Science Versus Ideology*

The Contribution and Martyrdom of Nikolai Vavilov

Sujata Deshpande

This is the story of an outstanding plant geneticist who was determined to use modern science to rescue the starving citizens of his motherland from a series of frequent and severe famines but tragically fell prey to terrible socio-political changes that eventually made him die of starvation in a prison. This plant geneticist is Nikolai Ivanovich Vavilov, who made numerous, far-reaching, original contributions to basic and applied fields of genetics and agriculture. Some of his major contributions are the establishment of the largest seed bank in the world of his time, the idea of 'homologous series in hereditary variations', and the concepts of 'centres of origin of cultivated plants' and of 'genetic erosion'.

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Early Life

Nikolai Vavilov was born on 25th November 1887 to Ivan Ilyich Vavilov and Alexandra Mikhailova Vavilov in Moscow. Ivan Vavilov came from a peasant family of freed serfs (forced labourers). However, he decided not to follow farming but to be part of the industrialization that was growing at the time. He joined a textile firm as an errand boy and, through his hard work and organization skills, eventually climbed to the top ranks in the firm. A leader in the Moscow City Council, he was a wealthy man with liberal and humanitarian views, who provided the workers of his textile factory fair wages, good working and living conditions. Nikolai Vavilov's mother was the daughter of a fabric designer in the textile industry. Ivan and Alexandra married in 1884 and had seven children. Among the children surviving to

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adulthood were two daughters – Alexandra and Lydia – and two sons – Nikolai and Sergei. Though they were well off, Ivan Ilyich and Alexandra Mikhailova brought up their children in a simple and modest household, in which rules of hard work and discipline were strictly followed. As their father saw it and was a custom of that time, the daughters went on to get a medical education and the sons were encouraged to take up commerce. However, Nikolai and Sergei were fascinated by science from an early age and eventually followed their interests in botany and physics, respectively, to become renowned scientists in their fields. The books by John Pringle [1] and Igor Loskutov [2] give a detailed account of Nikolai Vavilov's life. This article is based on the biographical information given in these books in addition to other references cited.

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Nikolai Vavilov's life is a complex fabric woven from the events of personal importance as well as that of scientific and socio-political significance at the national and international levels. To understand his life, one needs to look closely at the scientific developments in biology and socio-political upheavals that took place during 1880–1940. In about less than three decades before Vavilov's birth, the world had seen the publication and rise of Darwin's theory. Augustus Weismann had disproved the theory of inheritance of acquired characters; however, this theory was to maintain its hold in Russia and become one of the reasons for Vavilov's end. Soon after Vavilov's birth, came the Great Famine of 1891 which took thousands of lives in Russia. More famines (natural and/or man-made) were on the way to strike the Russian land. In 1900, Mendel's theory was rediscovered [3]. In 1905, the British biologist and one of the main popularisers of Mendel's theory, William Bateson, coined the term 'genetics' [4], and this new branch of biology was rising fast in America and Europe. The first major event of the Russian revolution took place in January 1905 (Bloody Sunday) in the form of Czarist guards firing at the peaceful demonstration that demanded better working conditions for workers and killing one hundred and thirty unarmed people. The socio-political situation in Russia was becoming turbulent. Russia was going to experience revolution and civil war from 1917 to 1923. The world was going to see the two great wars – World Wars I (1914–18) and II (1939–45).

Graduation

Nikolai Vavilov joined, as per his father's wish, and graduated from Emperor's High School of Commerce in 1906. However, for his higher education, he chose to study agriculture and graduated from Petrovskaya Agricultural Institute (now known as Timiryazev Agricultural Academy), Moscow. He was very active at the institute – taking part in a student expedition to the Caucasus in 1908 and writing a report on *Darwinism and Experimental Morphology* for the meeting held to celebrate Darwin's Centennial in 1909. He completed his diploma work on the protection of agricultural plants from pests in 1910 [5]. He graduated from the institute in 1911. Vavilov created quite an impression on the teachers and students of his time in the institute. He was a bright, hardworking student and a good looking, handsome fellow. This is where he met his first wife – Yekaterina Sakharova – whom he married in 1912. Together they had one son, Oleg Vavilov, who died in a mysterious skiing accident in 1946.

Nikolai Vavilov graduated from the Petrovskaya Agricultural Institute, having carried out his diploma work on the protection of crops from pests. The recurrent famines and the sorrow state of agriculture had left an impact on young Vavilov's sensitive mind, and he decided to concentrate on the study of cultivated plants to increase their productivity to eliminate famines in his country and elsewhere. He had also realised that the study of Mendel's work and Genetics would hold answers to develop the varieties of crop that would resist pest attacks and would survive the Russian climatic conditions. Thus, soon after graduation, he launched himself in the field of plant-hunting and breeding. Here plant breeding refers to developing new varieties of crops that would give a higher yield, resist pest attacks and tolerate harsh climate. He needed mentors in the field and approached two eminent people –

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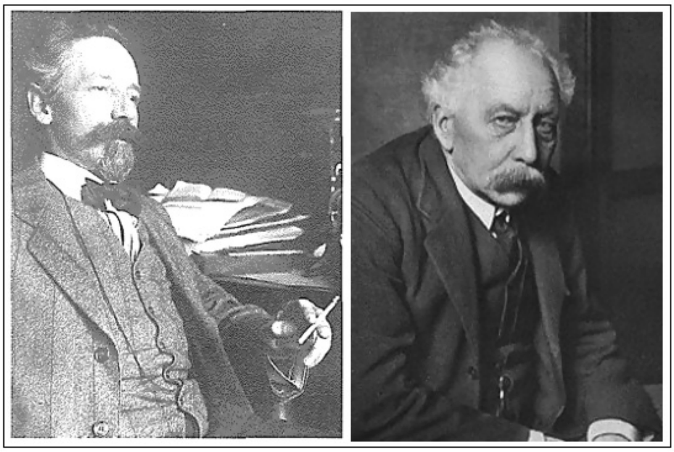

Figure 1. (**Left**) Robert Regel (Image credit: Loskutov 1999 and VIR Archive). (**Right**) William Bateson (Image credit: Wikimedia).

the Russian horticulturist Robert Regel (*Figure* 1) and the British biologist William Bateson.

Aspiring Scientist

In 1911, Vavilov wrote to Professor Robert Regel, the Director of the Bureau of Applied Botany, requesting to join the Bureau. The Bureau, at that time, was a well-known and respected institution for studies on crop diversity in Russia and abroad. Prof. Regel accepted him. Here, Vavilov worked mainly on wheat for a year. Prof. Regel was impressed with Vavilov's work and provided reference letters to introduce young Vavilov to scientists abroad. From 1913 to 1914, Vavilov worked in Britain, France and Germany.

Before going abroad, in 1912, Vavilov conducted lectures for the Golytsin Higher Agricultural Course for Women. In his lecture on 'genetics and its linkage with agronomy', he spoke about Mendel's theory [3, 6], and de Vries's and Johannsen's work related to mutation theory [6]. He highlighted the possibilities of developing new crop varieties based on Mendel's principles. One can visualize the young scientist, in his mid-twenties, mastering modern developments in the science of his time and connecting scientific theory to practice.

In Britain, Vavilov worked with William Bateson at John Innes Horticultural Institute, Merton. Though Bateson was some 26 years elder to Vavilov, the former treated the latter as an equal. The two became good friends and continued their correspondence until Bateson's death in 1926. Vavilov also spent time with V. H. Blackman at the Institute of Plant Physiology, London, and with R. Punnett [7] (creator of Punnett's square to predict possible genotypes) and Sir Roland Biffen at Cambridge University. There, he studied immunity of cereal plants to diseases. He also interacted with the wheat scientist, Sir John Percival, at the University of Reading. Vavilov visited Darwin's personal library at the Botanical Institute in Cambridge! What a place to visit and see pages written by Darwin himself – it would be a dream of perhaps every student of evolutionary biology! He studied Darwin's work on plant domestication and breeding. And as it has happened to many, Darwin's work left a deep impact on him, sowing the seeds of the origin of cultivated plants in his mind.

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In France, Vavilov worked at Pasteur Institute and at France's important agricultural firm of Vilmorin and Andrier. He developed important contacts with the Vilmorins, which became useful to him later during his plant hunting expeditions. In Germany, he visited the eminent scientist Ernst Haeckel [8]. Vavilov had to cut short his studies abroad to return to Russia as World War I broke out in 1914. During the return, the ship carrying his plant samples sank after being struck by a German mine. Vavilov lost all his plant samples.

Back in his homeland, he was spared from the compulsory joining of military, owing to a childhood accident in a chemistry experiment that caused blurred vision in one eye. He joined Petrovskya Agricultural Institute to pursue research on disease-resistant crops. He identified the wheat variety that was resistant to mildew[1] attack. By 1916, Vavilov had become a promising young scientist. He also started field trips to collect various cereal crops to enrich the collection of his institute and to find disease-resistant varieties of wheat. His mentor Prof. Robert Regel was impressed with the work of this bright young scientist and recommended him to the

[1] A fungal infection.

Ministry of Agriculture. Vavilov joined the Faculty of Agriculture, University of Saratov as a professor. He stayed here from 1917 to 1920. In 1921, he succeeded Prof. Regel after the latter's death, to become the Director of the Bureau of Applied Botany.

The Explorer and the Visionary

While Vavilov was busy developing his science, World War I was raging around. In 1916, the Russian soldiers fighting on the Persian front were falling sick (becoming dizzy and unable to focus) after eating local bread. Vavilov was consulted to solve the problem and was taken near the Persian border. He could easily solve the problem. He realised that the wheat used to make the bread was infested with the highly toxic weed, Darnel ryegrass (*Lolium temulentum*). The military gave orders forbidding the use of local grain in making bread. After solving this problem for the military, Vavilov embarked upon his pursuit of plant hunting. In Persia, he collected seeds of wild perennial flax and high-quality rice to be taken back to his institute in Moscow. He also collected samples of wheat, barleys, ryes and other crops.

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During his time with William Bateson, Vavilov had developed the idea of 'plant hunting' – to look for and study new varieties of crop plants in various parts of the world. At that time, the plant breeders had started searching for those varieties of the wild relatives of crop plants to develop disease-resistant, hardy crops. Vavilov realised the importance of developing such varieties to increase crop productivity, and hence eliminate famine. He had also realised that this natural diversity was at the risk of elimination due to the destruction of natural habitats for various reasons (the problem that has intensified tremendously in our time). It is the genius of Vavilov that he realised the problem of 'genetic erosion' i.e. the loss of biodiversity, about hundred years ago, when the term 'biodiversity' was not even coined [9].

Vavilov decided to do two things – first, to identify, collect and study cultivated crops and their wild relatives from their native habitats, and second, to conserve the diversity of cultivated plants and their wild varieties by building seed banks or gene banks as they are called today. To carry out these two tasks, he set out on expeditions all over Russia and the world. *Table* 1 lists the expeditions he undertook along with his students and co-workers. In addition to numerous trips within his own country, he and his teams went to about 50 countries and 5 continents. They collected many plant samples (called 'accessions') in the form of seeds, stems, roots and fruits. In Vavilov's time, his teams collected over 36,000 accessions of wheat, over 23,000 accessions of legumes, over 10,000 accessions of maize, about 18,000 accessions of vegetables, about 12,000 accessions of fruits and small fruit crops and over 23,000 accessions of forage!

Even today, in the era of digital maps, GPS, emails and mobile networks, arranging an expedition is a laborious task. There are so many things to manage while planning an international expedition – permissions at home and at foreign locations, route planning, food, equipment, transport, accommodation, inter-personal relations, local hospitality and so on. Imagine the task about a hundred years back in the absence of quick and widespread communication systems. But Vavilov managed this herculean task. The expeditions, of course, were not easy. He faced many problems, including lack of enough funds. On his trip to Iran, he was arrested and was accused of being a spy as he was carrying German textbooks. In Pamir, his local guides abandoned him. During a train journey in Afghanistan, he landed on buffers when stepping between two cars and the train kept thundering on. On his trip to Syria, he contracted malaria and typhus. But Vavilov was undeterred and continued his mission of collecting plants. He worked with indefatigable energy. He had no problem sleeping on the earthen floor of a native hut at night. To communicate with the locals and to talk to the local farmers about their cultivation practices, he learnt their languages. He thus knew about a dozen languages. On these expeditions, Vavilov not only collected plants but also gathered information about local cultivation techniques, site ecology, geographical and meteorological conditions of the countries, and archaeological, ethnographical, historical and lin-

On his expeditions, Vavilov not only collected plants but also gathered information about local cultivation techniques, site ecology, geographical and meteorological conditions of the countries, and archaeological, ethnographical, historical and linguistic aspects (e.g. local names of the crops) of the regions.

Year	Location
1916	Iran (Hamadan, Khorasan), Pamir (Shungan, Rushan and Khorog)
1921	Acquaintance visits to Canada (Ontario) and USA (New York, Pennsylvania, Maryland, Virginia, North and South Carolina, Kentucky, Indiana, Illinois, Iowa, Wisconsin, Minnesota, North and South Dakota, Wyoming, Colorado, Arizona, California, Oregon, Maine)
1924	Afghanistan (Herat, Afghan Turkestan, Gaimag, Bamian, Hindu Kush, Badakhshan, Kafiristan, Jalalabad, Kabul, Herat, Kandahar, Baquia, Helmand, Farakh, Sehistan)
1925	Khoresm (Khiva, Novyi Urgench, Gurlen, Tashauz)
1926–27	Mediterranean countries (France, Syria, Palestine, Transjordan, Algeria, Morocco, Tunisia, Greece, Sicily, Sardinia, Cyprus, Crete, Italy, Spain, Portugal and Egypt) and Abyssinia (Djibouti, Addis Ababa, banks of Nile, Tsana Lake), Eritrea (Massaua) and Yemen (Hodeida, Jidda, Hedjas)
1927	Mountainous regions in Wuertemberg (Bavaria, Germany)
1929	China (Xinjiang - Keshgar, Uch-Turfan, Aksu, Kucha, Urumchi, Kulja, Yarkand, Hotan), Taiwan, Japan (Honshu, Kyushu and Hokkaido) and Korea.
1930	USA (Florida, Louisiana, Arizona, Texas, California), Mexico, Guatemala and Honduras
1932–33	Cuba, Mexico (Yucatan), Ecuador (Cordilleras), Peru (Lake Titicaca, Puno Mt., Cordilleras), Bolivia (Cordilleras), Chile (panama River), Brazil (Rio de Janeiro, Amazon), Argentina, Uruguay, Trinidad and Puerto Rico and Visits to Canada (Ontario, Manitoba, Saskatchewan, Alberta, British Columbia) and USA (Washington, Colorado, Montana, Kansas, Idaho, Louisiana, Arkansas, Arizona, California, Nebraska, Nevada, New Mexico, North and South Dakotas, Oklahoma, Oregon, Texas, Utah)
1921–40	Systematic explorations of the European part of Russia and the entire region of the Caucasus and Middle Asia.

Table 1. The major collecting expeditions taken up by Vavilov. (Based on Loskutov 1999.)

guistic aspects (e.g. local names of the crops) of the regions. Not only did he run successful expeditions and collect a huge amount of data but also took care of people who were involved in these

Figure 2. Vavilov in the field. (Image credit: Loskutov 1999 and VIR Archive.)

endeavours. Vavilov was particular about his attire and generally wore a simple but elegant three-piece suit with a fedora hat even during fieldwork. It is amusing to see his handsome figure clad in this sophisticated attire with a bunch of plants in his hands and squatting down to look at the soil (*Figures* 2 and 3).

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Important Contributions

Law of Homologous Series in Hereditary Variability

Vavilov collected a vast number of plant samples from all over the world. He analysed the traits shown by these plants across families, genera and species. Amidst the striking diversity of traits, he noticed that the series of variations were similar. These variations were in the morphological features that had a similar position, structure or evolutionary origin and, therefore, were called 'homologous'. Let us take one example. As cited in his classical paper [10] in 1922[2], Vavilov showed that eight species of wheat could be divided into three groups. Let us consider the species, from Group I, *Triticum vulgare*, which is represented by various

[2]Reprinted in this issue of *Resonance* under the Classics section.

Figure 3. Vavilov with his samples. (Image credit: Loskutov 1999 and VIR Archive.)

races which differ in the following traits:

1. Bearded, beardless, semi-bearded ears
2. White, red, grey, black ears
3. Smooth, hairy ears
4. White, red seeds
5. Winter, spring varieties and so on.

Vavilov observed that the other species from Group I also showed various races. He, further, observed that these races showed similar varieties with respect to the above mentioned traits. The species from Group II did not show the trait 'bearded' and its variations. But with respect to the other traits, there were similar variations – for example, there were variations with respect to colour and presence or absence of hair on ears. Similar variations were observed among the traits shown by races of species from Group III. He then went on to report the existence of such similar series of variations in crops like barley, oats, millets, cotton and so and so forth. What is the use of this observation of similar series of variation? On page 72 of his classical paper, Vavilov says, "...it is already evident that the similarity in series of polymorphism of allied Linneons, genera, and even of nearly related families, is so regular that it becomes possible to forecast, on this basis, the existence of forms and of varieties (and even Linneons), not yet discovered."

'Linneons' are species identified based on morphological features (nowadays, molecular markers such as DNA and protein sequences are also used to identify a species). Thus, Vavilov provided a rule that could have predictive power. Such laws or rules are rare in biology.

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Based on previous and his own studies, Vavilov found that rye (Genus *Secale*) shows similar series of variations as wheat (Genus *Triticum*). During his 1916 expedition to Afghanistan, Vavilov had observed a wheat variety in which leaves did not have a structure called ligula (or ligule). This observation was new to science. This structure, ligula, is in the form of a strap-shaped outgrowth at the junction of the leaf and the leafstalk. A picture of this structure is shown in the classical paper printed in this issue (Plate IX). Based on the series of homologous variations, Vavilov expected to find a similar variety in rye as well. In his 1918 expedition to the Pamir mountains, he found the variety of rye without ligula! Vavilov cited many such examples. He also pointed out the presence of such homologous series not only at the phenotype but also at the genotype level. The law is now extended to the molecular genetic level as well [11], as seen in the genes for kernel retention and, to a certain extent, in the genes for flowering time. Let us take the example of the genes for kernel retention. In grasses, as the seeds or kernels mature, they shatter from their covering so that seed dispersal can occur. However, when we cultivate grasses such as wheat, rice, rye, oats, barley and so on, for commercial purposes, we do not want the seeds to separate at the time of harvest, which would be a loss of grains for us. Thus, we have artificially selected those varieties in which seeds or kernels are retained on the plant and are not shattered. A gene called *Sh1* is found in wild sorghum and is associated with shattering. Three alleles of this gene are found in cultivated sorghum, in which mutations in the gene have led to the development of non-shattering varieties. Similar observations are noted in rice and maize. Such examples have become the modern application of Vavilov's 'homologous series in hereditary variability'.

Centre of Origin of Cultivated Plants

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From the analysis of data collected from a large number of plant-collecting expeditions across the world, Vavilov could see the distribution of cultivated crop plants and their wild relatives. Vavilov was not the first to ponder upon this distribution. A Swiss botanist, A. P. de Candolle, and Charles Darwin had also considered this topic. Vavilov had seen their views when he visited Darwin's personal library at the University of Cambridge. However, Vavilov developed it to a greater extent, adding his insights and observations. He realised that the distribution of cultivated plants was not random but was focused in specific regions of the world. These regions were also associated with higher diversity of wild relatives of the cultivated crop plants and other distantly related species. He noticed that the centres of cultivated crop plants were not located along the rivers but in the mountainous regions where primitive agricultural practices existed. Vavilov proposed that these were the centres where our cultivated crop plants originated. Such regions are called 'Vavilovian centres of origin' of cultivated plants. These regions have played an important role in the development of early human civilizations and migrations [12]. Vavilov was a true scientist who kept on updating his knowledge and revising his theories as new information came in. This aspect is evident from the fact that Vavilov initially proposed three centres in 1924, then revised them to five, then to

Figure 4. Vavilovian centres of origin (now called 'diversity') of cultivated plants.
(Reprinted with permission from Hummer and Hancock, *HortScience*, Vol.50, No.6, pp.780–783, 2015.)

eight centres in 1934 as he gathered more data, and eventually to seven centres in 1940. Today, after a lot of debate, investigations and refinements, these regions are called the 'centres of diversity'. *Figure* 4 shows a world map with eight centres of origins of cultivated plants. *Table* 2 lists the details of these centres.

Genetic Erosion

Vavilov had realised the importance of the wild relatives of cultivated plants. These wild relatives could be used to develop and/or improve crop plants, through systematic plant breeding experiments to make them resistant to diseases and pests and tolerant to the harsh climatic conditions. He also realised, much ahead of his time, that this diversity could be lost due to man-made or natural reasons leading to genetic erosion. He could see that this erosion could be prevented by documenting and preserving the diversity. Therefore, the diversity of crop plants and their wild relatives needed to be preserved. He brought the plant samples (seeds, fruits, stems, etc.) back to his institute where these samples were stored, thus creating 'seed banks' or 'gene banks'. During Vavilov's time, the modern storage conditions required to keep seeds viable were not available. Thus, the collected seeds had to be germinated and grown into plants. Then new seeds were harvested to be returned to the gene bank. These seeds were also used to develop new varieties of crops across Russia in varied en-

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Centres of Origin	Description
I. East Asian Centre	Includes central and western China, Korea, Japan and Taiwan. Native regions for soya beans, millet, many vegetable and fruit crops.
II Hindustani Centre	Includes tropical Indian, Indochina region, southern China and islands of south-eastern Asia. Native region for rice, sugarcane, tropical fruit and vegetables.
III. Inter Asiatic Centres	Includes mountains of Asia minor, Iran, Syria, Palestine Trans-Jordania, Afghanistan, Inner Asia, North-western India. Native region for wheat, rye and fruit trees.
IV. Caucasian Centre	Includes Caucasian region. Native for temperate fruit trees, wheat and rye.
V. Mediterranean Centre	Includes countries bordering the Mediterranean Sea. Native for many vegetables and forage crops including olive and carob tree.
VI. Abyssinian Centre	Native for teff, niger seed plant, banana, coffee.
VII. Central American Centre	Includes southern part of North America, Mexico, the West Indies islands. Native for maize, cotton, beans, pumpkins, cocoa, avocado and subtropical fruits.
VIII. Andean Centre	Includes Andean mountain range. Native for tuber bearing crops such as potato, quinine tree and coca bush.

Table 2. Details of Vavilovian centres of origin of cultivated plants. (Adapted from Hummer and Hancock, *HortScience*, Vol.50, No.6, pp.780–783, 2015.)

vironmental conditions. Gradually, newer methods of seed storage were found. The seed bank at his institute was the largest seed bank of his time. Today, 11 primary global gene banks are part of the Consultative Group on International Agricultural Research (CGIAR) [13]. India is also a part of this group, in the form of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and manages 1,25,000 accessions.

Apart from these major contributions, Vavilov also developed many disease resistant and harsh climate tolerant crop varieties, thus contributing to plant breeding.

Promotor and Organizer of Science

From 1921 to 1940, Vavilov served as the Director of the Bureau of Applied Botany in Petrograd (now Saint Petersburg) and its successor institutions. He often had to struggle with meagre funds. As the Director, he encouraged young people to join the institution, developed contacts with scientists abroad, invited them to his institute, attended conferences abroad (*Figure* 5), developed studies on plant genetics, taxonomy, agro-economics, crop evolution, plant introduction and crop improvement, and successfully increased the scientific publications of the institute. During 1929–35 he was the President of Lenin All-Union Academy of Agricultural Sciences (VASKhNIL) which included 111 research institutions, 206 specialized zonal stations, 26 agricultural research stations, 36 breeding centres and 28 affiliates of central research institutes under its wing.

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Tragic End

After the revolution of 1917, Russian agriculture started declining, riddled by frequent famines. This decline became severe during Stalin's regime. Food production was badly affected due to civil war, periodic droughts in the crop-producing regions, and rising industrialization. Further implementation of collectivization policy of re-organization of the USSR's production so that it was owned and managed by the government contributed immensely to decreased production. Stalin wanted a quick solution. It was in this background that Trofim Lysenko rose in 1927. His claims of improved wheat yield garnered great publicity. He claimed that winter wheat could be made sowable in spring if the seeds were frozen before planting. This process of 'vernalization' made him rise and shine in Stalin's eyes. Vavilov had taken problems of famine to his heart and was open to any agricultural practice that could solve these. Thus, he initially supported Lysenko. He invited Lysenko to his institute and his experimental farms in order to find out more about Lysenko's experiments. He also recommended Lysenko to become a corresponding mem-

Figure 5. Vavilov with Thomas Hunt Morgan and Nicolay Timofeyev-Ressowsky at the Sixth International Genetics Congress in Ithaca, NY. (Image credit: Loskutov 1999 and VIR Archive.)

ber of the Academy of Science. However, it was soon realised that Lysenko's data were fabricated. Lysenko and his supporters had rejected Mendel's law of inheritance and genetics. Vavilov was given three years to solve the problem of food shortage by Stalin. This was an impossible task. Developing improved crop varieties usually took about a decade. The impatient and ruthless government charged Vavilov and geneticists like him with treason. They were called 'wreckers', 'saboteurs' and 'enemy of people'. Genetics was considered to be reactionary[3]. Vavilov was denied permissions to conduct international expeditions, to go abroad or to interact with scientists of the world. The 7th International Congress of Genetics that he wanted to arrange in Moscow in 1936 was cancelled. The meeting was shifted to Ed-

[3] Opposing political and social progress.

Figure 6. Mugshot of Vavilov taken in prison. (Image credit: Loskutov 1999 and VIR Archive.)

inburgh. Though the international community elected Vavilov as the Honorary President for the meeting to be held in 1939, Stalin's government did not allow him to attend the meeting. In 1938, Lysenko became the President of Lenin Academy, the topmost position in the hierarchy of agricultural science in the country. He was now Vavilov's boss! All around Vavilov, many geneticists were getting jailed or executed. Vavilov was, of course, worried but undeterred to stand by science and keep up his fight against the wrong views. At the meeting of All-Union Institute of Plant Industry in 1939, Vavilov gave a talk in which he said, "We shall go into the pyre, we shall burn, but we shall not retreat from our convictions." Eventually, in 1940, when Vavilov was on an expedition in Ukraine, he was arrested and jailed (*Figure* 6). He was interrogated for several months, each session lasting 10–12 hours, mainly at nights. It is said that he underwent about 400 interrogations! His initial sentence of execution was commuted to twenty years of imprisonment in corrective labour camp. His pleas for pardon were ignored. He was put in solitary confinement. It is amazing to know that Vavilov still kept up his resilience and started writing a book on the global evolution of agriculture since ancient times. Of course, no material survived. The prisoners were given two spoons of kasha (Russian porridge

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Figure 7. Vavilov on postal stamps. (Re-printed with permission from J. Janick, *HortScience*, Vol.50, No.6, pp.772–776, 2015.)

made of grains boiled in water or milk; for prisoners it must have been in water!), a small cup of soup made from rotten tomatoes with a piece of fish for lunch, and one spoon of kasha for supper. The prisoners were not allowed to receive any parcels, to meet any relatives, friends or colleagues. They were denied any exercise. Eventually, on 26th January 1943, the man who wanted to free people from hunger, died of hunger in the prison located in the same city (Saratov) where his second wife (Yelena Barulina) and son (Yuri Vavilov) were living without even knowing about his existence in the prison. There is no grave for Nikolai Vavilov or headstone marking his resting place because his body was dumped in an unmarked ditch, a mass grave for bodies of prisoners. Thus, Vavilov became a nonperson and was never mentioned until his name was rehabilitated in 1950s.

Revival

In 1955, in Nikita Khrushchev's regime, Vavilov's name was rehabilitated. His work was published posthumously. The All-Union Institute of Plant Industry was renamed, in 1967, as the N. I. Vavilov All-Russian Institute of Plant Genetic Resources (VIR) [14]. Vavilov was honoured on Russian postage stamps in 1977 and 1987 (*Figure* 7). Vavilov's legacy will continue in the form of his scientific contributions, his stand on science, and the seeds sitting in seed banks because of him.

Acknowledgement

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Suggested Reading

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