Exploitation de données d'enquêtes sur la santé du végétal: de l'analyse à l'interprétation et à la modélisation

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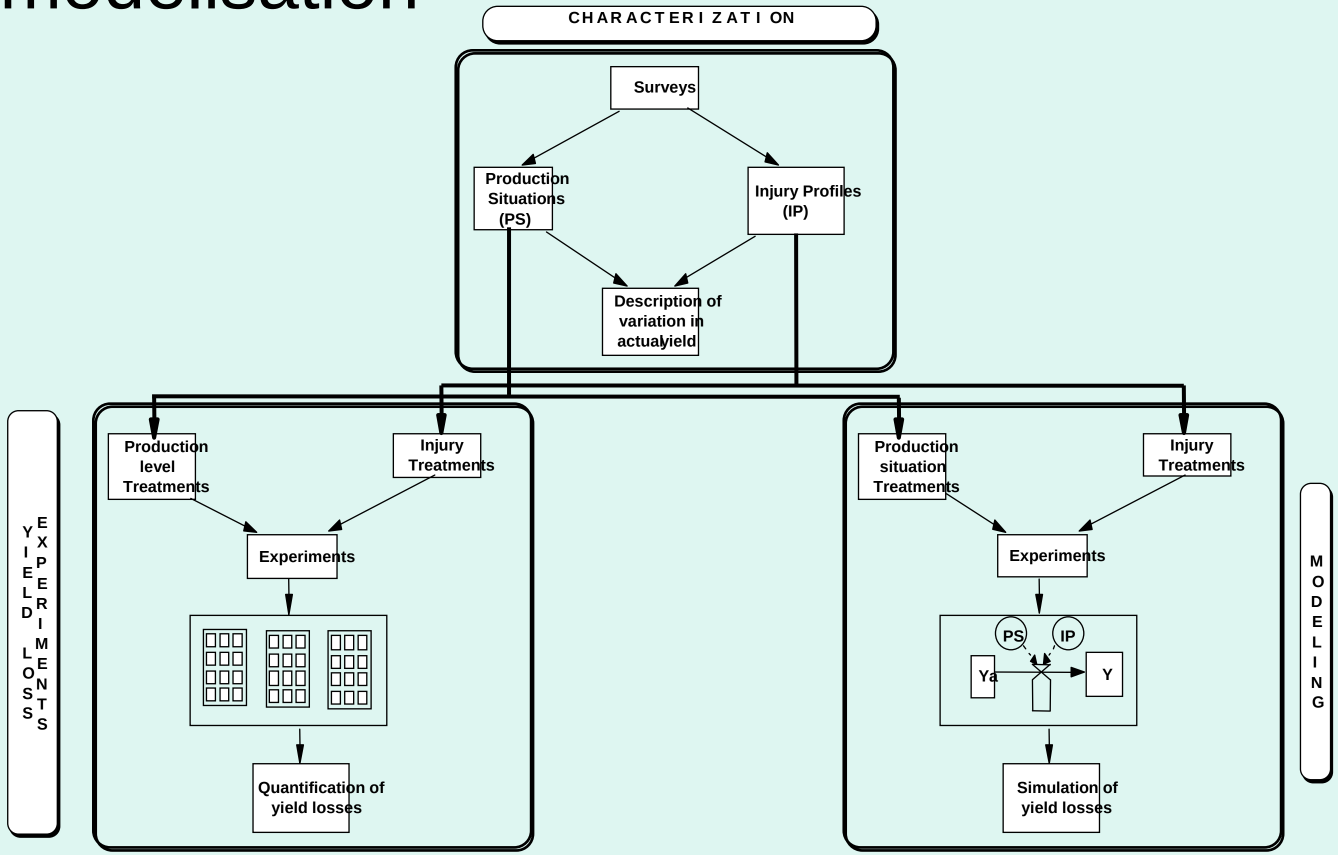
Données d’enquêtes: nature, objectifs et démarche

- Nature des données
  - données de terrain, collectées avec un protocole standardisé, normalisé (dégâts, situations de production)
  - données d’enquêtes existantes
- Objectifs
  - liens généraux [syndromes de dégâts] x [situations de production]
  - liens spécifiques: un type de dégât, un composant de situation de production (variété, climat, lutte chimique, etc.)
  - très souvent: des résultats inattendus surgissent → nouvelles questions
  - d’une manière générale: continuum enquête – expérimentation – modélisation – applications / recommandations / stratégies
- Démarches
  - très diverses; accent sur la prise en compte de données soit qualitatives (cardinales ou ordinales), soit quantitatives (discrètes ou continues)

Liens entre enquêtes, expérimentation formelle, et modélisation



Savary, S., Willocquet, L., Elazegui, F.A., Teng, P.S., Du, P.V., Zhu, D., Tang, Q., Huang, S., Lin, X. Singh, H.M. & Srivastava, R.K., 2000. Rice pest constraints in tropical Asia: Characterization of injury profiles in relation to production situations. Plant Disease 84: 341-356.
Savary, S., Willocquet, L., Elazegui, F.A., Castilla, N. & Teng, P.S., 2000. Rice pest constraints in tropical Asia: Quantification of yield losses due to rice pests in a range of production situations. Plant Disease 84: 357-369.
Willocquet, L. Savary, S. Fernandez, L. Elazegui, F. & Teng, P.S. 2000. Development and evaluation of a multiple-pest, production situation specific model to simulate yield losses of rice in tropical Asia. Ecological Modelling 131: 133-159.

Situation de production (De Wit, 1982)

“ensemble des facteurs biophysiques et socio-économiques dans lequel la production agricole a lieu.”

→ inclut l’ensemble des facteurs déterminant le rendement potentiel (rayonnement, température, génotype);

→ inclut l’ensemble des facteurs limitant le rendement (alimentation hydrominérale) à un rendement accessible;

→ n’inclut pas les facteurs biologiques de réduction du rendement (adventices, pathogènes, animaux).

→ En protection des plantes, peut être opérationnellement défini par les variables décrivant les pratiques culturales, au sens large, qui reflètent l’adaptation des agriculteurs aux facteurs déterminant et limitant le rendement.

enquêtes, expérimentations et modélisation sur les syndromes de santé du végétal et les situations de production du riz en Asie tropicale

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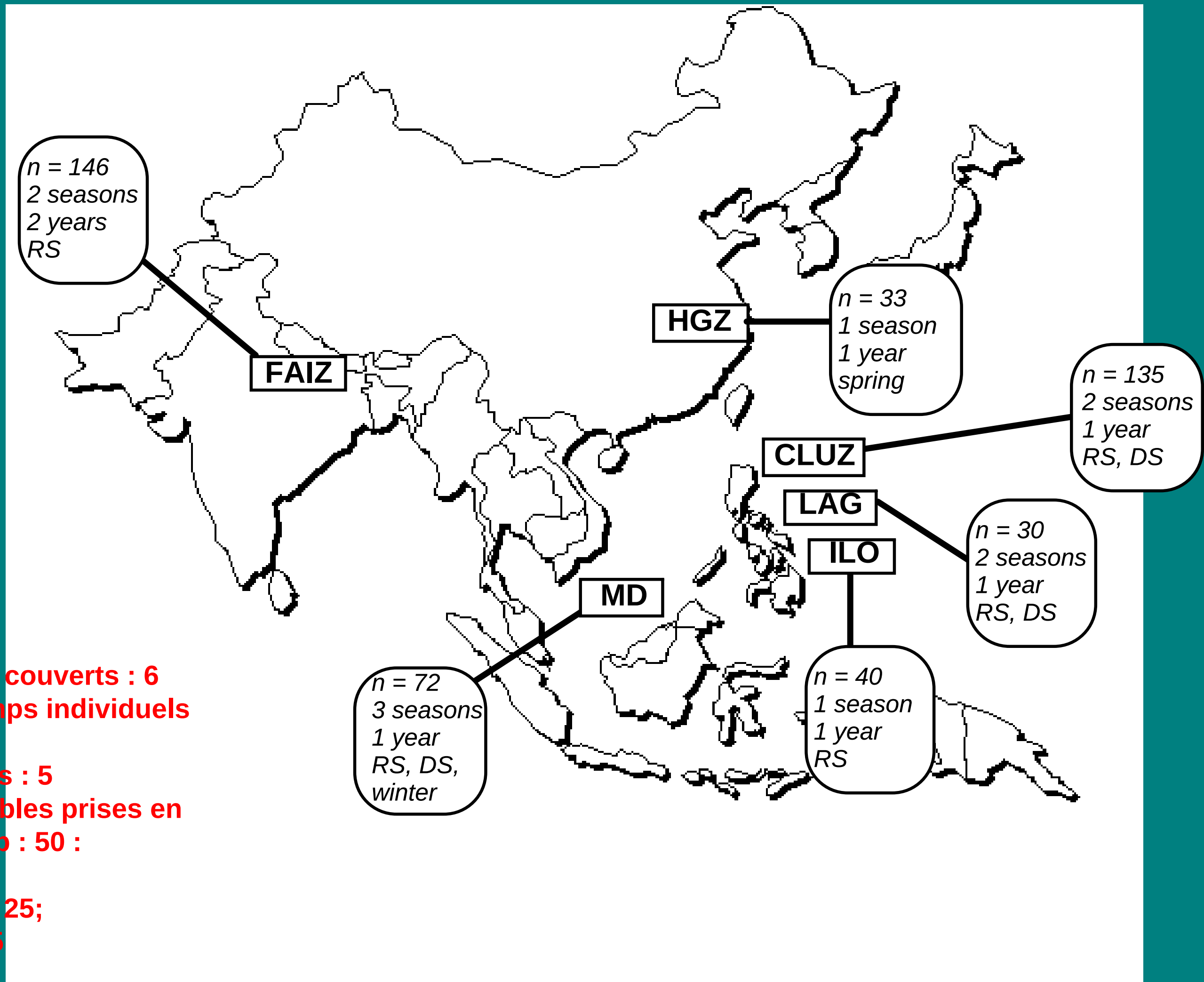
Cadre géographique d’une enquête à grande échelle



- **Nombre de sites couverts : 6**
- **Nombre de champs individuels considérés : 456**
- **Nombre d'années : 5**
- **Nombre de variables prises en compte par champ : 50 :**

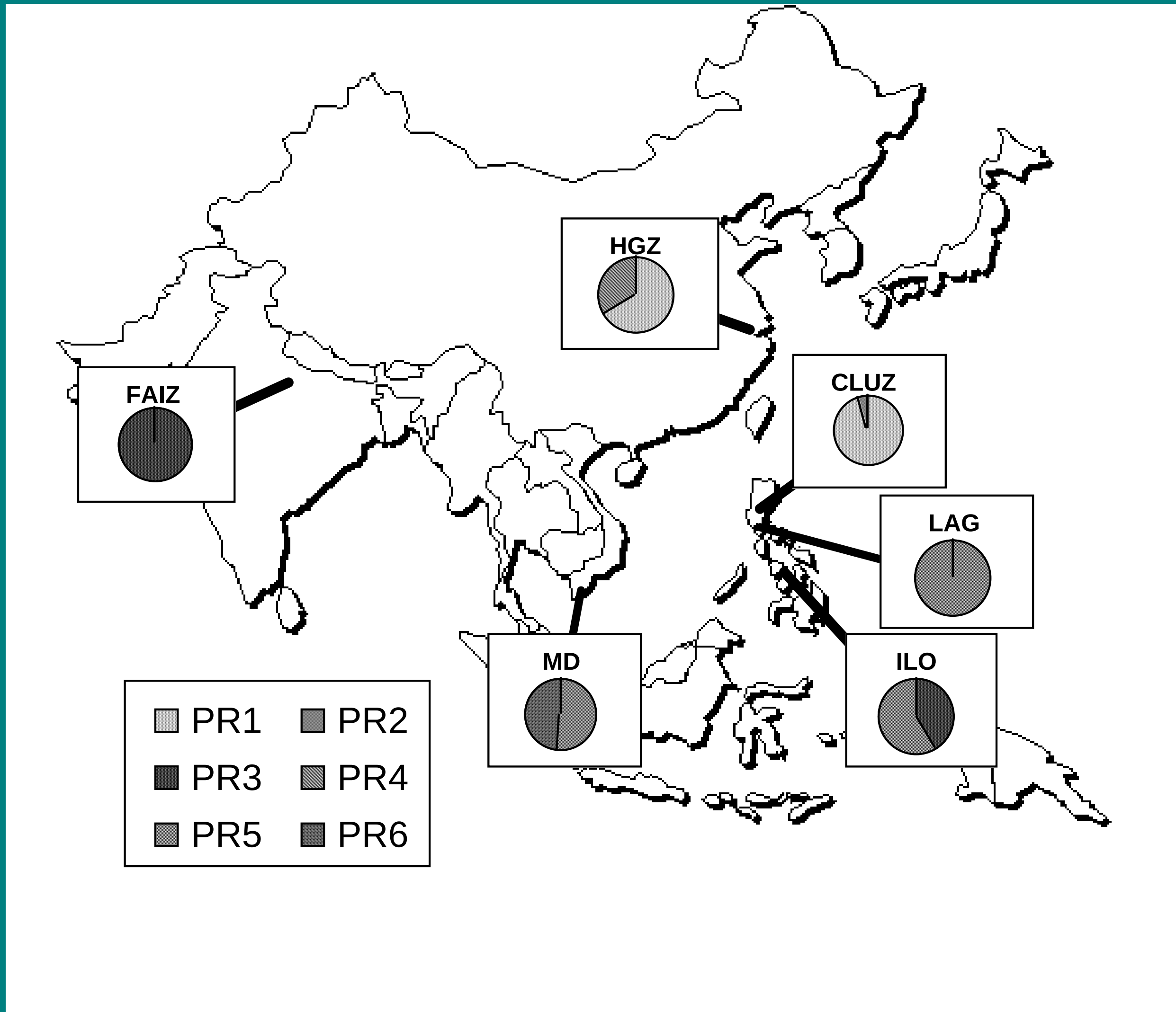
- pratiques : 20;
- bio-agresseurs : 25;
- performances : 5

Classification des situations de production

Cluster Analysis of Cropping Practices

Source: Savary, S., Willocquet, L., Elazegui, F.A., Teng, P.S., Du, P.V., Zhu, D., Tang, Q., Huang, S., Lin, X. Singh, H.M. & Srivastava, R.K., 2000. Rice pest constraints in tropical Asia: Characterization of injury profiles in relation to production situations. Plant Disease 84: 341-356.

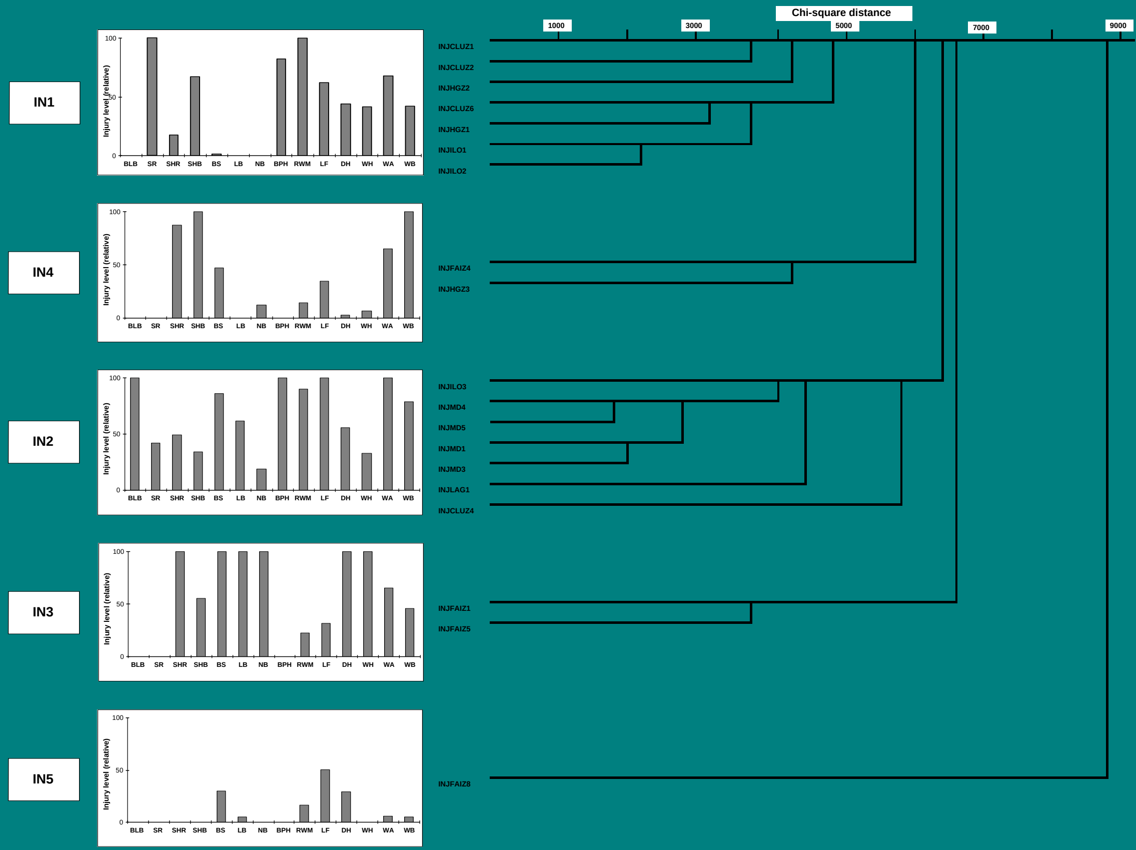
Distribution géographique des situations de production



Source:
Savary, S., Willocquet, L., Elazegui, F.A., Teng, P.S., Du, P.V., Zhu, D., Tang, Q., Huang, S., Lin, X. Singh, H.M. & Srivastava, R.K., 2000. Rice pest constraints in tropical Asia: Characterization of injury profiles in relation to production situations. Plant Disease 84: 341-356.

Classification des profils de bioagresseurs

Cluster Analysis of Injury Profiles



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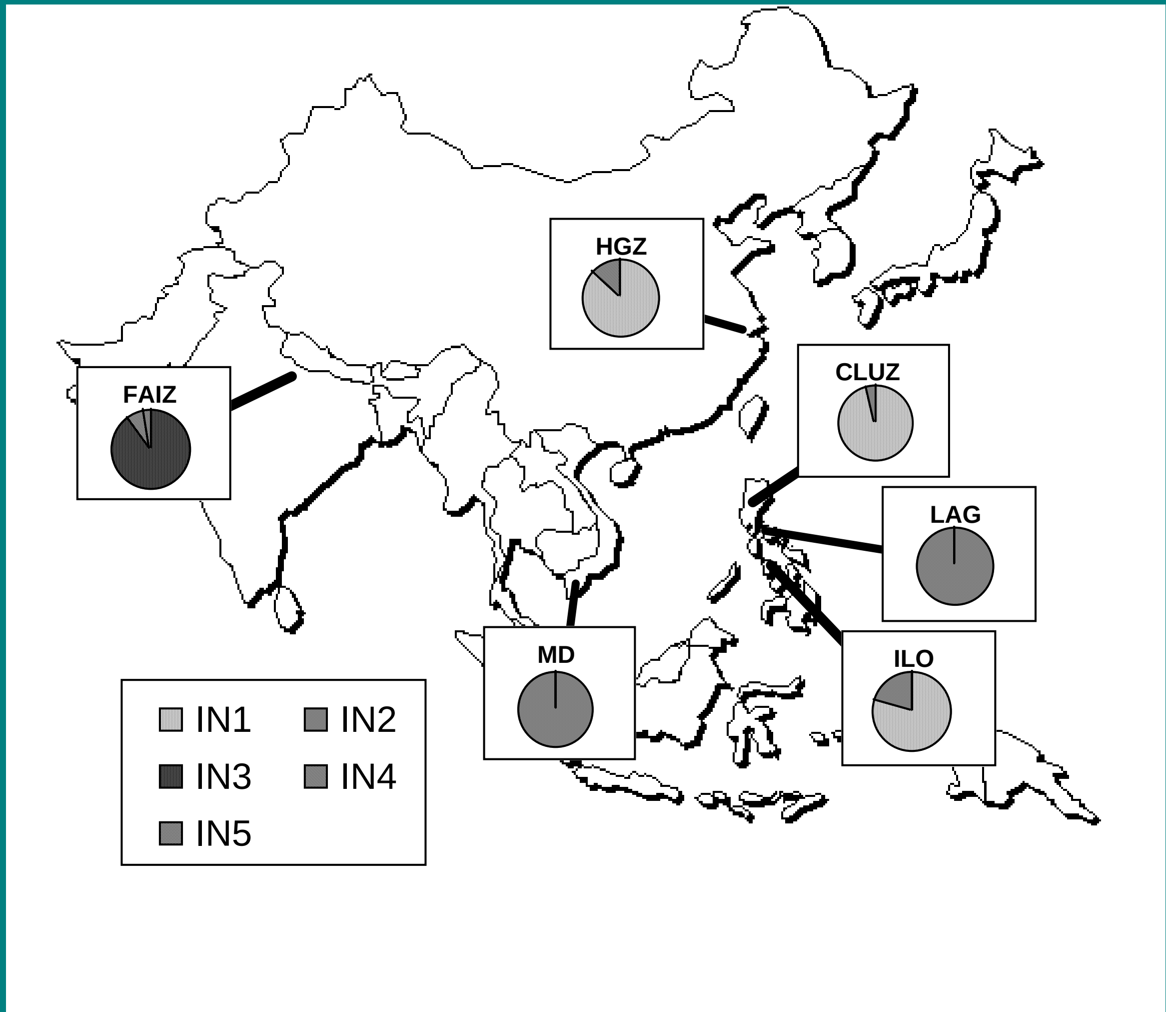
Savary, S., Willocquet, L., Elazegui, F.A., Teng, P.S., Du, P.V., Zhu, D., Tang, Q., Huang, S., Lin, X. Singh, H.M. & Srivastava, R.K., 2000. Rice pest constraints in tropical Asia: Characterization of injury profiles in relation to production situations. Plant Disease 84: 341-356.

Distribution géographique des profils de bio-agresseurs



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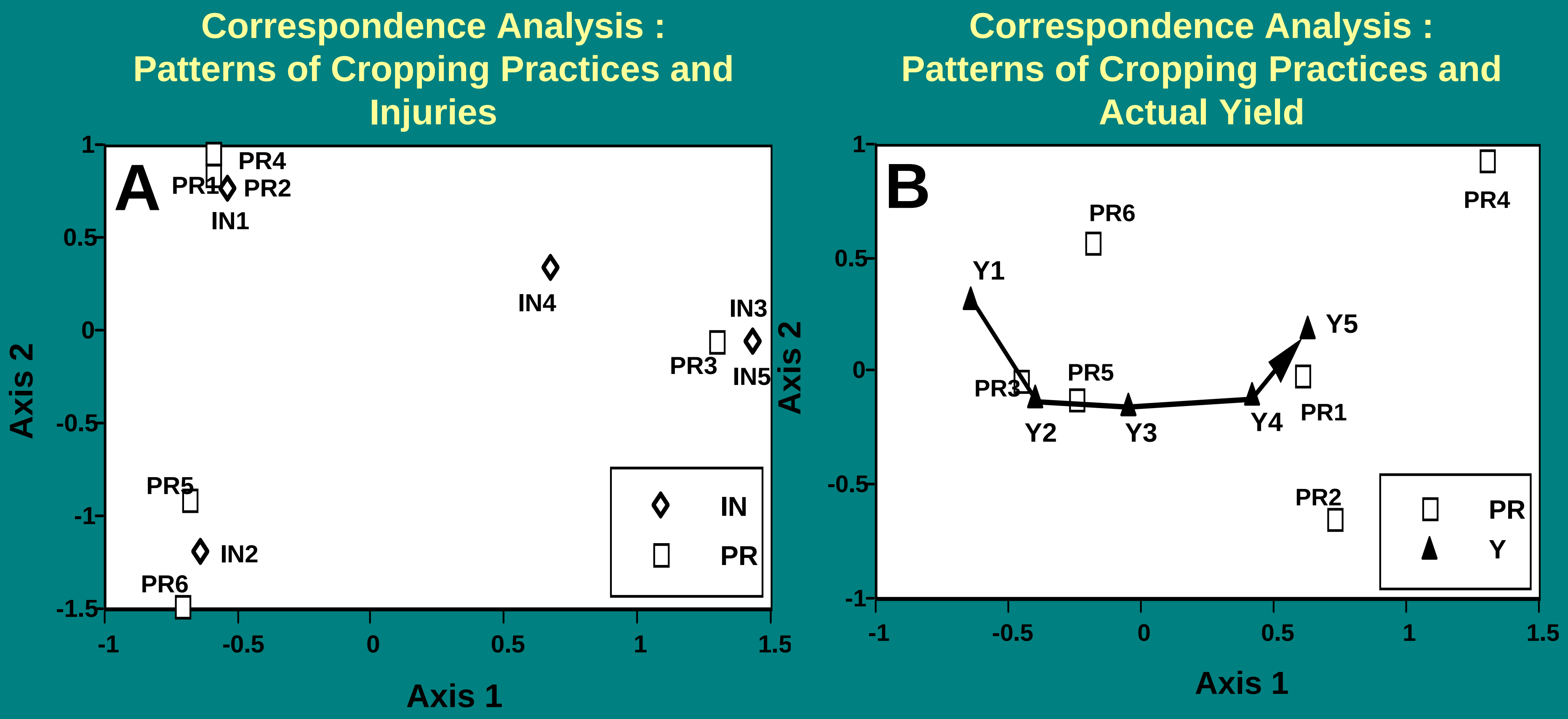
Analyses factorielles



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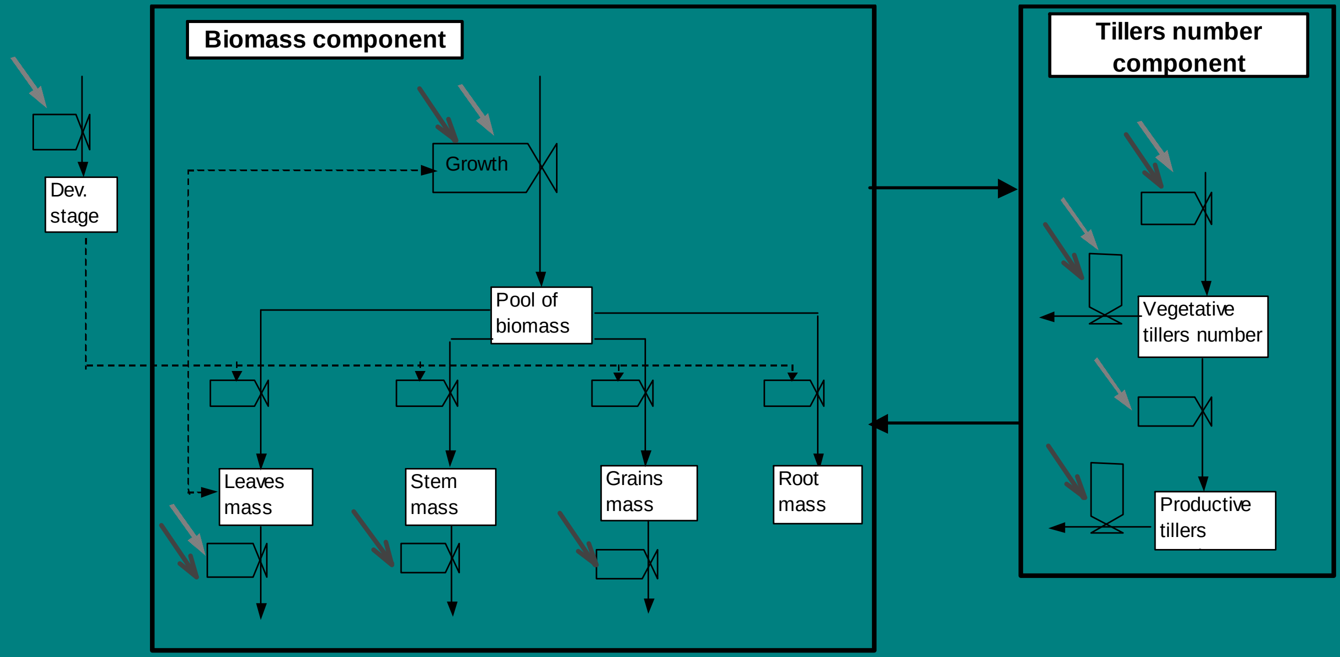
structures de RICEPEST (et de WHEATPEST)



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•Willocquet, L. Savary, S. Fernandez, L. Elazegui, F.A., Castilla, N., Zhu, D., Tang, Q., Huang, S., Lin, X., Singh, H.M., Srivastava, R.K., 2002. Structure and validation of RICEPEST, a production situation-driven, crop growth model simulating rice yield response to multiple pest injuries for tropical Asia. Ecological Modelling 153: 247-268.

•Willocquet, L., Elazegui, F. A., Castilla, N., Fernandez, L., Fischer, K. S., Peng, S., Teng, P. S., Srivastava, R. K., Singh, H. M., Zhu, D., and Savary, S., 2004. Research priorities for rice disease and pest management in tropical Asia: a simulation analysis of yield losses and management efficiencies. Phytopathology 94(7):672-682.

Applications des analyses d'enquêtes, des expérimentations sur les pertes de récoltes et de la modélisation

- **A l'échelle écoregionale (Asie tropicale) les pertes de recoltes varient de 22 à 43%.**
- **En moyenne, 36.5%, soit 202 10^6 tonnes de grain sont perdus chaque année a cause des ravageurs (adventices, pathogènes, insectes) sur les 87 10^6 ha de riz irrigué ou submergés d'Asie tropicale.**
- **Le classement, en termes de pertes de récoltes, des principaux ravageurs du riz de cette région du monde est: adventices (15.5%), flétrissement des gaines (8.3%), helminthosporiose (5.7%), pourriture des gaines (3.7%), foreurs des tiges (dégât sur talles portant des panicules 3.2%).**
- **Les pertes de recoltes causees par le fletrissement bacterien, la pyriculariose (feuille et panicules), la cicadelle brune, et les insectes defoliateurs, sont, en moyenne, et regionallement, inferieurs à 1%.**

Source:

Willocquet, L., Elazegui, F. A., Castilla, N., Fernandez, L., Fischer, K. S., Peng, S., Teng, P. S., Srivastava, R. K., Singh, H. M., Zhu, D., and Savary, S., 2004. Research priorities for rice disease and pest management in tropical Asia: a simulation analysis of yield losses and management efficiencies. Phytopathology 94(7):672-682.

analyse des données de l'Observatoire National des Maladies du Bois de la Vigne

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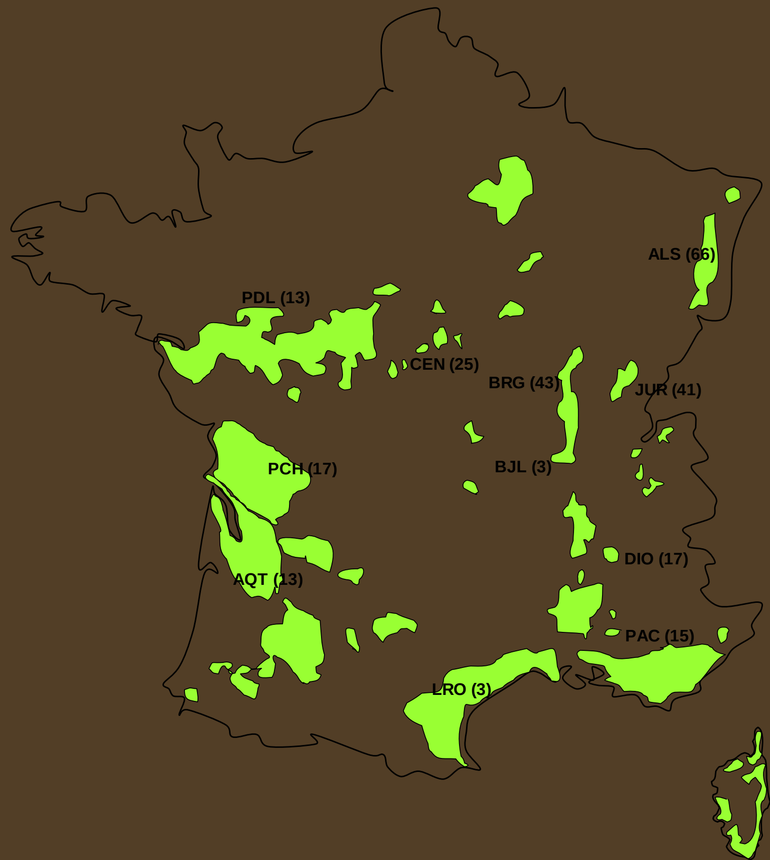
Grapevine trunk diseases and the French National Grapevine Trunk Diseases Survey

- **The National Grapevine Trunk Diseases Survey: established in France to monitor & analyze several grapevine diseases, in particular eutypa dieback and esca decline.**
- **Report of a first series of analyses: years 2003-5.**
- **Objectives: to characterize the incidences of the two diseases and grapevine mortality in relation with grapevine age, crop management, cultivars, and growing regions.**
- **Information representing 256 individual vineyards**
- **From this sample: mean incidences of 2.23% for eutypa dieback and 3.25% for esca decline.**

Fussler, L., Kobes, N., Bertrand, F., Maumy, M., Grosman, J., Savary, S. 2008. A characterization of grapevine trunk diseases in France from data generated by the National Grapevine Wood Diseases Survey. Phytopathology 98:571-579.

Distribution of field sites

- **most of the grapevine growing areas covered**
- **256 individual fields**
- **10 groups of 30 individ. plants assessed per field**



Vine growing regions in France involved in the National Grapevine Trunk Disease Survey. ALS: Alsace; AQT: Aquitaine; BJL: Beaujolais; BRG: Bourgogne; CEN: Centre; DIO: Diois; JUR: Jura; LRO: Languedoc-Roussillon; PAC: Provence-Alpes-Côte d'Azur; PCH: Poitou-Charentes; PDL: Pays de Loire (Table 1). Numbers of vineyards are indicated in parentheses.

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Variable list

Symbol	Variable	Categories	Numerical boundary of categories	Units
Euty	Eutypa incidence at the field scale	Euty0; Euty1; Euty2	Euty0: Euty = 0; Euty1: 0 < Euty ≤ 2; Euty2: Euty > 2	%
Esca	Esca or/and black dead arm (BDA) incidence at the field scale	Esca0; Esca1; Esca2	Esca0: Esca= 0; Esca1: 0 < Esca ≤ 3; Esca2: Esca > 3	%
Mort [a]	Proportion of grapevine plant mortality at the field scale	Mort0; Mort1; Mort2	Mort0: 0 ≤ Mort < 3; Mort1: 3 ≤ Mort < 10; Mort2: Mort ≥ 10	%
Age	Age of the grapevine since crop establishment	age0; age1; age2; age3	age0: 0 ≤ age < 15; age1: 15 ≤ age < 25; age2: 25 ≤ age < 40; age3: age ≥ 40	years
Ars	Number of sodium arsenite treatments during 1996-1999	ars0; ars1; ars2; ars3	ars0: 0 treatment; ars1: 1 treatment; ars2: 2 treatments; ars3: 3 treatments	num ber
VGR	Vine growing region	ALS; AQT; BJL; BRG; CEN; DIO; JUR; LRO; PAC; PCH; PDL	ALS: Alsace; AQT: Aquitaine; BJL: Beaujolais; BRG: Bourgogne; CEN: Centre; DIO: Diois; JUR: Jura; LRO: Languedoc-Roussillon; PAC: PACA; PCH: Poitou-Charentes; PDL: Pays de Loire	none
CEP	Grapevine cultivars (cépages)	AUX; CAR; CBF; CBS; CHD; CHE; CIN; GAM; GRE; GWZ; MDH; MEL; MER; MPG; PIN; PLS; RIS; SAU; SAV; SYR; TRS; UB	AUX: Pinot Auxerrois; CAR: Carignan; CBF: Cabernet-Franc; CBS: Cabernet Sauvignon; CHD: Chardonnay; CHE: Chenin; CIN: Cinsault; GAM: Gamay; GRE: Grenache; GWZ: Gewurztraminer; MDH: Muscat de Hambourg; MEL: Melon; MER: Merlot; MPG: Muscat Petits Grains; PIN: Pinot noir; PLS: Poulsard; RIS: Riesling; SAU: Sauvignon; SAV: Savagnin; SYR: Syrah; TRS: Trousseau; UB: Ugni-Blanc	none
Root stock	Rootstock	101-14; 161-49; 3309C; 41B; R110; SO4	as rootsock codes	none
PRUN	Pruning	cordon de royat; gobelet; guyot	as practices (COR, GOB, GUY)	none
PRE PRUN	Pre-pruning practices	pret0; pret1	pret0: no prepruning; pret1: pre-pruning	none
RES	Management of pruning residues	grinding, burning, removal	as practices (GRI, BUR, REM)	none

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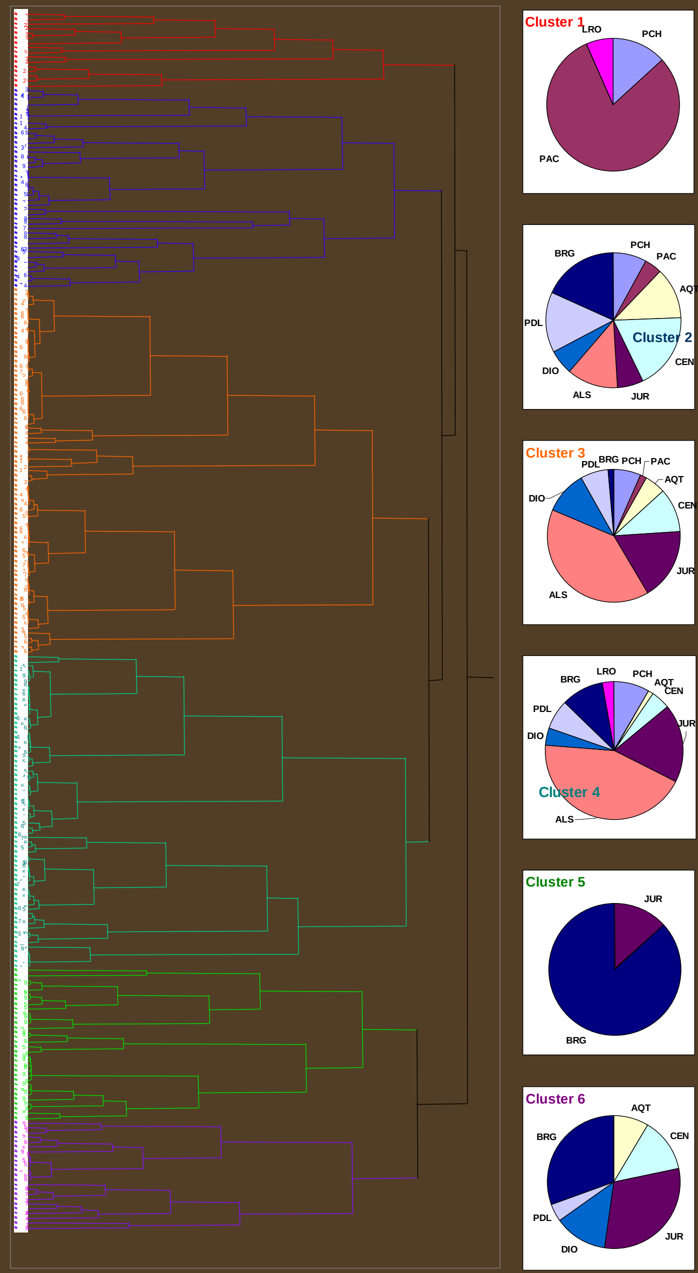
Ascending hierarchical cluster analysis

- **based on agronomic, management and cvr. variables (*not* disease incidences)**
- **distribution of grape growing regions among different clusters indicated for six clusters.**

Ascending hierarchical cluster analysis with a Euclidean distance and a Ward criterion on Age, Ars, CEP, PRUN, PREPRUN, RES.



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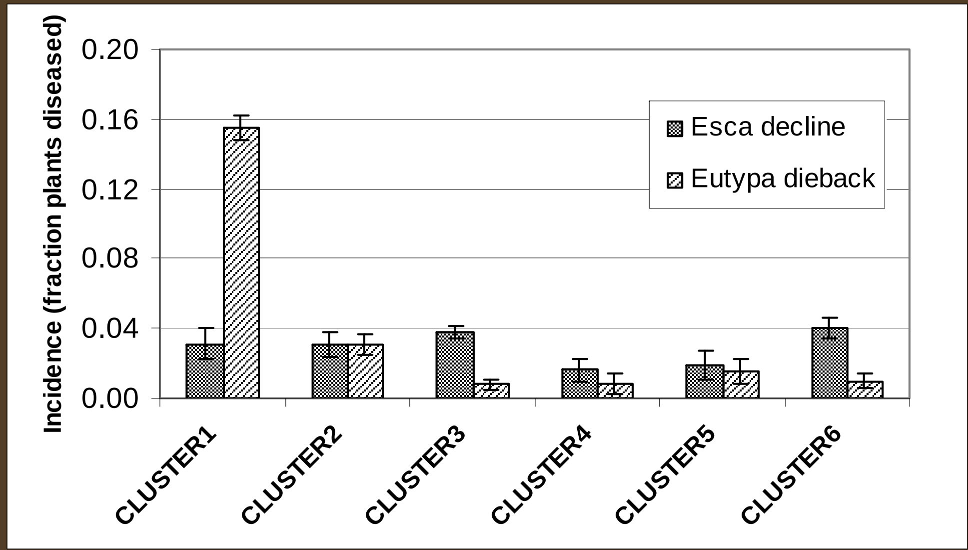
Variation of Eutypa and Esca incidences among clusters of cropping practices

- **eutypa much higher in Cluster 1**
- **esca decline more evenly distributed**
- **incidences of both diseases significant-ly different among clusters:**
- **Eutypa: F = 72.2, *P* < 0.001**
- **Esca: F = 2.26, *P* = 0.049**

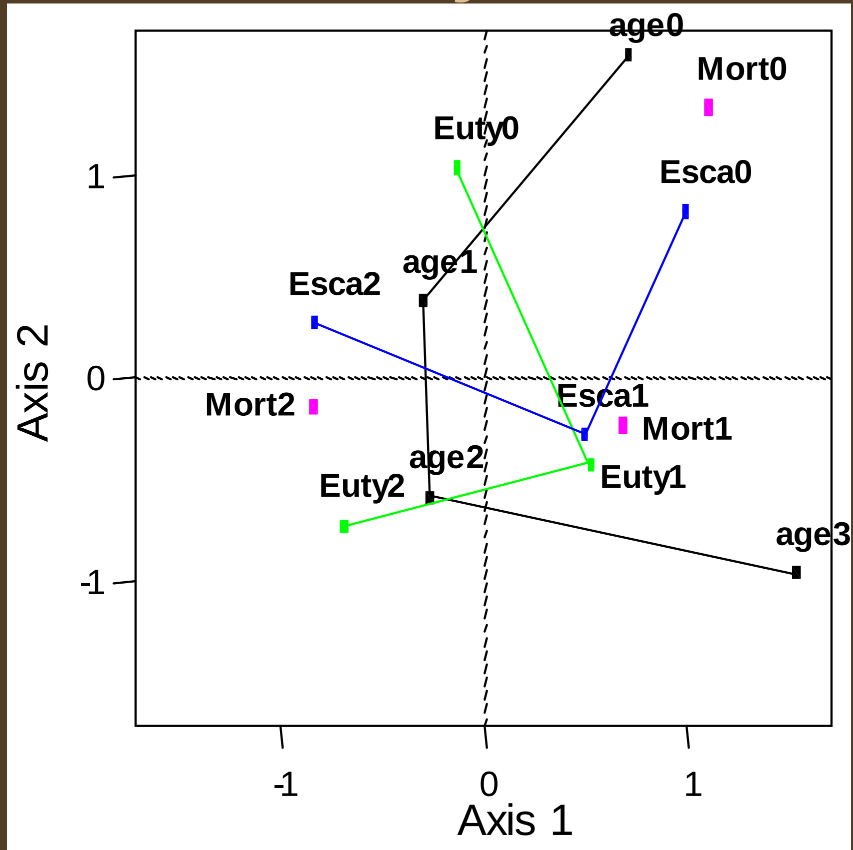


Mean incidences of Eutypa and Esca and standard error of the mean of incidences for six clusters determined from an ascending hierarchical cluster analysis. Incidences are indicated as disease proportions.

Fussler, L., Kobes, N., Bertrand, F., Maumy, M., Grosman, J., Savary, S. 2008. A characterization of grapevine trunk diseases in France from data generated by the National Grapevine Wood Diseases Survey. Phytopathology 98:571-579.

Correspondence analysis: axes-defining variables only

- overall increase of disease incidences with age
- paths for increasing Esca and Eutypa broadly associated, but depart at high incidences
- maximum Esca (Esca2) associated with age1; maximum Eutypa (Eutypa2) associated with age2
- highest mortality linked with both disease maxima

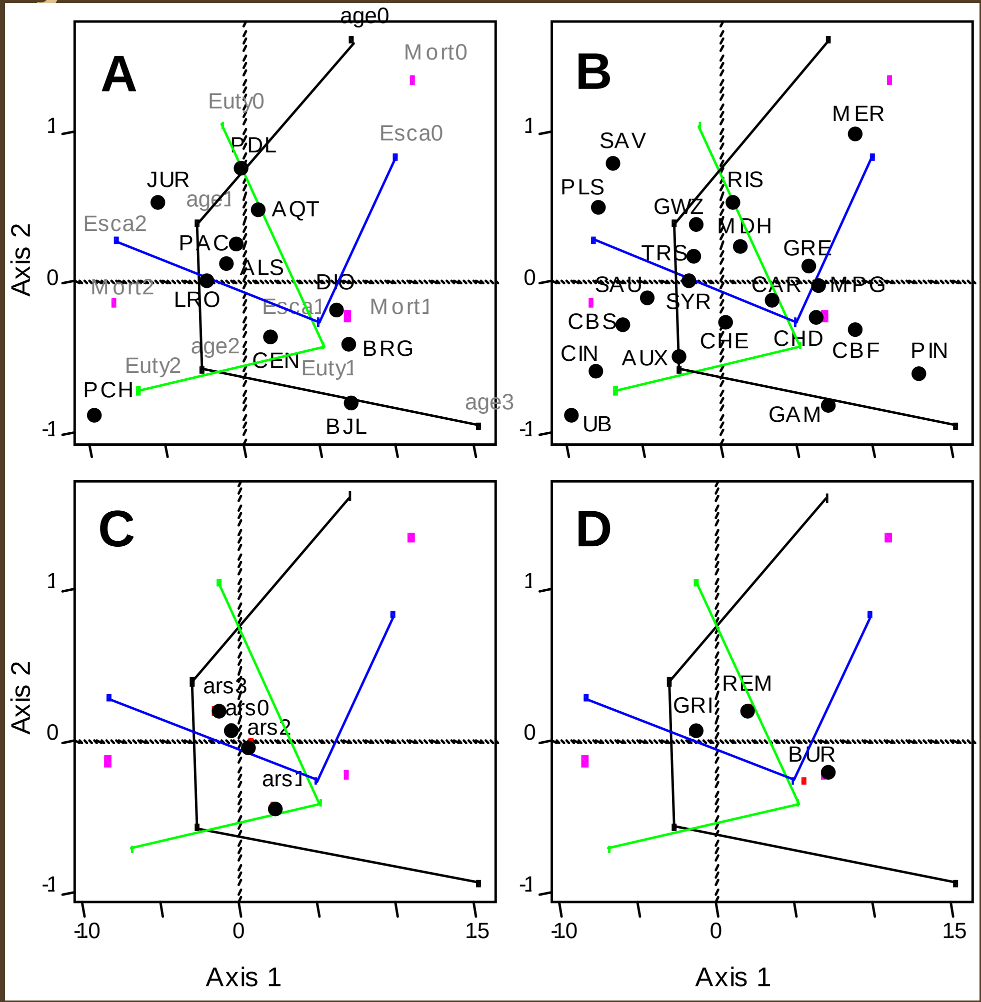


Multiple correspondence analysis of incidences of trunk diseases (esca decline, **Esca**, and eutypa dieback, **Euty**), grape age (**Age**), and grape mortality rate (**Mort**).

Fussler, L., Kobes, N., Bertrand, F., Maumy, M., Grosman, J., Savary, S. 2008. A characterization of grapevine trunk diseases in France from data generated by the National Grapevine Wood Diseases Survey. Phytopathology 98:571-579.

Correspondence analysis: additional variables

- **A: some provinces more affected by Esca (JUR), some by Eutypa (PCH); few are mildly affected by both diseases (AQT, PDL)**
- **B: some cvrs. are more affected by Esca (PLS), others by Euty (UB, CIN), few are marginally affected (MER)**
- **C: the history of arsenite treatments appears disconnected from levels of both diseases**
- **D: residue management (may) have marginal effects**



Additional variables are projected onto the background of axes and patterns generated by active variables (Esca, Eutypa, Age, Mort).

Fussler, L., Kobes, N., Bertrand, F., Maumy, M., Grosman, J., Savary, S. 2008. A characterization of grapevine trunk diseases in France from data generated by the National Grapevine Wood Diseases Survey. Phytopathology 98:571-579.

Binary logistic models

Equation	Dependant variable[a]	Independent variables considered[a]	Independent variables retained[a]	Parameters	SE[b]	Pparm[c]	G[d]	Pslope[e]	% concor-dant	Somers' D
1	Logit(P(Euty)>0)	Age, ars1, ars2, ars3	Constant	-1.17	0.40	0.004	26.8	<0.001	68.3	0.39
			Age	0.07	0.02	<0.001				
2	Logit(P(Esca)>0)	Age, ars1, ars2, ars3	Constant	3.38	0.42	<0.001	6.13	0.19	45.4	0.30
			ars1	-1.13	0.67	0.09				
			ars3	-2.00	0.89	0.03				
3	Logit(P(Mort)>0.03)	Euty, Esca, Age, ars1, ars2, ars3	Constant	-2.87	1.08	0.008	53.5	<0.001	96.4	0.93
			Esca	246.47	94.98	0.004				
			Age	0.16	0.05	0.001				
4	Logit(P(Mort)>0.03)	Euty, Esca, Age, ars1,ars2, ars3	Constant	-0.08	0.50	0.87	48.3	<0.001	94.6	0.90
			Euty	411.14	186.00	0.027				
			Esca	240.43	90.35	0.008				

Summaries of binary logistic regression models of
- **eutypa** and **esca** ***appearance*** with grapevine **age** and sodium **arsenite** treatments (equationsns 1 & 2),
- grapevine **mortality** with grapevine **age**, sodium **arsenite** treatments, **eutypa** dieback and **esca** decline (equations 3 & 4)

[a] **Age**: age of vineyard; **arsi**: i treatments with arsenite; **Esca**: incidence of esca decline; **Euty**: incidence of eutypa decline; **Mort**: mortality.
[b] Standard error of parameter.
[c] Pparm: p-value testing the null hypothesis that the parameter equals zero.
[d] G: statistic to test the null hypothesis that all slopes equal zero.
[e] Pslope: p-value associated with the G test.

Conclusions

- **Wide variations exist in eutypa dieback among clusters of crop management. Not so with esca decline.**
- **Multiple correspondence analysis indicates:**
  - **a non-linearity of relationships among variables**
  - **highest levels of eutypa dieback associated with medium-old grapevines,**
  - **whereas the highest levels of esca decline are associated with younger grapevines.**
- **χ^2 tests further suggest that**
  - **intensification of esca is not independent from arsenite use, but that**
  - **sodium arsenite use is not related with high mortality levels.**
- **Logistic regressions concur with the above conclusions:**
  - **eutypa levels are independent from arsenite treatment history;**
  - **lower levels of field symptoms of esca decline are somehow associated with arsenite use;**
  - **plant mortality is independent from these treatments.**
- **This can be interpreted as follows: treatments with sodium arsenite had some effect in reducing esca symptoms, but not on reducing plant mortality, which is in turn strongly linked with esca.**

analyse des données d'enquêtes du Directorat Indien de la Recherche sur le Riz

C.S. Reddy (1)
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Table 1. List of variables, symbols, units, and categorization.

(1) Legumes: includes groundnut, green manure (*Sesbania* spp.), chickpea, pigeon pea, and legume forage crops.

(2) Other crops include sugarcane, banana, sesame, rapeseed, sorghum, or vegetables.

(3) Landforms: IR: fully irrigated (flooded); RL: only rainfed (levees); UR: strictly upland; IR-RL indicates IR dominating RL, RL-IR indicates RL dominating IR, RL-UR indicates RL dominating UR, UR-RL indicates UR dominating RL.

(4) Injuries on the foliage: LB: leaf blast; BS: brown spot; LS: leaf scald; NBS: narrow brown spot; BLB: bacterial leaf blight; BLS: bacterial leaf streak; LF: leaf folder; RH: rice hispa; CW: cutworm; WM: whorl maggot.

(5) Injuries on tillers: SHB: sheath blight; SHR: sheath rot; SB: stem borers; BPH: brown plant hopper; WPH: white back plant hopper; GM: gall midge; GLH: green leaf hopper; AW: armyworm; RT: rats.

(6): Injuries on panicles and grain: NB: neck blast; RB: rice bug (Gundhi bug); FSM: false smut; BK: bakanae.

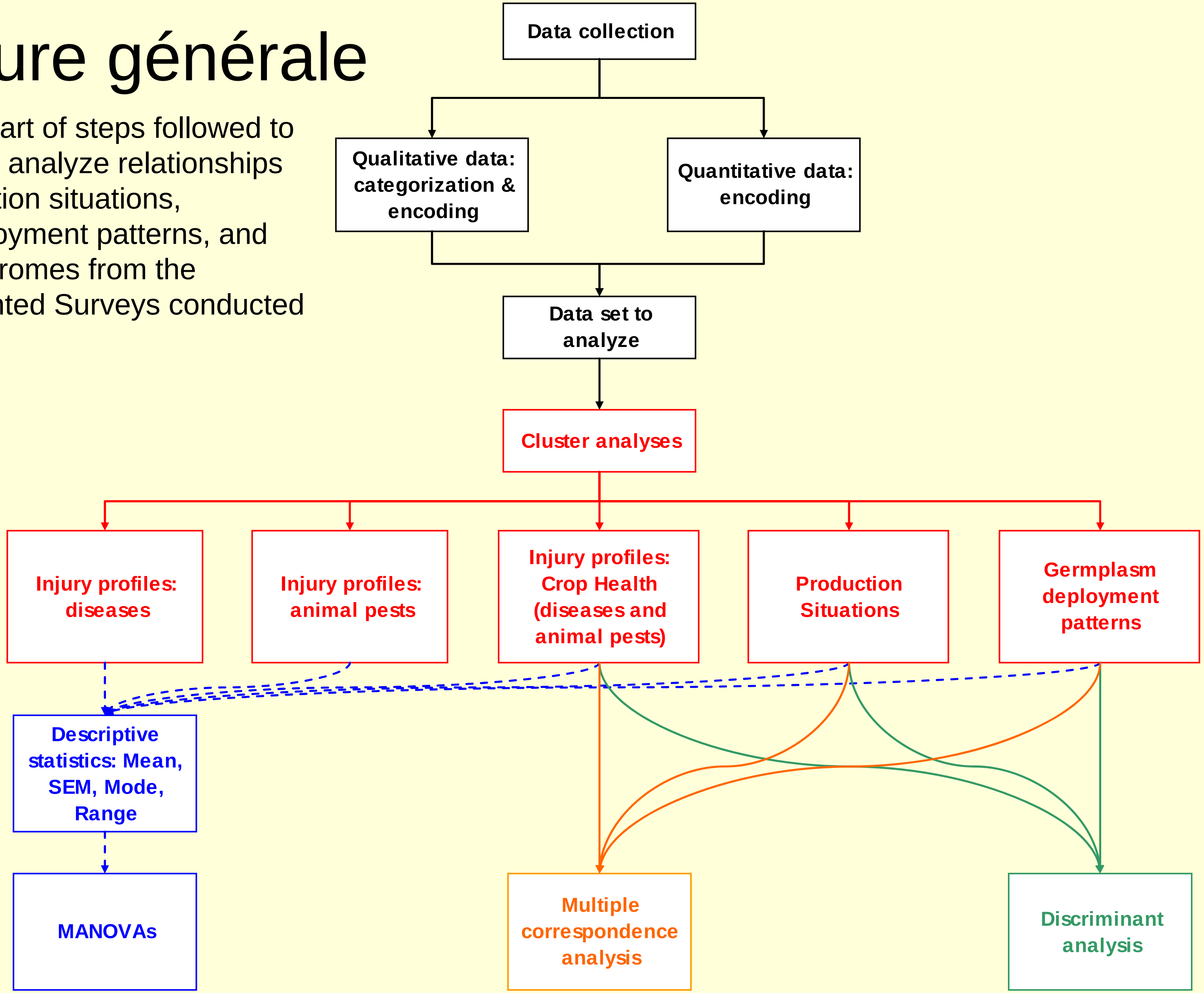
(7): Injuries on whole plants: rice tungro disease: RTD.

List of variables (cont'd)

Variable	Symbol	Unit	Categories
State	State	-	-
District	Distt	-	-
Crop establishment method	CEM	-	1: TR(transplanted); 2:TR-DS (transplanted more frequent); 3: DS-TR (direct-seeding more frequent); 4: DS (direct-seeded)
Most frequent preceding crop	PC1	-	0: Fallow (longer than 3 months); 1: Legume [1]; 2: Rice; 3: Wheat; 4: Other crops [2].
Second frequent preceding crop	PC2	-	As PC1.
Third frequent preceding crop	PC3	-	As PC1.
Rotation type 1	ROT1	-	Soil-improving: 0: if PC_i (i = 1, 2, or 3) is neither 0 nor 1; 1 if PC_i includes at least 0 or 1.
Rotation type 2	ROT2	-	Diversity: 1 if $\Sigma\ PC_i \leq 4$; 2 if $\Sigma\ PC_i > 4$
Nitrogen input	N	kg.ha^{-1}	NC = 1 if $N \leq 50$; 2 if $50 < N \leq 100$; 3 if $N > 100$
Phosphorus input	P	kg.ha^{-1}	PC = 1 if $P \leq 30$; 2 if $30 < P \leq 60$; 3 if $P > 60$
Potassium input	K	kg.ha^{-1}	KC = 1 if $K \leq 30$; 2 if $30 < K \leq 60$; 3 if $K > 60$
Landform	LFORM	-	IR: 1; IR-RL: 2; RL-IR: 3; RL: 4; RL-UR: 5; UR-RL: 6; UR: 7. [3]
Use of high yielding varieties (HYV)	FreqHYV	-	0: no HYV used; 1: less than 20% HYV used; 2: less than 50% HYV used; 3: less than 80% HYV used; 4: more than 80% HYV used.
Use of traditional varieties (TV)	FreqTrad	-	0: no TV used; 1: less than 20% TV used; 2: less than 50% TV used; 3: less than 80% TV used; 4: more than 80% TV used.
Use of hybrid rice	HybUse	-	0: less than 10% hybrids used; 1: more than 10% hybrids used.
Injuries on the foliage	[4]	-	0: not observed; 1: less than 5% of organs (leaves, tillers, panicles or whole plants) affected; 2: less than 25%; 3: less than 50%; 4: more than 50% of organs affected.
Injuries on tillers	[5]	-	
Injuries on panicles and grain	[6]	-	
Injuries on whole plants	[7]	-	

Procédure générale

Figure 1. Flowchart of steps followed to characterize and analyze relationships amongst production situations, germplasm deployment patterns, and crop health syndromes from the Production-Oriented Surveys conducted in India in 2005.



Reddy C.S., Laha G.S., Prasad M.S., Krishnaveni D., Castilla N.P., Nelson A., Savary S., 2011. Characterizing multiple linkages between individual diseases, crop health syndromes, germplasm deployment, and rice production situations in India. Field Crops Research. 120: 241–253.

Outputs from hierarchical cluster analyses

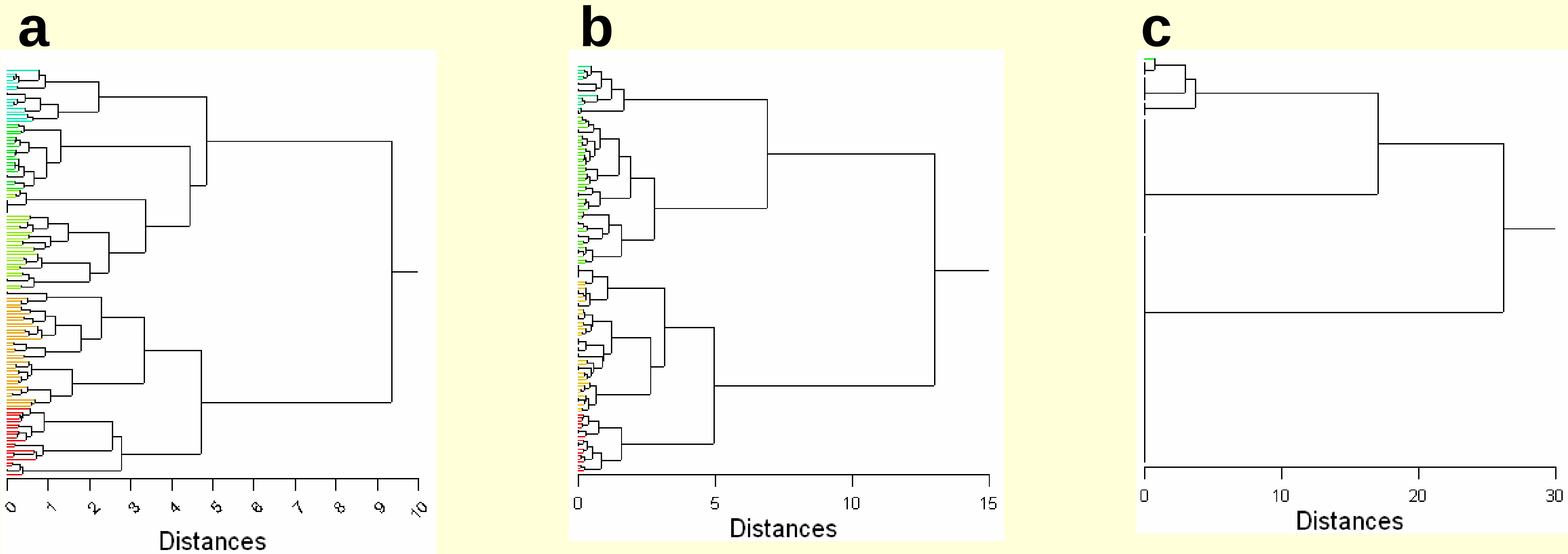


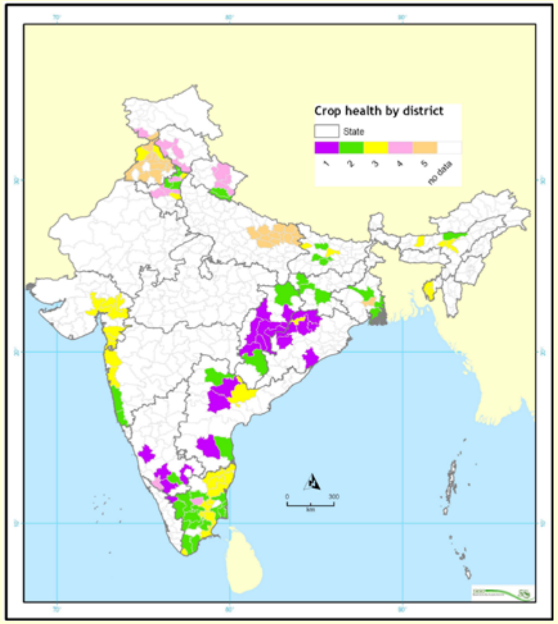
Fig. 2a: crop health syndromes

Fig. 2b: production situations

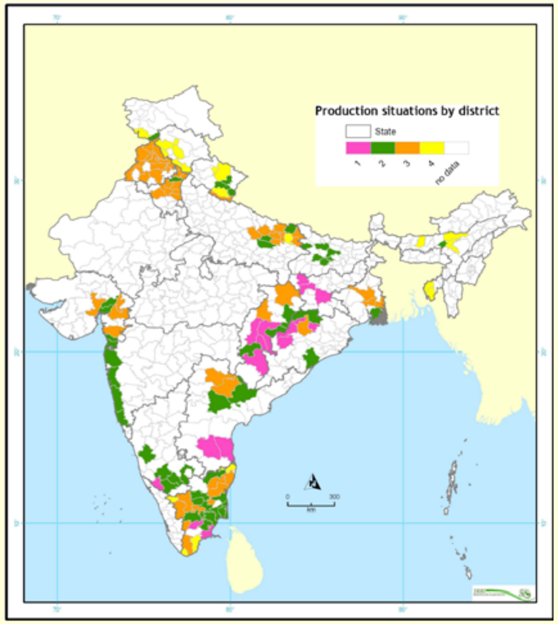
Fig.2c: patterns of rice germplasm deployment

distribution of rice crop health syndromes production situations, and of patterns of germplasm deployment, India, 2005

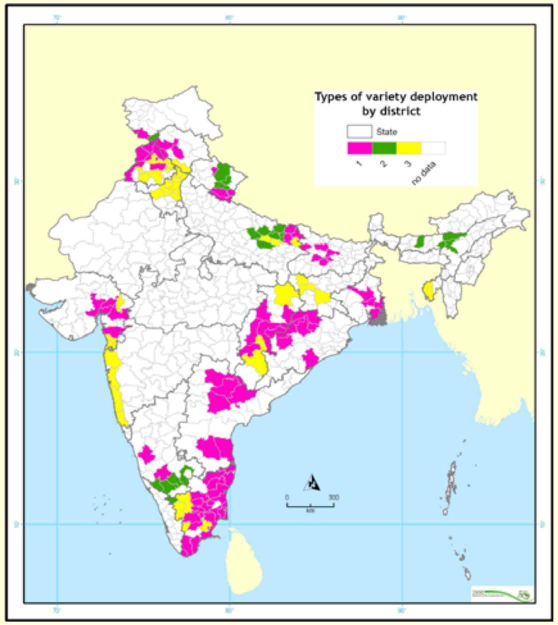
a



b



c



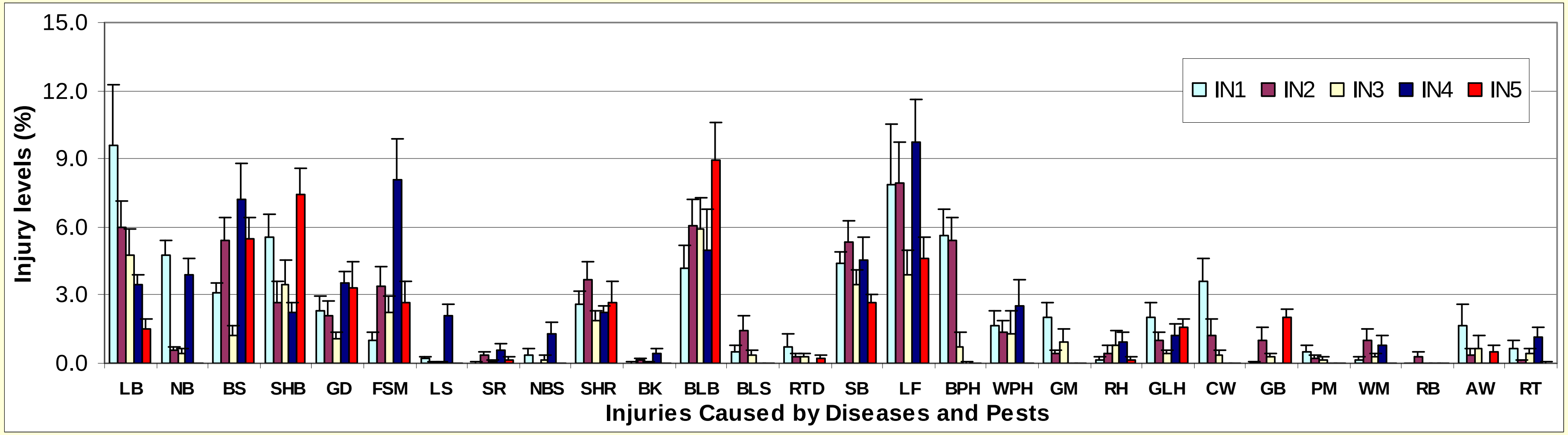
Geographical distribution of

Fig. 3a: rice crop health syndromes

Fig. 3b: production situations

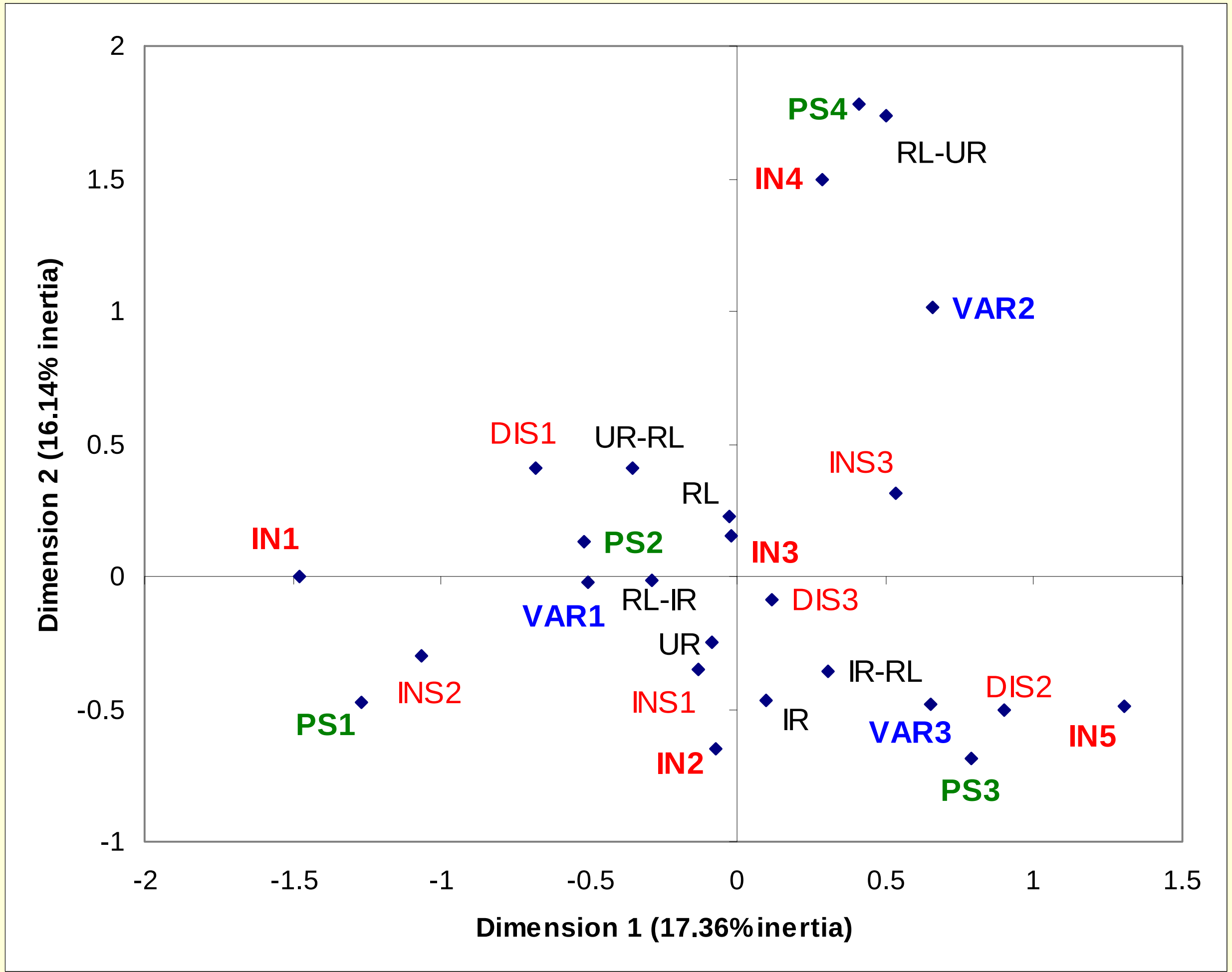
Fig. 3c: patterns of germplasm deployment

Levels of injuries in the different crop health syndromes



Levels of injuries in the different crop health syndromes (IN1 to IN5) are derived from hierarchical cluster analysis on injuries caused by diseases and pests.

Multiple correspondence analysis of production situations, crop health syndromes, and germplasm deployment



Production situations (PS1-4), crop health syndromes (IN1-5), and patterns of germplasm deployment (VAR1-3) are directly used in the definition of axes (see text); Clusters of injuries caused by diseases (DIS1-3), clusters of injuries caused by pests (INS1-3), and landforms (IR, IR-RL, RL-IR, RL, RL-UR, UR-RL, and UR) are additional, superimposed variables (projected on the PS-IN-VAR system of axes).

Discriminant analyses

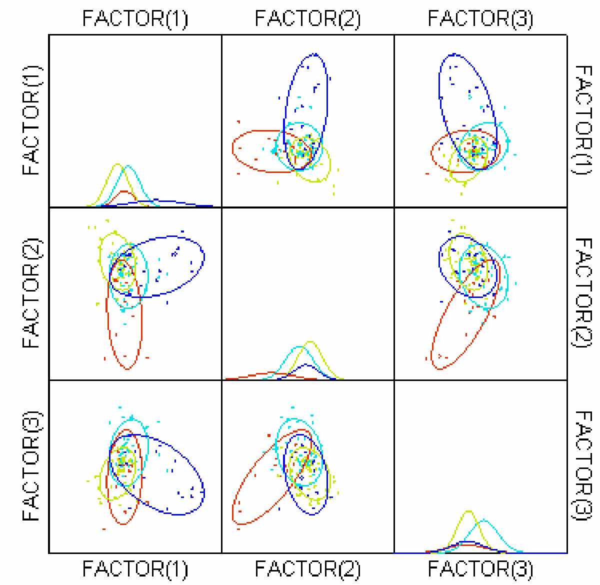


Fig. 6a. Crop health syndromes and production situations

Production situations (PS)

1
2
3
4

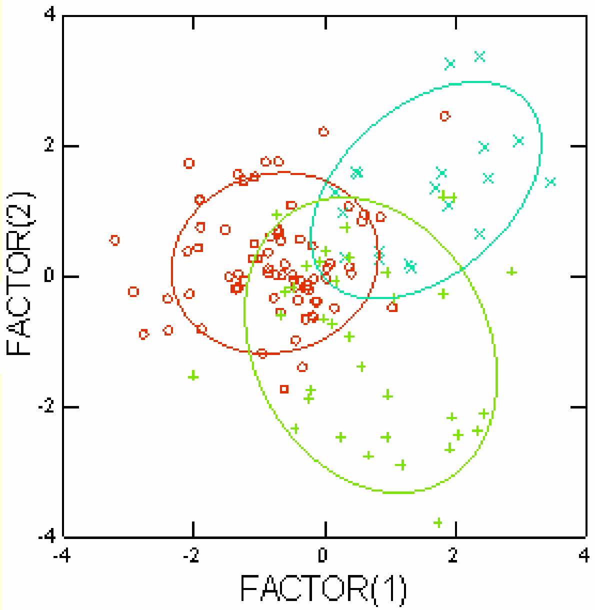


Fig. 6b. Crop health syndromes and germplasm deployment patterns

Germplasm deployment pattern (VAR)

1
2
3

Canonical score plots from discriminant analyses of production situations (Fig. 6a) and germplasm deployment (Fig. 6b) on crop health syndromes (Each symbol represents a district. 95% confidence ellipses for each group around centroids are indicated).