Tobacco cultivars evolution in France 1989-2006 and impact to the raw matter.

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1. Altadis – Institut du tabac
2. ANITTA (Association Nationale Interprofessionnelle des Techniques du Tabac)
3. UCAPT (Union des Coopératives Agricoles de Planteurs de Tabac)

2006 CORESTA CONGRESS – Paris, 15-20 October
History of tobacco breeding, France

➡️ Before 1963: Dark Air-cured

- Mostly Paraguay
- PVYN resistant
  - no problem with the new occurrence of PVYN in Europe (50’s)
- Tolerant to black root-rot → withstands low infestations

➡️ 1963: Blue-mold epidemic

- F1 hybrids with Hicks resistant
- Breeding Dark Air-cured for blue-mold res.
  - TMV + blue-mold res.


- First introduction of a new cultivar
History of tobacco breeding, France

1980: first attempts to produce flue-cured

- Cultivars lacking adaptation
  - Disease resistance problems
    Black root-rot, PVY
  - And / or too late for leaf maturity

Renewal of breeding objectives:

- Leaf quality to meet international standards
- Resistances to black root-rot, PVYN,
  - AlsoTMV, Blue-mold, Powdery mildew
- Early leaf maturity

Extension of the breeding to flue-cured.
Flue-cured acreage 1989-2006

Legend:
- S: Pvy+brr
- R: PVY+brr
- R: PVY+brr+pm

- ITB683
- ITB661
- ITB667
- ITB623
- ITB620
- ITB30808
- ITB30804
- ITB33024
- ITB31612
- ITB3003
- K326
- ITB3308
- ITB3304
- ITB3413
- ITB30
- GOLTA
- VD

Year:
- 1989
- 1991
- 1993
- 1995
- 1997
- 1999
- 2001
- 2003
- 2005

Acreage (ha):
- 0
- 500
- 1000
- 1500
- 2000
- 2500
- 3000
- 3500
- 4000
- 4500

Varieties:
- 30
- 3304
- 33024
- 31612
- VD
- R: brr
- R: PVY
Tobacco cultivars evaluation

→ Joined effort involving:
  ✓ Growers cooperative union: UCAPT
  ✓ Extension: ARREAT, ANITTA
  ✓ ALTADIS – Institut du tabac

→ 3 steps:
  ✓ Preliminary RCB field trials, Bergerac:
    • Yield, leaf chemistry and quality
  ✓ RCB field trials, (multilocal since 2001)
    • Same traits + Standardised smoking test (Tar, nicotine) + smoking panel
  ✓ Small scale release (30 ha)
    • Comparison to reference variety (UCAPT)
Important renewal of cultivars:

- Potential for leaf quality may vary according to cultivars

Generalization of disease resistance genes:

- PVY: va gene $\rightarrow$ lower leaf exudates
- Brr: resistance from *N. debneyi* origin, supposed to be detrimental to leaf quality in flue-cured
- Any disease res. gene may affect leaf quality.

How the cultivar turnover affected leaf quality and chemical equilibrium?
Material and methods

1. Grouping of data from RCB field trials.

2. Least square estimates of cultivar effects for different traits.

3. Combining cultivar effects with the acreage devoted to each cultivar in each year.

4. Flue-cured: comparing results with evolution of raw tobacco bought by Altadis over several years in France.
1. Field trials

- Randomized Complete Blocks
- Leaf quality
  - All leaf levels
  - Quality score (1:low – 5: best).
    - mean of 3 leaf buyer panels.
  - Quality index (0-100)
    - Leaf level separated among quality classes that have pre-defined scores.
    - QI= the weighed mean of scores.

Flue-Cured: Average Harvest Date

\[
\text{(date 1 x weight 1) + (date 2 x weight 2) + ...+ (date n x weight n)} / \text{total weight}
\]

<table>
<thead>
<tr>
<th>Replicates</th>
<th>Plants / plot</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Step 2</td>
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<table>
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<th>FC</th>
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<tr>
<td>B</td>
<td>80</td>
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</table>
1. Field trials (cont.)

→ **Leaf sampling**

- Before 1999: cigarettes & powder from whole leaves.
  - 4 leaf levels, weighed results over levels.
- Starting 1999: cigarettes & powder from strips
  - Threshing of a representative sample:
    - According to quality classes
      - Burley: mediane + top, FC: 4+5th harvests

→ **Chemical analysis or NIRS estimate**

- Nicotine, total nitrogen, ashes, reducing sugars (FC).

→ **Smoke evaluation**

- Cigarette sample: target pressure drop (SODIMAT, 55 mm WG)
- ISO4387 mechanical smoking → tar and nicotine yields (mg/cig).
2. Estimating cultivar effects

- **Grouping RCB data**
  - Cultivars: reference + tested at least for 2 years
  - Multilocal trials: averaged over all location

- **Least square estimates of cultivar effects**
  - Value = constant + cultivar effect + trial effect + residual
    - Variance analysis: Statgraphics ® Plus V 5.1
  - Every trial homogeneous for methodology and climate
  - Variations linked to climatic conditions (year) and methodology are captured into the trial effect.
2. Estimating cultivar effects (cont.)

Burley
86 cultivars, 341 data
among which
16 developed, 126 data

Flue-cured
131 cultivars, 488 data
among which
17 developed, 156 data
3. Combining data with acreages

- Acreage grown with each variety
  - from 1989 to 2006
  - source: ANITTA

- Each year: genetic potential of the tobacco crop = weighed mean of cultivars effects x acreage.

- Evolution from 1989 to 2006.
Results: Burley (1)

→ Assessment of cultivars

- field and tobacco quality data

<table>
<thead>
<tr>
<th>Variable</th>
<th>50% flo</th>
<th>Leaf number</th>
<th>Yield</th>
<th>Maturity score</th>
<th>QI</th>
<th>Quality score</th>
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<tr>
<td></td>
<td>Unit</td>
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</tr>
<tr>
<td></td>
<td>days</td>
<td>n</td>
<td>kg/ha</td>
<td>1-5</td>
<td>%</td>
<td>1-5</td>
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<td>R²</td>
<td>90</td>
<td>80</td>
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<td>2,9</td>
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</table>

dat: days after transplantation
Results: Burley (2)

Weighed averages of cultivars effects x acreage, burley, field and leaf quality data

- 50% flo: 65.7 - 68.3 days
- Yield: 3.1 – 3.2 T/ha
- leaf nb: 20.7 – 20.9
- maturity: 3.1 – 3.0

% of 1989 crop

- 80
- 90
- 100
- 110
- 120
Results: Burley (3)

- Assessment of cultivars
  - chemical equilibrium and tar potential

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ashes</th>
<th>Nicotine (leaf)</th>
<th>N</th>
<th>Tar</th>
<th>nicotine / cigarette</th>
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<tr>
<td>Unit</td>
<td>%dm</td>
<td>%dm</td>
<td>%dm</td>
<td>mg/cig</td>
<td>mg/cig</td>
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<tr>
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<tr>
<td>Constant</td>
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Results: Burley (4)

Weighed averages of cultivars effects x acreage, burley, chemical and tar potential data

- **QI:** 68 - 79
- **Nicotine:** 3.7 – 3.8 %dm
- **Ashes:** 21.2 - 22.2 %dm
- **N:** 4.1 – 4.0 %dm
- **Tar:** 15.0 – 14.8

Puros no filter mg/cig
Results: Flue-cured (1)

→ Assessment of cultivars

✓ field and tobacco quality data

<table>
<thead>
<tr>
<th>Unit</th>
<th>50% flo.</th>
<th>Leaf nb.</th>
<th>Yield kg/ha</th>
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dat: days after transplantation
Results: Flue-cured (2)

Weighed averages of cultivars effects x acreage, flue-cured, field and leaf quality data
Results: Flue-cured (3)

- **Assessment of cultivars**
  - chemical equilibrium and tar potential

<table>
<thead>
<tr>
<th>Unit</th>
<th>Red. sugars</th>
<th>N</th>
<th>Ashes</th>
<th>Nicotine (leaf)</th>
<th>RS/A</th>
<th>Nicotine / cigarette</th>
<th>Tar</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>%dm</td>
<td>%dm</td>
<td>%dm</td>
<td>%dm</td>
<td>%</td>
<td>mg/cig</td>
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<td>416</td>
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<td>17,1</td>
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Results, Flue-cured (4)

Weighed averages of cultivars effects x acreage, flue-cured, chemical and tar potential data
French Flue-cured evolution


Variance analysis for GFS

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<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Proba.</th>
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<td>EFFECTS</td>
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<td>44,909</td>
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<td>2978,43</td>
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Variance analysis for alkaloids

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<th>Mean square</th>
<th>F</th>
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Tous les F sont basés sur l'erreur résiduelle quadratique moyenne.
Conclusions (1)

- Improvement of the genetic potential for leaf quality (body, color, grain...)
  - Flue-cured (QI : + 60%), and Burley (QI: +18%)
  - Concomitant with generalization of disease resistance genes
    - « va » gene, N. debneyi derived res. to the Black root-rot.

- Flue-cured
  - Earlier leaf maturity
    - Sharp decrease in sugar content and sugar / alkaloid ratio
    - 15% decrease in tar potential
  - Slight increase in nicotine (from 1.1 to 1.3 % dm) except in most recent years

- Burley
  - Stability for the chemical equilibrium and tar potential
Renewal of cultivars was an essential tool for developing the French production of blond tobacco.

Improvement of leaf quality (leaf body, color, grain...) and chemical equilibrium genetic potential: help to design better products.

Thank you for your attention