Demand and Supply Constraints to Improved Sorghum Technology Adoption and their Gender-Differentiated Effects in Burkina Faso

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Introduction and Motivation

- Widely observed low rates of input utilization with potential yield gaps reduced through input intensification in cereals.
  - Average sorghum yields in Burkina are estimated at 0.8 tons/hectare, despite agronomic estimates of 2 tons/hectare (MOA Burkina 2010).
    - Gates Foundation funding to investigate input intensification in 7 African countries (GISAIA).
- Why don't farmers adopt new seed and/or fertilizers to increase yield? Are demand or supply constraints potentially more binding?

Demand side	Supply Side
Credit, labor, input or land constraints	Uncertain availability
Risk aversion or discount rates	Commitment mechanisms
Information on the expected profitability of the technology/ social networks	Price

Sorghum seed markets

- Breeding of new varieties that outperform local landraces is difficult
  - Photoperiodicity
  - Heterogeneity of biophysical conditions across zones and between farms
  - Hard for farmers to observe differences in seed without experience

- Sorghum seed markets are primarily informal through:
  - diffusion of new varieties by farmer to farmer exchange through social networks
  - little seed needed per hectare
  - improved varieties need not be purchased annually
  - “shame” of buying seed

- Farmer demand for certified seed has remained weak since informal exchange dominates.

- Au passée, tu chercherais les semences si tu avais besoin d'eux. Maintenant, nous connaissons là où on peut les trouver.

- Tu n'échange pas les variétés améliorées, tu les achètes.

- Il conte aux garder chaque année. S'il voit qu'elles changent, il achètera encore.

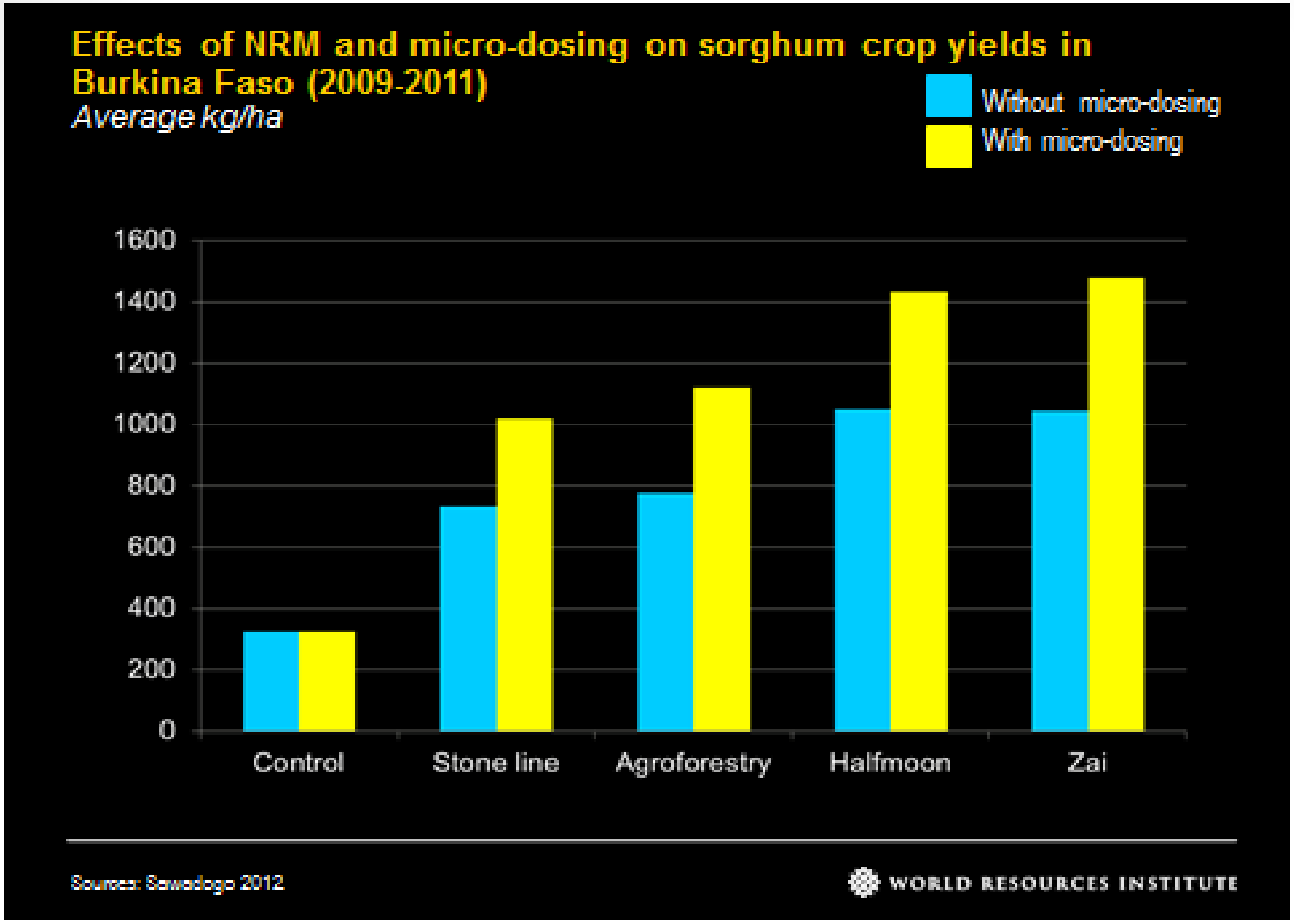
- Il va les renouveler cette année [il les a acheté en 2010].

Kouraogo Mady, Founa, Burkina Faso

Source: Weltzien et al. 2012, INERA/ICRISAT presentation at McKnight Foundation meeting, Bamako, Mali.

Is improved sorghum seed profitable?

- Use of improved seed may not be profitable if water and soil fertility constraints are not addressed.
- Land and water management practices diffused on a large scale after the 1970s droughts.
  - When combined with micro-doses of fertilizer and these practices, improved seed can be highly profitable.
- Micro-dosing is commonly recommended agricultural practice under water and soil fertility constraints.
  - Farmers apply 6 g of fertilizer (a bottlecap) in the hole where seed is planted.
  - By correcting soil deficiencies for essential nutrients with tiny doses, root systems develop and capture more water.



Effects of land and water management practices on sorghum yields, with and without microdosing, 2009-11
Source: Sawadogo, 2012

Experimental Design

- Which constraints to adoption are potentially most relevant?
  - Because of the informal nature of sorghum seed markets and farmer to farmer exchanges, social networks seem to be an important mechanism through which seeds diffuse.
  - Underdeveloped agro-input sector yields unreliable access to inputs.

- Demand side
  - Social networks may promote knowledge sharing/influence on adoption decisions
    - Foster and Rosenzweig (1995), Conley and Udry (2004), Munshi (2004), and Bandiera and Rasul (2006), Jackson (2010), Beaman et al. , Beaman and Dillon

- Supply side
  - Commitment (Duflo et al. 2011)
  - Credit constraints (Giné and Yang 2009)
  - Price/profitability (Carter et al. 2013)

Experimental Design

Demand Side		Supply Side	
Treatment	Seed+Fertilizer Packet + Marketing/Training	Treatment	Marketing/Training
A	20% initial free distribution randomly	D	Early commitment offer at fixed 'market' price
B	20% initial free distribution based on degree	E	Late commitment offer at fixed 'market' price
C	20% initial free distribution based on eigenvector centrality	F	Late commitment offer at discounted price
Control	No interventions	G	Market Availability

Note: Each group will contain 20 villages where 20 farmers per village will be interviewed.

Research Questions

	Comparison
What is the productivity effect of the packet (seed+fertilizer+training)?	A-Control
Does targeting based on SN characteristics increase adoption spillovers and aggregate productivity gains?	A,B,C, Control
Do commitment mechanisms to relieve credit constraints induce higher adoption than price subsidies?	D,E,F,G Control
What is the effect of supply side constraints on adoption and productivity?	G-Control
Are demand side or supply side effects larger constraints to adoption and productivity gains?	A,G, Control

Sorghum Production By Gender

	Plot Controled by a Male		Plot Controled by a Female	
	%	# of Obs.	%	# of Obs.
White Sorghum	87	11672	46	3025
Red Sorghum	48	6230	23	1305

Data Source: DGPER Panel Data (2008-2012)

Pareto Inefficiency in Production

- Households in Burkina Faso do not necessarily allocate production inputs in a Pareto efficient manner (Udry 1996):
  - lower yields for women's plots than those of men's plots, controlling for the crop and year.
  - differences in yields are primarily attributed to a greater use of fertilizer and labor on men's plots

- Explanations for Pareto inefficiency
  - (Male) Household heads share outputs of their plots, and therefore control inputs best (Kazianga and Wahaaj 2013)
  - Cooperative agreements are costly to enforce and monitor, unless productivity is low (Akresh 2008)
  - Investment is higher for those with more secure land tenure rights (Goldstein and Udry 2008)

Gender and Labor Substitution

- Adoption of improved seeds and microdosing will likely occur on male controlled sorghum plots.

- Microdosing is time-consuming. Sorghum productivity would also raise demand for labor during weeding and harvest periods. Will adoption change:
  - the allocation of inputs such as labor and fertilizer to the production of other crops and to overall household productivity?
  - the allocation of women's labor among farm, household, and nonfarm income-earning activities?
  - The allocation of children's time between farm labor and schooling?

- Will productivity gains alter intrahousehold bargaining within the household?

Intrahousehold Bargaining and the Collective Model

$$\max_{\{q_h, q_w, Q\}} U_h(q_h, q_w, Q) + \mu(p, y, z) U_w(q_h, q_w, Q)$$

subject to:

$$p(q_h + q_w + Q) = y$$

- The outcome of this problem is a function $q^*=f(p,y,\mu)$.
- That is, we can derive demands for goods consumed exclusively by men (q_h), women (q_w), and Q (household public goods) as functions of the Pareto weight μ.
- In our study, access to our hybrid sorghum seed and micro-dosing packet will potentially raise total household productivity, and individual productivity – it is a distribution factor (z).

Measuring q_h and q_w

- The difficulty in measuring changes in intrahousehold bargaining is the identification of 'male' and 'female' goods for which increased consumption would indicate a shift in bargaining power.
  - Clothing expenditures
  - All individuals have some "pocket money" they use to buy snacks for themselves, etc. (e.g., Lee 2007 on pocket money in South Korea).
  - Women with more bargaining power may spend more of it on foods they and their children prefer (eggs, dairy, sweet potato, spices; rather than meat). These would need to be identified through qualitative research and piloting.

- Men provide women with a Prix de Condiment (PC) – money to be used for food on a daily or weekly basis. We will ask men and women about these amounts.

Fieldwork Plan

Date	Activity
October 2013	SN Census and HH Enumeration
November-December 2013	Baseline Survey
January 2014	Treatment for groups A,B,C and D
January-June 2014	Market Availability of Packet at Market Prices in group G
June 2014	Treatment for group E and F
November-December 2014	Follow-up Survey + Adoption Survey

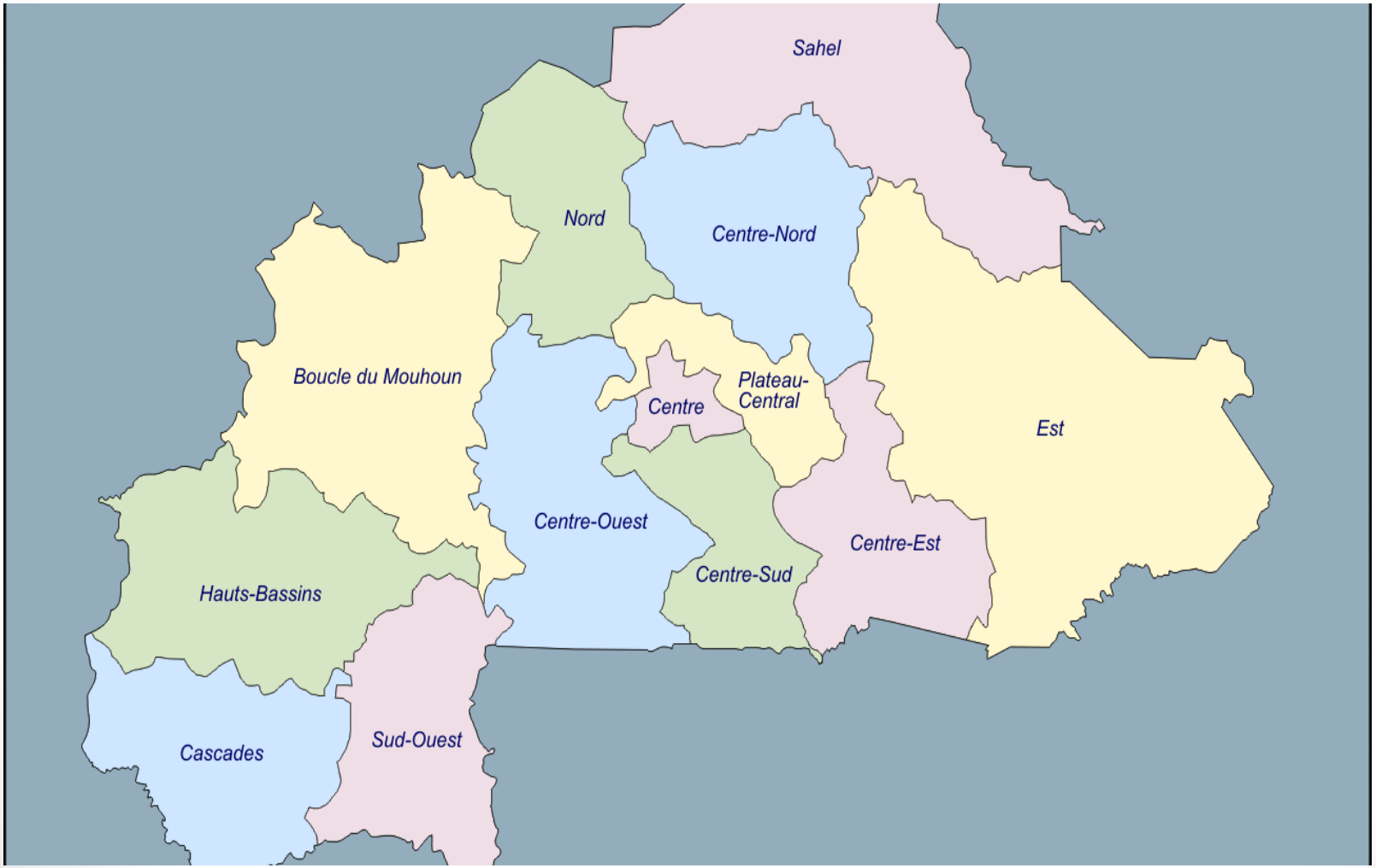
Research Partners

- Gates Foundation funded Guiding Investments in Sustainable Agricultural Intensification in Africa (GISAIA) project focused on demand side interventions for promoting input intensification.
- Institut de l'Environnement et de Recherches Agricoles (INERA)-seed breeders, agricultural economists and gender specialist, training of trainers
- National Directorate of Rural Development (DGPER)- policy dissemination
- Innovations for Poverty Action-design, fieldwork and treatment coordination
- Association des Grossistes et Detaillants Distributeurs d'Intrants Agricoles(AGRODIA)—Training of ag-input dealers
- IFDC-collaboration on identification of agro-input dealers

Sample Frame Enumeration

- We are defining the study area to one agro-ecological zone, the sudano-sahelian zone where rainfall and soil fertility differences are minimized.
- We wanted to locate the study in an area where sorghum was a main subsistence and cash crop.
  - Cotton producing areas may create fertilizer spillovers away from sorghum.
  - Originally identified the Boucle de Mouhoun area, but we now think that the Northern-Central and Northern region may be better suited to the study.
- Village identification is proceeding through administrative list verification.
- Agro-input dealers are being identified with IFDC's recent ag-input dealer census data.

Administrative Map

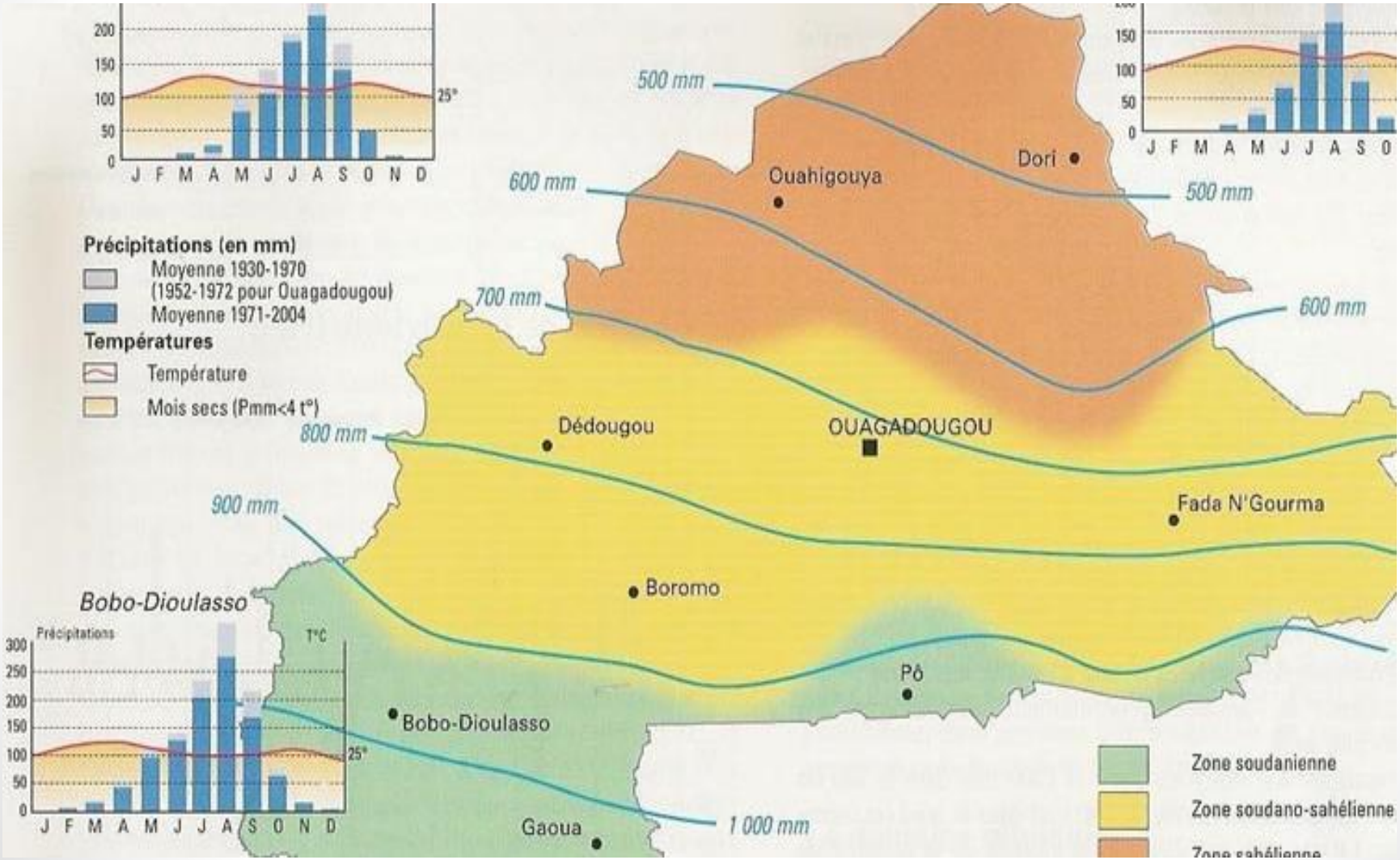


Sorghum Cultivation By Region

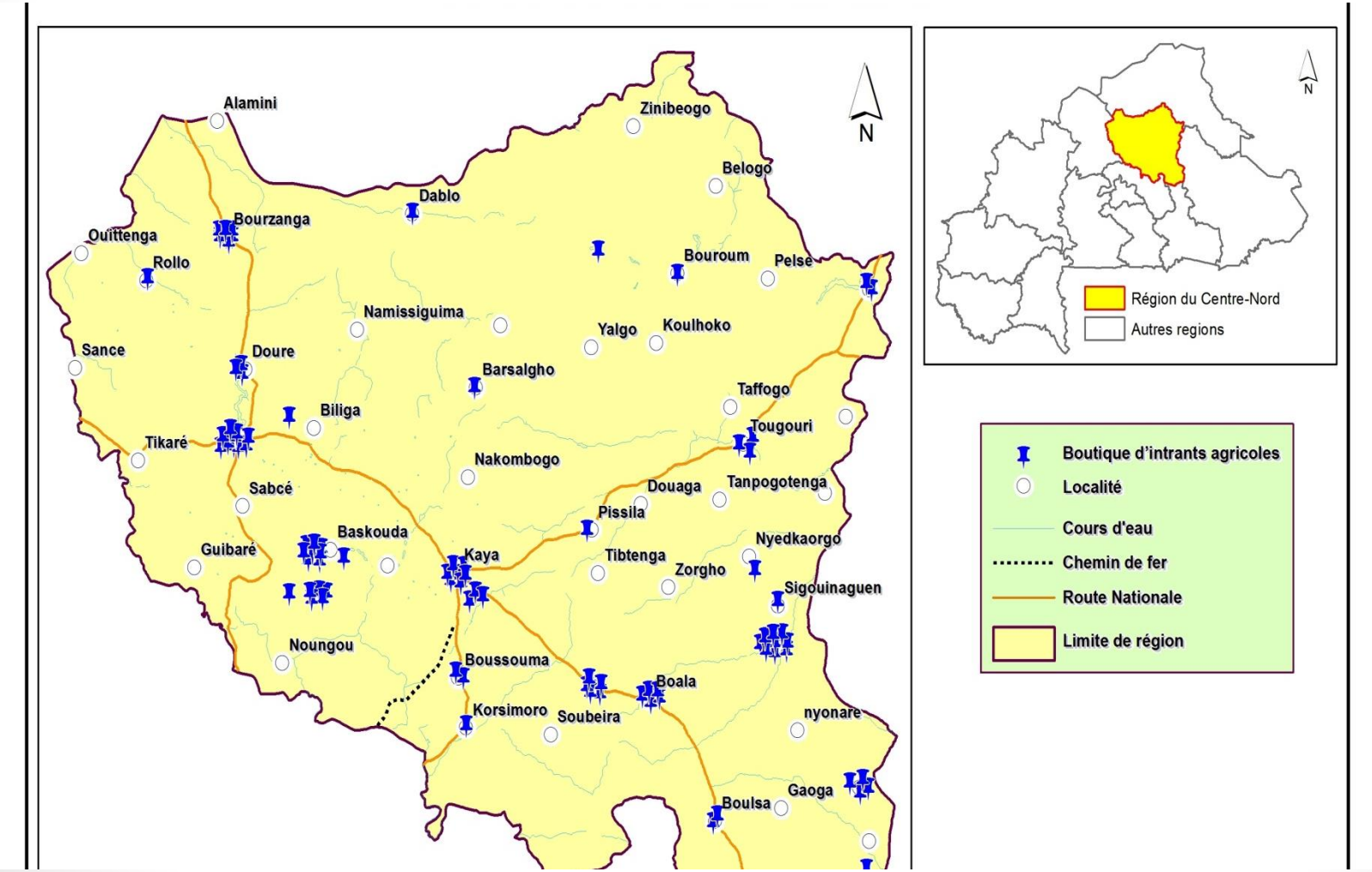
	White Sorghum (% of HHs)	Red Sorghum (% of HHs)	# of Obs.
Boucle du Mouhoun	22.5	4.08	22,780
Cascades	6.75	1.44	8,742
Centre	18.72	13.55	5,150
Centre-Est	5.14	21.12	17,995
Centre-Nord	32.65	0.5	15,546
Centre-Ouest	25.03	9.29	23,445
Centre-Sud	8.89	14.94	16,957
Est	17.16	9.56	18,750
Hauts-Bassins	15.82	4.19	16,317
Nord	25.02	1.23	19,478
Plateau	19.18	14.47	19,921
Sahel	26.14	0.86	4,878
Sud-Ouest	10.08	9.17	17,294

Data Source: DGPER Panel Data (2008-2012)

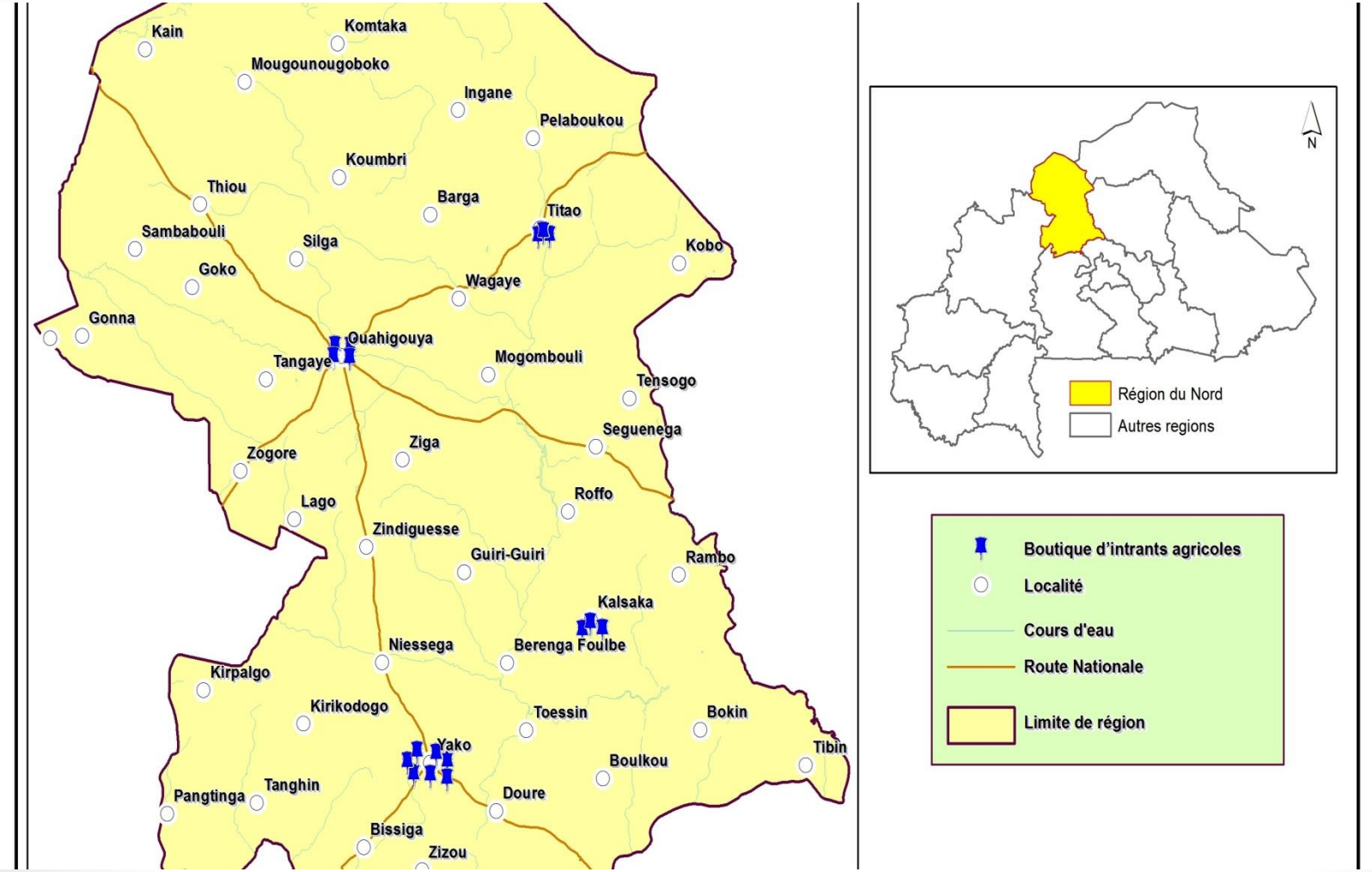
Climatic Regions



The Northern-Center Region



The Northern Region



Questionnaire Design: Measuring Social Networks

- Most social network analyses in economics has used a network sample. Some evidence that this leads to measurement error (Chandrasekhar, 2011) by omitting influential links.

- We will field a social network census designed to measure already used in several studies in Mali and Burkina Faso:
  - Type of network: Farmers within village, households, men and women's networks
  - Type of SN links: Relatives, organizations, plot neighbors, financial ties, people with whom they discuss agricultural issues, friends.
  - Type of information: Frequency of communication, subject of communication
  - Information on link: household composition, assets, education

Further questions about the design

- Other recommendations for gender based goods
  - Small ruminant holdings? Other assets?

- We have concerns about land size measurement and yield measurement which may lead us to do some GIS verification to estimate self-reported land correction factors.

- We need to be careful to identify sorghum varieties planted across plots to measure partial adoption and adoption intensity.
  - What if farmer's only partially use packet inputs?
    - Seed but no microdosing, microdosing but no seed

Thanks for your comments!