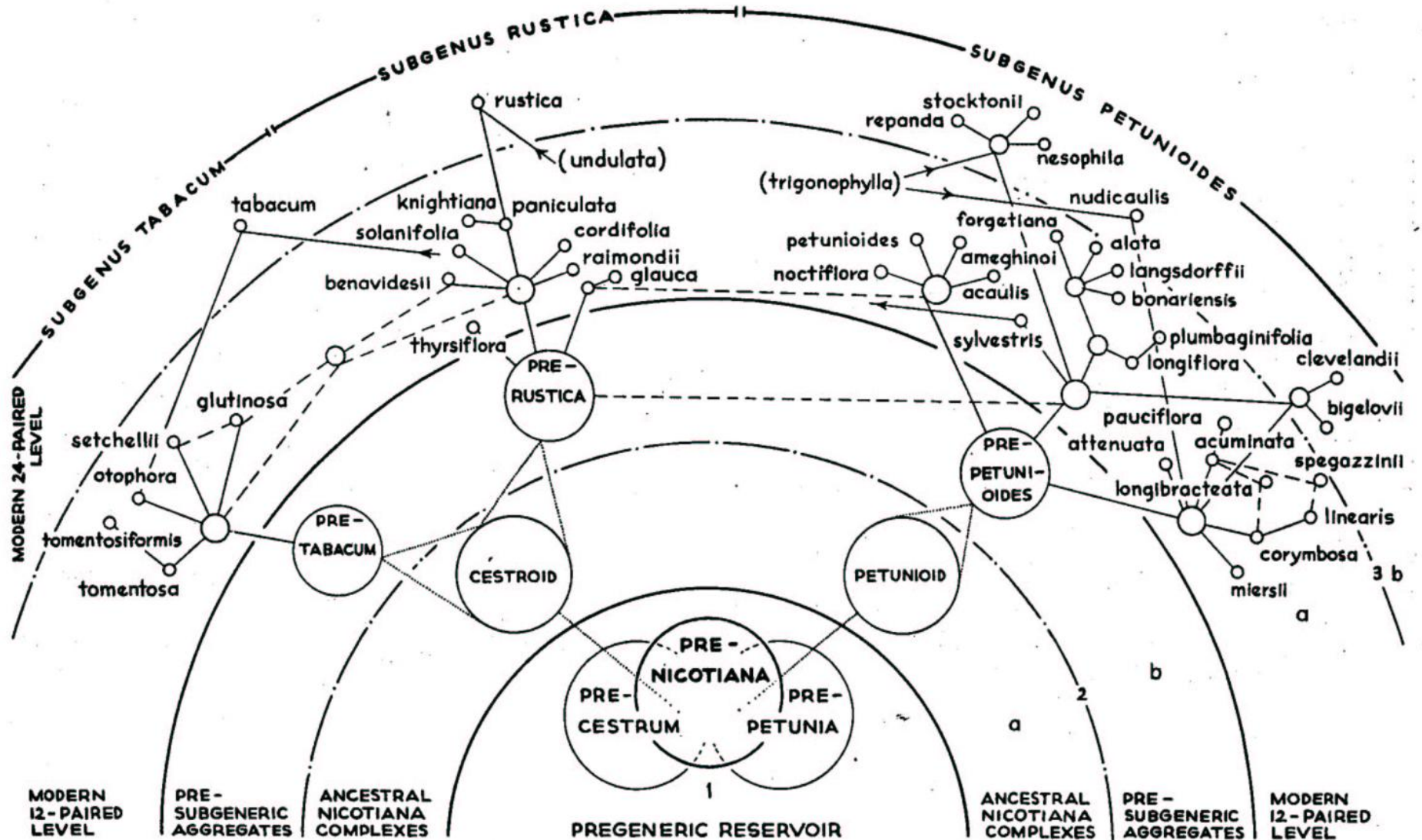

Status of the United States *Nicotiana* Germplasm Collection: What to do Next?

Tobacco Workers Conference
January 17, 2012
R.S. Lewis



Nicotiana Genus



76 recognized naturally-occurring species (Knapp et al., 2004)

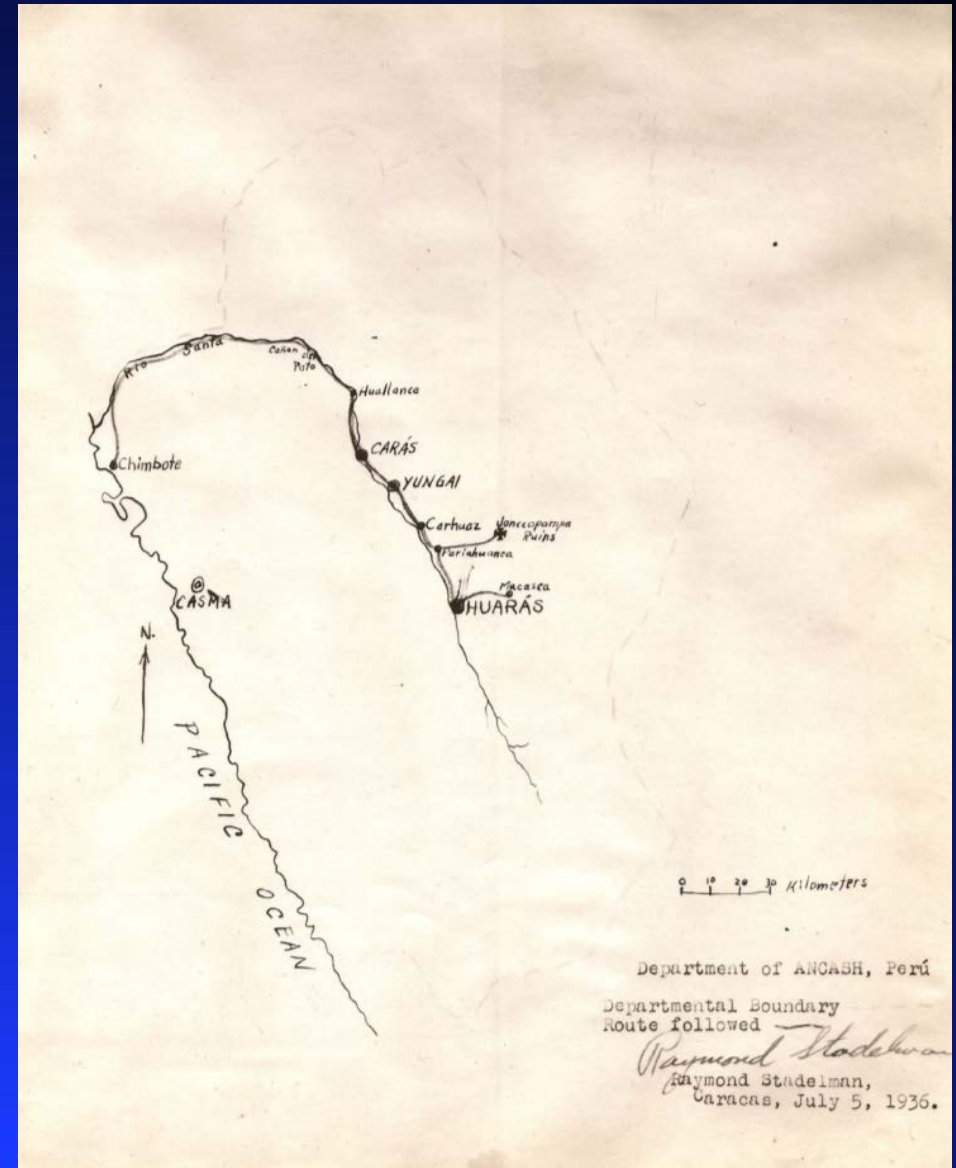
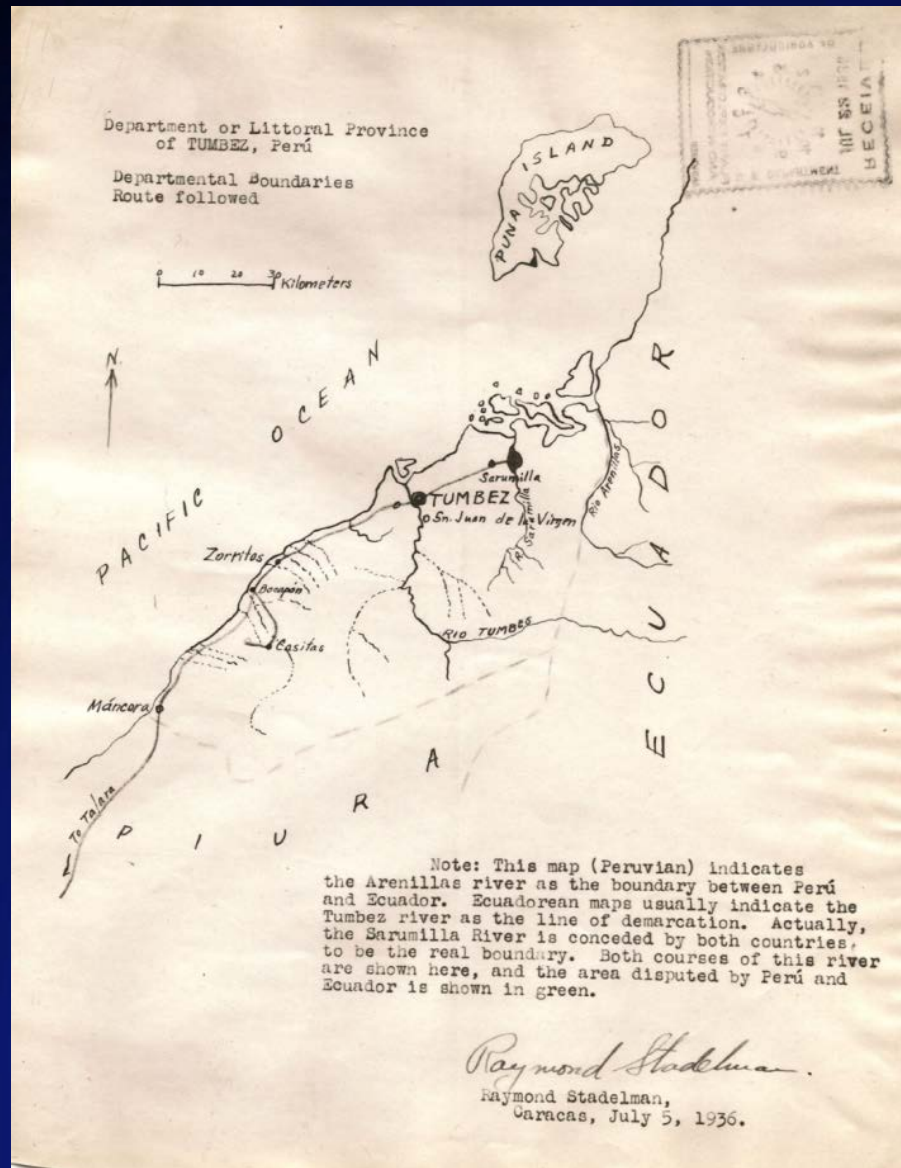
U.S. *Nicotiana* Collection: History

Prior to 1934: USDA collection consists of ~150 ‘Tobacco Introductions’ or TIs

1934: USDA plant pathologist E.E. Clayton organizes collection trip

1935 – 1937: W. Andrew Archer & Raymond Stadelman collect seed of native varieties in Mexico, Central America, & South America. Collection increased to 1,160 TI’s by 1937.

Stadelman & Archer Collection Trips



Many thanks for your kindness in arranging to keep me on the pay roll. Speaking of that, I believe that I did not receive my salary check for the last half of February. I have no record of it in my books, and I always enter them as soon as they are received. I have received five subsequent ones, so it must have been lost. Can you check up on this and let me know if it was cashed?

Incan ruins that had never been photographed, so I decided to go there, and Vallejo agreed to accompany me. We started out the following morning on a pair of worthless horses, and had to climb a considerable distance over a very narrow trail that had a very deep abyss on one side. My horse almost gave me the jitters by his apparent indifference to danger, as he walked almost on the edge. He finally became so careless that he started walking into small bushes and huge boulders on the curves of the trail, and at last, when he escaped by a hairs breadth from falling into the abyss with me, I got off his back and started cursing him for a blind so-and-so. And then I noticed that he was, after all, quite blind, for a leather blinder strap that all bridles in these parts carry, had slipped and fallen down over his eyes. As I looked back over the narrow trail up which we had come blundering along, I thanked my lucky star and felt like apologizing to the horse.

mail. That evening we had the misfortune to become lodged in the middle of the La Sierra river, as the water was deep enough to enter the car, and extinguished the motor. It was raining up river, and the water carried a good deal of mud and sand, so that this mess, when it got into the clutch housing, locked the motor so tightly that it was impossible to even budge it with the crank. Two men came along about that time, and the four of us managed to push the car partly out of the water, but as there was a steep incline up the bank, we could not get it completely out of the water. The river was rising fast (it rose three feet in less than half an hour) so we tied the car to a distant tree for security. Sending for more men and

U.S. *Nicotiana* Collection: History

1950's: Tobacco Wild relative (TW) collection assembled largely as a duplication of original materials collected by botanist Dr. T.H. Goodspeed.



U.S. *Nicotiana* Collection: History

TW collection maintained in Beltsville until 1960's when moved to Oxford Tobacco Research Station

TI collection maintained in Beltsville until 1982 when moved to Oxford Tobacco Research Station (Verne Sisson, Curator)

USDA ceases all support for tobacco related activities in 1994. Collection transferred to N.C. State University.

Curator

Verne Sisson	until 2004
Jennifer Nicholson	2004-2007
Ted Woodlief	2008-2011
Nobody	2012



Oxford Tobacco Research Station

U.S. *Nicotiana* Collection: Current Situation

- Approximately 1900 accessions of *N. tabacum*
- 223 accessions representing 59 wild *Nicotiana* relatives

Table 3 Components of the U.S. *Nicotiana* Germplasm Collection

Group	Number of accessions,
Tobacco Introductions (TIs)	1,244
Tobacco Cultivars (TCs)	656
Tobacco Wild Species (TWs)	137
Tobacco Rustica (TRs)	87
Tobacco Hybrids (THs)	50
Tobacco Mutants (TMs)	30 ^a





U.S. *Nicotiana* Collection: Maintenance

Seedstocks maintained in 25 ml glass vials at ~10 deg C.
Approximately 15 g (~200,000 seed) are maintained for TI & TC collections.

Small subsamples are kept in a freezer maintained at -20 deg C.

Backup also maintained by National Center for Genetic Resources Preservation (Ft. Collins, CO)

Seed generally regenerated at intervals between 10 and 15 years.

Some species very difficult to produce seed for.



U.S. *Nicotiana* Collection: Current Situation

Collection is a component of the National Plant Germplasm System (NPGS).

Each accession has an associated Plant Introduction (PI) number.

Information available on Germplasm Resources Information Network (GRIN).

PI 119208 (TI 1068)

[Nicotiana tabacum](#) L. SOLANACEAE

Donated from: Argentina

Maintained by the [Nicotiana Collection](#). NPGS received: Dec-1936. PI assigned: 1936. Inventory volume: 129. Form received: Seed.

View original Plant Inventory data ([PDF](#) format)

Accession names and identifiers

TI 1068

Idtype: OTHER. Group: TI. Comment: Tobacco Index numbers (Nicotiana sp.).

Availability

Material not available at this time, contact the maintenance site for more information.

Source History

- Accession was donated. Dec-1936. Argentina.

Observations

Observations for accession PI 119208

Characterization and Evaluation Data

Descriptor	Value	Q
Chemical composition descriptors		
ADVTDIOL	28.8	
ADVTOL	1.4	
ANABASINE	0.0	
ANATABINE	0.00	
BDVTDIOL	12.47	
BDVTOL	0.68	
C22OH	0.570	
CISABIENOL	9.2	
LADENEDIOL	2.68	
NICOTINE	11.8	
NNICOTINE	0.00	
SUCROESTER	28.3	
Growth descriptors		
GRDSUCKERS	0.00	
PLANTFORM	3=INVERTED CONE	
PLTHGTOP	150	
PLTHGTOP	169	
PLTHGTUNTP	151	
SUCKNOPOST	6.0	
SUCKNOPOST	12.0	
SUCKNOPRES	1.0	
SUCKNOPRES	1.0	

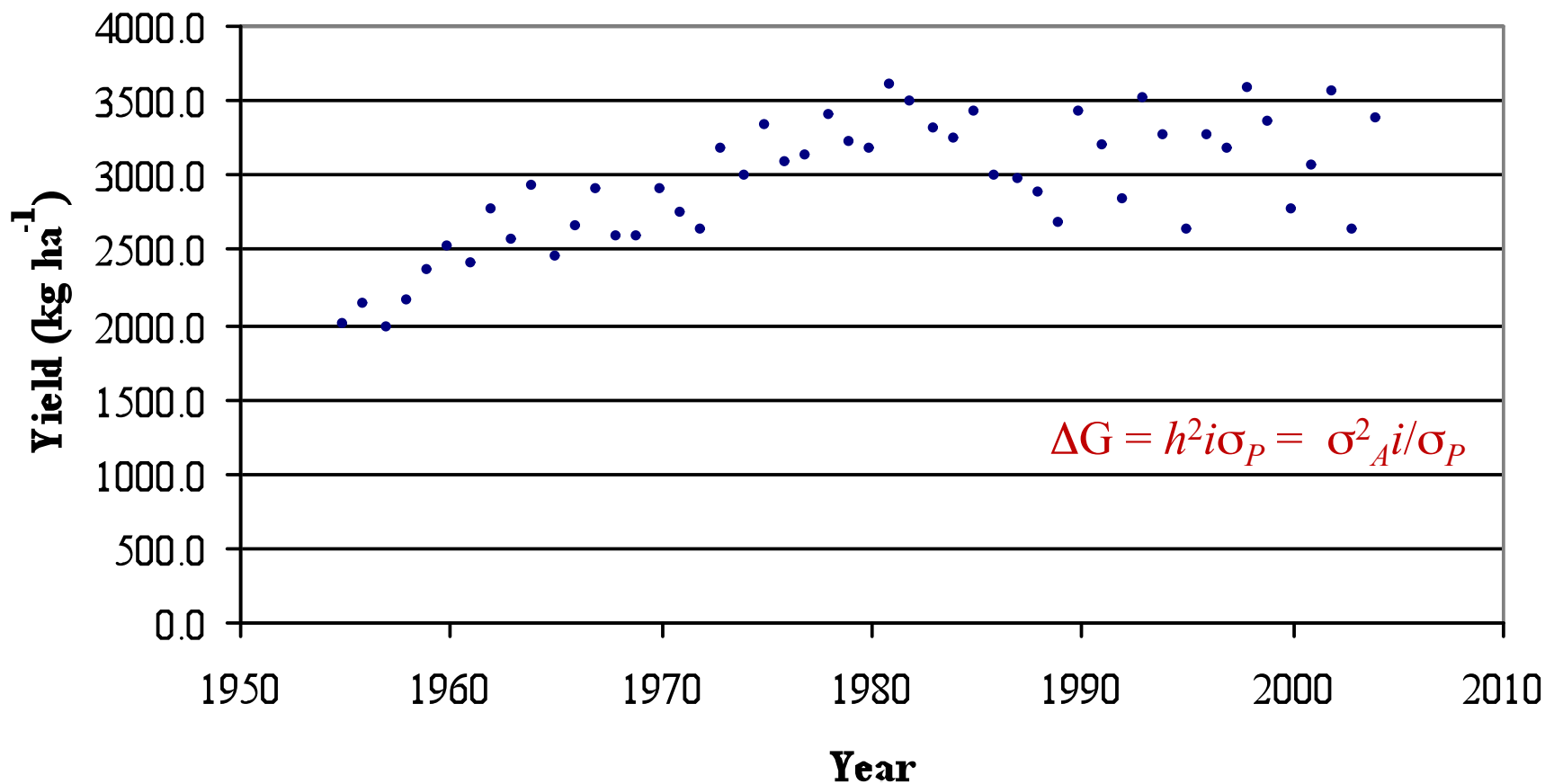
Morphological descriptors

FLWRCOLOR	P=PINK	
FLWRCOLOR	P=PINK	
LEAFATTACH	S=SESSILE	
LEAFATTACH	S=SESSILE	
LEAFATTACH	S=SESSILE	
LEAFCARR	2=NOT ARCHED (COKER 347, BU 21)	
LEAFCOLOR	1=LIGHT GREEN (COKER 298, K 399, MD 609)	
LEAFMARGIN	2=NOT WAVY (MCNAIR 373, SPEIGHT G-70)	
LFANGLE10	68	
LFANGLE10	63	
LFANGLE10	45	
LFLENGTH10	56.0	
LFLENGTH10	74.0	
LFLENGTH10	63.0	
LFMARGCURV	2=NOT RECURVED (SPEIGHT G-70, MCNAIR 373)	
LFNOTOPPED	20.0	
LFNOTOPPED	33.0	
LFNOUNTOP	30.0	
LFSURFACE	1=SMOOTH (HICKS, SPEIGHT G-70)	
LFWIDTH10	22.0	
LFWIDTH10	21.0	
LFWIDTH10	27.0	
STALKDIAM	29.0	
TIPSHAPE	2=ACUMINATE (SPEIGHT G-70, MCNAIR 373, COKER 48)	
VENATIONPN	2=ANGULAR (SPEIGHT G-70, HICKS)	
Phenological descriptors		
MATURITY	77	
MATURITY	84	
Production descriptors		
CLASS	OT=OTHER	
LEAFYIELD	1122	

Genetic Variation in *Nicotiana*: Reasons to Care

1) Source of variation for breeding flexibility & continued improvement of quantitative traits

Average Yields for NCOVT: 1955-2006



Genetic Variation in *Nicotiana*: Reasons to Care

There is a very high degree of relatedness among elite flue-cured materials

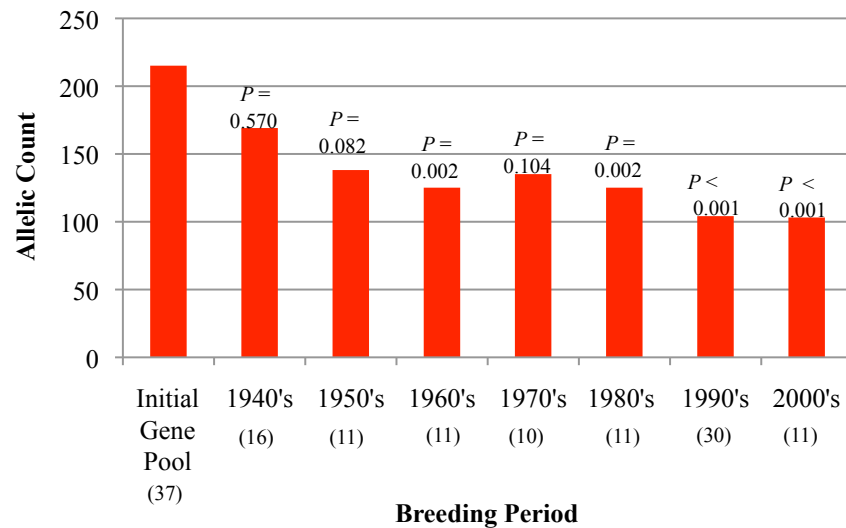
Table 2 Average coefficients of parentage among cultivars of various cultivated crops

Crop		Basis of determination	Average coefficient of parentage	Reference
Cotton	(<i>Gossypium hirsutum</i> L.)	260 upland cotton cultivars released between 1970 and 1990	0.07	Bowman et al. (1996)
Peanut	(<i>Arachis hypogaea</i> L.)	12 U.S. Virginia market type peanut cultivars released between 1969 and 1989	0.21	Knauft and Gorbet (1989)
Peanut	(<i>Arachis hypogaea</i> L.)	8 U.S. runner market type peanut cultivars released between 1969 and 1989	0.20	Knauft and Gorbet (1989)
Wheat	(<i>Triticum aestivum</i> L.)	55 U.S. hard winter wheat cultivars released prior to 1986	0.26	Murphy et al. (1986)
Wheat	(<i>Triticum aestivum</i> L.)	55 U.S. soft red winter wheat cultivars released prior to 1986	0.19	Murphy et al. (1986)
Barley	(<i>Hordeum vulgare</i> L.)	45 North American two-rowed barley cultivars released prior to 1991	0.11	Martin et al. (1991)
Barley	(<i>Hordeum vulgare</i> L.)	122 North American six-rowed barley cultivars released prior to 1991	0.10	Martin et al. (1991)
Soybean	(<i>Glycine max</i> L.)	61 Northern U.S. soybean cultivars and breeding lines chosen mostly to represent the period from 1989 to 1991	0.23	Sneller (1994)
Soybean	(<i>Glycine max</i> L.)	61 Southern U.S. soybean cultivars and breeding lines chosen mostly to represent the period from 1989 to 1991	0.26	Sneller (1994)
Soybean	(<i>Glycine max</i> L.)	44 Northern U.S. and Canadian public soybean cultivars released from 1984 to 1988	0.21	Gizlice et al. (1993)
Soybean	(<i>Glycine max</i> L.)	19 Southern U.S. public soybean cultivars released from 1984 to 1988	0.26	Gizlice et al. (1993)
Tobacco	(<i>Nicotiana tabacum</i> L.)	131 historically important U.S. flue-cured tobacco cultivars and breeding lines	0.41	Murphy et al. (1987)

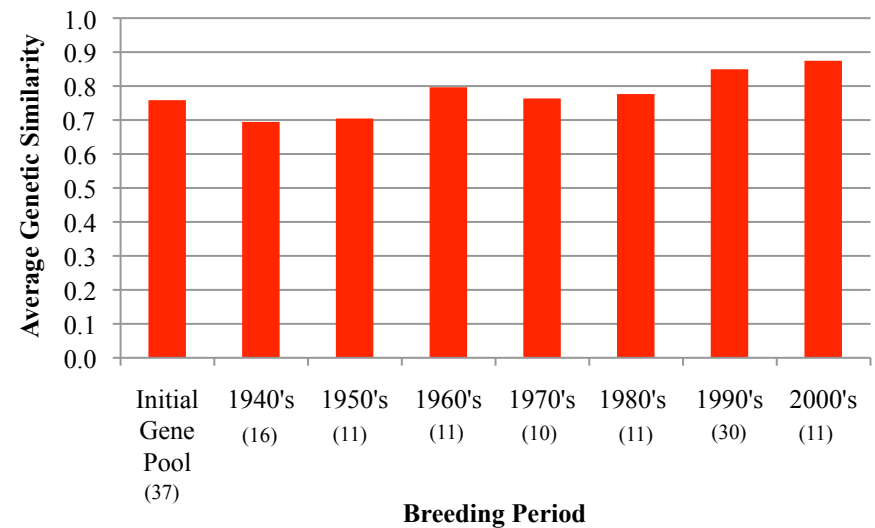
Changes in Genetic Diversity of U.S. Flue-Cured Tobacco Germplasm over Seven Decades of Cultivar Development

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

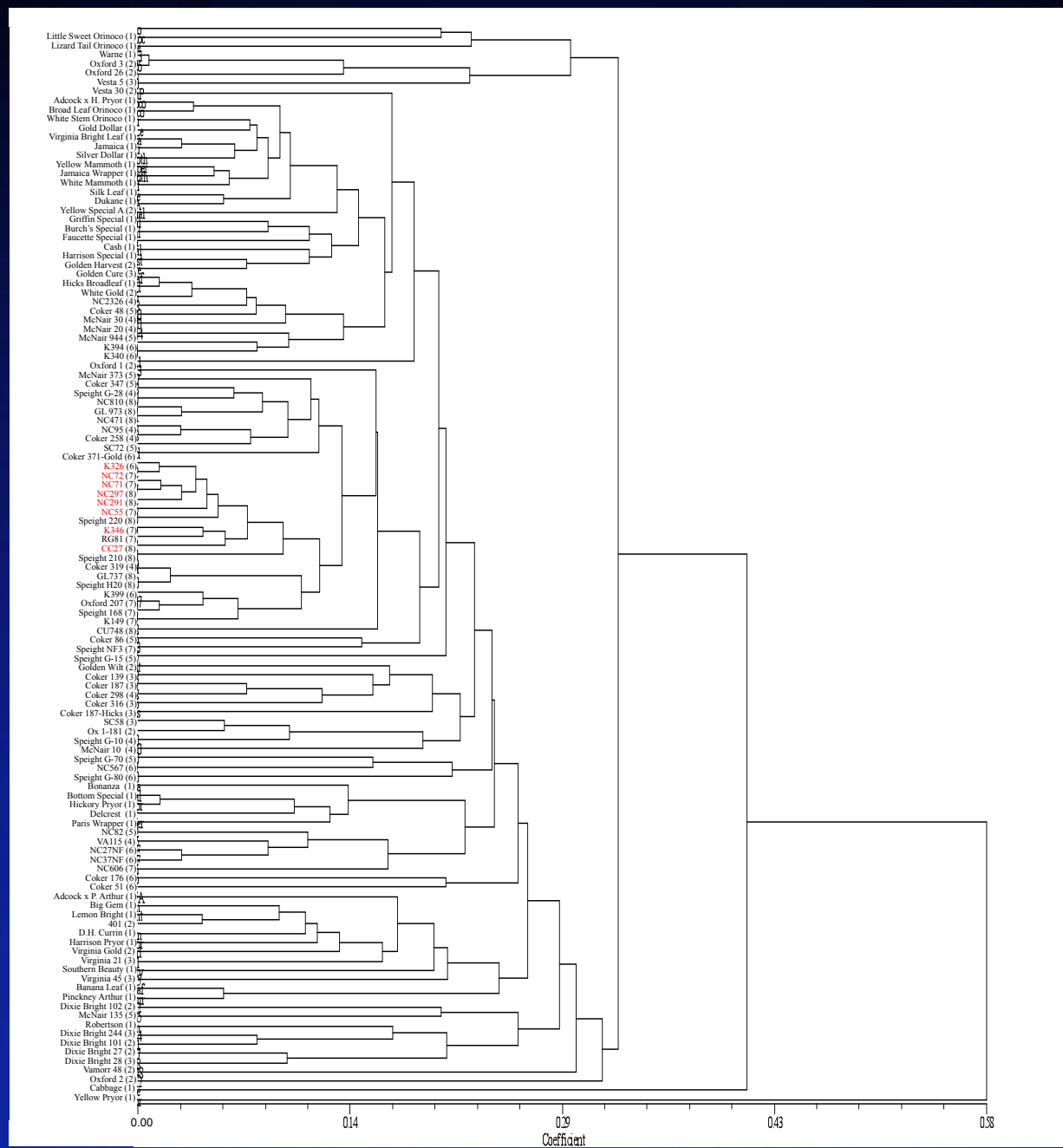
Allelic Counts for Eight Time Periods of Flue-Cured Tobacco Breeding



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



Based on 71 microsatellite marker loci.



Microsatellite-based UPGMA dendrogram of 117 flue-cured tobacco cultivars from eight time periods.

Genetic Variation in *Nicotiana*: Reasons to Care

2) Source of resistance genes for biotic and abiotic stresses?

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)
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>	Clayton (1947)
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>)	<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)

Genetic Variation in *Nicotiana*: Reasons to Care

3) Sources of variation for working within a regulatory environment

The image displays three overlapping document covers. The top-left cover is the WHO Framework Convention on Tobacco Control (FCTC), featuring a white background with a red dotted pattern on the left and bottom edges, and the WHO logo and FCTC acronym. The top-right cover is the WHO Technical Report Series 951, titled 'THE SCIENTIFIC BASIS OF TOBACCO PRODUCT REGULATION', with a light blue background and the WHO logo at the bottom. The bottom-right cover is H.R. 1256, titled 'One Hundred Eleventh Congress of the United States of America AT THE FIRST SESSION', with a white background and a blue border.

WHO Technical Report Series
951

THE SCIENTIFIC BASIS OF TOBACCO PRODUCT REGULATION

Second Report of a WHO Study Group

WHO FRAMEWORK CONVENTION ON TOBACCO CONTROL

H. R. 1256

One Hundred Eleventh Congress
of the
United States of America

AT THE FIRST SESSION

*Begun and held at the City of Washington on Tuesday,
the sixth day of January, two thousand and nine*

An Act

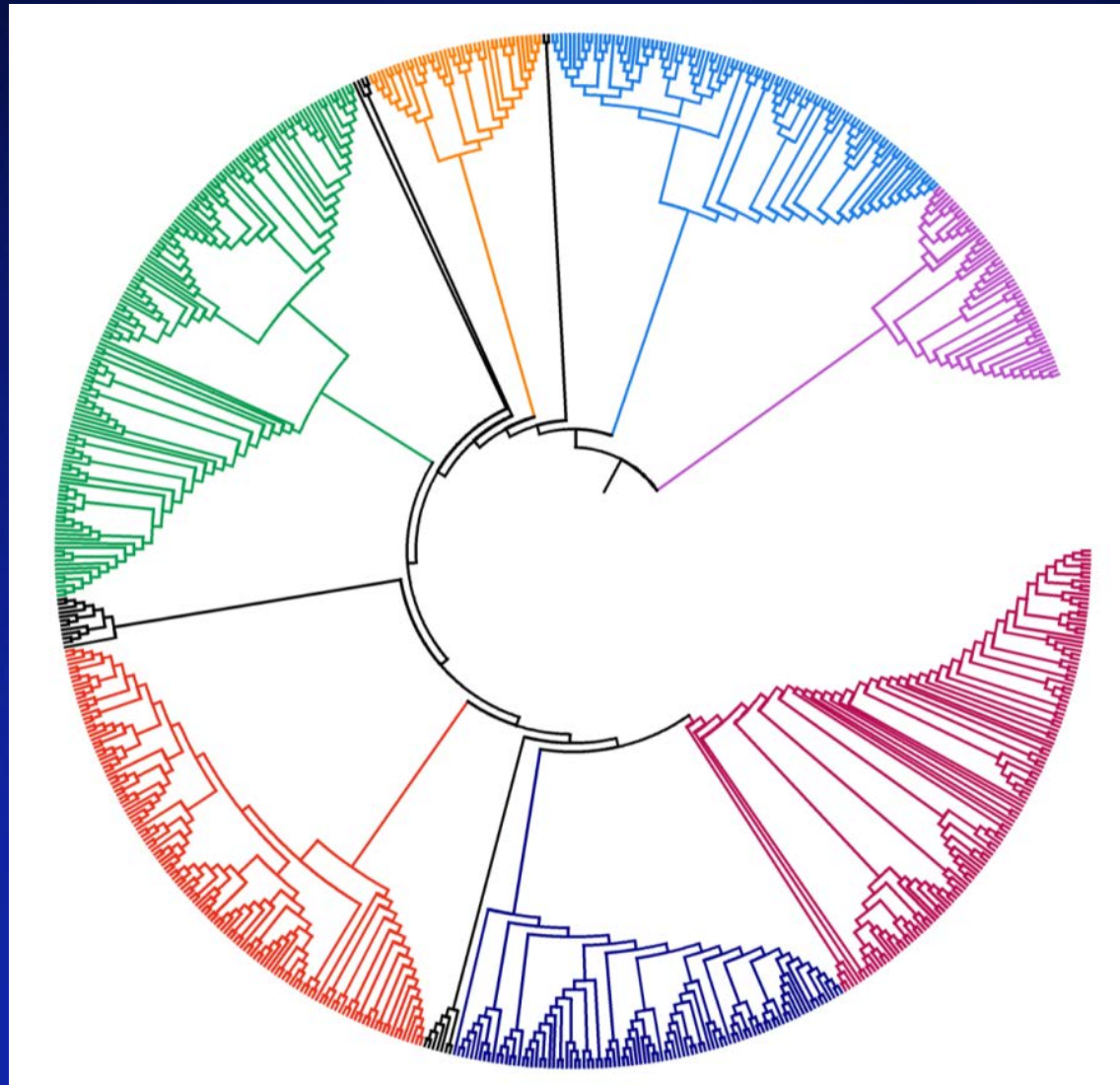
To protect the public health by providing the Food and Drug Administration with certain authority to regulate tobacco products, to amend title 5, United States Code, to make certain modifications in the Thrift Savings Plan, the Civil Service Retirement System, and the Federal Employees' Retirement System, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

DIVISION A—FAMILY SMOKING PREVENTION AND TOBACCO CONTROL ACT

Genetic Variation in *Nicotiana*: Reasons to Care

4) Sources of variation for genomic studies in *Nicotiana* and experiments in basic plant biology



U.S. *Nicotiana* Germplasm Collection: Number of Requests

Seed requests filled by the curator of the United States *Nicotiana* Germplasm Collection: 2000-2004, 2009-2010

Requesting Agency Classification	2000		2001		2002		2003		2004		2009		2010	
	# of Requests	# of Accessions	# of Requests	# of Accessions	# of Requests	# of Accessions	# of Requests	# of Accessions	# of Requests	# of Accessions	# of Requests	# of Accessions	# of Requests	# of Accessions
U.S. Agricultural Research Service	0	0	1	1	3	12	7	76	4	8	-	-	-	-
U.S. state agencies and universities	27	89	32	203	39	283	39	172	31	269	-	-	-	-
U.S. commercial company	12	50	22	163	13	144	22	604	25	343	-	-	-	-
U.S. non-profit organization	1	1	4	7	3	4	3	8	4	10	-	-	-	-
U.S. individuals (no affiliation)	6	38	5	14	5	36	12	74	15	116	-	-	-	-
Foreign genetic resources unit	2	2	0	0	3	72	0	0	0	0	-	-	-	-
Foreign commercial company	1	34	6	18	4	13	3	112	1	1	-	-	-	-
Foreign non-commercial organization	13	51	20	153	9	20	14	193	14	161	-	-	-	-
Foreign individual (no affiliation)	3	6	0	0	1	2	3	6	1	1	-	-	-	-
Total	65	271	90	559	80	586	103	1245	95	909	436	3,087	529	3,374

U.S. *Nicotiana* Germplasm Collection – Resources Needed

- 1) The NCSU breeding program is currently **NOT** in a position to run the collection as it has been run in the past
- 2) Effort probably requires ~ 0.75 time employee
- 3) Continuity of support (personnel and financial) is very important

U.S. *Nicotiana* Germplasm Collection – Future

- 1) Transfer collection to an interested party?
- 2) USDA involvement:
 - a) reinterpretation of 1994 legislative language
 - i) take and maintain collection
 - ii) provide support to interested group
- 3) Do nothing – Rely on other collections worldwide