

Opportunities for Sustainable Intensification of Agricultural Practices to Improve Crop Productivity of Small Holding Farmers in West Africa

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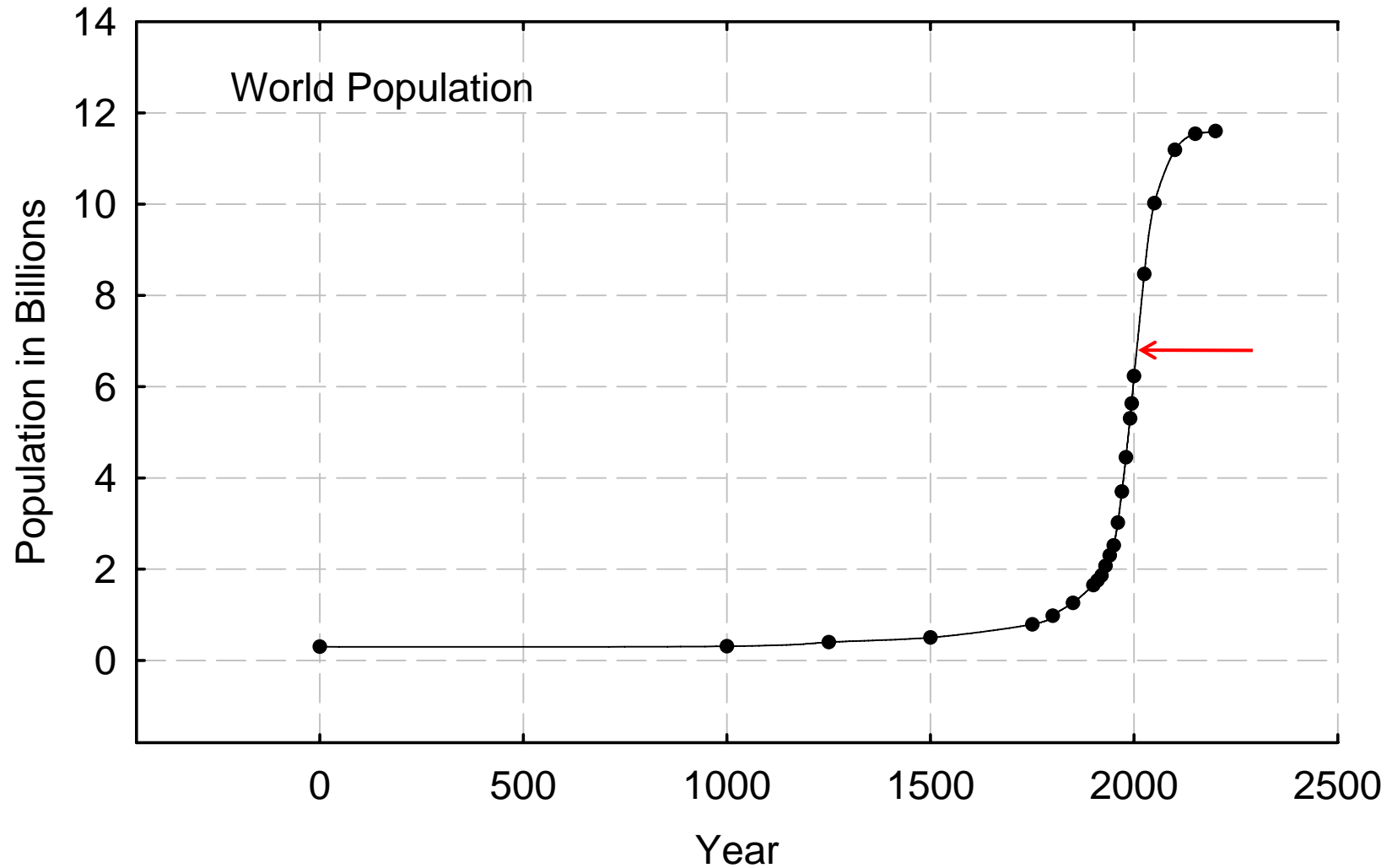


Presentation: Outline

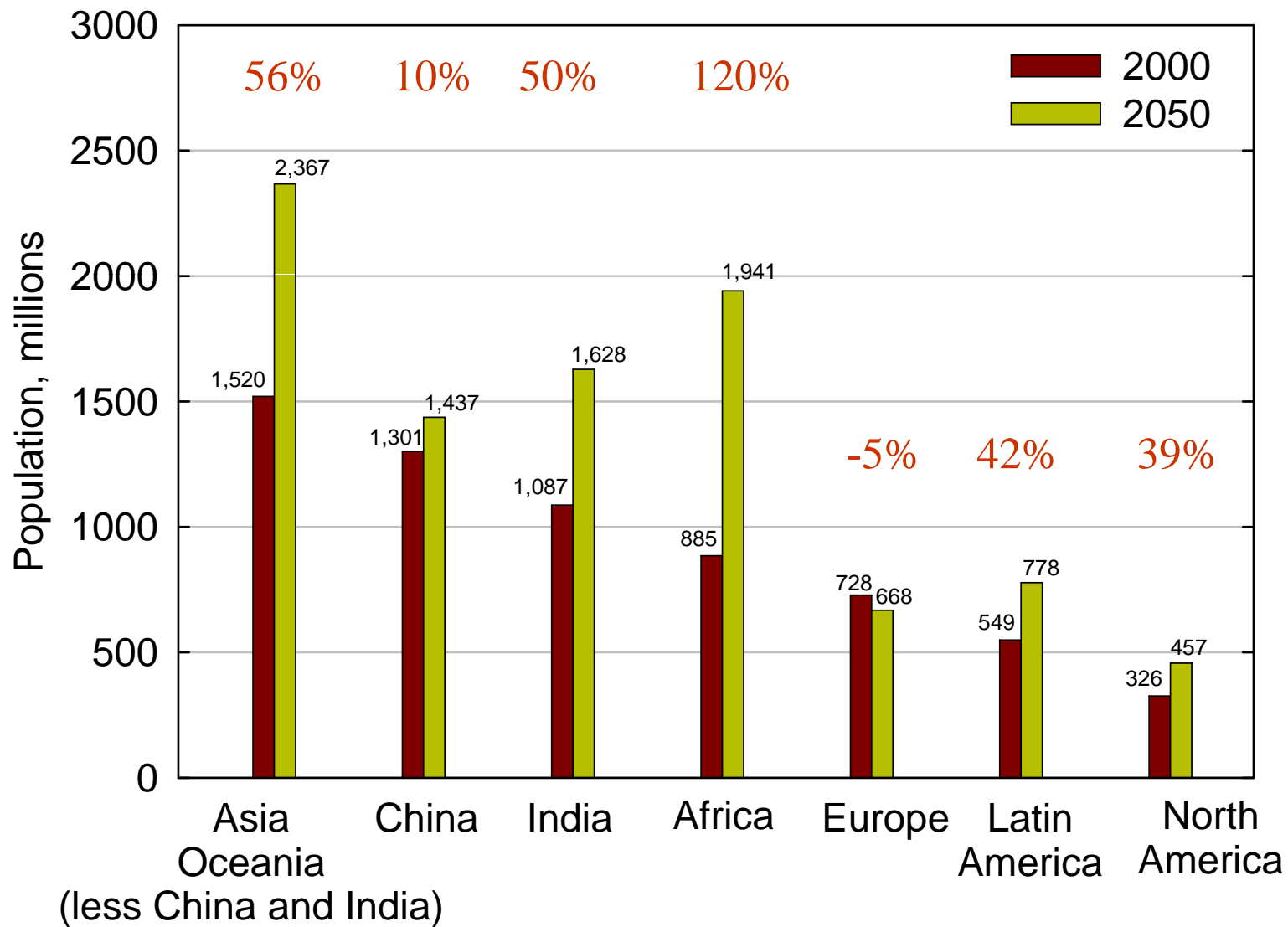
- 1. Challenges to Global Agriculture.**
- 2. Crop Production Constraints in West Africa (Ghana).**
- 3. Role of Conservation Agricultural Practices.**
- 4. Project Objectives and Research Approach.**
- 5. Preliminary Results**
- 6. Questions and Discussion.**

Past, Current and Future Population

Current Population (25 September 2011): 6,922,490,460



Future Population Growth: Major Countries



Most Important Challenges to Agriculture

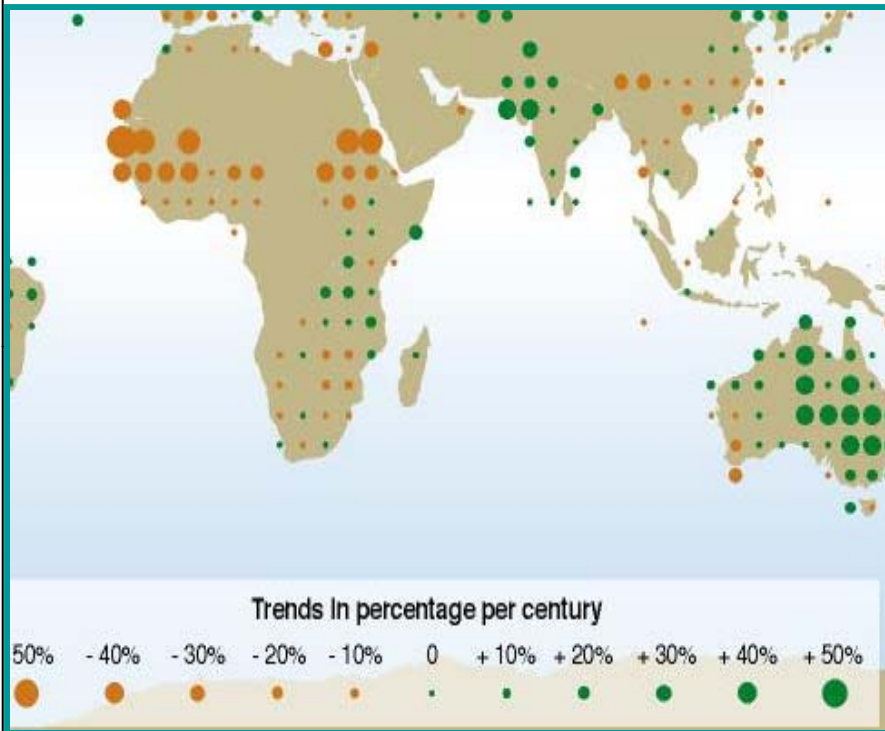
Survey results of global scientific communities in national and international research institutes.

Major Challenge	Ranking (%)
1. Climate Change	51
2. Water Stress	29
3. Desertification	28
4. Water Pollution	28
5. Loss of Biodiversity	23

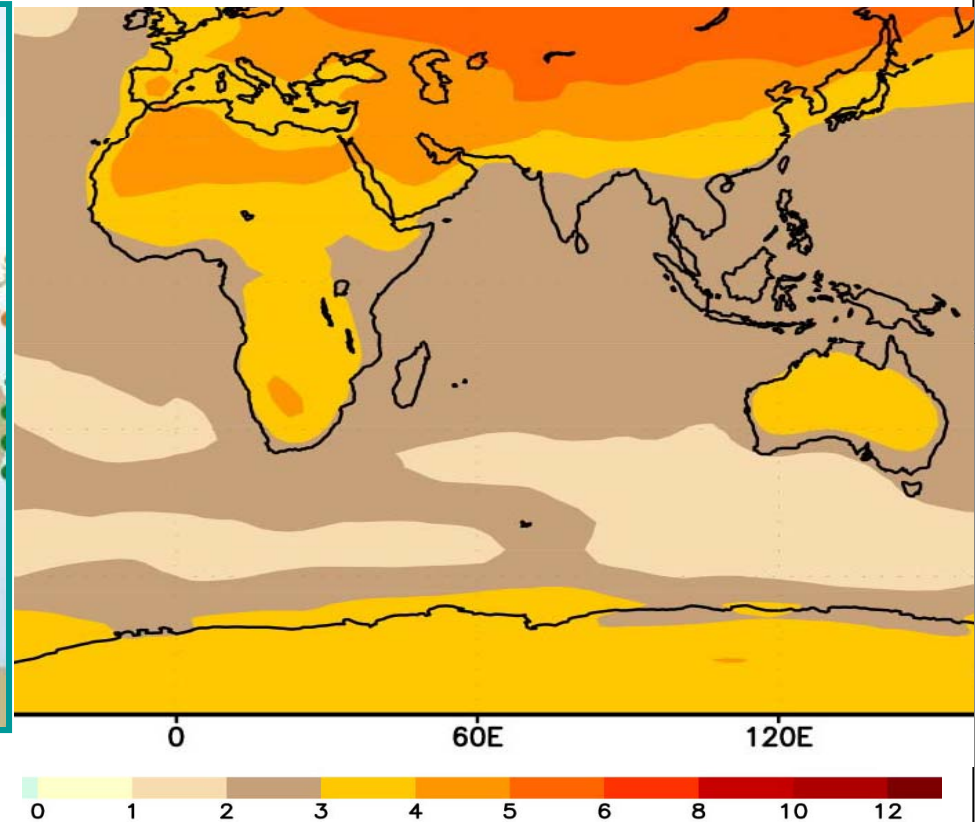
Source: Dr. John Sheehy, International Rice Research Institute: Survey of most significant environmental challenges to agriculture in 21st century.

Drought (water scarcity) was one of the top three concerns.

W. Africa: Problems: Climate Change



Projected Water Resources

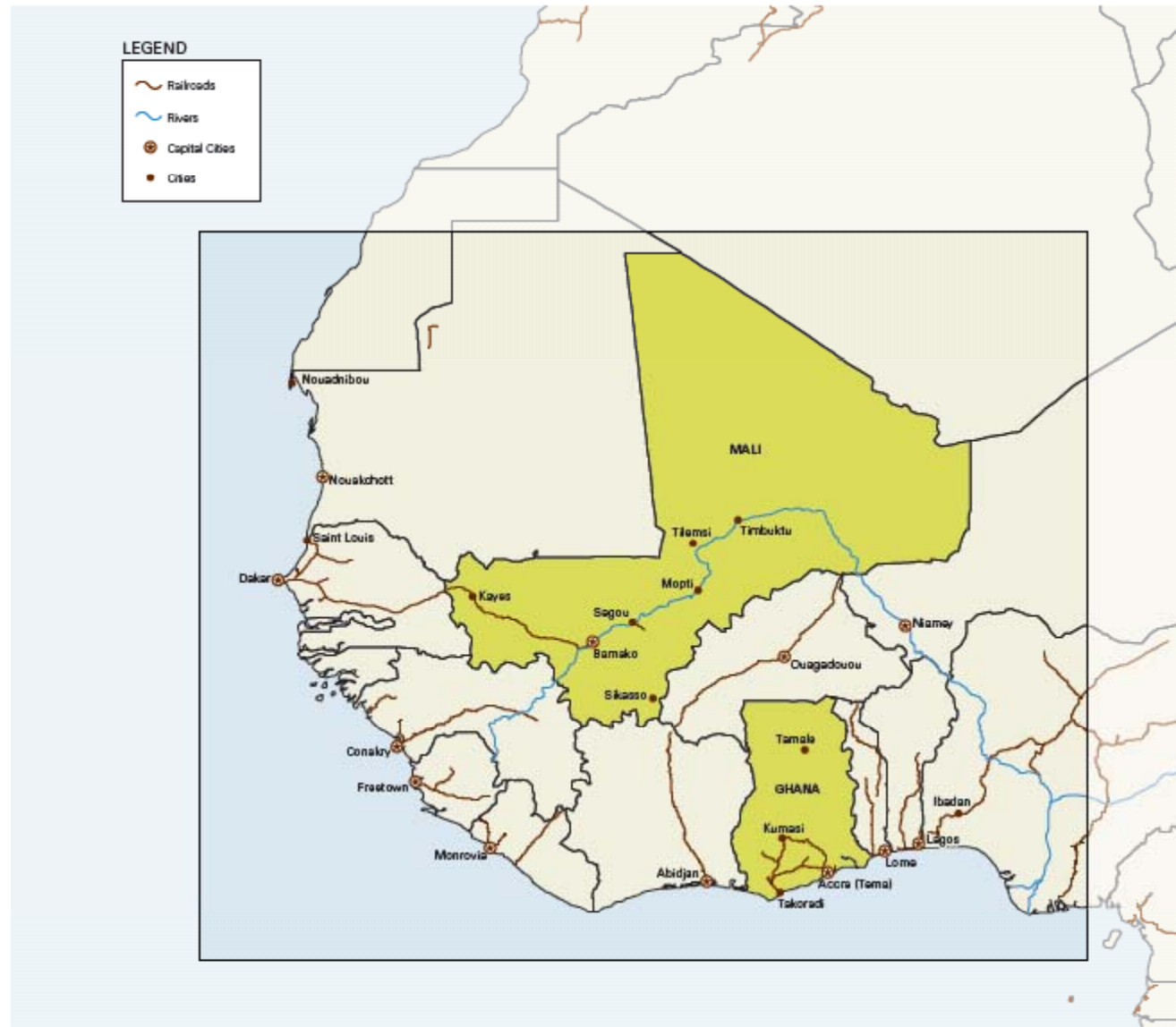


Projected Temperatures

West Africa is going to experience more heat and drought stress.

W. Africa: Mali and Ghana

Map of West Africa



Problems: Soil Erosion and Soil Quality



Soil Erosion: Wind



Soil Erosion: Water

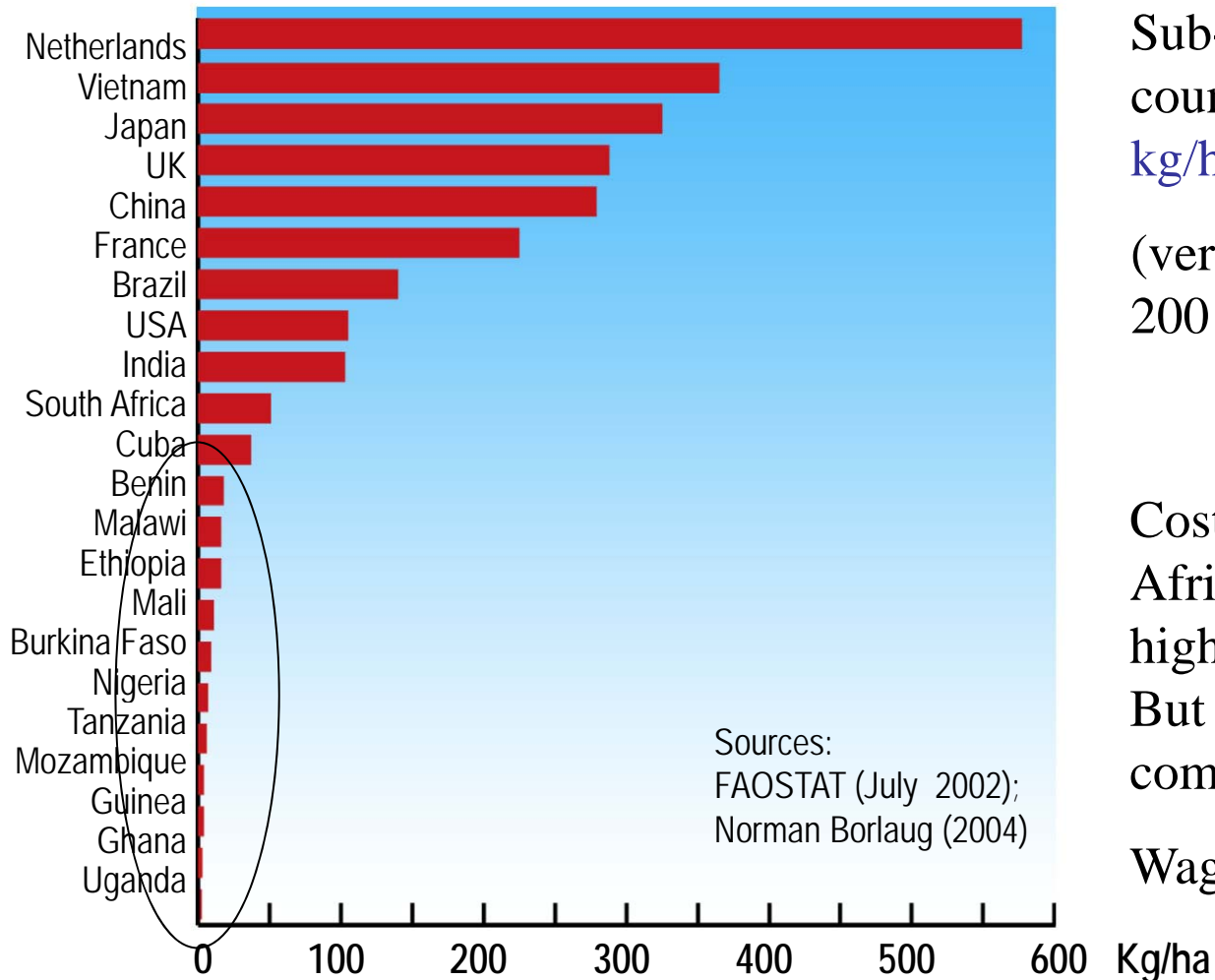


Wild Fires: Burning



Poor Soil Fertility

Problems: Soil Fertility and Fertilizer Use



Sub-Saharan African countries use **less than 10 kg/ha** of fertilizer

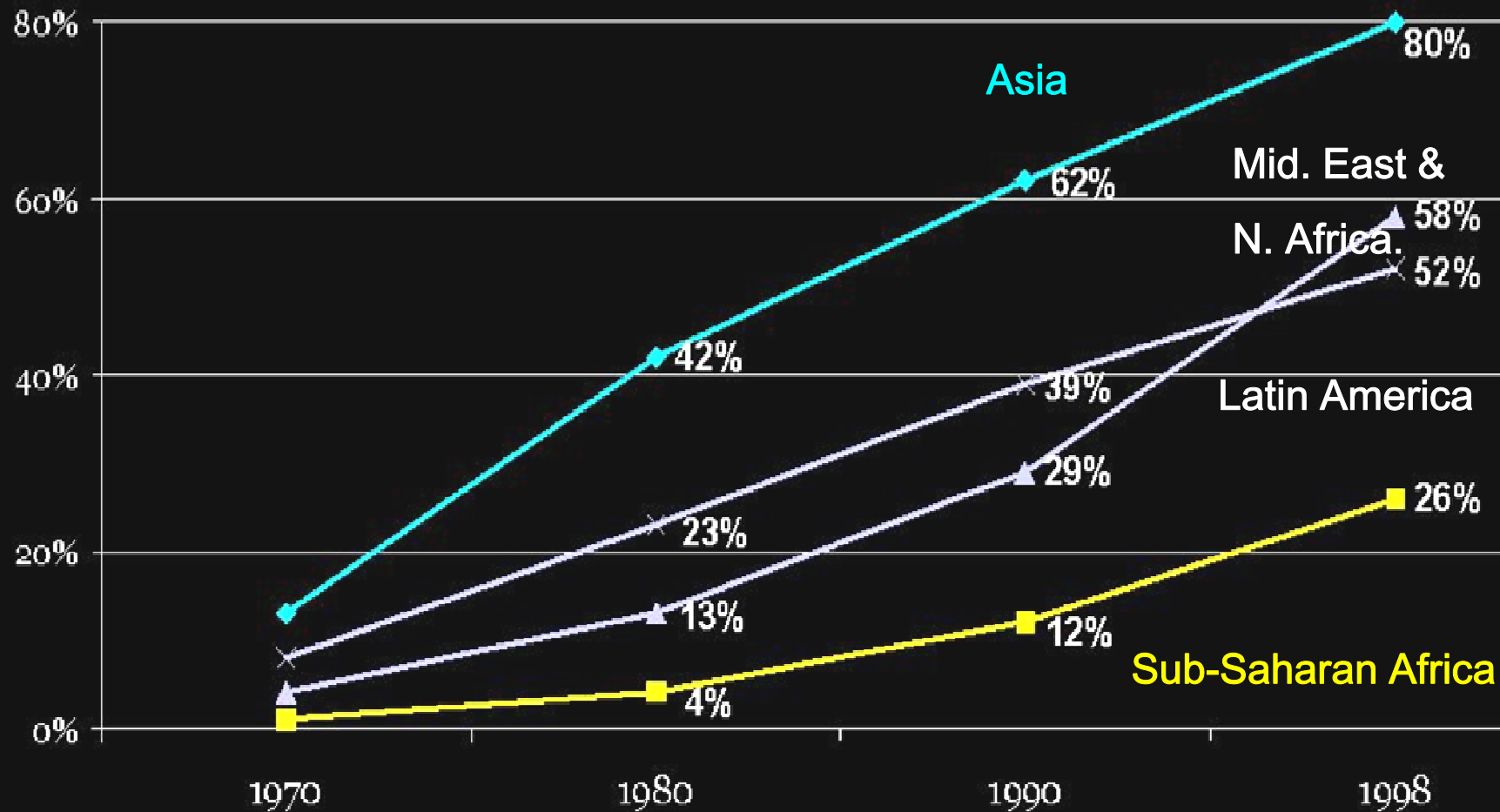
(versus an average of 100-200 kg/ha in Asia)

Cost of fertilizer for West African farmer is similar or higher than US farmers cost. But his income is 0.10% compared to US farmers.

Wages per day is about <\$5.

Problems: Cultivar Adoption and Genetics

New Variety Adoption by Region



Source: Calculated from data in R.E. Evenson and D. Gollin, 2003. *Crop Variety Improvement and its Effect on Productivity*. Cambridge, MA: CABI.

Our Project: Goal

Our overall goal is to provide food security by increasing economic returns to smallholder farming households dependent on rain-fed agriculture.

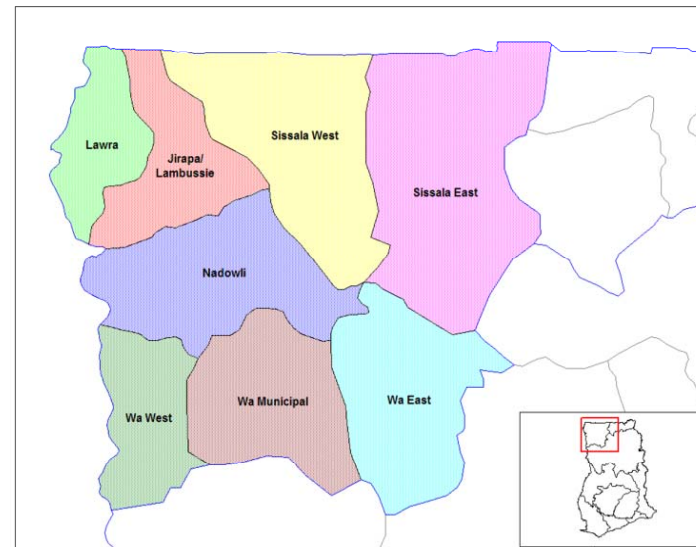
This will be achieved through gender-sensitive farmer participatory development, discovery and dissemination of sustainable CAPS that improve soil quality, water capture, water use efficiency, crop productivity, and efficient use of inputs and labor.



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Region – Ghana – Upper West - Villages



Districts: Municipal, Wa West, Nadowli and Lawra.

Lawra District: Brutu, Bo and Puffiu. (NGO, LACERD).

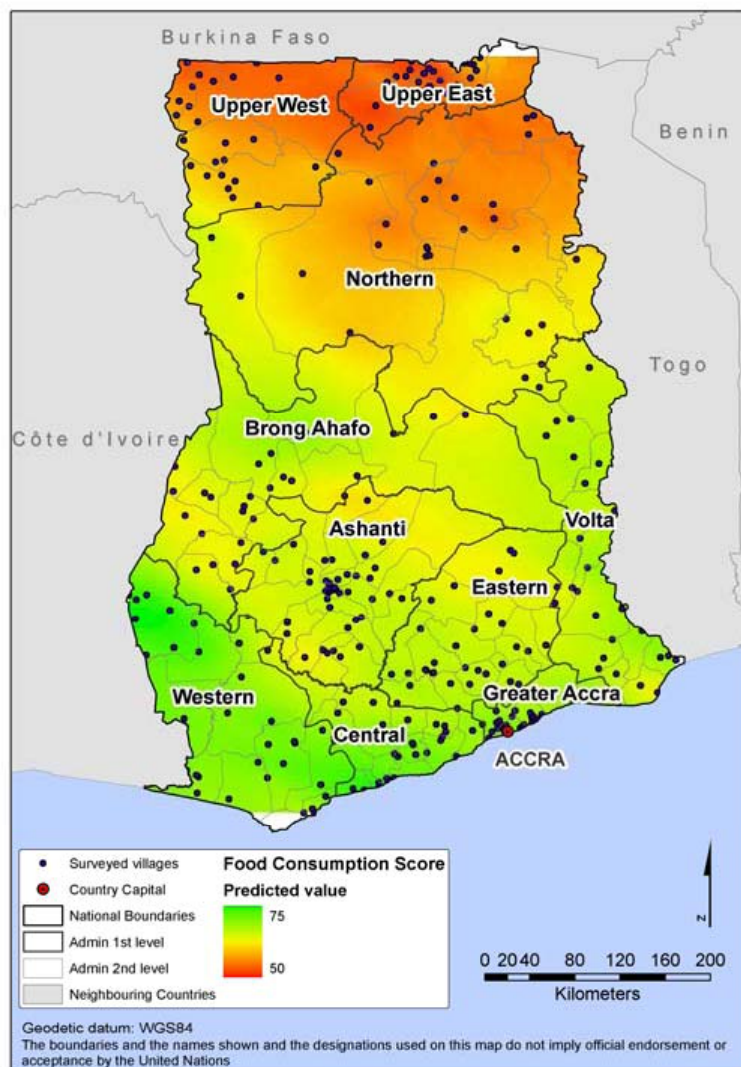
Nadowli District: Sombo (NGO, Upper West Agro-Industries

Wa Municipal: Busa, and Busa Tangzu. (NGO Upper West Agro-Industries)

Wa West District: Nyoli, Sieyiri, Dornye, and Kpongri. (NGO responsible is Lassia Tuolu Agric. Project).

Working in 10 villages Upper West Region

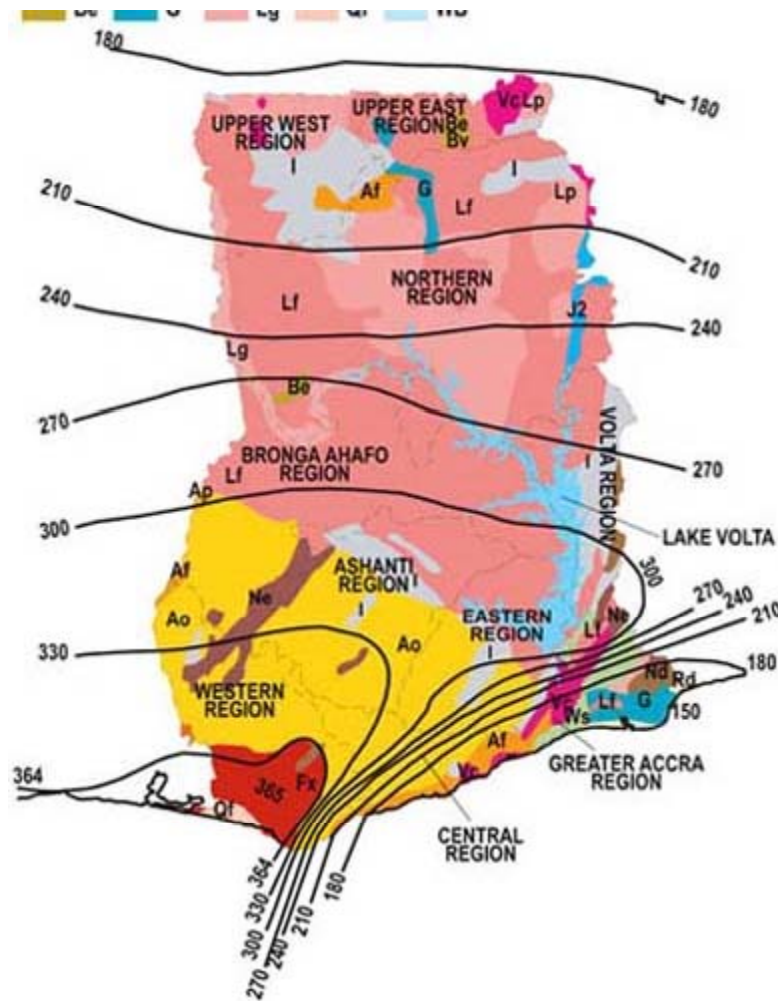
Region – Ghana – Upper West - Villages



Regions	Food Insecure		Vulnerable to food insecurity	
	No. of people	% pop	No. of people	% pop
Western Rural	12.000	1%	93.000	6%
Central Rural	39.000	3%	56.000	5%
Greater Accra Rural	7.000	1%	14.000	3%
Volta Rural	44.000	3%	88.000	7%
Eastern Rural	58.000	4%	116.000	8%
Ashanti Rural	162.000	7%	218.000	10%
Brong Ahafo Rural	47.000	3%	152.000	11%
Northern Rural	152.000	10%	275.000	17%
Upper East Rural	126.000	15%	163.000	20%
Upper West Rural	175.000	34%	69.000	13%
Urban (Accra)	69.000	2%	158.000	4%
Urban (Other)	297.000	4%	572.000	8%
Total	1.200.000	5%	2.007.000	9%

Upper West region is food insecure and vulnerable.

Region - Ghana – Upper West - Soil



Average soil fertility status of upper west region
 Source: Soil Research Institute (SRI) CSIR - Kumasi.

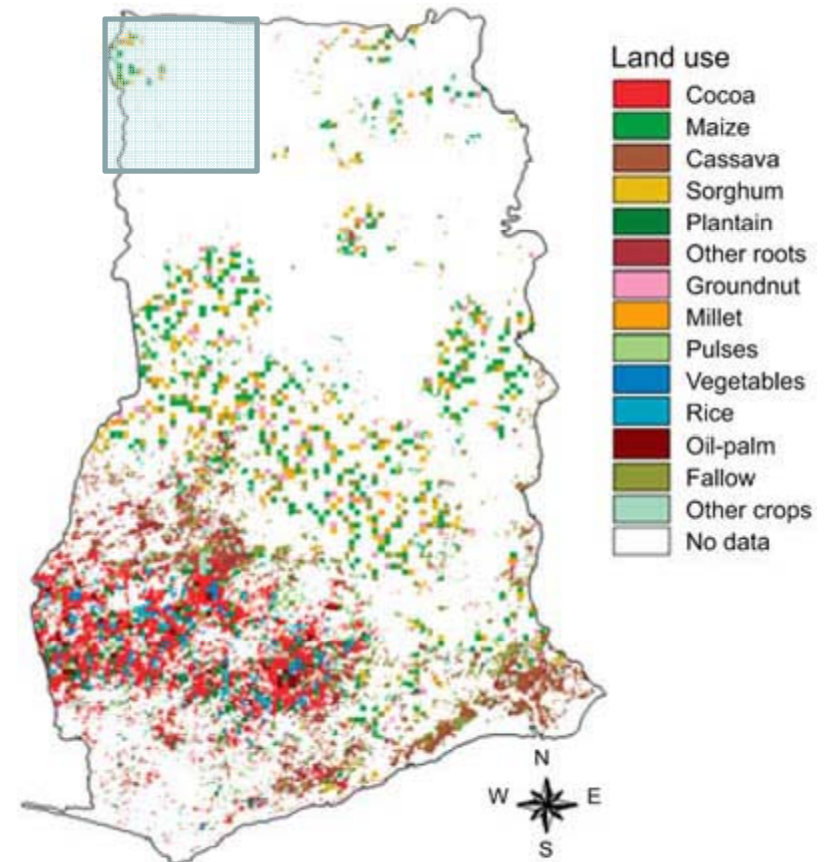
Trait	Upper West
Soil pH	6.0 – 6.8
Organic matter (%)	0.5 – 1.3
Total nitrogen (%)	0.01 – 0.07
Available P (mg /kg soil)	2.0 – 7.4
Available Ca (mg / kg soil)	52 - 152

**Available crop growing season is about 180 – 210 days.
 Soil are mostly light textured with poor fertility.**

Region – Ghana – Upper West - Crops

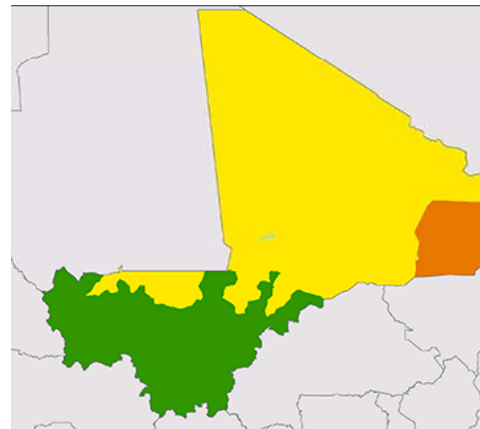
Main Crops in Upper West Region

Group	Crops
Cereals	Maize, <u>millet</u> , <u>sorghum</u> , rice
Industrial crops	Cotton, sheanut
Legumes	<u>Cowpea</u> , <u>bambara nut</u> , <u>groundnut</u> , soybean
Fruits	Papaya, mango, cashew,
Vegetables	Tomato, pepper, okra,
Roots and tubers	Yam, cassava, sweet potato



Main crops include sorghum, millet, maize, peanut, cowpea and bambara nuts

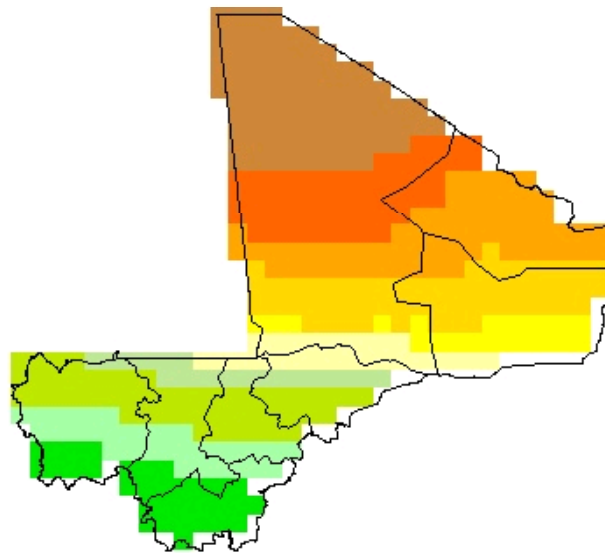
Region – Mali – Mid and North Districts



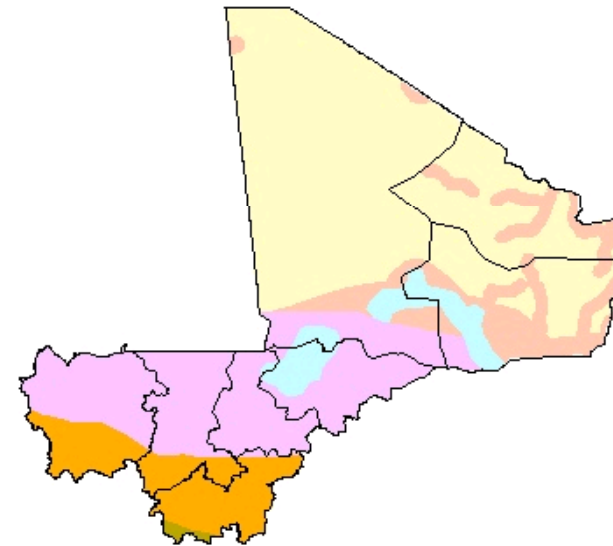
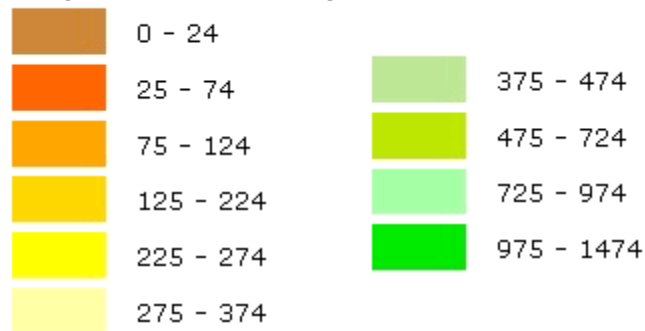
Villages	Region	Rain (mm)	Cropping System
Koporopin	Mopti	500	Millet
Lagassagou	Mopti	500	Millet
Fambougou	Segou	700	Millet / Sorghum
Bouawere	Segou	700	Millet / Sorghum
Sigidolo	Segou	800	Sorghum
Oumarbougou	Sikasso	800	Maize
Fansirakoro	Koulikoro	900	Maize
Noyaradougou	Sikasso	1000	Maize

Most northern regions are food insecure and vulnerable.

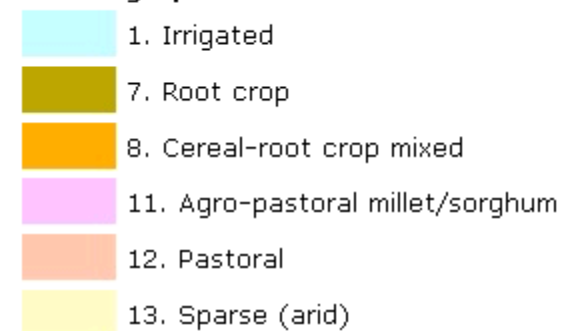
Region – Mali – Rainfall and Crops



Precipitation Ave mm/year



Farming Systems



**Most central and northern regions are dry and south is wet.
Important crops include sorghum, millet and cotton in north.**

Conservation Agricultural Practices (CAPS)

Can CAPS help small farmers improve productivity and help adapt to climate change?



Crop Residue



Cover Crop



Minimum Tillage



Crop Rotation



Water Harvesting



Nutrient Management

Our Project: Critical Questions

Critical questions associated with CAPs for smallholder resource-poor farmers of Ghana, include:

- (a) which CAPs can positively contribute to productivity, address needs of farmers and under what specific conditions;**
- (b) what are positive and negative aspects (trade-offs) of CAPs both in short-term and long-term;**
- (c) can CAPs be economically beneficial in short run, can they be adopted by smallholder farmers and if preconditions for adoptions exist; and**
- (d) which types of processes are most efficient in assessing CAPs with farmers and extending them to larger scale.**

Conservation Agricultural Practices (CAPS)



Crop residue is available.

Conservation Agricultural Practices: Challenges

Residue Picked up



Stored and Alternative Uses



Residue High Market



Building Material



Crop residue is valuable forage, and important building material.

Conservation Agricultural Practices: Challenges

Fences



Free Grazing



Termites



Fire

If left in field problem of free grazing, termites and fire.

Farmers Driven Research Approach

Farmers should be the key component at all stages of research and development

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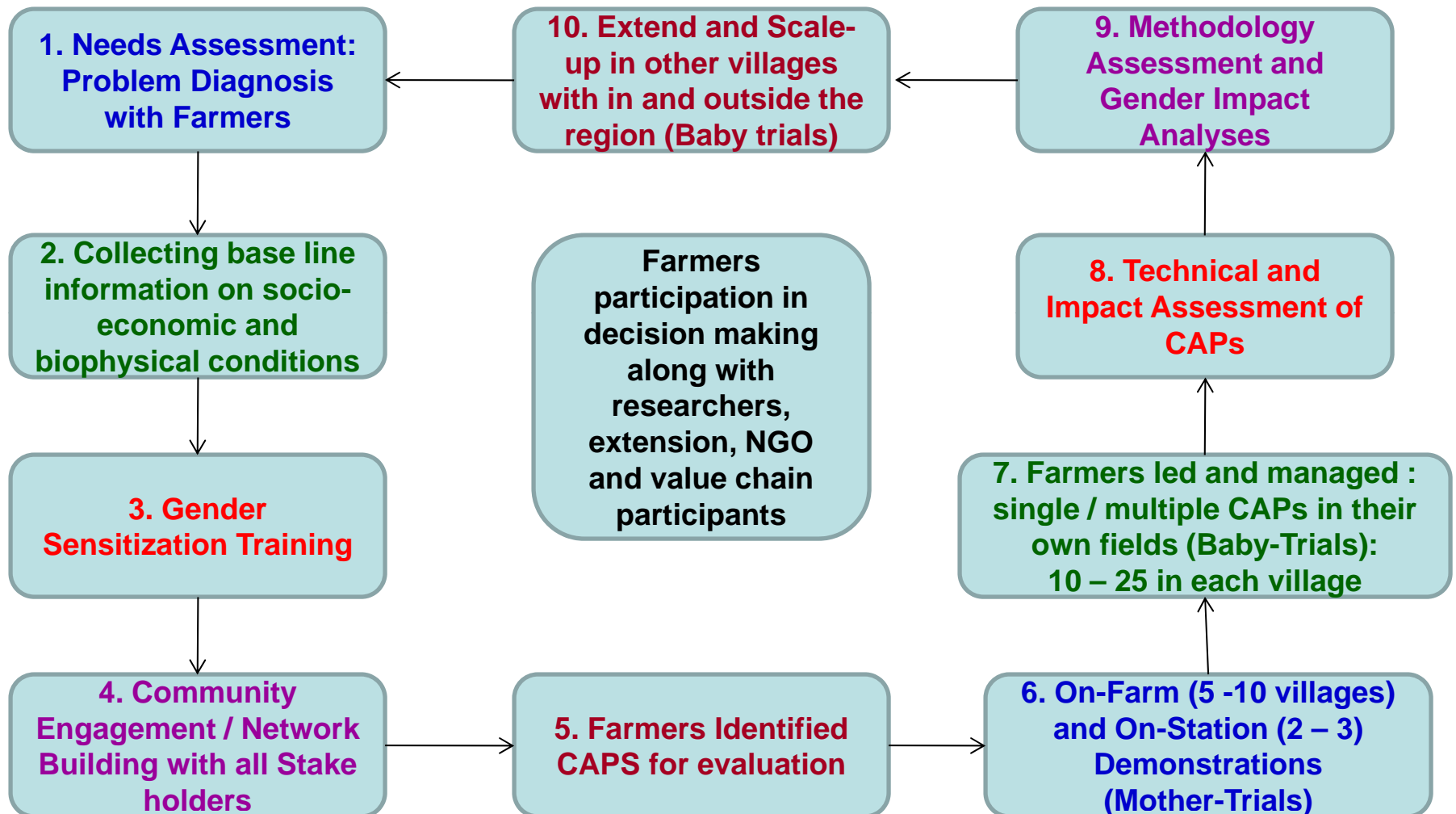


Farmers



**Farmers should feel ownership in research.
Build-on existing local technologies.**

Approach and Road Map



Ghana – SANREM Activities

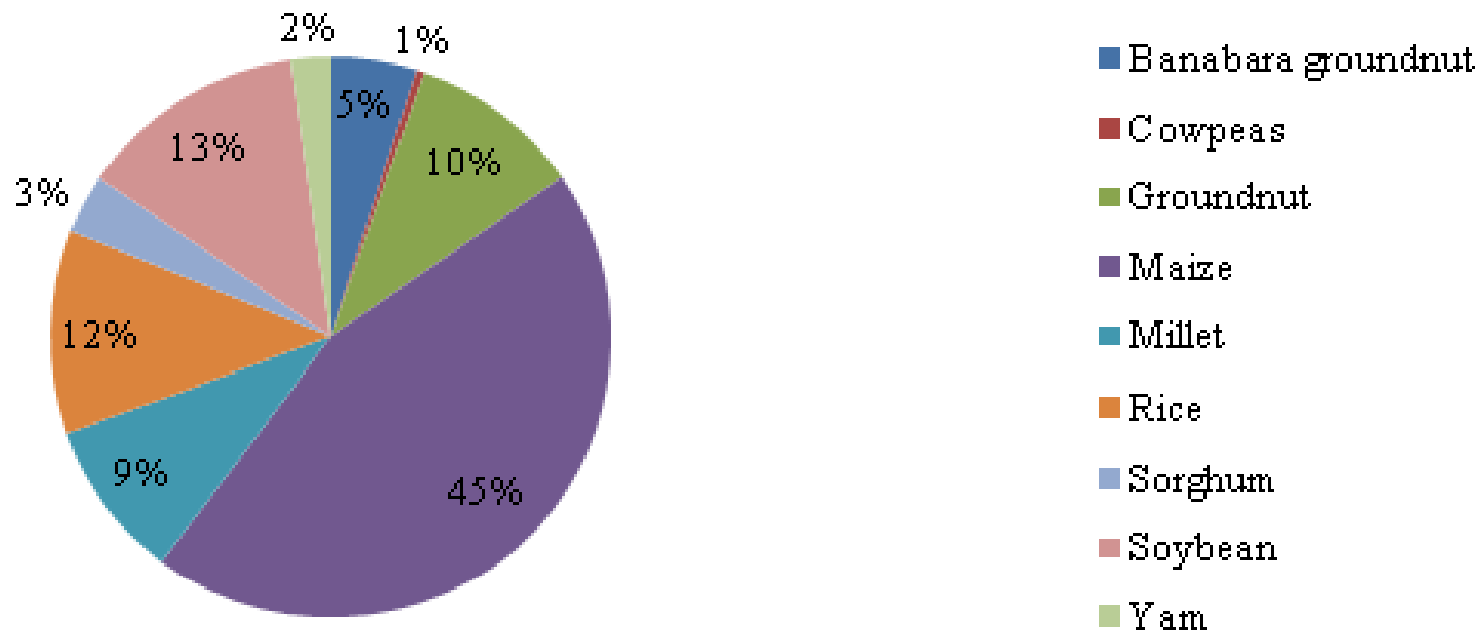
Results

- **Majority of the household heads (60%) had no education.**
- **Average total household wealth ranged from \$900 – \$1250.**
- **Sole or mono-cropping with peanut, maize, millet, rice, soybean and yam was practiced by most households (42%). Mixed cropping was followed by 31% with cereal and legume.**
- **About 97% of agriculture was rainfed without irrigation.**
- **Average farm size was 10 acres per household, most of the land (87%) was owned (inheritance and purchase).**

Ghana – SANREM Activities

Results

Percentage of average acres used in producing crops by households



Distribution of crops as total land use by households

Ghana – SANREM Activities

Results

- **Most seed was retained from previous crop. Value of purchased inputs (means: \$150 for seed; \$55 for fertilizer with subsidy; and \$5 for other inputs).**
- **Soybean, peanut and cowpea are predominantly (90-100%) marketed and sold. Value of all crops sold highly varied (mean = \$1860; median = \$300).**
- **Majority of households (77%) were involved in sale of their produce. Overall, households were net sellers of products. Transactions occurred at local markets (45%), town market (26%) and own farm (9%).**
- **Most household heads (60%) belonged to a club or local farmer group, and about 55% report receiving some form of information from NGOs and government institutions.**

Ghana – SANREM Activities

Results

Knowledge of Conservation Practices	Response	Male	Female
		(%)	
Crop residue are sources of organic matter to soil	True	98.5	93.6
	False	1.5	6.4
Organic matter improves soil water holding capacity	True	93	90.4
	False	7	9.6
Manure is as strong as purchased fertilizer	True	80.6	79
	False	16.4	21
Manure improves soil water holding capacity	True	91.5	86.6
	False	8.5	13.4
One can plant directly without ploughing	True	39.8	38.8
	False	60.2	61.2
Tilling the soil assists in water infiltration	True	79.6	73.9
	False	20.4	26.1

Ghana – SANREM Activities

Results

Knowledge of Conservation Practices	Response	Male	Female
		(%)	
Seed bed increases water holding capacity	True	82.6	78.9
	False	17.4	21.1
Seed bed improves aeration in the soil	True	94.5	82.8
	False	5.5	17.2
Rotating cereals and legumes improves soil fertility	True	98	85.3
	False	2	14.7
Crop rotations prevents some plant diseases	True	95	85.3
	False	5	14.7
Cover crops prevent soil erosion	True	90.5	86.6
	False	9.5	13.4
Cover crops increase microbial action in the soil	True	87.6	81.5
	False	12.4	18.5

Ghana – SANREM Activities

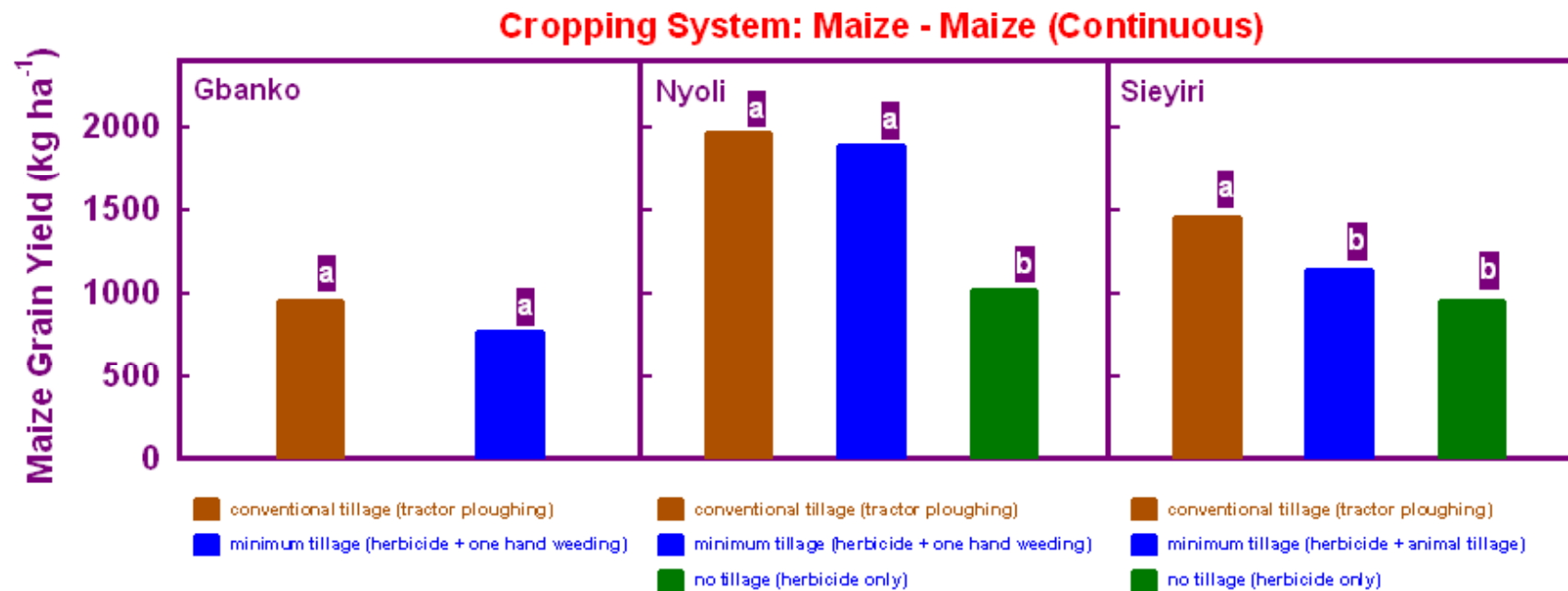
Effect of CAPS

Five mother trials were implemented (started in 2010)

- (1) Effect of tillage and cropping system (maize and soybean) on soil carbon and grain yield (Nyoli in Upper West District).**
- (2) Effect of tillage and cropping system (maize and soybean) in soil carbon and grain yield (Sieyiri in Upper West District).**
- (3) Effect of tillage, cropping system (maize and soybean) and fertilizer (0, NPK and P) on yield (Buza and Tanzu, Wa Municipal District).**
- (4) Effect of seed bed (flat and tied ridges) and moisture conservation practices (no bunds, grass bunds and pigeon pea bunds) on water use and maize yields (Nandom, Lowra District).**
- (5) Effect of tillage, cropping system (maize an soybean) and residue management (25, 50 and 100%) on grain yield and soil carbon (Gbanko in Nadowli District).**

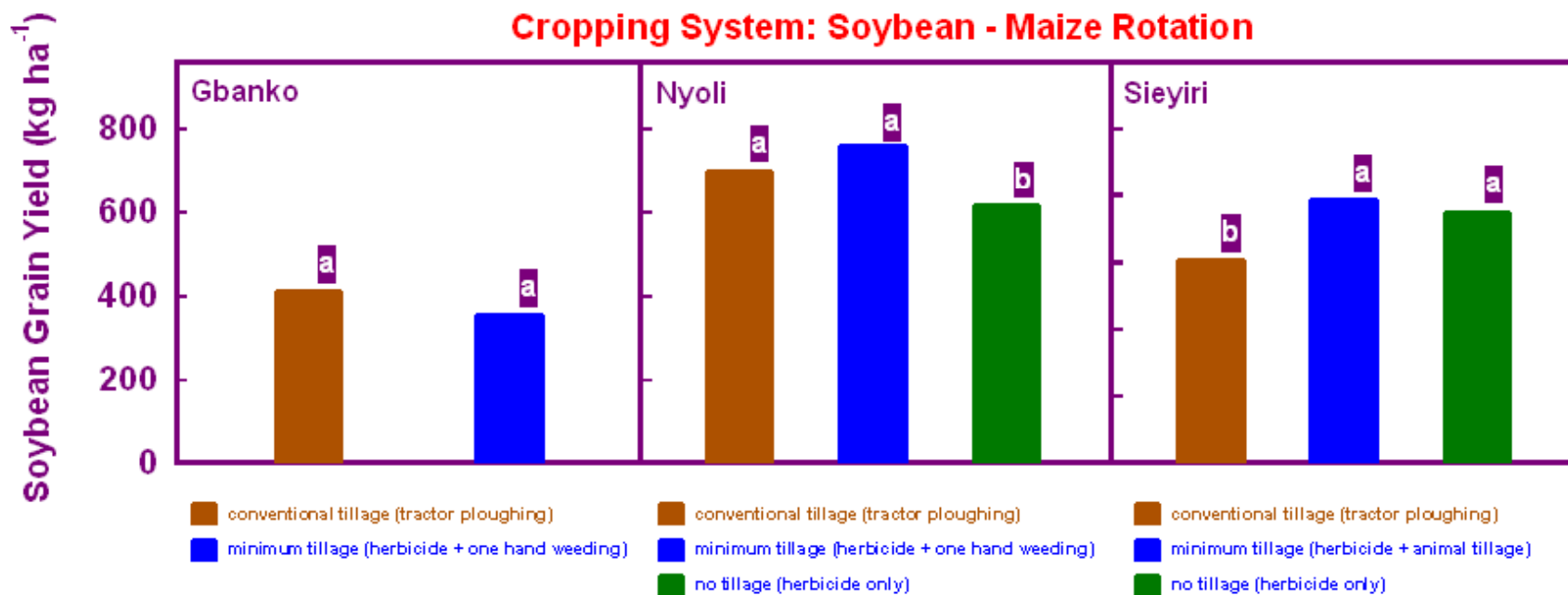
Ghana – SANREM Activities

- Minimum tillage produced same grain yields of maize as conventional tractor tillage in all cropping systems (continuous maize).



Ghana – SANREM Activities

- Minimum tillage produced same grain yields of soybean as conventional tractor tillage in all cropping systems (soybean – maize rotation).



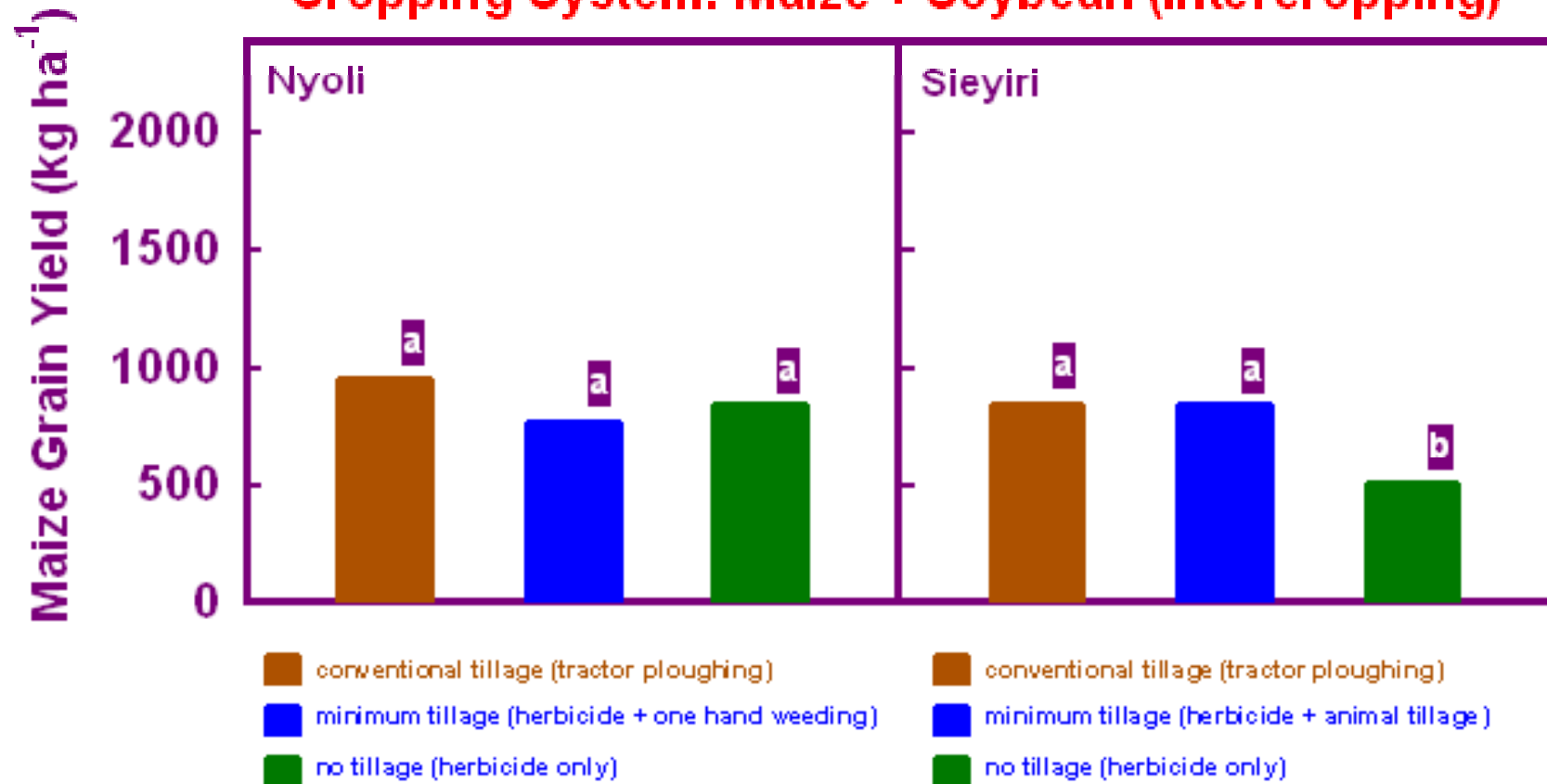
Ghana – SANREM Activities

- No tillage produced lower yield due to weed infestation
- Minimum tillage was on par with conventional tillage.



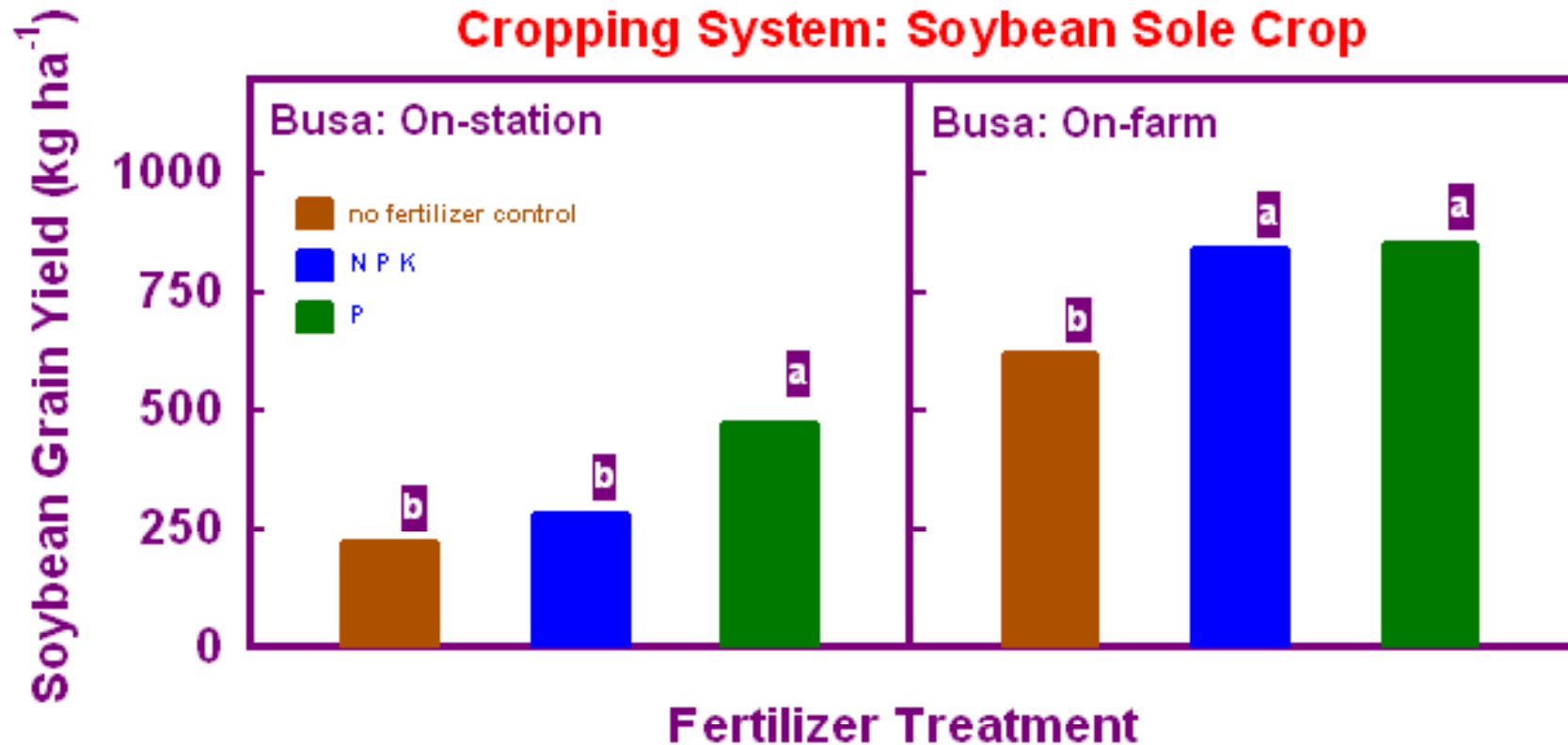
Weed infestation in no tillage

Cropping System: Maize + Soybean (Intercropping)



Ghana – SANREM Activities

- Application of inorganic P fertilizer (26 kg P ha^{-1}) produced higher yields of soybean under all tillage practices. Low rates of NPK ($37:16:31 \text{ kg ha}^{-1}$)



Ghana – SANREM Activities



No Fertilizer Control



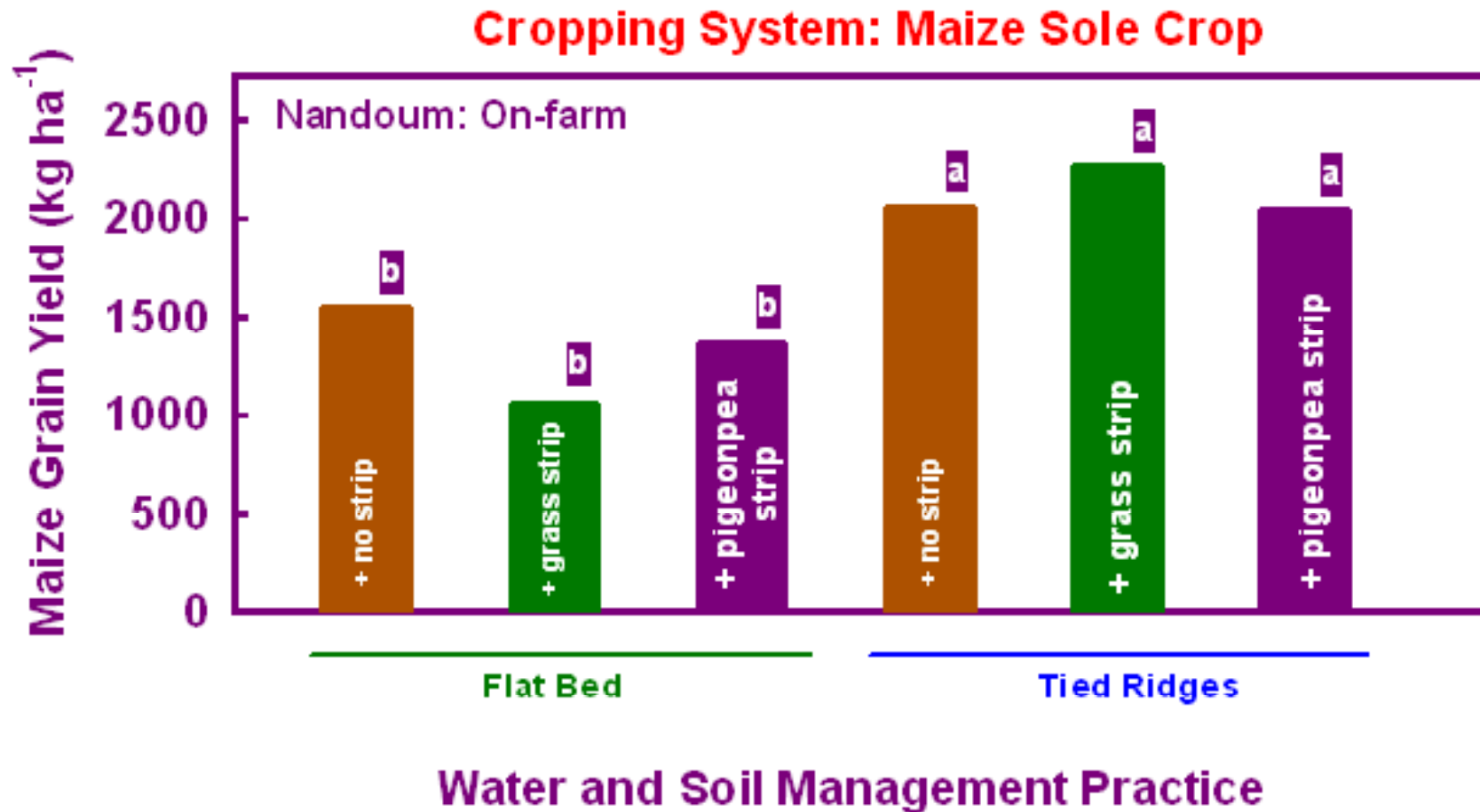
Low rates of NPK
(37:16:31 kg ha⁻¹)



P at 26 kg ha⁻¹

Ghana – SANREM Activities

- Maize planted on tied ridges produced higher grain yields than flat beds either with or without strips of grass or pigeonpea.



Ghana – SANREM Activities



Flat beds with
grass strips



Tied ridges with
grass strips



Tied ridges with
Pigeonpea strips

Mali – SANREM Activities

Influence of CAPS

Eight mother trials were implemented (started in 2010).

Long term experiments being implemented on research stations include combinations of the following factors

- (1) Minimum or Reduced Tillage**
- (2) Crop Residues**
- (3) Cover Crops / Weeds**
- (4) Water Harvesting**
- (5) Organic and Mineral Fertilizers**
- (6) Crop Mixtures or Rotations**

Conclusions

- **Our results suggest that there are some opportunities to increase crop yields through use of intensive sustainable agricultural practices such as application of fertilizer, minimum tillage, crop rotations and water management practices can help improve crop yields.**
- **The impact of sustainable agricultural practices on soil quality and ecosystems services will be challenging and is to be determined**

K-State Team



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Multi-disciplinary: integrated for research, extension and graduate training

Question / Discussion

Questions

Suggestions

Discussion

Thank You



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