



***Nicotiana* Germplasm (NGPC) Task Force Report**

Cancun, Mexico

October 16, 2023



Long-Term Maintenance of *Nicotiana* Germplasm

Objectives

To study potential systems for long-term support of public *Nicotiana* germplasm maintenance.

Proposed Milestones

The current intent of the Task Force on *Nicotiana* germplasm is to stimulate a CORESTA-facilitated discussion amongst members of the tobacco industry regarding a pathway for sustainable maintenance of genetic diversity within the genus *Nicotiana*.

Preferred Deliverable

A CORESTA recommendation or solution for long-term maintenance of publicly-available *Nicotiana* germplasm.

Tobacco Market Types





Steps In Cultivar Development

- 1) Determine the objectives of the breeding program
- 2) Assemble genetic variation that will help meet the defined objectives
- 3) Develop and select amongst different types of progeny
- 4) Stabilize and multiply superior genotypes
- 5) Disseminate new and improved varieties to interested parties

Diverse Germplasm: Sources of Pathogen Resistance

Table 10.2 Documented trait introgressions to *N. tabacum* from wild *Nicotiana* relatives

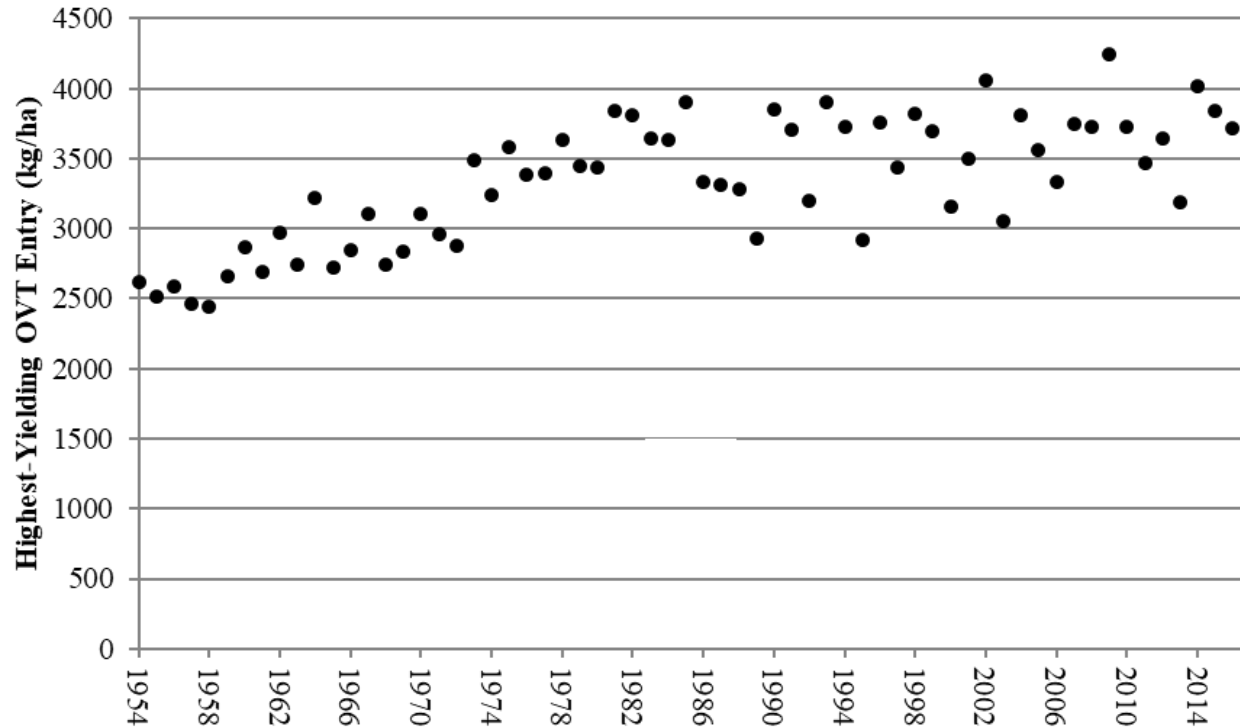
Trait	Donor species	Reference(s)
Tobacco mosaic virus (TMV) resistance	<i>N. glutinosa</i>	Holmes (1938), Ternovsky (1945), Gerstel (1945a), Kostoff (1948), Valleau (1952) Clayton (1947)
Wildfire (<i>Pseudomonas syringae</i> pv <i>tabaci</i> (race 0)) and angular leaf spot (<i>Pseudomonas syringae</i> pv <i>angulata</i>) resistance	<i>N. longiflora</i>	
Wildfire (<i>Pseudomonas syringae</i> pv <i>tabaci</i> (race 0 and 1)) and angular leaf spot (<i>Pseudomonas syringae</i> pv <i>angulata</i>) resistance	<i>N. rustica</i>	Stavely and Skoog (1976), Woodend and Mudzengerere (1992)
Black shank (<i>Phytophthora parasitica</i> var <i>nicotianae</i>) (race 0) resistance	<i>N. longiflora</i>	Valleau et al. (1960)
Black shank (<i>Phytophthora parasitica</i> var <i>nicotianae</i>) (race 0) resistance	<i>N. plumbaginifolia</i>	Apple (1962), Chaplin (1962)
Black shank (<i>Phytophthora parasitica</i> var <i>nicotianae</i>) resistance (race 0)	<i>N. rustica</i>	Woodend and Mudzengerere (1992)
Black root rot (<i>Chalara elegans</i> ; Syn. <i>Thielaviopsis basicola</i>) resistance	<i>N. debneyi</i>	Clayton (1969)
Blue mold (<i>Peronospora tabacina</i>) resistance	<i>N. velutina</i>	Clayton (1967), Clayton et al. (1967), Lea (1963)
Blue mold (<i>Peronospora tabacina</i>) resistance	<i>N. debneyi</i>	Wark (1963, 1970)
Blue mold (<i>Peronospora tabacina</i>) resistance	<i>N. goodspeedii</i>	Wark (1963, 1970)
Root knot nematode (<i>Meloidogyne javanica</i>) resistance	<i>N. longiflora</i>	Schweppenhauser (1968, 1975), Ternouth et al. (1986)
Root knot nematode (<i>Meloidogyne javanica</i>) resistance	<i>N. repanda</i>	Ternouth et al. (1986)
Root knot nematode (<i>Meloidogyne incognita</i>) (races 1 and 3) resistance	<i>N. tomentosa</i>	Clayton et al. (1958), Yi and Ruffy (1998)
Powdery mildew (<i>Erysiphe cichoracearum</i>) resistance	<i>N. debneyi</i>	Smeeton and Ternouth (1992)
Powdery mildew (<i>Erysiphe cichoracearum</i>) resistance	<i>N. glutinosa</i>	Smeeton and Ternouth (1992)
Powdery mildew (<i>Erysiphe cichoracearum</i>) resistance	<i>N. tomentosiformis</i>	Smeeton and Ternouth (1992)
Tomato spotted wilt virus (TSWV) resistance	<i>N. alata</i>	Gajos (1987)
Potato virus Y (PVY) resistance	<i>N. africana</i>	Lewis (2005)
Potato virus Y (PVY) resistance	<i>N. tomentosiformis</i>	Legg and Smeeton (1999)
Tobacco cyst nematode (<i>Globodera tabacum</i>) resistance	<i>N. plumbaginifolia</i>	Apple (1962), Chaplin (1962), Johnson et al. (2009)
Increased leaf number and delayed flowering time	<i>N. tomentosa</i>	Clausen and Cameron (1944), Lewis et al. (2007b)

Response to selection (***R***)

$$R = h^2 D = h^2 i \sigma_P = i \sigma_A^2 / \sigma_P$$



Plant Breeding: Gain From Selection

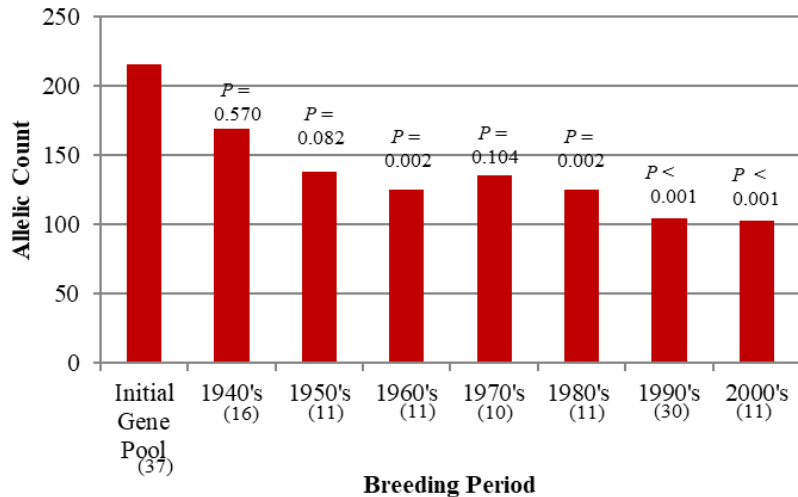




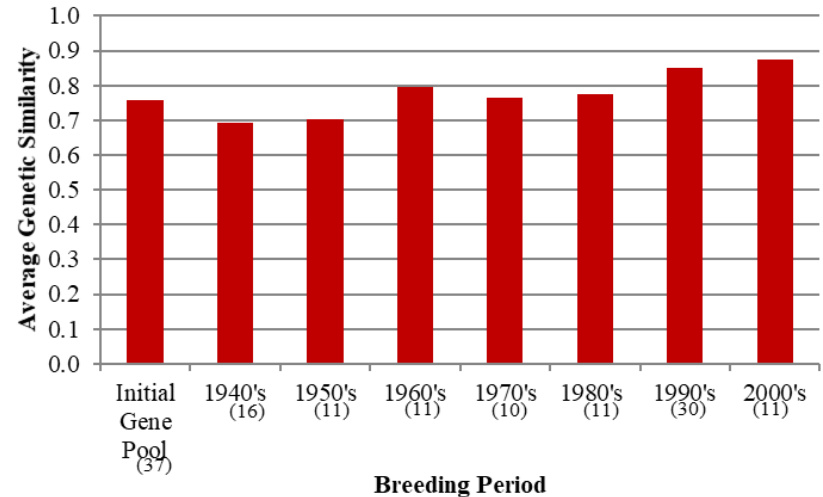
Changes in Genetic Diversity of U.S. Flue-Cured Tobacco Germplasm over Seven Decades of Cultivar Development

H.S. Moon, J.S. Nicholson, A. Heineman, K. Lion, R. van der Hoeven, A.J. Hayes, and R.S. Lewis*

Allelic Counts for Eight Time Periods of Flue-Cured Tobacco Breeding

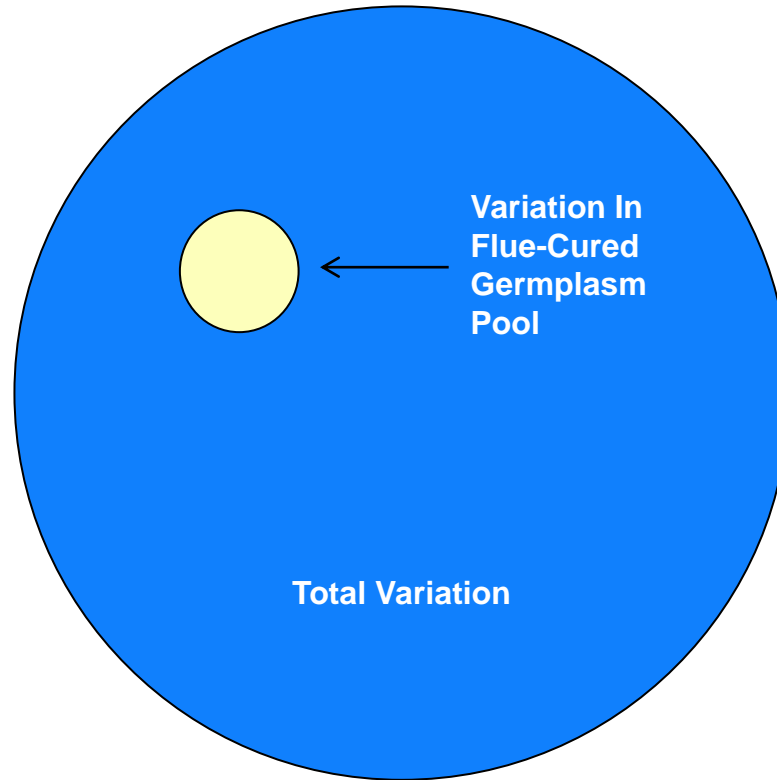


Average Genetic Similarities Values (S_{ij}) for Flue-Cured Tobacco Cultivars from Eight Time Periods

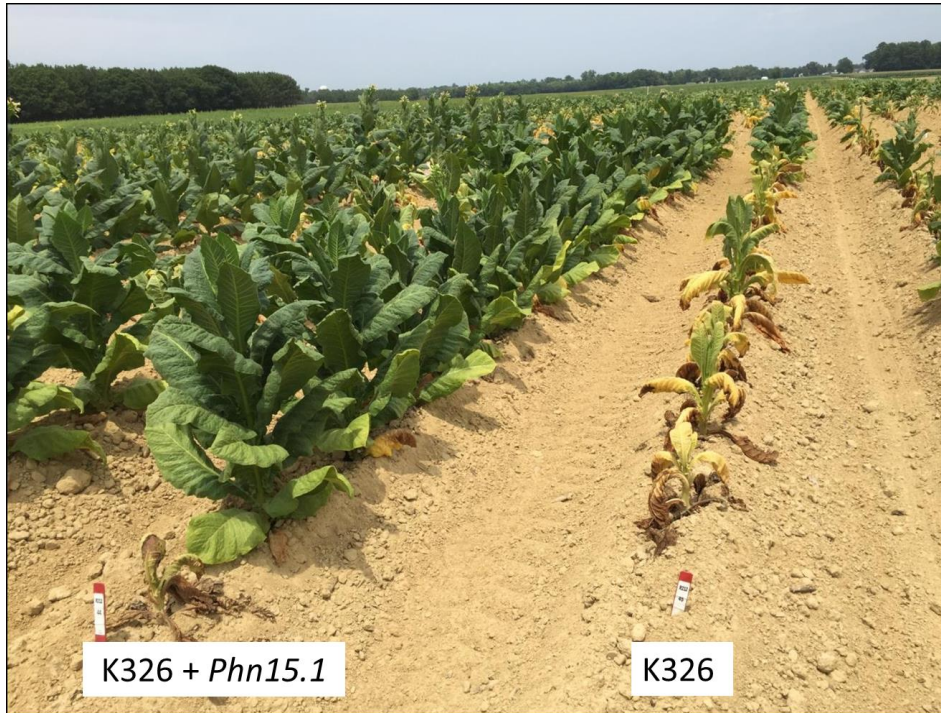




Plant Breeding: Use of Genetic Variability



Use of Genetic Variability In *Nicotiana*



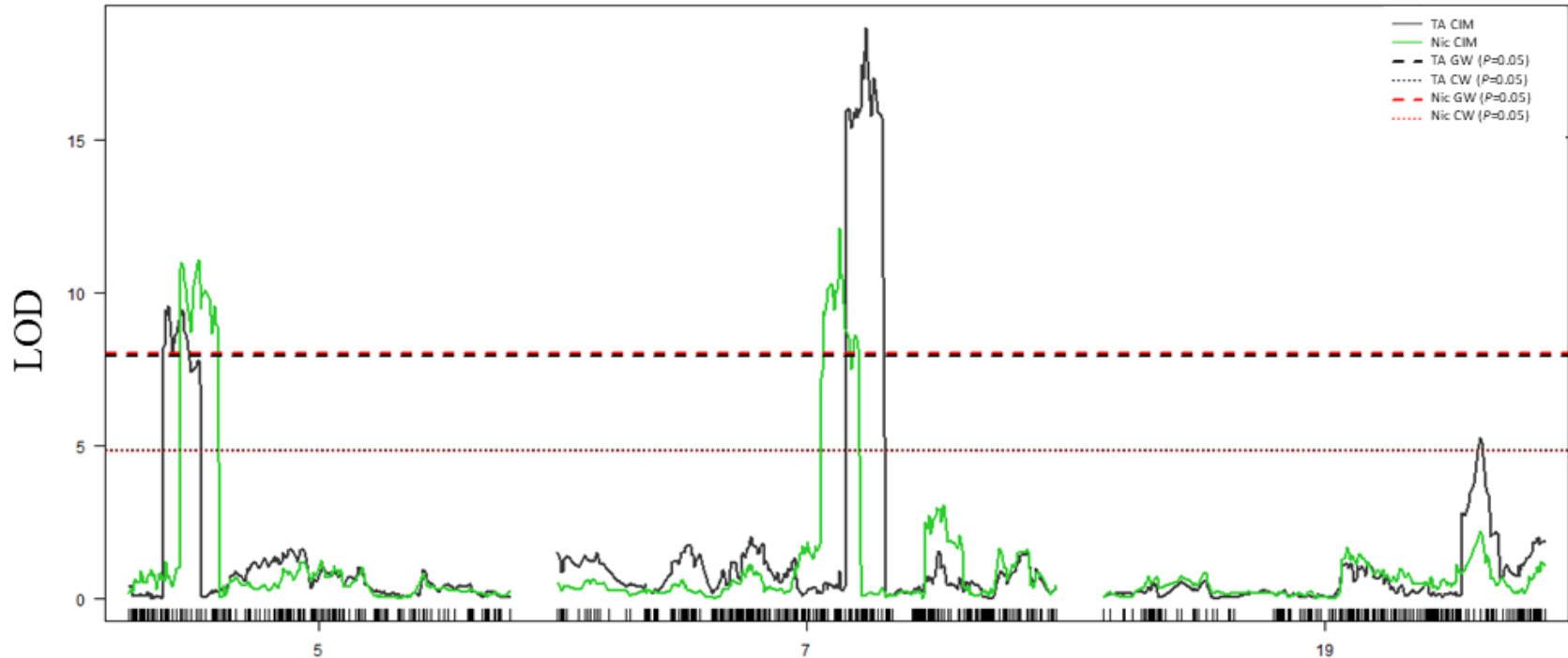
Novel Black Shank Resistance

Use of Genetic Variability In Nicotiana



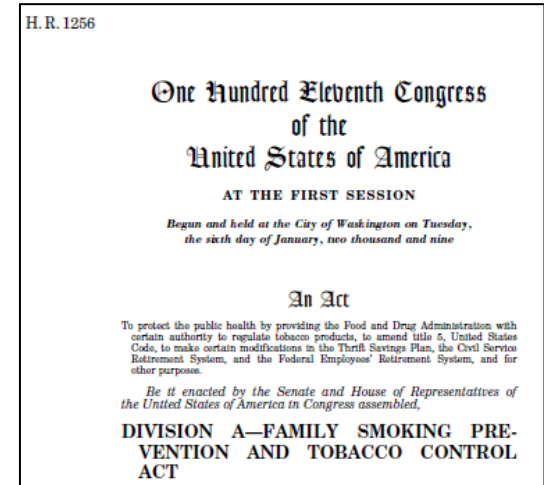
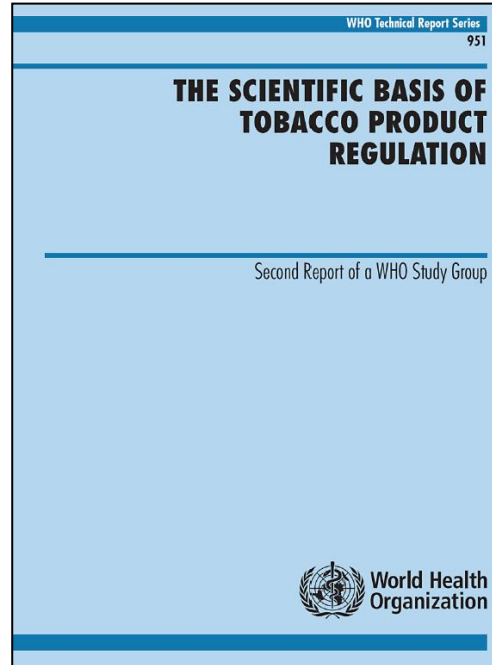
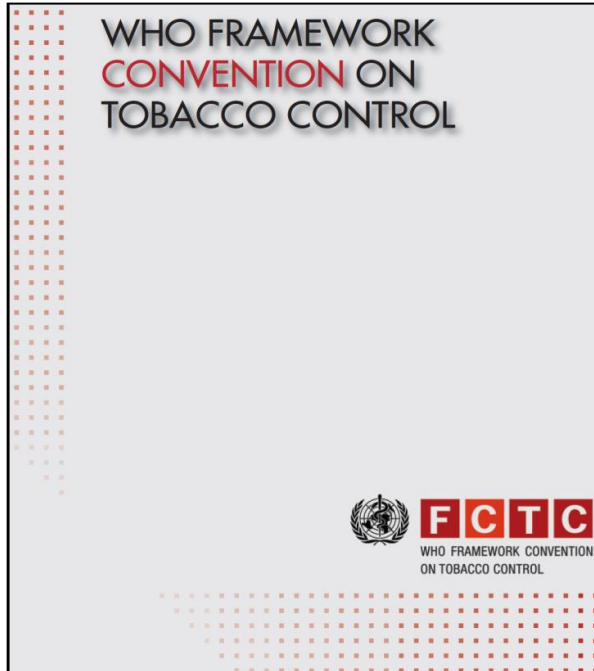
Early Leaf Ripening

Use of Genetic Variability In Nicotiana



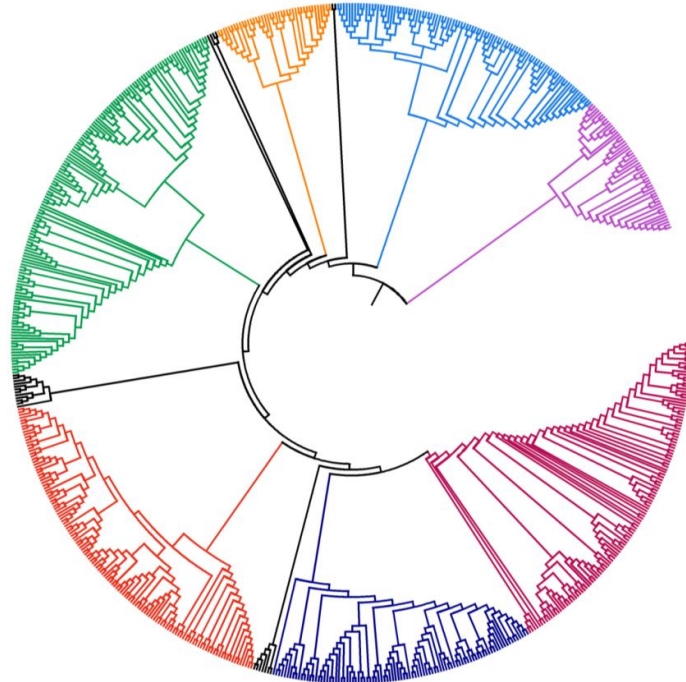
Reduced Nicotine Accumulation

Use of Genetic Variability In Nicotiana



New Products May Benefit From Alternative Genetic Variability

Use of Genetic Variability In Nicotiana



Sources of Variation for Genetic Studies in *Nicotiana*

Nicotiana Germplasm Maintenance

1) Private companies



- bears internal costs, maintenance of personnel and know-how, long-term commitment, limited public distribution

2) Public collections

- unstable footing



Nicotiana Germplasm Task Force

- 1) Where are publicly available, non-privately-owned, *Nicotiana* germplasm collections located and what are the volumes of their holdings? Do they make these materials readily available worldwide?
- 2) Does the CORESTA Taskforce believe that public collections are important, and worthy of discussion regarding strategies for long-term financial support?
- 3) What are some ideas regarding potential strategies for tobacco industry partnerships in such activities? Possibilities might include the use of CORESTA as a conduit to (1) collect annual financial support from interested companies, or (2) collect industry contributions to be deposited in a Foundation account whereby annual support would be generated via interest.



Nicotiana Germplasm Task Force

A number of publicly-available, non-privately owned *Nicotiana* germplasm collections were identified.

The most significant are (1) the United States *Nicotiana* Germplasm Collections maintained by N.C. State University, and (2) two collections maintained in Germany by NiCoTa and IPK Gaterslaben.

All survey respondents indicated that a system of financial support for one or more publicly-available *Nicotiana* germplasm collections would be in the best interest of the tobacco industry, as a whole.



***Nicotiana* Germplasm Task Force**

An industry/public sector partnership to provide organized financial support would benefit the tobacco industry by:

- 1) gained confidence that an invaluable public genetic resource for the future of the tobacco industry will be preserved
- 2) providing opportunity for private companies to reduce operating costs by donating a reasonable number of accessions (non-duplicate) to a public collection for maintenance and distribution (as needed).



Nicotiana Germplasm Task Force

Recommends the tobacco industry:

- (1) Contribute annually to a fund administered through CORESTA to support one or more *Nicotiana* germplasm collections
- (2) OR establish an endowment to perpetually maintain the U.S. *Nicotiana* Germplasm Collection
 - a) approximately USD \$2.1 million would be required
 - b) This collection could absorb unique accessions from other *Nicotiana* collections
 - c) CORESTA could act as a conduit for financing
- (3) Create a new task force to assess allelic variability and relationships amongst diverse materials in germplasm collections



Ref: COR-220/23

Paris, 24 July 2023

RE: Long-Term Public Maintenance of *Nicotiana* Germplasm

Dear CORESTA Member,

We are writing to ask for your organisation to support an endowment to enable the long-term public maintenance of the largest public *Nicotiana* germplasm collection held at North Carolina State University. This collection is a critical resource, and the endowment will perpetually support the maintenance and international access to genetic diversity contained within the collection.

Genetic diversity within *Nicotiana tabacum* and related species has been crucial for improvements in tobacco cultivars to meet the needs of stakeholders. Continued varietal improvement requires the existence, maintenance, and use of genetic diversity within the genus *Nicotiana*. Public availability of this genetic variability should be considered of extremely high importance, as further improvements in production efficiency and sustainability remain important objectives, as is the potential to address emerging regulatory needs and future product development.

However, reduced support from public institutions and governments for tobacco-related activities during the last 20 years has made it difficult to maintain publicly available tobacco germplasm collections. Future genetics-based solutions will not be possible without the strategic use of genetic diversity within the genus *Nicotiana*, and a mechanism for long-term access to *Nicotiana* germplasm is in the best interest of all.

The CORESTA *Nicotiana* Germplasm Collection Task Force recommended that members work collaboratively to establish an endowment with The North Carolina Agricultural Foundation, Inc. that would perpetually support the maintenance of international access to genetic diversity contained with the United States *Nicotiana* Collection. It is estimated that an endowment with a market value of USD \$2.1 million is required to produce a spending budget necessary to maintain the collection in perpetuity. This collection can also absorb a reasonable number of unique accessions from other *Nicotiana* collections for public availability and use.

As an organization of stakeholders, CORESTA would like to act on this Task Force recommendation; however, the existing organizational budget is not equipped for this special funding need. For this reason, **we are engaging all CORESTA members to consider a direct contribution to the North Carolina Agricultural Foundation, Inc. in recognition of the importance of this resource to ongoing scientific efforts.**

This foundation will support the work undertaken at North Carolina State University to maintain the germplasm collection. From a fiscal perspective, there are options available to address contributor accountability and tax needs. If your organization is willing to support this important germplasm resource, please contact Dr Ramsey Lewis **before the end of 2023** for information on how to make a contribution (ramsey_lewis@ncsu.edu; +1 919-218-2339).

Yours sincerely,


Dr Stéphane COLARD
Secretary General


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Thank You And Questions