



# THE UTILITY OF CROP AND LIVESTOCK INTRASPECIFIC DIVERSITY WITHIN AGROECOSYSTEM TO IMPROVE ECOSYSTEM SERVICES, AGRICULTURAL PRODUCTIVITY AND RESILIENCE

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## BACKGROUND & STATE OF THE ART

For centuries plants and animals have been domesticated by farmers developing into crops, livestock species, traditional varieties, and breeds. The genetic heritage found in plant and animal species, and varieties and breeds have been maintained, modified, and adapted through their uses, management, and selection by farmers within their production systems, fitting their local environment. This allowed farmers secure their own consumption and helped feed the world's ever-growing population with their surplus.

Overall, agricultural production systems have moved towards simplification and the reduced use of biological diversity with the increased use of chemical inputs, and recently developed modern, highly productive, inputs relying, and mainly uniform varieties and breeds. Numerous production systems have therefore lost the various benefits of traditional farming systems, including pests and diseases control, soil quality maintenance, and the provision of organic fertilizers.

On the one hand, the evidence of the value and relevance of traditional crop varieties and local livestock breeds in low input production systems and/ or harsh production conditions is supported by the large number of small-scale farmers continuing their use and maintenance of such diversity. On the other hand, modern agricultural practices are more and more widely recognized as unsustainable, leading to ecosystem damages and the loss of functions supporting ecosystem services including food provision.

Although the value and importance of agricultural biological diversity is more widely recognized, there is often a lack of real and relevant data and information on the amount, the type, and the distribution of this diversity, and how, when and where to best use it. Moreover, knowledge on the intraspecific diversity and its distribution, its utilization, and benefits, is not used into agricultural decision-making. An adapted tool gathering existing methodologies and improving the efficiency of collection and analysis is also missing.

## OBJECTIVES & RESEARCH HYPOTHESIS/QUESTIONS

### Focus of the research project

Intraspecific genetic diversity of crop and livestock and the provision of ecosystem services and support to productivity and resilience of agroecosystems

### Main research aim

Demonstrate that the lack of crop and livestock intra-specific genetic diversity has negative impacts on production systems both in terms of resilience and productivity

### Specific goals with research hypothesis/questions and eventually corresponding predictions

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Study the role of intraspecific diversity in production systems:

- Does *on farm* crop intraspecific diversity impact the provision of ecosystem services and the resilience of production systems?
- Does *on farm* livestock intraspecific diversity impact the provision of ecosystem services and the resilience of production systems?
- How does the access to and availability of genetic material affect diversity?

Show the benefit of using an innovative IT tool

- What is the effectiveness and utility of the tool?
- Does it facilitate data collection and analysis as well as agricultural decision making?

Support small producers in improving their food production, health, livelihoods, food sovereignty and agricultural heritage through the use of agrobiodiversity

- Does intraspecific diversity and its use improve productivity and resilience of production systems?
- Does the tool favour and support the conservation of agrobiodiversity through its use?

### **Scientific and social implications of the research**

Better understanding of the distribution of intraspecific diversity in farm and its roles in the agricultural production system

Support of smallholders in improving their food production, health, livelihoods, food sovereignty and agricultural heritage

## **METHODS/ANALYSIS**

### **Methods, statistics, models used to answer each research question**

Data are first collected through surveys at community and farm level and questionnaires to key informants. Surveys are conducted following a sampling method.

Data will go through a quality control process.

Data analysis -which is planned to be integrated into the DATAR tool- will rely on statistical tools: diversity indicators (richness, evenness, divergence) principal component analysis, linear regression models, ANOVA (analysis of variance), multivariate analysis, UPGMA, etc.

DATAR, the Diversity Assessment Tool for Agrobiodiversity and Resilience, is being developed to gather all tools and models listed above. DATAR will be used to conduct data collection and analysis.

### **Why these methods are appropriate to answer your research question**

These methods will allow understanding intraspecific diversity distribution at farm and community level. It will also allow linking functional descriptors available in varieties and breeds to genetic material providers and identify any other relevant correlation.



## STUDY DESIGN AND DATA COLLECTION

### Study design

The student will demonstrate that the lack of intra-specific crop and livestock genetic diversity has (strong) negative impacts on the resilience and productivity of agricultural production systems based on the literature, data already collected and to be collected for crop and for livestock, and the overall experience of countries using intra-specific genetic diversity in their agricultural development projects.

The student will test DATAR effectiveness for data collection and analysis, using both already collected datasets and data to be collected in the field.

The student will link agrobiodiversity assessments and studies into a decision-making tool, DATAR, that aims to assess intraspecific agrobiodiversity in the field and pasture, and to support agricultural development decision making based on these assessments, and to guide farmers towards relevant and adapted agrobiodiversity related interventions and actions to increase productivity and resilience in their production systems.

### Source of data and Sampling strategy

Data will be collected in partner countries working in the sectors of crop and livestock with various target species. Target crops are rice and sorghum (cereals), common bean (protein legume), apple (perennial crop) and target livestock are cattle, goats, and chicken.

Four field trips are planned in Nepal, Sri Lanka, Uganda and Uzbekistan to meet with local partners, make field observation, collect complementary data, and discuss data collection and DATAR use, and any issue relevant to the study.

Surveys used are Focus Group discussions, Household Surveys, and Key Informant Questionnaires

### Timing of data collection

During the first year, data from previous studies will be gathered and harmonized.

Due to the sanitary situation, data collection in the countries is expected to be postponed to the 2<sup>nd</sup> year of the study.

## EXPECTED RESULTS

- **Paper 1** Assessment, state of the art/ state of play

*The lack of intra-specific genetic diversity and its impact on the provision of ecosystem services.*

Paper 1 is a study on how the lack of intraspecific genetic resources of crop and livestock impacts the resilience and productivity of smallholder's production systems based on a large literature review and analysis. It will analyse the potential for crop and livestock genetic diversity to enhance specific ecosystem functions through increased functional traits, facilitative interactions and facultative differences. The regulating ecosystem services targeted are the regulation of pest and disease, pollination, seed dispersal, water quality and quantity, soil erosion and soil quality. The supporting ecosystem services targeted are nutrient cycling and habitat provisioning.

- **Paper 2** DATAR development and Case studies



### ***DATAR, building an innovative IT tool, and case studies***

Paper 2 will show how DATAR was developed and structured based on previous projects and experiences. It will detail the process of its theoretical and technical development, and highlight the key questions and issues identified during this process. It will further explain components and sections of the DATAR tool. Paper 2 will analyse the benefit of using this innovative IT tool: eased data collection and surveys conduction, benefit of using GIS tools linked to basic statistical analysis to produce maps, diagrams and graphics easing the understanding of the distribution of diversity at community level. Paper 2 will also apply DATAR to specific crop and livestock species in a few selected countries. Case studies will be conducted using already existing data sets and complementary data collected during the field trips planned for the PhD. For crops, the student will work on common bean in Uganda, apple in Uzbekistan, rice in Nepal and for livestock, on chicken in Sri Lanka, cattle in Uganda and goats in Nepal.

- **Paper 3** Synthesis paper

#### ***Synthesis paper***

Paper 3 will be a synthesis of the previous papers and will also be drawing on the PhD experience itself. It will link -both logically and scientifically- the entire project process and will be upscaling to other production systems: including aquatic resources, organic agriculture etc.

### **CONTINGENCY PLAN**

Sanitary risk: If travels are not allowed, alternate sources of data will be surveys realized by the national partners themselves

Technical risk: If there are IT issues (malfunction or dysfunction of the IT tool developed), extraction of the spreadsheets and analysis with classic tools

Organizational risk: If other tasks of my work are overwhelming, the solution will be to book time fully dedicated to the PhD

Financial risk: none

### **PROVISIONAL TIMEFRAME**

#### **1<sup>st</sup> year November2020-October2021**

#### ***Training activities planned for this period:***

Mandatory trainings, other possible trainings/courses (statistical analysis for ecology, GIS...), seminars

#### ***Research and writing activities planned for this period:***

**Paper 1:** Detailed outline Paper 1 December 2020, Literature review- deadline February 2021

Literature study, Advanced draft April 2021, submission deadline September 2021

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**Paper 2:** Literature study and detailed outline October 2021, Re-analysis of the research hypothesis based on first results (literature and data analysis),

***Data collection and analysis:***

Gathering, cleaning and analysis of data collected during previous projects related

***Monitoring:***

6 months review (report + discussion) + online meeting with monitoring committee April 2021; Annual review (Year 1 report+ discussion) + meeting with monitoring committee October 2021

**2<sup>nd</sup> year November2021-October2022**

***Trainings/ courses /seminars***

***Research and writing activities planned for this period:***

**Paper 2:** Literature review, Identify necessary dataset(s) to demonstrate hypothesis, Data gathering and data collection, Data analysis, Advanced draft May 2021, Submission deadline August 2022

**Paper 3:** Start drafting outline

***Field work/travel: dates of travels will depend on sanitary situation***

Travel to Uganda – one week: meetings with local partners, data collection, field observation; Travel to Uzbekistan – one week: meetings with local partners, data collection, field observation; Travel to Sri Lanka – one week: meetings with local partners, data collection, field observation; Travel to Nepal – one week: meetings with local partners, data collection, field observation

***Monitoring:***

18 months review (report+ discussion) - online meeting with monitoring committee April 2022; Annual review (Year 2 report+ discussion) + meeting with monitoring committee October 2021

**3<sup>rd</sup> year November2022-October2023**

***Seminars***

***Research and writing activities planned for this period:***

**Paper 3:** Advanced draft February 2023, submission deadline May 2023

**Final report and defence:** Final revisions + preparing defence June-October 2023

***Monitoring:***

30 months review (report +discussion) - online meeting with monitoring committee April 2022