19th International Sunflower Conference, Edirne, Turkey

Academician DRAGAN ŠKORIĆ,
Republic of Serbia

HISTORY OF SUNFLOWER BREEDING IN THE WORLD

Presentation
1st Part

MAIN PERIODS IN SUNFLOWER BREEDING ON GLOBAL LEVEL

- **A. 1912 - 1970**
  - DEVELOPMENT OF HIGH-YIELDING CULTIVARS WITH A HIGH SEED OIL CONTENT
  - GENETIC POTENTIALS:
    - a/ SEED YIELD > 4 t/ha
    - b/ SEED OIL CONTENT: raised from 30-36% to 48-53%
  - BREEDERS: PUSTAVOJT, ŽDANOV and others…

- **B. 1970 TO PRESENT**
  - DEVELOPMENT OF HYBRIDS BASED ON CYTOPLASMIC MALE STERILITY (CMS)
    - IMPORTANT: LECLERQ (1969)
    - SOURCE: CMS, RESTORER GENES

The sunflower originates from North America. There is firm archeological evidence that it was cultivated by the tribes of the Ozark Bluff dwellers (USA) before 2000 BC, Therefore, Native Americans were the first breeders of sunflower, which played a significant role in their daily lives.

Unusual sunflowers journey...

The sunflower arrived in Europe in 1510 as an ornamental plant and was grown in a botanical garden in Madrid, Spain. Later, sunflowers spread across Western Europe as a decorative plant....

There is i written evidence the sunflower arrived in Russia in 1599 (Valuysky District) and in Ukraine in 1613.

A FIRST PERIOD IN THE SUNFLOWER BREEDING (1912-1970)

In the first part of the 20th century at the above institution a large number of varieties were developed that were highly productive and had an increased oil content, resistance to the sunflower head moth (*Homoeosoma nebulella* Hb.) and the exixsting races of broomrape (*Orobanche cumana* Wallr.). In the 1960's productive varieties with an oil content of above 50% were developed (Pustavoit and Zhdanov). Among these varieties, the most well known ones were Peredovik, VNIIMK 8931, Majak and others. They contributed to the spread of sunflower across the world. Using interspecific hybridization between the cultivated sunflower and *H. tuberosus*, Galina Pustovoit developeed a large number of varieties with a broader resistance to diseases.

RUSSIAN EMPIRE and USSR
Sunflower breeding

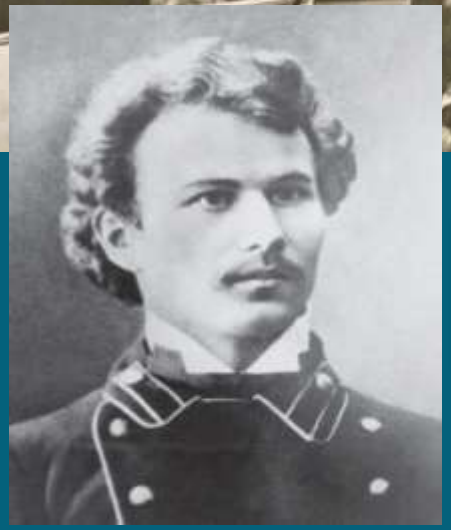
In the 1830's in the Russian Empire (the Saratov and Voronezh oblasts) sunflower began to be grown as the oilseed crop. The farmers chose the most productive plants from populations they grown and thus started "people's selection" – the improvement of the local populations.

Sunflower breeding on scientific basis began in imperial Russia in the early 20th century (Kharkiv Trial Station in 1910, Kruglik Trial Station in Krasnodar in 1912, Saratov Trial Station in 1913, and a little bit later in Rostov on Don, Armavir and several other places

The evocation of Academician Vasilii Stepanovich PUSTOVOYT (1886-1972)

Revealing of the monument to double hero of socialist labor, V.S. Pustovoita , set in Krasnodar

Vasilij Stepanovich Pustovojt, the founder of the Soviet school breeding, breeding methods remembered as Pustovoit's method of reserves



Vasilij Stepanovich Pustovojt, as a young student

VNIIMK, Russia

Vasilij Stepanovich Pustovojt,
with his student,
A.I. Gundaev.

A.I. Gundaev worked a lot on inbreeding, heterosis, male sterility, GCA and SCA in the early 1960s he had over inbred lines. Unfortunately, he has left VNIIMK and tranmsferred to Moscow to work for the Institute of Genetics.

VNIIMK, Russia

V.S. Rushkovsky,
Oil analysis

Galina V. Pustovoit (1975).

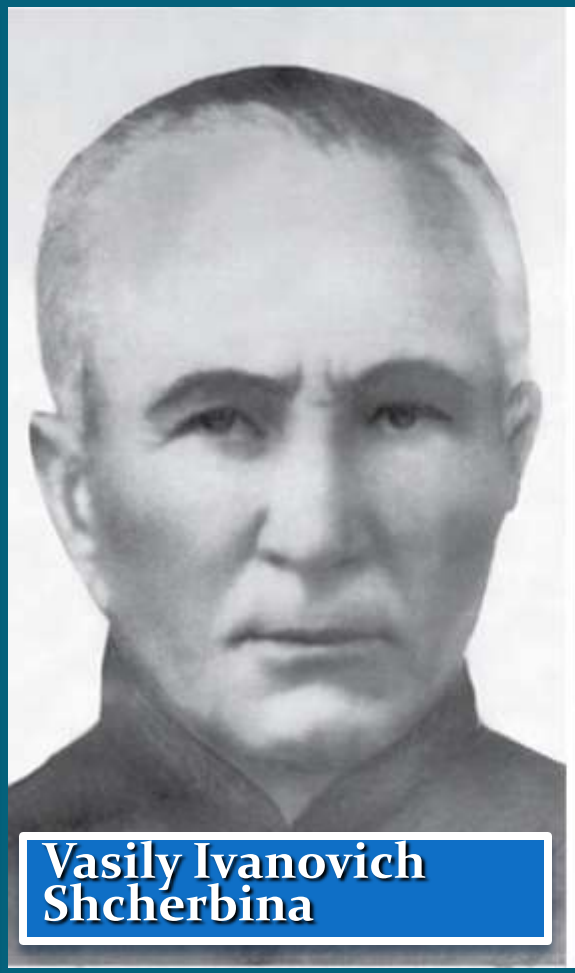
V.S. Rushkovsky had developed a method for rapid determination of seed oil content, which has enabled breeders to rapidly analyze a large number of samples for their seed oil content and hence develope high-oil varieties.

Galina V. Pustovoit, V.S. Pustovoit's daughter and continuator of his work. On base interspecific hybridization (VNIIMK 8931 × *H. tuberosus*), Cultivars: Yubileyniy 60, Progress, Novinka, October... High yield, high oil + disease resistance

VNIIMK, Russia

Vasily Ivanovich Shcherbina, Sunflower breeding station, Armavir. He and his team have developed a number of varieties that differ genetically from those developed at Krasnodar and are very suitable for developing inbred lines.

K.I.Prohorov, Sunflower breeding station, Belgorod. He and his coworkers have developed a number of productive varieties.



Vasily Ivanovich Shcherbina

K.I. Prohorov

VNIIMK, Russia

Fyodor Ivanovich GORBACHENKO

Leonid Afanasievich ZHDANOV

Leonid Afanasievich Zhdanov, Sunflower breeding center, Rostov on Don, High yielding cultivars. He has developed a large number of productive varieties (Zhdanov, etc.) that differ a lot from those developed at Krasnodar.

Fyodor Ivanovich GORBACHENKO Rostov on Don, VNIIMK Oil-Crops breeding center. High yielding hybrids. He has developed a large number of hybrids and varieties of sunflower.

Saratovskiy region, Russia

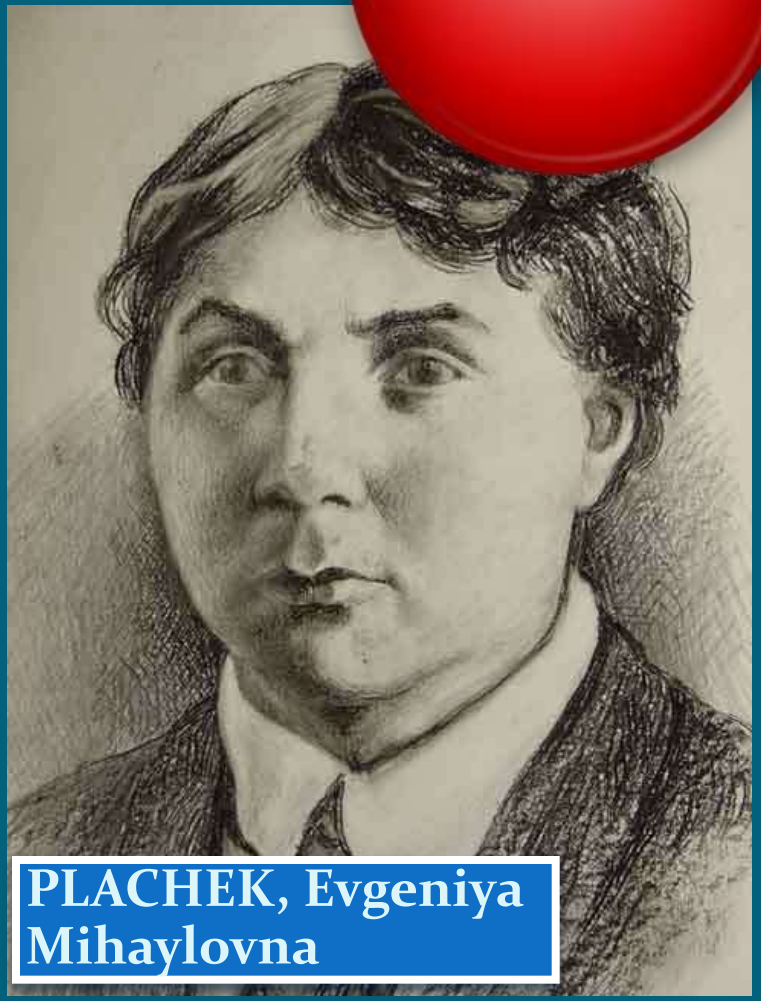
Laboratory for cytology and genetic, Research Institute of Agriculture at Southeast, Saratovskij region.

MOROZOV, V.K.

A great geneticist and breeder from the first half of the 20th century. Especially remarkable is his contribution to the development of breeding methods, and the study of inbreeding, heterosis, GCA and SCA.

PLACHEK, Evgeniya Mihaylovna

A great figure in the history of sunflower breeding from the first half of the 20th century. She was the first in the world to study inbreeding in sunflower (in the 1920s), perform diallel crosses, and study the combining abilities of inbred lines. Undeservedly overlooked in the sunflower literature.



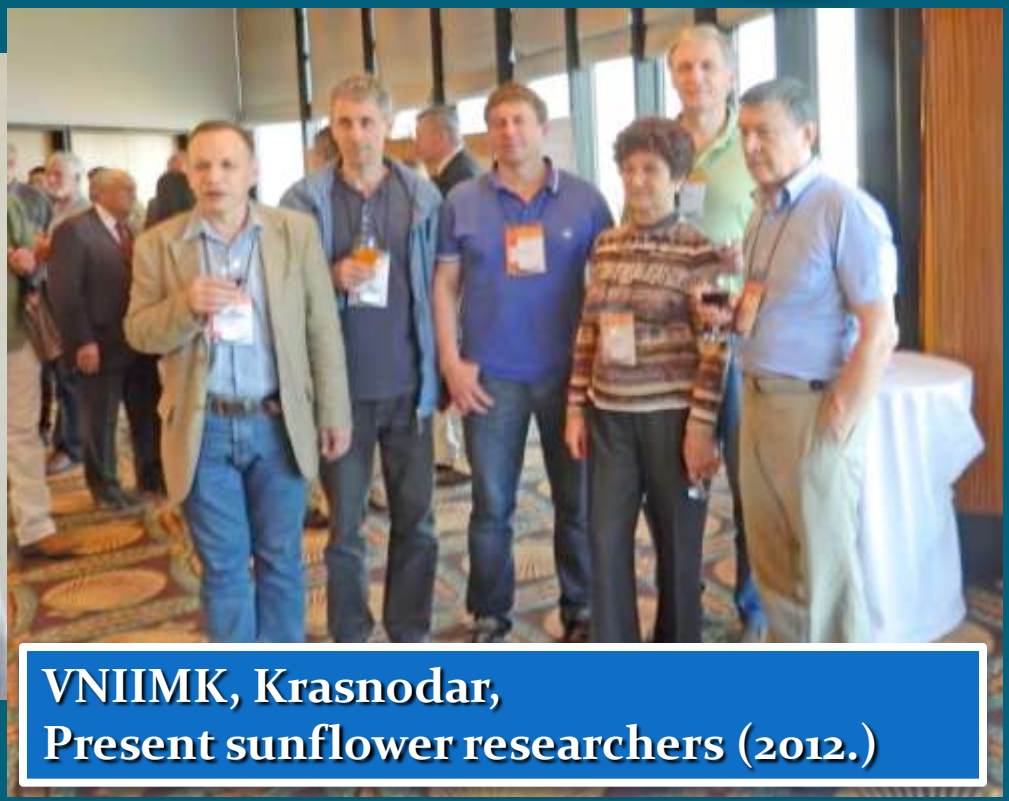
PLACHEK, Evgeniya Mihaylovna

VNIIMK, Russia

Karm Ivanovich SOLDATOV

Karm Ivanovich SOLDATOV, student VS Pustovojta . Author of the first in the World high-oleic variety of sunflower Pervenec (1976) treating seeds of the cultivar VNIIMK 8931 with DMS.

Dr Yakov DEMURIN



VNIIMK, Krasnodar,
Present sunflower researchers (2012.)

Dr Yakov DEMURIN, VNIIMK Krasnodar.
Spontaneous mutation, different type and content of tocopherols (lines):
LG-15 (50% alpha + 50% beta)
LG-17 (5% alpha + 95% gamma)
LG-24 (8% alpha + 84% gamma + 8% delta

VIR, Sankt Peterburg, Russia

Dr Vera GAVRILOVA

Dr Alexander Viktorovich ANASCHENKO

Dr Alexander Viktorovich ANASCHENKO, VIR, Sankt Peterburg, Russia. A world renowed expert in the study of the taxonomy of the genus *Helianthus*. He worked intensively on inbreeding, male sterility, heterosis and the study of different sunflower traits. For many years he was custodian of the VIR sunflower collection (germplasm).

Dr Vera GAVRILOVA, VIR, Sankt Peterburg, Russia. She took over dr. V.A. Anaschenko the maitenance and study of the VIR sunflower collection as one of the largest such collections in the world. In addition, she has done a lot in the study of different traits withun the VIR germplasm. She has also made a great contribution in the study at the molecular level of the mode of inheritance of a large number of biological sunflower traits.

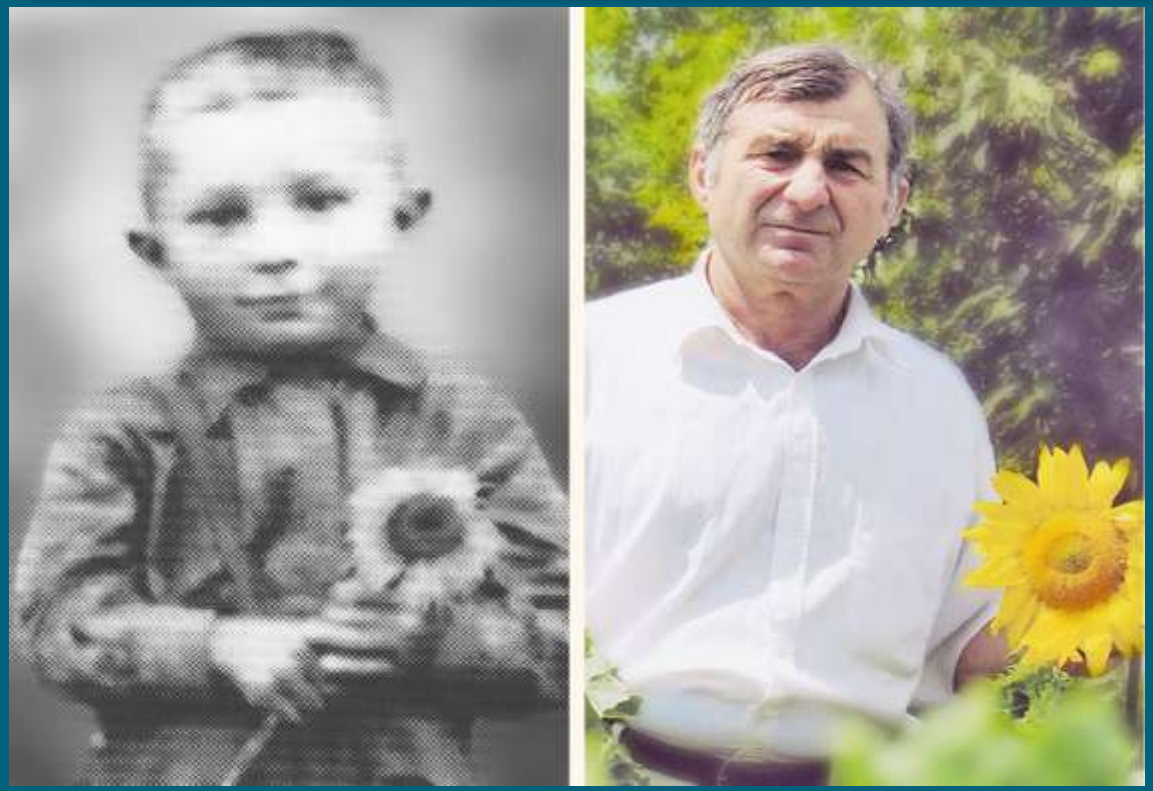
Private company in Russia - RHI

The first private-owned sunflower breeding company in Russia – **The Russian Hybrid Industry (RHI)**, Krasnodar. Its owner and primary breeder is **Igor MARIN**, who along with his team has developed a large number of productive sunflower hybrids.

Igor MARIN

Sunflower breeders from RHI, Russia

Private company in Russia - Everest- Olvik



Innovation project:

- criomutation selection of sunflower on winter resistance (**wint**),
- ephemeral state (**pervotsvet**) and
- leaflessness (**aphylla**)

Kalaidzhyan Ashot Andranikovich:
in 6 (1952, left side)
and in 60 (2006, right side)

Kalaidzhyan Ashot Andranikovich, Krasnodar. He devoted his entire career to induced mitations, first at VNIIMK and then in his own private company (Everest – Olvik, Krasnodar). He was the first in the world who obtained sunflower mutants resiastant to low temperatures (winter sunflower) and mutants with different biological traits. He has developed unique sunflower germplasm based on induced mutations.

Republic of UKRAINE
Sunflower breeding

Boris Enken (1883 - 1943)

In Kharkiv, the beginning of sunflower breeding is associated with the name of professor **Boris Enken**, who worked at Kharkov Breeding Experiment Station since its organization - since 1908. Boris Enken created domestic sunflower varieties 'Zelenka 76' and 'Kharkovskiy 22-82', which were sown in 1928 and 1930, respectively.

Thus, a special period in the history of domestic breeding began: it was conducted for a set of traits (breeders were interested both in high oil content and high yield capacity, and resistance to pathogens, such as sunflower moth, local broomrape races, rust, sunflower downy mildew).

Republic of UKRAINE
Sunflower breeding


Victor Wolf (1904 - 1977)

Heterosis sunflower breeding was founded by Victor Wolf .

To obtain valuable breeding material with group immunity, scientists began using interspecies hybridization, i.e. they used remote species to create interspecies hybrids. Interspecies cultivated sunflower hybrids created by Pogorletskiy Boris in Odessa and Victor Wolf in Kharkiv played an important role in the generation of line material that is now widely used in breeding for heterosis. In addition, Victor Wolf was a remarkable methodologist: he developed and substantiated methods of heterosis breeding and seed production.

Alexander Ryabota studied meiosis, types of sunflower fertilization, gene male sterility. He managed to create several high-yielding hybrids: 'Zustrich' (together with the Plant Production Institute named after V.Ya. Yuriev), 'Zaporizkyy', 'Zaporizkyy 14', 'Baida' and others.

Republic of UKRAINE
Sunflower breeding

Anatoly Gumenyuk

After Volf, work on sunflower breeding in Kharkiv was continued by **Anatoly Gumenyuk**, who investigated the plant for productivity and oil content. Over the years, he created varieties with high oil content 'Kharkovskiy 100', 'Kharkovskiy 101' and others. In fact, this breeder managed to achieve the biological maximum of oil content in seeds of sunflower varieties-populations.

Republic of UKRAINE
Sunflower breeding

The name of **Academician of NAAS Victor Kirichenko** is connected a special page in the history of breeding. For over 40 years, he has been dealing with heterosis sunflower breeding and is the coordinator of sunflower breeding in Ukraine. He has created more than 80 hybrids, formed a scientific school of sunflower genetics, breeding and seed production.

Viktor Kirichenko

His hybrids represent the entire spectrum of modern sunflower hybrids:

- **Oleic hybrids** ("Eney", "Kvin", "Bohun", "Zorepad", "Hector", "Oreol") are targeted at improvement of nutritional quality of oil and contain 88-92% of oleic acid;

- **Linoleic hybrids** ("Yason", "Zlatson", "Forvard") are notable for high potential yield capacity (5.5 t/ha) and high oil content in seeds (50.1%);

- **Palmitic hybrids** ("Kapral", "Kursor", "Truvor", "Rubikon") contain 22% of palmitic acid;

- **Confectionery hybrids** ("Shumer", "Forsazh", "Hudvin") are distinguished for early ripening, high yield capacity and have 1000-seed weight over 120 g .

Republic of UKRAINE
Sunflower breeding

Dr Victor Burlov, IGB, Odessa, and **Dr D.I. Nikitchin**, IOC, Zaporozhiye with colleagues at the Symposium held in Institute for wheat and sunflower, Dobroudja, Bulgaria.

In the Plant Breeding and Genetics Institute (Odessa), **Professor Victor Burlov** was the first in Ukraine who created valuable for industrial use sunflower hybrids.
Among of them - the first domestic hybrid "Rassvet" (1981) as well as hybrids:
- "Odesskiy 122", - "Odesskiy 123",
- "Odesskiy 249",- "Odesskiy 504",
- "Zgoda".

Especially important is **Dr Victor Burlov**, who in the process of developing sunflower hybrids paid great attention to sunflower resistance to different races of Orobanche cumana and high tolerance of drought, first at the Institute for Genetic in Odessa and then in his own private company.

Dr D.I. Nikitchin, Institute for Oil Crops, Zaporozhiye. A long-standing director of said Institute and breeder, who together with his team developed one of the largest breeding programs on sunflower in Ukraine.

Private sunflower breeding companies in Ukraine

- “FLORA” – Odessa (Victor Burlov)
- “Sady Ukraine” – Kharkov
- “NASINNYA LTd.” –Kyiv
- And … Others

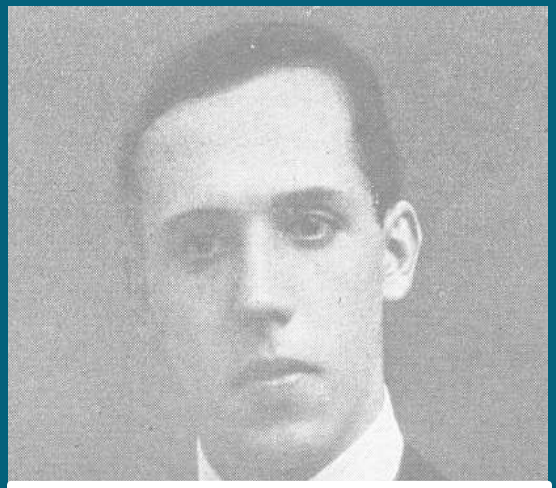
Brief sunflower history in Argentina

Ing. Enrique Klein

In 1931 nearly all sunflower seed available in the south of the province of Buenos Aires was the " Russian Giant" variety.

•In **1933**, Ing. Enrique Klein began sunflower breeding in his farm located in Pla, Buenos Aires province, making selection from local populations. In 1938 he obtained " **Seleccion Klein**", **first Argentinean sunflower variety.**

Brief sunflower history in Argentina



Ing. V. Brunnini

Ing. B. Scheloto

In 1938, in the experimental farm “La Prevision”, located in Barrow, Buenos Aires province, V. Brunini and B. Schelotto, making selection from the “Russian Giant” obtainded “**La prevision 8**". Later, in 1942, the same authors obtained “**La prevision 9**" from the " Russian Giant " too.

In 1938, J. Etchecopar and M. Illia, from EERA INTA Pergamino obtained **Saratov Sel M.A,** selecting from the Russian variety " Saratovsky

Martin Illia

Brief sunflower history in Argentina

Selections from Russian varieties in the 70s

Interspecific crosses:

- In 1947, J. Baez, T. Macola and H. Bauer, from Manfredi Agricultural Experimental Station in Cordoba province, obtainded the cultivar "**INTA Manfredi**"(*Helianthus annuus Helianthus annuus* var x var Klein. Saratov Sel. Perg. M.A.) x *Helianthus annuus* ssp. *annus*
- In 1962, the same breeders obtained "**Impira INTA**" (*Helianthus annuus* var x *Helianthus argophyllus* Saratov Perg MA Sel)
- In 1964, A. Luciano, W. Kugler and M. Daureaux, In EERA INTA Pergamino created the varieties " **Guayacán INTA**" (Sunrise x 953-102-1-1-22 -4) and "**Ñandubay INTA**".
- In 1969, the same authors created " **Pehuén INTA** " {VNIIMK 6540^3 x [CA3 x (9-2-5-4 x M688-1)] } x [VNIIMK 8932^3 x (Sunrise x 953-102-1-1-22-4)]
- In 1970, F. Saura from Northrup King, registered the variety "**Norkinsol**", from a selection made on the Russian variety VNIIMK 1646
- In 1971, J.San. Martin, and J.. Sequeira, from Norberto de la Riestra, Buenos Aires, obtained the variety "**Riestra 70**" from VNIIMK1646

Brief sunflower history in Argentina

Juan Carlos San Martin

Hugo Bahuer

Aurelio Luciano

Mauricio Davreux

Brief sunflower history in Argentina

In 1980, F. Tcach, from EERA INTA Saenz Peña , in Chaco province, gets the variety "Charata INTA" from the " Early Mix " from INTA Pergamino.

Ing. Monge Navarro - Cargill S200

F. Tcach

The first three hybrids obtained in Argentina:

- Contiflor (19747
- Cargil S200 (1974)
- Dekalb G90

Research team from Argentina

INTA Pergamino Breeding program

Private companies in Argentina

NIDERA, Argentina

Arnaldo Vázquez

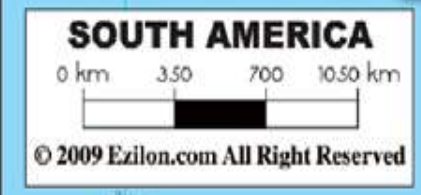
Amelia "*Baby*" Bertero de Romano

DuPont Pioneer

Abelardo de la Vega
Research Director - Sunflower at DuPont Pioneer

Private companies in Argentina

- ACA, Pergamino
- SPS, Pergamino
- *Helianthus* (Nestor Luciano)
- Sursem, Pergamino
- Advanta Argentina
- And others …



Inbreeding and Heterozis

The first inbreeding efforts were begun by Plachek (1915) at the Saratov Trial Station, while the manifestation of heterosis for the major traits based on diallel crosses was first implemented by Morozov (1947). In the 1950's in several centers there was intensive investigation of inbreeding and heterosis in sunflower. The research was carried out by Putt in Canada, Habura and Schuster in Germany, Vranceanu and Stoenescu in Romania, and Gundaev, Zhdanov, Wolf and others in the former USSR.

Hybrids

Leclercq (1969) obtained the first stable source of CMS by crossing the wild species *H. Petiolaris* Nutt. With the cultivated sunflower. Kinman (1970), Enns at al. (1970), Leclercq (1971), Vranceanu and Stoenescu (1971) and some others discovered the *Rf* genes, which enabled the development of commercioal sunflower hybrids. At that time in public institutions and numerous private companies intensive programs were established on the development of sunflower hybrids, which quickly led to introduction of sunflower hybrids into large-scale production and an increase in areas under this crop. In the paper proper we will discuss in detail the mail centers of sunflower breeding in the world and their achievements.

Use of heterosis

Development of hybrids based on *cms* and *Rf*-genes – INRA France

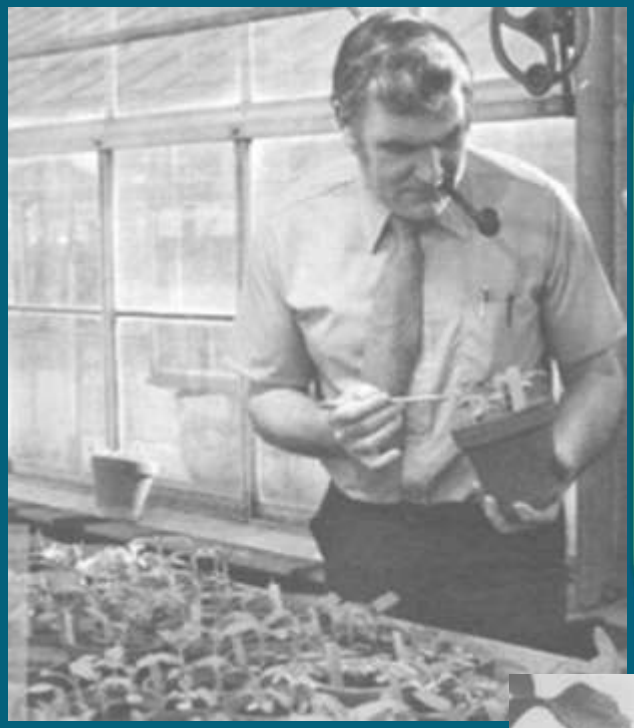
a) *CMS*

b) *Rf*-gen

Patrice LECLERQ

c) Hybrid seed production

USA, Sunflower Breeding



Dave Zimmer, USDA Suflower Pathologist

USA – USDA – Agricultural Research Service, Sunflower Research, Northern Crop Science Laboratory FARGO, ND

Gerhardt N. Fick, USDA Sunflower Breeder at Fargo

Don Zimmerman, USDA Oilseed Biochemist

USA, Sunflower Breeding

Dr Jerry Miller, Research Geneticist and Breeder. One of the world´s best sunflower geneticists and breeders. He studied inbreeding and heterosis for a large number of important sunflower traits.

He has developed a large number of sunflower inbred lines. He has also developed germ-plasm resistant to herbicides, imidazo-linones, and sylfonyl urea. He has helped a large number of young experts from across the world complete their specialization in the field of sunflower breeding and genetics.

Dr Jerry Miller,
Research Geneticist and Breeder

USA, Sunflower Breeding

Dr C.C. Jan, Research Geneticist
(adjunct Professor of Plant Sciences, NDSU).

USA, Sunflower Breeding

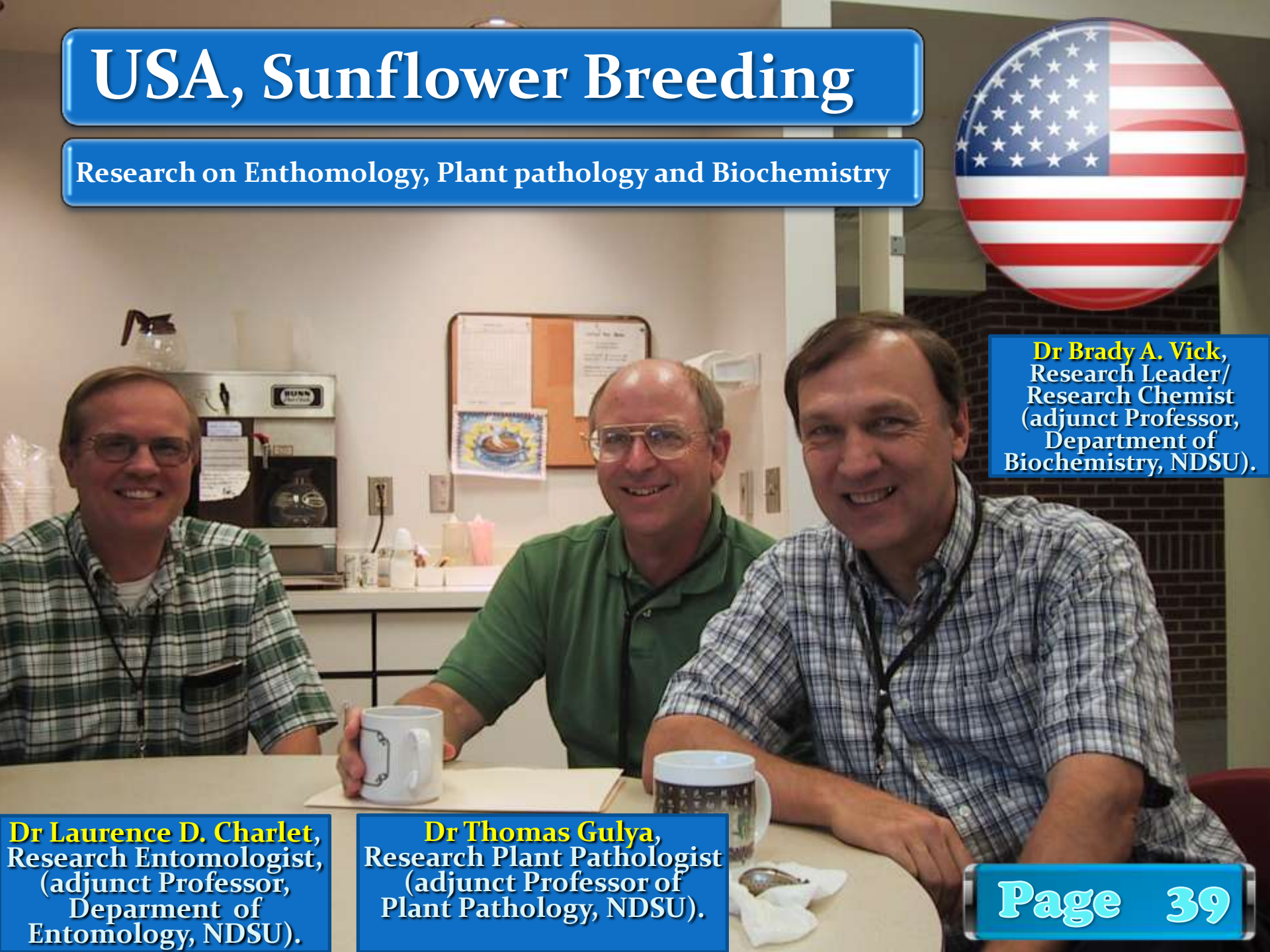
Dr Gerald J. Seiler, Research Botanist
(adjunct Professor, Department of Plant Sciences, NDSU).

A long-standing world leader in the collection, conservation, evaluation, and use of wild species of genus *Helianthus* for increasing the genetic variability of the cultivated sunflower.

It should be noted here that wild sunflower species through the use of interspecific hybrids played a significant role in the increse of genetic variability of the cultivated sunflower, especially in the discovery of sources of resistance to different pathogenes. Also, the wild species were used to identify resistance to the herbicides imidazolinones and sulfonilurea.

USA, Sunflower Breeding

Research on Enthomology, Plant pathology and Biochemistry



Dr Brady A. Vick, Research Leader/ Research Chemist (adjunct Professor, Department of Biochemistry, NDSU).

Dr Laurence D. Charlet, Research Entomologist, (adjunct Professor, Deparment of Entomology, NDSU).

Dr Thomas Gulya, Research Plant Pathologist (adjunct Professor of Plant Pathology, NDSU).

USA, Sunflower Breeding

Resistance to insects…










USA, Sunflower Breeding

Charles Heiser (left), USA; Tikhonov O.I. (reght, instead of Anashchenko), Pustovoit Award, Argentina, 1995.

Murray Kinman, USDA Sunflower Breeder , College Station, Texas

USA, Sunflower Breeders (Private Companies)

Mounir Abdallah, Interstate, USA

Gerhardt Fick, USA

Freeman Johnson, Red River Commodities, Fargo, USA

Mary Lou Straley, Cargill, USA

Jim Lofgreen, Dahlgreen, USA

USA, Sunflower Breeders (Private Companies)

Tom Heaton, USA

Jim Gerdes, USA, Nuseed – Sunflower Breeding Program Leader

Pat D., 2000 seeds, USA

Jerry Miller with colegues, USA