribe to these monthly compilations of abstracts. There was even duplication or overlapping efforts by VASKHNIL and the Academy of Sciences. A journal titled "Agriculture Abroad," published monthly, consisted of literature reviews and trip reports.

The relationship of the Academy with respective institutions in developing countries had political overtones. The governments of friendly countries (Yemen, Angola, Afghanistan) were supported in agricultural research by joint projects with Soviet experts posted there. Some countries were used to establish VASKHNIL outreach locations. For example, the Vavilov Institute (VIR) had one location in Vietnam to regenerate its collection of tropical crops and another in Mexico to tap into local bio-diversity. The All-Union Institute of Phytopathology had a station in Ethiopia to study cereal diseases.

Several centers in the CGIAR system had working relations with VASKHNIL. CIMMYT trained several wheat researchers as far back as 1972 and there were many short-term visits to Mexico after this. A germplasm exchange operated continuously. Similar relations were developed with ICARDA and CIP and VASKHNIL scientists had technical information about research conducted in the CGIAR centers. While they received their germplasm, the way of funding the international centers, their objectives and operational mechanisms were not known.

Both national and international relations of the Academy were realized according to a hierarchy. The institutes would have their own level of interactions, but, they would not be allowed to independently develop a cooperative international research project. As with everything else in society, these international relations were strictly regulated.

3. Evaluation of the USSR Academy of Agricultural Sciences (1929-1991)

In evaluating the agricultural research system of the USSR, the questions of paramount importance are if it was productive in delivering technologies which increased agricultural output and if it was competitive compared to the level of global science development. In analyzing the National Academy of Sciences of the USSR, Cross (1995) points out that the research level in such priority subjects as physics was comparable or higher than in the West. How was it for agricultural science? Pray and Anderson (1997) gave a few examples of excellent achievements in research which were well recognized outside of the USSR. In general, however, the level of agricultural science in the USSR was lower compared to other developed countries due to relative isolation in communications and lack of advanced scientific equipment and computers.

Undoubtedly, agricultural science in the USSR had impact on production and contributed to the steady growth of agricultural output from 1950 to 1980. Crop production was almost entirely based on local varieties using local technologies. A similar situation was observed in animal husbandry. Local technologies were mostly inferior to foreign ones in the processing industry. In stating that agricultural science in the USSR was basically capable of delivering a useful product, two important issues remain. First, what was the cost of the achievements made? Second, would it have been possible to reach the target in a more efficient manner?

The following are listings of some of the advantages and disadvantages of the agricultural research system of the USSR with particular reference to the Academy of Agricultural Sciences (VASKHNIL).

3.1. Advantages

There were several aspects of the Academy of Agricultural Sciences which contributed positively to its ability to serve the agricultural sector. The following advantages may be relevant considerations for the development of the agricultural research systems of the new Republics.

Research network - The Academy and its institutes had the most elaborate research network in the country. The all-union mandated commodity institutes had regional branches and experimental stations in all targeted environments. This network allowed the conduct of comprehensive experiments. For example, the Institute of Fertilizers was able to evaluate the response to major compounds in different crops across the country in 100 sites within 3-5 years. The Vavilov Institute had the network to evaluate genetic resources across the country at its numerous stations.

Communication forum - The Academy scheduled two general assembly meetings each year: a mid-term meeting normally outside of Moscow and an annual meeting at headquarters. These meetings attracted leading scientists, policy makers and representatives of the produces. Both meetings provided an excellent opportunity for communication and exchange of ideas. In addition to these two formal meetings, a number of other meetings and conferences were conducted for scientists of all levels.

Information system - The Central Scientific Agricultural Library and the Institute of Information provided superior services to its corporate and individual clients in literature searches, reviews, etc. The Library had basically all the important global journals related to agriculture. The Institute of Information routinely published abstracts of foreign research papers in Russian. There were from 50 to 60 all-union journals related to agriculture published by either VASKHNIL or MOA.

Recognition of achievements - Membership in the Academy was the most valuable recognition of the achievements of an individual scientist. At the time when financial motivation was very limited, this type of recognition was very encouraging for scientists. VASKHNIL also had a number of its own awards given for outstanding research in a particular subject.

Human resources development - This area was always a high priority for the Academy and attention was paid both to graduate students and post-graduate experiences. Researchers below 35 years of age had their own association of young scientists in each institute. They conducted conferences and produced separate publications. The limited travel abroad was compensated by a number of regional or national meetings and conferences which targeted this specific group of agricultural researches.

3.2. Disadvantages

Some aspects of the Academy had negative consequences. These too bear consideration in the design of national agricultural research systems in the Republics.

Dependence of research on politics - The politicized society had politicized science. There are several examples given in this paper showing that the will of party or an influential individual was extremely important for the development of agricultural science with respect to its priorities and its structure. Nikonov (1990) points out that "The management system tried to make science knuckle down, to make it an extension of itself. This is the main reason for our failures and our backwardness."

The rate of technology adoption - Though each institute had an extension department, there was no functioning bridge between product development and its adoption for commercial use. Science has been turning to industry and has often found no reciprocal interest (Nikonov, 1990). In such circumstances, the scientists themselves had to sacrifice research and act as extensionists to have their product find the way to the producers. As Romanenko (1997) mentions, this is still one of the major problems and concerns for agricultural research in Russia.

Strict government control - All functions of the research institutes were strictly regulated by the government. This left very little flexibility for modifications in financing, research priorities and research structure.

Expanded bureaucracy - Very little can be added to the statement made by Holderbaum (1993): "The Academies, Ministry of Agriculture and State Committees that directed and administered the overall research agendas and budgeting were often viewed as being inflated bureaucracies that were more an obstacle to scientific endeavors than a support mechanism".

Absence of a fair system of evaluation - Depending on the institute, different criteria were used to evaluate a research program. The appointment of independent review teams consisting of prominent scientists was not an approach utilized to evaluate research programs.

Weak economic justification of research programs - In many cases, the size of the research program or the institute was determined by the necessity to implement the objective without taking into account how economically justifiable it was. When research funding was unlimited, this resulted in an over investment in research programs.

Disparity between the number of research and technical staff - Over investment in research coupled with poor work efficiency resulted in a huge number of research positions. At the same time, it was difficult to attract personnel for poorly paid technical positions. As a result, the ratio between scientists and technical staff approached 1:1. In more efficient research programs, this ratio is in a range of 1:2 to 1:4. As a result, many scientists had to implement the duties of technical staff, thus, decreasing the level of their professional output.

Separation between agricultural research and education - The system did not include close relationships between agricultural research and education. As a result, both suffered from isolation.

4. The Development of National Agricultural Research Systems in the Republics (1991-1998)

With the absorption of VASKHNIL into the Russian Academy of Agricultural Sciences in 1992, the other republics were required to define and develop their own national agricultural research systems. As pointed out earlier, each had inherited a particular set of research institutions with different origins and alliances. Not all were or would be useful in their Soviet form for national purposes. Yet, most remained with their staffs, physical assets and histories waiting for their fates to be determined by national policy makers. Table 5 summarizes the changes which have taken place in the agricultural research systems of the republics of Central Asia, the Caucasus, Russia and Ukraine since 1991. Table 6 provides UNDP data on human, physical and economic indicators which form the basis of the size and scope of the research systems of Central Asia and the Caucasus.

The following is a brief summary of the agricultural research systems in the three new Republics of the Caucasus region and the five new Republics of Central Asia. Russia and the Ukraine are added as points of comparison. ISNAR profiles about each of the republics of Central Asia and the Caucasus provide more complete information about their agriculture and their research systems.

4.1 Armenia

There are currently 13 separately managed agricultural research institutions coordinated by the MOA. These institutions employ a total of 517 scientists of which 44 are Doctors and 263 Candidates. Before 1991, most of these institutes and centers were operating in association with institutions in the Soviet Union (many through the Transcaucasus Regional Branch of VASKHNIL) and their programs were determined in large part by these institutions. The only mechanism for funding by the State was initiated in 1994 and consists of competitive support of themes proposed by the institutes to the Prime Minister's Office. The MOA has established a Department of Science and Education to develop and support the national agricultural research and education components of the agricultural technology system of Armenia.

In March 1998, a World Bank loan agreement was signed to develop a well integrated system of agricultural research, education, extension and information. An agricultural research council has been established by the MOA for coordination of a research system which will eventually be integrated with the Armenian Agricultural Academy (university). A total of five research centers will replace the 13 institutes and the university will be the 6th research center. Experiment stations will be rationalized to serve the entire system. Agricultural service centers in each Marz will offer the opportunity for adaptive research, testing and demonstration of new technologies directly to farmers.

4.2 Azerbaijan

There were several agricultural research institutes and stations in Azerbaijan prior to the break up of the USSR. Some belonged to the MOA of the republic and others to the Transcaucasian branch of VASKHNIL based in the Republic of Georgia. One station belonged to the All-Union Irrigation Association under the umbrella of the MOA of the

USSR. Shortly after the independence of Azerbaijan, the majority of the agricultural research institutions (a total of 15) were united under the Ministry of Agriculture. These institutes have a total scientific staff of 825 of which 38 are Doctors and 362 Candidates. In addition, one institute belongs to the State Committee of Melioration and Water Resources and four institutes related to agriculture belong to the Academy of Sciences. An Academy of agricultural sciences, following the VASKHNIL model, was not established in Azerbaijan. The current system of agricultural research in the country is described by Mustafaev (1996) and Aliev & Mustafaev (1997).

The Central Board of Science, Education and Extension supervises the scientific council in the MOA and this is responsible for setting priorities; the development of the strategic research policy; coordination of research, education, and extension; and international collaboration. All institutes work on state contracts and are financed by the government. Four institutes were transformed into Scientific-Industrial Associations as a measure for self-financing agricultural research. The Agricultural Research Institute (crops) in Baku with all its stations was united with 20 farms to form an association. Similar associations were established on the basis of the Vegetable Institute, Horticulture Institute and Forage Institute. In June of 1997, ISNAR conducted a review of the agricultural research system of the country at the request of the Ministry of Agriculture.

4.3 Georgia

Before independence in 1991, Georgia was host to the Transcaucasian regional branch of VASKHNIL. The branch managed a number of institutes across Armenia, Azerbaijan and Georgia. The Georgian Ministry of Agriculture also had several research institutions. Some years after independence, nearly all the agricultural research institutes of Georgia were united within the Georgian Academy of Agricultural Sciences (GAAS) under the former leadership of the Transcaucasian branch.

Aleksidze et al., (1997) provides brief description of the Academy objectives and its structure. There are currently 11 institutes and 5 centers in a system of 876 scientists of which 56 are Doctors and 435 Candidates. GAAS is an independent, self-managing, scientific organization based on democratic principles. The main goal of this Academy is to establish priorities for scientific and technological progress and conduct research to develop the agro-industrial complex of Georgia. One of the main functions of the Academy is financing basic and applied priority research through agreements with research institutions on a competitive basis. The current organization of GAAS basically copies the VASKHNIL structure. Agricultural education is concentrated in the Georgian Agrarian University (GAU) which is one of the oldest in the USSR (founded in 1918). Other educational institutions involved in research are the Zootechnic Training and Research Institute and the Institute of Subtropical Farming. These educational institutions are independent from GAAS and there have been few functioning linkages among them.

4.4 Kazakstan

In 1941, VASKHNIL established in Almaty its Kazak Regional Branch which was transformed into the Kazakstan Academy of Agricultural Sciences in 1957. In 1962, the Academy was closed and all research institutions were placed within the Ministry of Agriculture. In 1971, the Eastern regional branch of VASKHNIL was established

(Anonymous, 1997d). Most of the ARIs in the Kazak Republic were part of this branch, with the exception of the Cereals Production Institute in Akmola which had an all-union mandate and reported directly to Moscow.

In 1990, all research institutions Kazakstan were united to form the Kazakstan Academy of Agricultural Sciences (KAAS). The Academy copied the VASKHNIL structure. There were six subject departments in KAAS uniting 32 research institutes, 28 experimental stations and 45 experimental farms (Kaliev & Suleimenov, 1995). Research management and coordination was done through the subject departments and coordinating institutes. KAAS was an association of both the institutes and the scientists.

During 1996, the system of agricultural science in the country was reorganized. KAAS was transformed into the National Academic Center of Agricultural Research (NACAR) and became a part of the recently established and combined Ministry of Science/Academy of Sciences. NACAR currently comprises 29 institutes, 13 experimental stations and 36 experimental farms with a total planted area of 345,000 hectares 1997. The academicians and the corresponding members of the KAAS have become members of the Academy of Sciences of Kazakstan. Figure 6 presents the overall relationship between agricultural science, production and the local economy as it is currently viewed in Kazakstan (Satybaldin, 1997b).

Though the structure of the NACAR is essentially the same as it was for KAAS, management and coordination procedures have changed. Currently, headquarters only defines the strategic plan for the major national research programs and participating institutions which also include agricultural universities and research institutes outside of NACAR. The technical coordination implementation of programs is delegated to the regional research institutes. NACAR encourages the research institutions to establish private or semi-private consulting, extension and training companies which can earn money to support scientists and to invest in research. The funding of agricultural research is currently channeled through 12 national programs. The distribution of funds and personnel between different subjects is presented in Table 3.

4.5 Kyrgyzstan

In 1995, the agricultural research system of Kyrgyzstan comprised five research institutes which were in the network of the Ministry of Agriculture and Water Resources (MAWR). They included the Institute of Cropping Systems, Institute of Forage and Pastures, Institute of Soil Science, Institute of Veterinary and Institute of Animal Husbandry. The total staff of these Institutes was 442 of which 203 were scientists. Another agriculture related institute, Biochemistry and Plant Physiology, is within the national Academy of Sciences.

In 1996, a reorganization of the agricultural research system took place based on advantages foreseen in combining education and research. Accordingly, all five MAWR research institutes were subordinated to a newly established Kyrgyz Agrarian Academy which is now the major agricultural research and education institution in the country. The Academy is a management entity that is responsible directly to the Cabinet of Ministers. It is currently not an association of scientists. Research funding, management and program coordination is concentrated in the Academy administration. As in other countries, the funding of research has diminished, but the number of research programs has remained basically the same.

Currently, plans are being made to develop a large project for further reforms in the agricultural research and education system.

4.6 Tadjikistan

Before 1991, there were seven agricultural research institutes in the country which were either part of the Central Asian branch of VASKHNIL or belonged to the MOA of the republic. All of them remained until 1997 and form the agricultural research network in the country. The current structure is confusing. The Tadjikistan Academy of Agricultural Sciences claims that the agricultural research institutes belong to it. The Ministry of Agriculture (MOA) provides a structure clearly indicating that the research institutes are included in their respective ministry departments. From this structure, the Academy seems to be more a consultative organ rather than an executing agency. The Academy has few personnel and is currently involved in the preparation of the laws, the evaluation of major agricultural projects, and in conducting meetings between researchers and producers.

The research priorities of the institutes are set by the MOA. Day-to-day management is implemented by the respective deputy minister. All institutes have suffered uncontrolled downsizing, mainly because many experienced scientists of non-Tadjik nationality left the country. The institutes conduct only the most essential operations utilizing manual labor even for planting and harvesting because much of the farm machinery was destroyed during the civil war. The most important tasks at present are the revitalization of the research infrastructure, incorporation of the institutes in the regional and global scientific community, and the training of scientists. For the mid- and long-term periods, the concept of agricultural research and education needs to be further developed.

4.7 Turkmenistan

Before 1991, there were twelve agricultural research institutes in Turkmenistan. By the order of the President of the country, the institutes were united to establish the Turkmenistan Academy of Agricultural Sciences. Some institutes were subsequently merged and by 1995, there were six agricultural research institutes. The structure of agricultural research in the country in 1995 and in 1997 remained essentially the same with the exception of a change in the apex body.

Designed to be self-financed, the new Academy used its about 25 000 hectares of land to produce cotton and process this production in its own plants. The profit was then invested in agricultural research and used for salaries and operating costs. At that time, the Academy and the institutes were said to be financially sound. In early 1996, the President of the country dissolved the Academy. The Academy was then transformed into the Turkmenistan Agricultural Research Institute and it was required to divest of some of its land and all its cotton processing plants. Despite the transformation of the Academy into the Institute, very little has changed in terms of research management. Former institutes (now departments) are physically separated and maintain a high degree of independence from each other. The reorganization was coupled with frequent change in leadership. Furthermore, it has negatively affected the financial status of the institutes.

4.8 Uzbekistan

At the time of the USSR, Tashkent hosted the Central Asian Regional Branch of VASKHNIL. Due to the importance of agriculture for the country, this Branch traditionally had a well developed network of agricultural research. Shortly after the break up of the USSR, the research institutions were united within a newly established Uzbek Academy of Agricultural Sciences. The Academy was an autonomous structure responsible for agricultural research in the country. Both the institutes and individual scientists were members of the Academy. The Ministry of Agriculture and Water Resources has in its structure one research institute working on water resources and four agricultural education institutions.

In 1996, a reorganization took place which resulted in the transformation of the Academy into the Scientific Production Center of Agriculture (SPCA) subordinated to the Cabinet of Ministers. The SPCA comprises 19 research institutes with 26 branches and experimental stations and 23 experimental farms (Usmanov & Azimov, 1997). The SPCA employs 2,850 scientists and possesses 109,000 hectares of arable land including 43,000 hectares which are irrigated. The institutes are funded by the government while the experimental farms are self-financed.

The SPCA institutes are involved in ten research programs. The first three priority programs relate to the development of effective, resource-saving technologies for grain, cotton and vegetable production. Researchers from the Academy of Sciences and educational institutions are also involved in the implementation of these programs. A significant change in the structure of the SPCA, as compared to the Academy is the establishment of some ten regional departments of the Center in each administrative unit (oblast) of the country. The prime responsibility of these departments is extension and the introduction of the new technologies and products developed by the SPCA (Usmanov & Azimov, 1997).

4.9 Russia

As mentioned above, immediately after the break up of the Soviet Union, the Russian Academy of Agricultural Sciences (RAAS) was established by uniting the All-Russian Academy of Agricultural Sciences and VASKHNIL. The share of agriculture (including agricultural research) in state expenditures decreased from 12% in 1991 to 6% in 1994 and to 3.2% in 1996 (Anonymous, 1996). This reduction was reflected in the funding of agricultural science within the structure of RAAS and MOA. In 1996, for instance, the plant breeding centers within RAAS received from the state 44% of their budget (Anonymous, 1997a). Despite this severe budget constraint, the structure of RAAS and the number of the institutes has remained essentially the same as at the time of its establishment.

Initially RAAS was established as an independent organization (Romanenko, 1993), but later, it was transferred under the umbrella of the Ministry of Agriculture. RAAS still maintains a high degree of independence. The President of the Academy is the Deputy Minister of Agriculture.

The resources of the RAAS as of April 15, 1997 (Anonymous, 1997b) are presented Table 4. The Academy employs 17,000 researchers including more than 1,000 doctors of science and 6,500 Candidates of Science. There are 405 experimental farms with a total area exceeding 7

million hectares including 1.7 million hectares of arable land. Annual gross production of agricultural products within the Academy totals about $1 billion (Romanenko, 1997).

The management of research remains largely the same as in VASKHNIL. The financing and coordination of agricultural research is currently executed through federal or regional targeted programs. The RAAS is involved in 31 agricultural research programs, 2 federal programs financed by the Ministry of Science and 26 international projects. Depending on the mandate of the institute, state funding varies from 80% (national mandate commodity or subject institutes) to 20% (regional or local mandate institutes covering all aspects of agriculture). The rest comes from production and contract research with producers. As a result of reduced funding, some institutes suffered up to 60-70% reduction in staff in 1997 compared to 1990. The official figures put the total number of scientists in Russia in 1994 as 67.7% compared to 1990 level (Anonymous, 1994). Unfortunately, it is the younger and the brighter people who are leaving. The agricultural educational institutions in 1993-94 attracted 14% less students compared to the 80s (Anonymous, 1994). The separation between agricultural research and education remains the same as in the USSR.

President Romanenko (1997) of RAAS, while summarizing the results of the first five years of Academy activities, pointed out that the weakest point is the application of research results in practice. The extension services of the Academy do not have the resources to introduce new products. On the other hand, the producers are weak economically and are not able to pay extra for the development of new technology.

The objectives of RAAS as stated in 1998 (Anonymous, 1998) are:

- the development of basic and priority applied research for the agro-industrial complex of Russia;
- to study the trends of the development of the agro-industrial complex and its future;
- scientific support of the agro-industrial complex, agrarian reforms and rural development;
- to study, summarize and disseminate advances in national and global science; and
- human resources development and training.

The Academy and the Ministry of Agriculture have recently jointly drafted "The concept of the improvement of the system of research support for the development of agro-industrial complex of Russian Federation" (Romanenko, 1997). The concept defines the research priorities for the Academy. It also defines the mechanisms of research planning, funding, management and implementation of the results. The necessity of restructuring and optimizing the research network is mentioned. The obvious tendency at present is a decreased share of the funds coming to the research institutes through the Academy.

4.10 Ukraine

The national agricultural research system of the Ukraine was established in December 1990, one year before the break up of the USSR. At that time, Ukraine hosted the Southern Regional Branch of VASKHNIL with its developed network of research institutes. A few all-union mandated institutes under direct management from Moscow were also situated in the

Ukraine (the Plant Breeding and Genetics Institute in Odessa was one such institute). In 1991, all of these institutes were transferred to the newly established Ukrainian Academy of Agricultural Sciences (UAAS). The Academy is an independent self-governing organization under the Cabinet of Ministers. However, the President of the Academy is, at the same time, the Deputy Minister of Agriculture.

Very few changes in UAAS took place in the course of the 90s to respond to the changing agricultural situation. Its structure and management remain largely similar to VASKHNIL. It is also both an association of institutions and an association of scientists. The UAAS now comprises 45 academicians, 59 corresponding members and 21 foreign members (Anonymous, 1993). The Academy research network comprises 177 institutions including 51 research institutes, 17 regional experimental stations and 7 commodity experimental stations. The production base consists of 228 experimental farms with a total of 800,000 hectares. The UAAS employs 127,000 people including 7,000 scientists.

Agricultural research is funded though government, contracts and other sources. The funds from the government are distributed on a project and competition basis. The research agenda of the institutes and stations is included in 15 national and a number of regional programs. For each program, a coordinating institute is designated and this institute forms the coordination council to manage the program. At present, the research institutes in Ukraine suffer from low funding. In 1996, government funding of agriculture (including research) decreased 7.5 times (Anonymous, 1996b). Lack of funds for scientific information, scholarships, and the purchase of foreign equipment negatively affects research output. ISNAR reviewed the system in the summer of 1997.

5. Future Prospects for Agricultural Research Reforms in the Republics

What is the future for the agricultural research systems of these new republics? This question is strongly imbedded in the minds of the scientists and of increasing concern to agricultural leaders and government policy makers. While the actual future remains unknown, there are some observable trends and experiences with strategies which may be indicators of the near term destinies of these agricultural research systems.

5.1 Current Trends in Reforming Agricultural Research

There are several common trends in the evolution of the agricultural research systems of the republics of Central Asia and the Caucasus which can be observed. The future development of agricultural research in these countries requires attention to these trends.

Strict state control of the NARS - The control of government over the agricultural research system in all the countries has remained, although it is not as strong as in the USSR. Since less and less funds come to the institutes from the state through academies or other structures, they feel less dependent on these structures in terms of priority setting and research implementation. On the other hand, the bodies which manage science (academies or centers) want to continue to exercise significant control over research programs.

Strong necessity to optimize the system - The evolution and the changes in the NARS of the states of the FSU clearly indicate that the government and the research establishment are preoccupied with the status and efficiency of the system. In many countries, the research systems have been reorganized using a pragmatic approach. Unfortunately, these reorganizations do not take into account the knowledge and experience accumulated abroad to avoid common mistakes.

Two approaches in NARS organization - The evolution of the NARS of the FSU countries have developed along two distinct patterns of organization: (1) the VASKHNIL type Academies and (2) the more practical production-oriented structures which are either independent or subordinated to the MOA. This, in a way, proves the conclusions of Balazs (1997) about the future of the Academies in the Eastern block countries. She stated that since some of them have gained political power, they will stay. On the other hand, if the organization and management of research in the Academies continues to remain inefficient and unresponsive to changes in the agricultural sector, they will not have a future.

Conservatism in management structure - The last President of VASKHNIL, A. Nikonov, optimistically stated in 1990: "We are departing from the rigid structure of research groups to give them creative freedom. These changes will also lead to the improvement of the quality of studies, the reduction of research time and the increased responsibility of scientists." Unfortunately, this has not happened. Balazs (1997) views conservatism as a major obstacle in the development of science. The procedures for planning, funding, coordination and evaluation have undergone some changes, but are not yet significant enough to have an effect on research efficiency.

Funding constraints and downsizing - The NARS of all the FSU countries have experienced severe budget cuts. This has resulted in reduced operations and low salaries.

Some uncontrolled downsizing of staff took place when funding and programs shrunk and others closed; but, the number of institutes has basically remained as before 1990. Only a few NARS revised their whole system and were able to close entire research institutions. The recent organization of parallel private or semi-private enterprises to support research and scientists is symptomatic for this period.

Changing research priorities - Holderbaum (1993) listed "reformed research objectives to address the new needs" as one of the conditions for the research institution to survive the period of restructuring. One of the major priorities at the present time is to assist in the development of the concept of agricultural reform and accompanying laws and regulations. More emphasis is given to the commodities which provide self-sufficiency in meeting basic food requirements, such as wheat in Central Asia. Every single NARS is preoccupied with genetic resources it terms of their collection, documentation, conservation and utilization. Ecological problems of agricultural production, which were long ignored, are beginning to attract much more attention at present. Technologies and genotypes for low input agriculture are being developed.

Disintegration of established scientific contacts and projects within the ex-USSR - This is one of the most negative consequences of the evolution of the system. Researchers communicate very little between countries at present. This results in duplication of research efforts between the countries. For example, it would be surprising if the Viticulture Institutes of Georgia and Azerbaijan had different research agendas. Taking into account the similarity in environment and the scarce resources for funding, regional and sub-regional cooperation, especially in Central Asia, would be advantageous to all at the present time.

Improved communication/collaboration with the global scientific and donor communities - This is undoubtedly a positive development. The exchange of scientists builds the basis for communication and cooperation. However, the process is by no means easy due to very different mentalities and approaches. The first contacts are normally followed by disappointment of both sides. The NARS have high expectations from the foreign research community and from the donors. On the other hand, their understanding of cooperation is in terms of big projects with major investments in infrastructure, machinery and, possibly, an improvement of salaries. Foreigners with financial resources are not willing to be involved in such projects, but prefer small, targeted projects where the results can be obtained in two to three years. Lack of information about the country sometimes results in proposals that make local scientists laugh because the problems suggested were already studied a long time ago. Gradually, while the process of learning about each other continues, cooperation gains momentum to the satisfaction of both sides.

Technical assistance from the West - Increased technical assistance is the reality of agricultural science, more in some countries than the others. Some common mistakes were listed by Bo Libert (1995): "Too often, projects reflect the interests of the funding organization or country rather than real needs. The number and size of projects are often not correlated with the magnitude of the problems in different regions. Too little effort is devoted to understanding the people and culture. Important stake-holders are often not properly involved in the projects. As the different bilateral donors have relatively small resources, the projects have rarely gone to the core of the problems. Seminars and feasibility studies are organized, but there is no strategic approach. Frequently, when the specialists from the West (often duplicating each other's work) have identified the problems already known to local

specialists, no resources are left to solve these problems." An important development in this area is the growing understanding among NARS leaders that no one will come and make their sector (country) prosper unless everybody contributes to this goal.

5.2 Application of Strategies for Reforming Agricultural Research

Stanley R. Johnson (1993), in his fundamental paper devoted to the subject addressed in this paper, outlined several alternative strategies for the development of the agricultural research base of the newly independent states. Five years have passed since his paper was published. The following is an assessment of the extent to which these alternative strategies have been applied in the newly established Republics and their implications for the future.

Preservationist - This strategy refers to the forces in the existing scientific communities which seek to maintain the current agricultural research and technology development system. Due to lack of finances, the likely outcome of this strategy was the downsizing of existing research institutions. The changes in the NARS described in this paper over the period of the last 3-5 years indicate that this strategy was dominant in the NARS development and evolution in the Republics.

Facilitating adaptation - According to this strategy, available resources would be allocated with significant incentives for adapting to the new economic and structural realities of the agricultural sector. The adoption of this strategy would imply a reorganization of the institutes with the emphasis on technology adoption, increased merging of research with education, and increased dissemination of research results. Some elements of this strategy were implemented in the NARS of the Republics. Kyrgyzstan, for example, merged educational and research systems, but retained former and unsustainable production units. In general, research institutes are slowly turning to the needs of producers. However, this strategy has not been dominant in last 5 years.

Differential support for applied and basic science - The strategy is for the state to support basic agricultural research in order to preserve scientific potential with the hope that the emerging private sector would fund applied research. To a certain degree, this concept of funding is accepted in the Russian Academy of Agricultural Sciences. Major institutes with national mandates have some 70-80% of their budgets paid by the government compared to 40-50% of the regional ARIs. However, the budget of these basic institutes/departments is still too low to be productive. The separation between the two was also made in Kazakstan with the opposite approach. Here, basic science receives just enough to survive during this difficult period.

A cottage industry - This strategy is designed to protect the key (highly qualified) scientists and research programs by full funding of their activities at the expense of the other programs. There are no indications that this strategy was applied in any of the NARS considered in the paper. As predicted by Johnson (1993), many internationally recognized scientists left for abroad. The movement of scientists within the FSU can not be ignored as a number of key researchers immigrated from Central Asian countries to Russia and Ukraine.

Import technology - This strategy implies importation of research products and technologies from more developed countries. There are certain elements of this strategy taking place, especially in the processing industry. On the NARS level, this strategy is, to a large extent, applicable in Tadjikistan where civil war nearly ruined research infrastructure and there was a

high degree of erosion of qualified scientists. There currently is and, in the future, there will be more of an element of technology spillover in all countries.

6. Conclusions

Agricultural research in the Soviet Union was highly organized, fully funded and overcapitalized. The newly independent countries of the former Soviet Union inherited from this system a number of agricultural research institutions designed to serve a large single country with a command economy. The new Republics were then left with the daunting task of creating effective and sustainable national systems to serve national needs.

The dominant strategy for dealing with agricultural research institutions, among the five mentioned by Johnson (1993), was the one which has the effect of maintaining the existing institutes as a system, i.e., preservationist. This appears to be true despite the very strong desire to optimize the agricultural research system by both scientists and selected government agencies. However, the importance of a scientific and systematic approach to this optimization is underestimated. The future development of these research systems will largely depend on the political will of the NARS leadership to take bold steps in reforming their agricultural research systems and in developing a sound strategy for this process. This strategy must take into account future demand for agricultural research as reflected in emerging local and international markets and be conditioned by the optimal utilization of the physical resources available.

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Tables

Table 1. - Changes in the Structure of Agricultural Research Organizations in the Republics of the USSR during 1950-1990.

Period	**Ukraine, Belorussia, Uzbekistan, Kazakstan, Georgia**	**Armenia, Azerbaijan, Kyrgyzstan, Tajikistan, Turkmenistan,**
Early 50s	Academy of Sciences of the republic	Academy of Sciences of the republic
Late 50s	Academy of Agricultural Sciences of the republic	Ministry of Agriculture of the republic
Mid 60s	Ministry of Agriculture of the republic	Ministry of Agriculture of the republic
70s and 80s	Regional Branch of VASKHNIL and Ministry of Agriculture of the republic	Part of a Regional Branch of VASKHNIL and Ministry of Agriculture of the republic

Table 2. - Distribution of USSR Agricultural Research Institutes by Subject*

Subject/Activity	**Total Institutes**		**VASKHNIL Only**	
	No.	%	No.	%
Economics and organization of production	31	6.8	17	7.4
Soil science and cropping systems	78	17.1	40	17.5
Crop science and breeding	94	20.7	73	32.0
Plant protection	19	4.2	7	3.1
Animal husbandry	49	10.7	30	13.1
Veterinary science	29	6.4	18	7.9
Mechanization and electrification	18	4.0	13	5.7
Processing	40	8.8	27	11.8
Land reclamation and water resources	27	5.9	-	-
Fishery	11	2.4	2	0.9
Forestry	17	3.7	1	0.4
Construction design	41	9.0	-	-
Total	454	100	228	100

* From Nikonov 1990

Table 3. - The Distribution of Research Funds and Scientists by Subject within NACAR, Kazakstan, 1997 [*]

Subject	**Funds, %**	**Scientists, %**
Grain Production	27.6	25.3
Water Resources	2.3	2.3
Animal Husbandry	21.3	26.4
Agroecology	1.9	2.2
Forage and Pastures	15.2	13.2
Medicinal Crops	0.5	2.2
Vegetables and Potato	12.9	8.3
Veterinary	8.7	6.9
Economics	4.8	4.8
Forestry	2.7	2.6
Industrial Crops	2.6	3.0
Food Industry	1.2	1.4
Total	100	100

[*] From Satybaldin, 1997b

Table 4. - Agricultural Research Resources in the Russian Federation, 1994 [*]

Resources	**Academy of Agricultural Sciences**	**Agr. Colleges & Univ.**	**MOA, Dept. of Science**	**Total**
Number of Research Institutions	235	91	91	417
Research Institutes Only	194	63	49	306
Number of Scientists	22,000	1,200	4,200	27,400
Doctors of Science	950	58	167	1,175
Candidates of Science	7,400	452	1,413	9,265
Land (million hectares)	7.4	-	0.4	-

[*] From Nikonov, 1995, page 488.

Table 5. - Summary of Changes in the NARS of the Independent States of the ex-USSR and their Current Status

Country	**Arable Land, mln ha**	**NARS when Established**	**NARS Reforms**	**NARS Organization in 1997**	**NARS Superior Body**	**No. Institutes**
Armenia	0.5	Ministry	1998	Ministry	MOA	13
Azerbaijan	1.6	Ministry	-	Ministry	MOA	15
Georgia	0.8	Academy	-	Academy	COM	16
Kazakstan	35.0	Academy	1996	Center of Agr. Research	MOS-AS	29
Kyrgyzstan	1.4	Ministry	1995	Education and Research	COM	5
Tadjikistan	0.8	Ministry	-	Ministry	MOA	8
Turkmenistan	1.4	Academy	1996	Institute	MOA	7
Uzbekistan	4.1	Academy	1996	Center of Agr. Research	COM	19
Russia	132.0	Academy	-	Academy	MOA	203
Ukraine	31.0	Academy	-	Academy	COM	51

Table 6 - CAC Country Data

1 - Human Indicators, 1994

Countries	**Est. Pop. (millions) 1994[1]**	**Pop. Growth (% per year) 1960-1994[2]**	**Pop. Density (persons/ ha) 1994[3]**	**Labor Force in Agr. (%) 1990[4]**	**Human Dev Index 1994[5]**
Caucasus					
Armenia	4	2.0	1.34	18	0.651
Azerbaijan	8	1.9	0.92	31	0.636
Georgia	6	0.8	0.86	26	0.637
Central Asia					
Kazakhstan	17	1.5	0.06	22	0.709
Kyrgyzstan	5	2.1	0.25	32	0.635
Tajikistan	6	3.0	0.42	41	0.580
Turkmenistan	4	2.7	0.08	37	0.723
Uzbekistan	22	2.9	0.49	35	0.662

2 - Physical Indicators, 1994

Countries	Total Land Area (000 ha) 1994[6]	Arable Land (000 ha) 1994[7]	Arable Land (% of total) 1994[8]	Arable Land/Person (000 ha) 1994[9]	Irrigated Land (% of arable) 1994[10]
Caucasus					
Armenia	2.980	483	16.2	0.1	59.4
Azerbaijan	8.660	1.602	18.5	0.2	62.5
Georgia	6.970	697	10.0	0.1	57.1
Central Asia					
Kazakhstan	271.730	34.510	12.7	2.0	6.4
Kyrgyzstan	19.850	1.409	7.1	0.3	64.3
Tajikistan	14.310	816	5.7	0.1	78.9
Turkmenistan	48.810	1.415	2.9	0.4	92.9
Uzbekistan	44.740	4.116	9.2	0.2	97.6

3 - Economic Indicators, 1994

Countries	GNP (billion US$) 1994[11]	GNP annual growth (%) 1980-1993[12]	GNP per capita (US$) 1994[13]	Real GDP per capita (PPP$) 1994[14]	Agriculture in GDP (%) 1994[15]
Caucasus					
Armenia	3	-14.8	680	1.737	49
Azerbaijan	4	-4.5	500	1.670	27
Georgia	-	-9.4	-	1.585	61
Central Asia					
Kazakhstan	19	-2.0	1.160	3.284	44
Kyrgyzstan	3	0.2	630	1.930	37
Tajikistan	2	-4.0	360	1.117	-
Turkmenistan	-	-	-	3.46916	-
Uzbekistan	21	1.7	960	2.438	33

Sources - UNDP Human Development Report 1997

1 UNDP Human Development Report 1997. p. 218 Table 43, column 2

2 ibid. p. 218 Table 43, column 2

3 calculated from Estimated Population, Table 1 column 1 / Total Land Area, Table 2 column 1

4 UNDP Human Development Report 1996. Labor force in agriculture is not provided for these countries in the 1997 report.

5 UNDP Human Development Report 1997 p. 159 Table 5 column 5 ,p. 147 Table 1 column 9

6 ibid p. 220 Table 43 column 1

7 calculated from columns in this table

8 UNDP Human Development Report 1997 p. 220 Table 43 column 3

9 calculated by Arable Land / Population.

10 UNDP Human Development Report 1997 p. 220 Table 43 column 4

11 ibid p 223 Table 46 column 1

12 ibid p 223 Table 46 column 2

13 ibid p 204 Table 27 column 11. Taken from the World Bank World Development Report 1996. More recent figures were not available to 1994.

14 ibid p 147 Table 1 column 4

15 ibid p 222 Table 45 column 2

16 Preliminary update of the Penn World Tables using an expanded set of international comparisons, as described in Summers and Heston 1991

Figures

Fig. 1. Agricultural research structure in the USSR

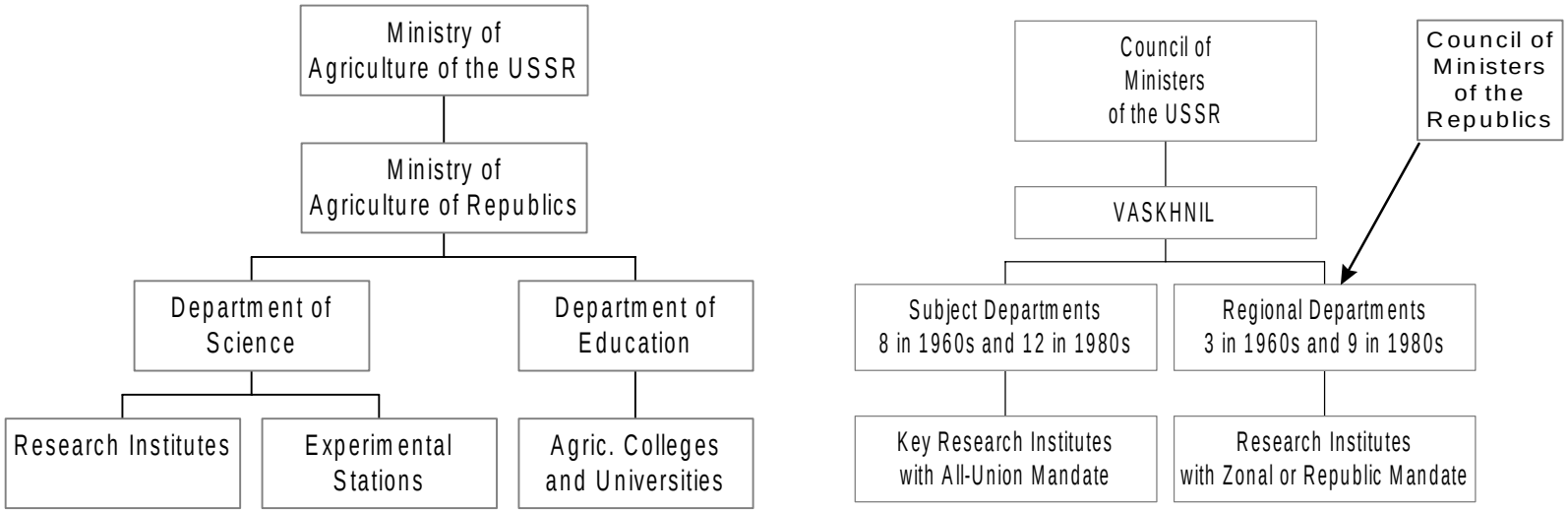
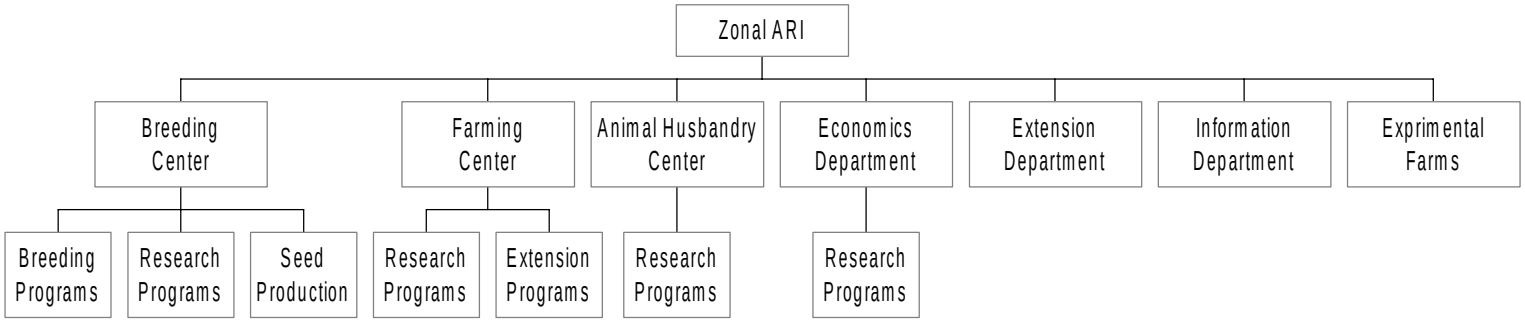


Fig. 2. Typical structure of a zonal research institute in the USSR in the 80s.



Average number of personnel in the ARI - 700-1000
Number of scientists - 100-200
Number of experimental farms - 3-5

Fig. 3. Administrative and scientific structure of VASKHNIL headquarters

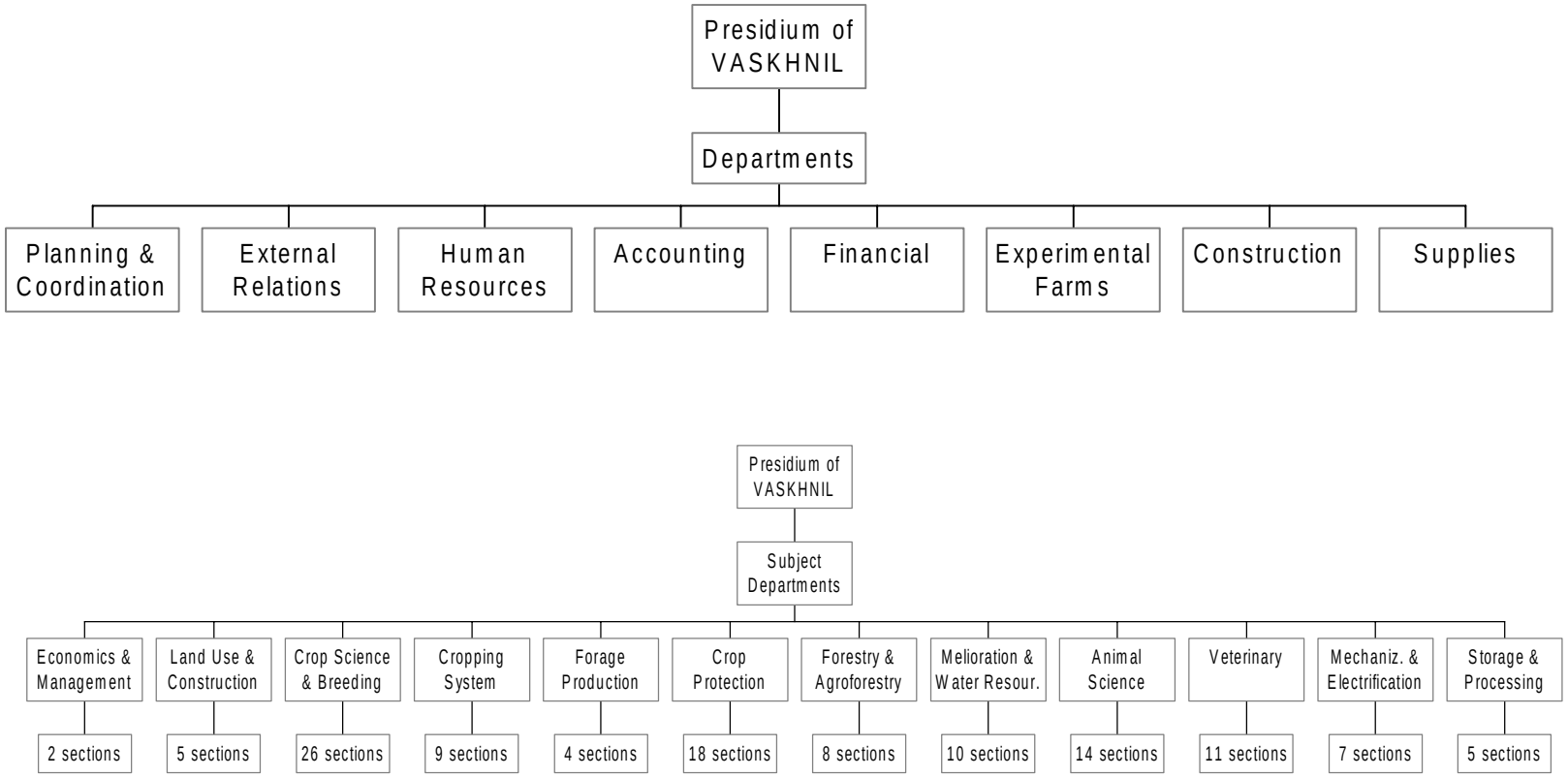


Fig. 4. The structure of the Department of Cropping System of VASKHNIL in the late 80s.

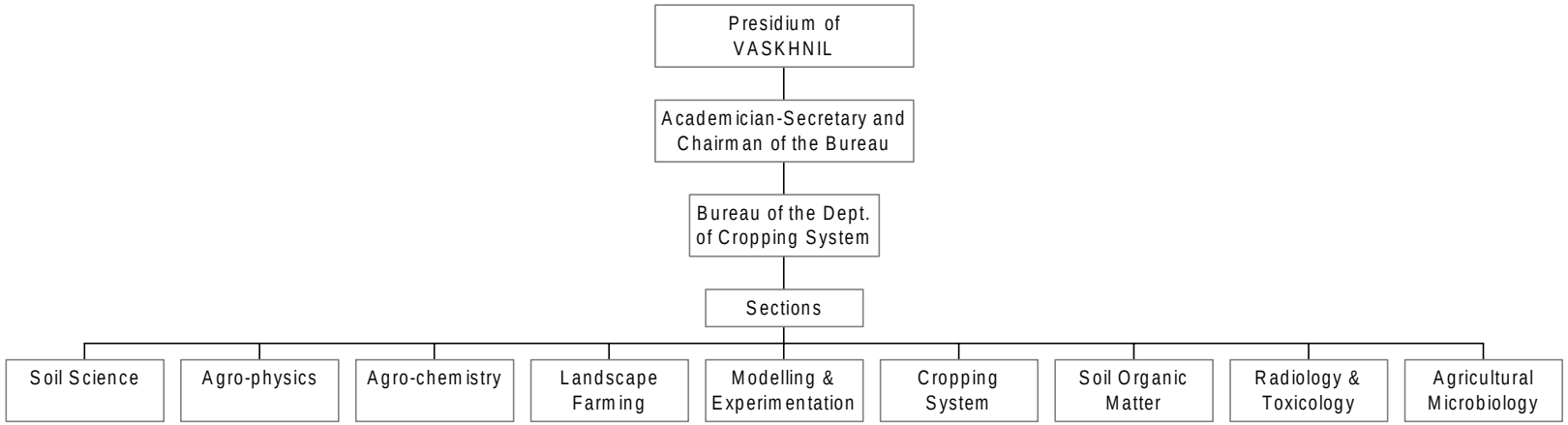


Fig. 5. The linkages of VASKHNIL

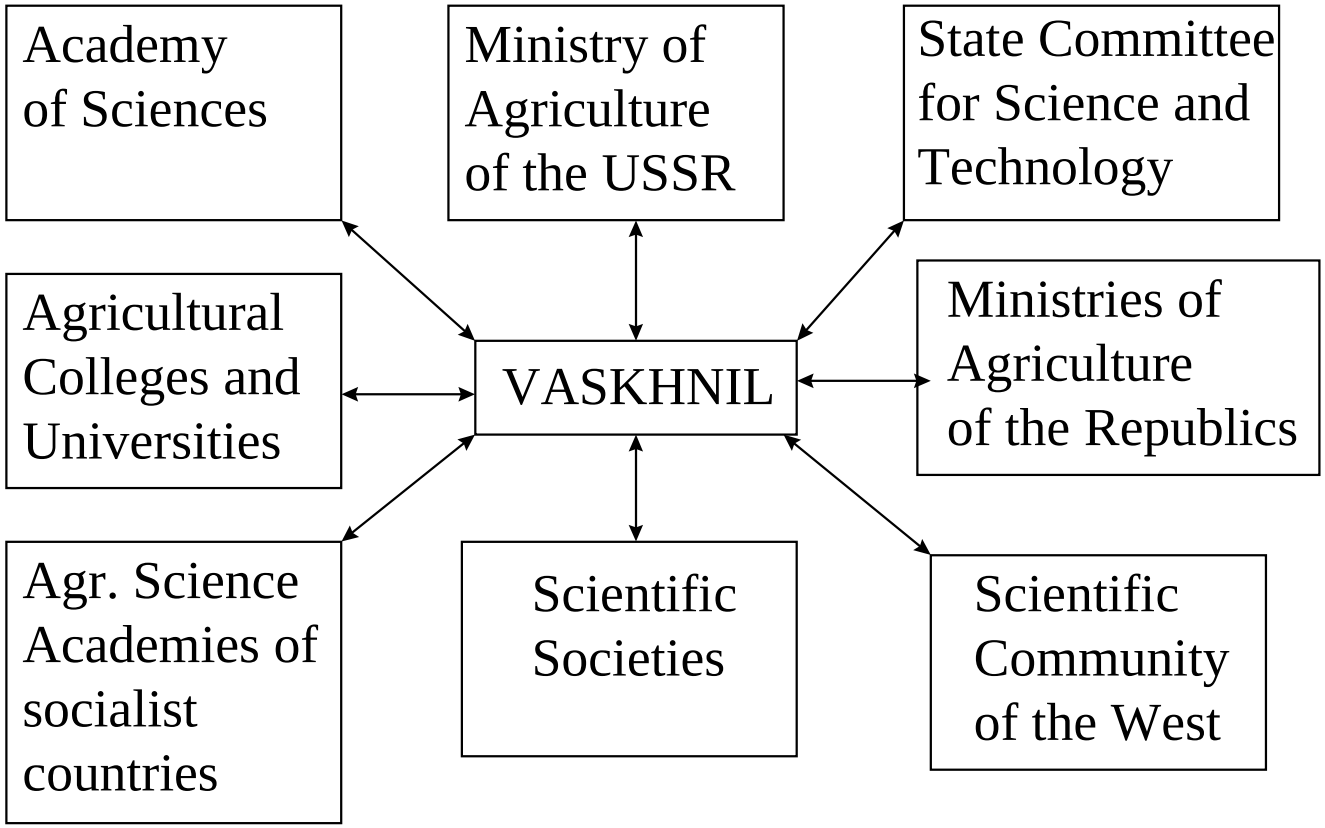


Fig. 6. Relationship between agricultural research system and other spheres on regional level in Kazakstan (Satybaldin, 1997b)