How many species, how many scales to study the uses of agrobiodiversity in the lake Chad Basin? Methodological trade-offs of the *Plantadiv* research program (2008-2012)

Eric Garine & Christine Raimond

4 countries (Cameroon, Chad, France, Niger)

Various scientific approaches: Geography, Agronomy, Genetics, Anthropology

International Workshop on Crop Agrobiodiversity Monitoring

23-25 March 2015
Agropolis International – Montpellier
Why studying together the diversity of species, landraces, genes in many agrosystems?

Because the agricultural know how in many (all?) communities is a complex engineering of various levels of biological diversity (landraces AND species)

- "Main crops": cereals, legumineuses, cash crops, tubers
- "Secondary crops": diversity of species/landraces essential for food, medicine, and cash
- "Semi-domesticated" species currently used and managed
Many anthropologist / human ecologist / geneticist studies have shown how fine tuned local adaptation are achieved through the management of Species + Landraces agrobiodiversity.

Coping with the diversity of needs (and wants)
+ 
Coping with seasonal / environmental hazards
+ 
Coping with market fluctuations

Which diversity counts?
27 Duupa landraces / 4 relevant clusters to the geneticist (neutral markers : 14 microsats ; 293 panicles)

Limits:
Spatial: How to generalize results of such local studies?
Time scale (one year snapshot): How these systems evolve?
Network: What connections to other localities/market places?
Regional driver for change n°1: Climate Impacts of isoyetes’ southward progression?

- Long maturation cycle sorghum landraces replaced by short cycle ones in most stressed areas (Mandara mountains, Sahelian villages with no access to water...)

- Genetic exchanges between late and early pearl millet landraces partly promoted by changes in sowing dates in response to climatic variability:
  
  This raises question about a likely pearl millet cycle length evolution

Lakis et al., Genetica, 2012
Agrobiodiversity to cope with seasonal constraints. Sirlawé (Floodplains. Northern Cameroon)

New Landraces since 1980

<table>
<thead>
<tr>
<th>Species</th>
<th>Short</th>
<th>Medium</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arachis hypogaea</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycine max</td>
<td></td>
<td></td>
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<tr>
<td>Ipomoea batatas</td>
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<td></td>
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<tr>
<td>Oryza sativa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennisetum glaucum</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Sorghum bicolor</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>Vigna subterranea</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vigna unguiculata</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Zea mays</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Facing 'hungry season', labour bottlenecks and ...

Choosing landraces of various species to:

- Have food during the hungry season &
- Have money for socially driven seasonality

Holiday is over!

Beginning of school time
Understanding regional trends and local situations:

**PLANTADIV methodological trade-offs and 'bricolage'**

1) **How to grasp the ecological complexity of agrosystems?**
   
   => 60 species in a trunk of herbarium vouchers for comparative ethnobotanical inquiry

2) **How to cope with the heterogeneity of local situations (ecology/ethnic groups/marketplaces)?**
   
   => 60 study sites in three countries

3) **How to manage time/energy for survey and gain from previous knowledge on agrosystems**
   
   => Quick survey (one week) / long term study on agrosystems (one to many years)

4) **How to combine ethnobotanical survey and sampling for genetic study?**
   
   => not sure we did it very well, so I'm not going to talk about it
1) How to grasp the ecological complexity of agrosystems?

=> 60 species in a trunk of herbarium vouchers for comparative ethnobotanical inquiry

Classification of 60 food plant species

<table>
<thead>
<tr>
<th>Cereals</th>
<th>Vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum bicolor</td>
<td>Gourds</td>
</tr>
<tr>
<td>Pennisetum glaucum</td>
<td>Allium cepa</td>
</tr>
<tr>
<td>Zea mays</td>
<td>Capsicum spp.</td>
</tr>
<tr>
<td>Oryza spp.</td>
<td>Cyperus esculentus</td>
</tr>
<tr>
<td>Eleusine coracana</td>
<td>Lycopersicum esculentum</td>
</tr>
<tr>
<td>Triticum aestivum</td>
<td>Saccharum officinarum</td>
</tr>
<tr>
<td>Digitaria exilis</td>
<td>Solanum aethiopicum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tubers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dioscorea cay-rotundata</td>
<td>Hibiscus esculentus</td>
</tr>
<tr>
<td>Dioscorea spp.</td>
<td></td>
</tr>
<tr>
<td>Ipomoea batatas</td>
<td></td>
</tr>
<tr>
<td>Manihot esculenta</td>
<td></td>
</tr>
<tr>
<td>Tacca leontopetaloides</td>
<td>Leptadenia hastata</td>
</tr>
<tr>
<td>Dioscorea abyssinica</td>
<td></td>
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<tr>
<td>Aracées</td>
<td></td>
</tr>
<tr>
<td>Coleus</td>
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</table>

<table>
<thead>
<tr>
<th>Leguminous grains</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigna unguiculata</td>
<td>Hibiscus sabdariffa</td>
</tr>
<tr>
<td>Vigna subterranea</td>
<td>Amaranthus spp.</td>
</tr>
<tr>
<td>Dolichos lablab</td>
<td>Autres malvacées</td>
</tr>
<tr>
<td>Glycine max</td>
<td>Solanum nigrum</td>
</tr>
<tr>
<td>Cajanus cajan</td>
<td>Cleome gynandra</td>
</tr>
<tr>
<td>Phaseolus vulgaris</td>
<td>Cassia tora</td>
</tr>
<tr>
<td></td>
<td>Celosia argentea</td>
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<tr>
<td></td>
<td>Momordica charantia</td>
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<tr>
<td></td>
<td>Crotalaria ochroleuca</td>
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<tr>
<td></td>
<td>Justicia insularis</td>
</tr>
<tr>
<td></td>
<td>Luffa aegyptica</td>
</tr>
<tr>
<td></td>
<td>Portulaca oleracea</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Oleaginous</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arachis hypogaea</td>
<td></td>
</tr>
<tr>
<td>Sesamum indicum</td>
<td></td>
</tr>
<tr>
<td>Hyptis spicigera</td>
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</tbody>
</table>

Inventory of knowledge on cultivation, uses and history of food plants

- Focus group discussions around an herbarium of 60 species
- Individual free listing, interviews and observation of fields
- Collection of seeds for 4 species (Sorghum bicolor, Pennisetum glaucum, Arachis hypogaea, Vigna subterranea)
2) How to cope with the heterogeneity of local situations (ecology/ethnic groups/marketplaces)?

=> 60 study sites in three countries

Observatory of Lake Chad Region
Cultural diversity, climatic gradient, exchange crossroad

60 villages
Quick surveys / long term studies
30 languages
3) How to manage time/energy for survey and gain from previous knowledge on agrosystems

=> Quick survey (one week) / long term study on agrosystems (one to many years)

Actual distribution of food plants is similar to that of early XXth century
No major loss of landraces according to interviews
Agrobiodiversity for food security and cash income: Where are the seeds coming from?

'Sasa' agropastoral system

Sorghum as the main crop and cultural 'superfood'.

High landrace diversity:
Rainy season & transplanted dry season landraces (48 landraces elicited with 25 individuals)

Sorghum seed exchange networks in the Diamaré Floodplains of Northern Cameroon

J. Wencélius's work
Geography of exchanges

Nb of events = 223
Nb farmers interviewed = 70

Sorghum. 2011/2012 Cropping season

Map of sourced villages

Type of seed sources

Within village: 59.2%
Markets: 14.8%
Other villages: 26%

Nb of sourced villages = 28
Social Networking to obtain seeds among the Masa (Nuldayna, 2011)

Each dot is a landrace \( a \) acquired by a farmer \( y \) (514 events, 82 farmers. Lifelong acquisitions of seeds)

Allies represent 26% of total seed transfer source, and 58% of non-market seed transfer source
Marrying women... Acquiring seeds from the same places (Nuldayna/Djongdong, 2011)

Inter-linguistic matrimonial unions:
- Nuldayna: 11% (of all surveyed unions)
- Djongdong: 34%

Survey Nuldayna: 171 seed acquisitions (in other villages) and 818 matrimonial unions
Survey Djongdong: 128 seed acquisitions (in other villages) and 555 matrimonial unions

Pearson correlation (seed exchange and matrimonial union locations):
- Nuldayna: Correlation coefficient = 0.775 significant at $\alpha = 0.05$ – p-value < 0.0004
- Djongdong: Correlation coefficient = 0.927 significant at $\alpha = 0.05$ – p-value < 0.0001
Agrobiodiversity for food security AND cash income
Where are the seeds coming from?

2011-2012
Nb of events = 223
Nb farmers interviewed = 70

But some households are connected to the network through marketplaces:

shall the markets remain just a blackbox for social analysis?

Nb of sourced villages = 28
Proximate mecanisms for getting seeds
Different strategies for different landraces

• Exotic and functionnaly specialized landraces are acquired from neighbors and in other villlages

• Dry-season sorghums are mostly correlated to market exchange

Inventory of all grown sorghum landraces and the source of their acquisition
(Sample: 57 households)

⇒ For one species no unique seed exchange type can be identified.
everyday life of Tupuri farmers for all the crops

- For every crop, seeds are acquired mostly through gift and between relatives (and neighbours).
- Gift mostly occur between relatives and purchases are made with strangers or kins in market places.

Gift mostly occur between relatives and purchases are made with strangers or kins in market places.

In case of emergency or by pure curiosity.

At local level, not a SINGLE, nor specific seed exchange systems for every plant but MANY seed systems coexist.

Importance of seeking and its effectiveness (68%). «Begging» strategies.

**However:**

- Some crops are more strongly associated with other types of transactions (legumes and market/transplanted sorghum and barter).
- Monetized transactions also occur at home with relatives (neighbors). In case of emergency or by pure curiosity.
- You need to ask in order to receive.
Nothing original: Two ways (scales?) of viewing seed networks

Leclerc (bio-socio-cultural) GxExS

Hodgkin (economic-geographic)

Figure 1. Hypothetical distribution of markets, villages, and seed flows in a marketshed

All these villages have marketplaces!
Where you can buy grain, seeds... or clothes

And marketplaces are one of the best place to meet your lover or bride

Merging economic and cultural approaches?
To better understand evolving systems

Meeting strangers as well as kins at marketplaces
How are we going to study geographic pattern, social structure and economic agency of highly mobile sexually reproduced individuals (*Homo sapiens*)? "meso scale" (400km)?

How many crop species/landraces?

How many marketplaces?

Need to think of a smart sampling method and quite a bit of funding.
Plantadiv Project 2012