Possibility of Rice Green Revolution in Sub-Saharan Africa

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Commonly Asked Question

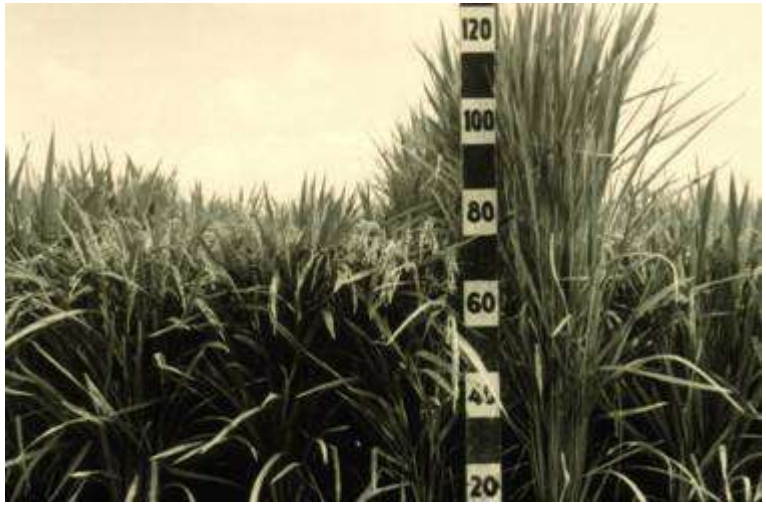
Why hasn’t Green Revolution taken place in SSA?

What is the Rice Green Revolution in Asia?

- Development and diffusion of a series of short-statured (semi-dwarf), fertilizer-responsive, high-yielding modern varieties (MVs) in irrigated and favorable rainfed areas in Asia.
- Major components of Asian rice Green Revolution technologies are the use of MVs, application of chemical fertilizer, and the application of improved management practices (e.g., bunding, leveling, and straight-row transplanting).

IR8 released in 1966: the original, shorter MV rice, called “miracle rice”

Peta: a tall TV (an IR8 parent)

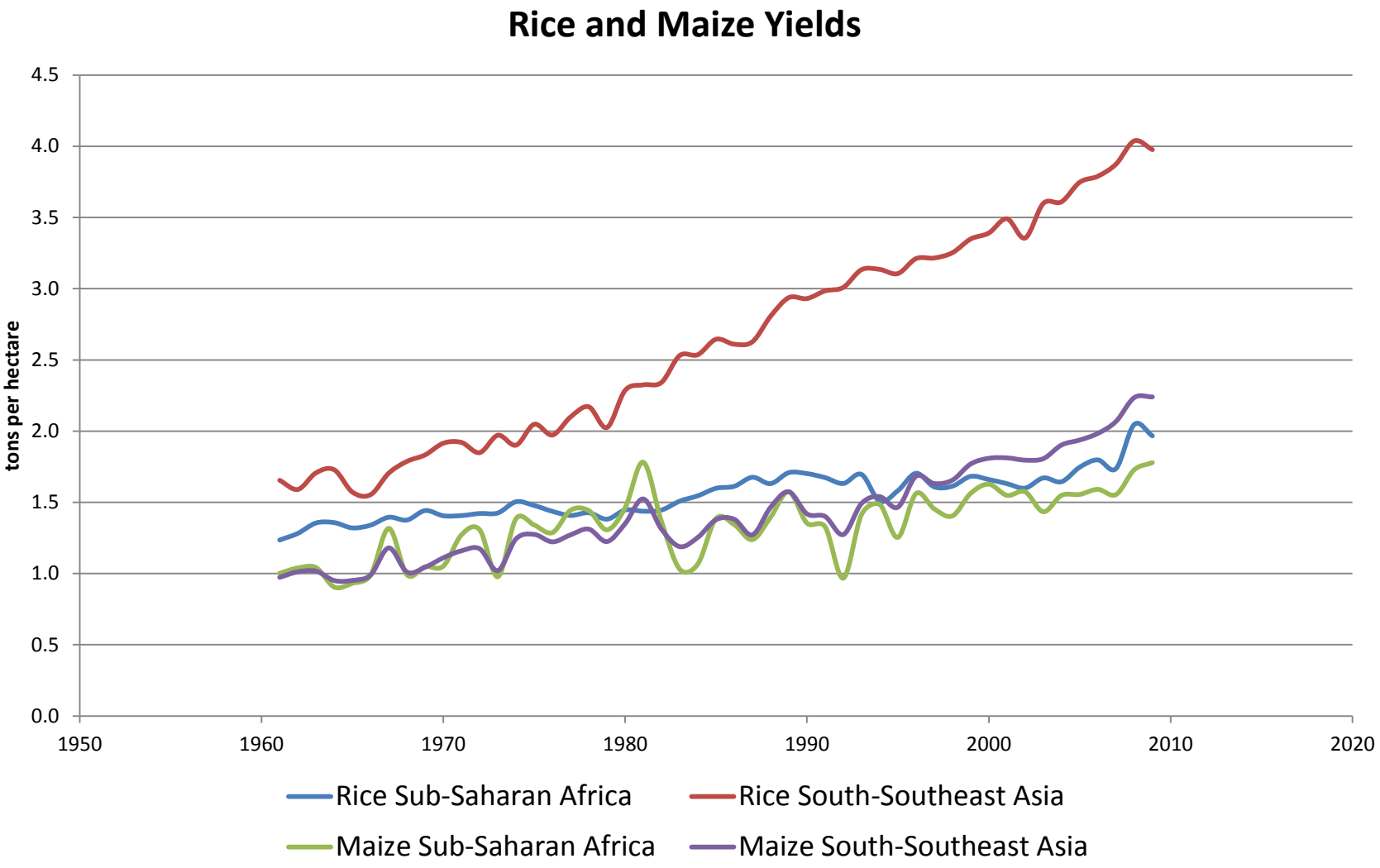


“Lodging,” major constraint on high-yield

Green Revolution is long-term process

- The Asian Green Revolution has entailed a long-term evolutionary process spanning more than three decades since the mid-1960s, in which irrigation investments increased, extension system and national research programs were built and strengthened, markets gradually worked better, fertilizer application increased, and so on.

Continuous growth in rice yield in Asia



Source: FAOSTAT (2011)

Fundamental Hypothesis

- *Asian Rice Green Revolution technology can be directly transferable to sub-Saharan Africa.*

-- In fact, rice Green Revolution has been taking place in a number of irrigated areas in SSA.

-- This is in sharp contrast to other grains, such as maize, sorghum, and millet, for which the transferability of technology from Asia to SSA is limited.

“Asian” Rice Green Revolution in Senegal River Valley

Another Major Rice Green Revolution in Mwea in Kenya

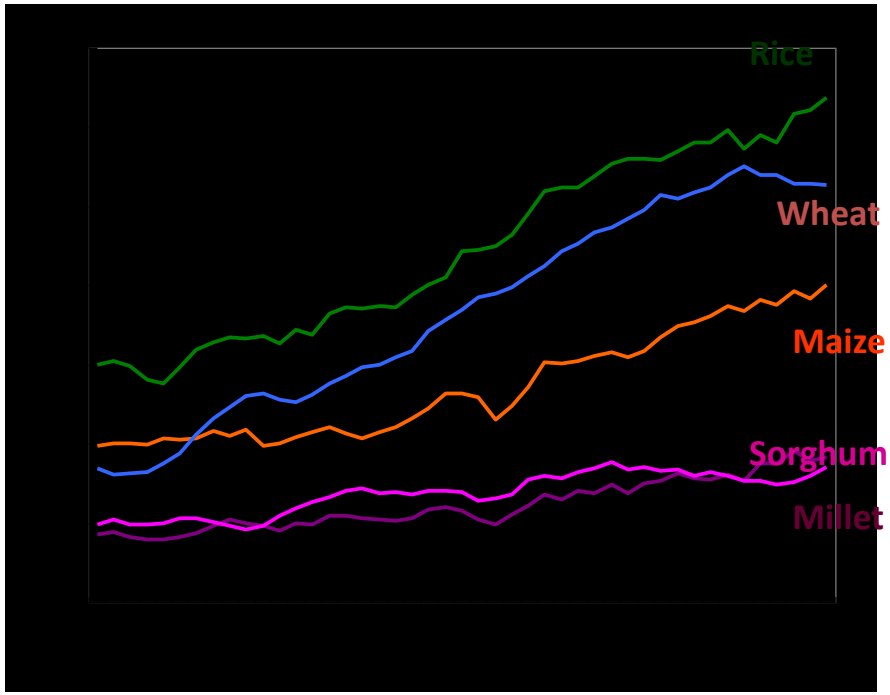
- Basmati varieties are most popular accounting for 80% of areas (see left)
- IRRI-type varieties (BW 196, IR 2793, IR 190-90, ITA 310) are extremely high-yielding (see right)

Transferability of Asian Technology

Cereal Yields by Crop: India vs. SSA

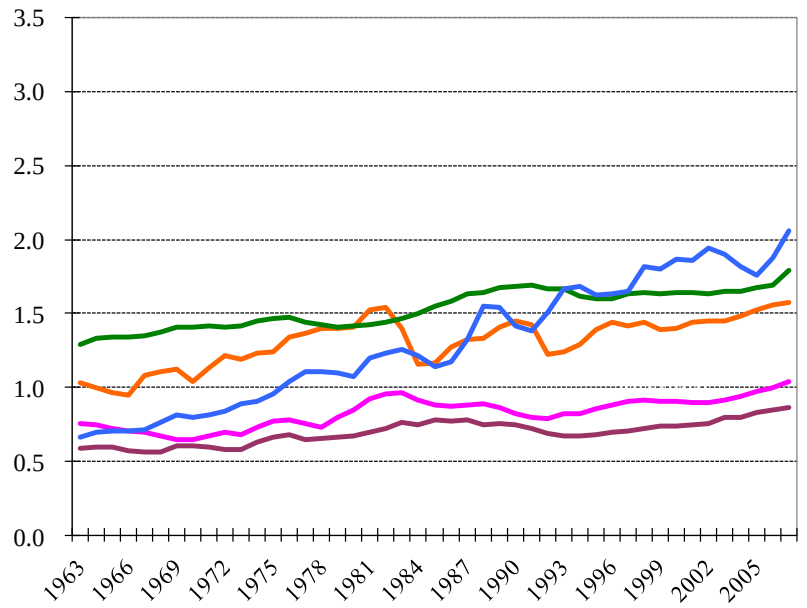
India

Yield (Ton/ha)

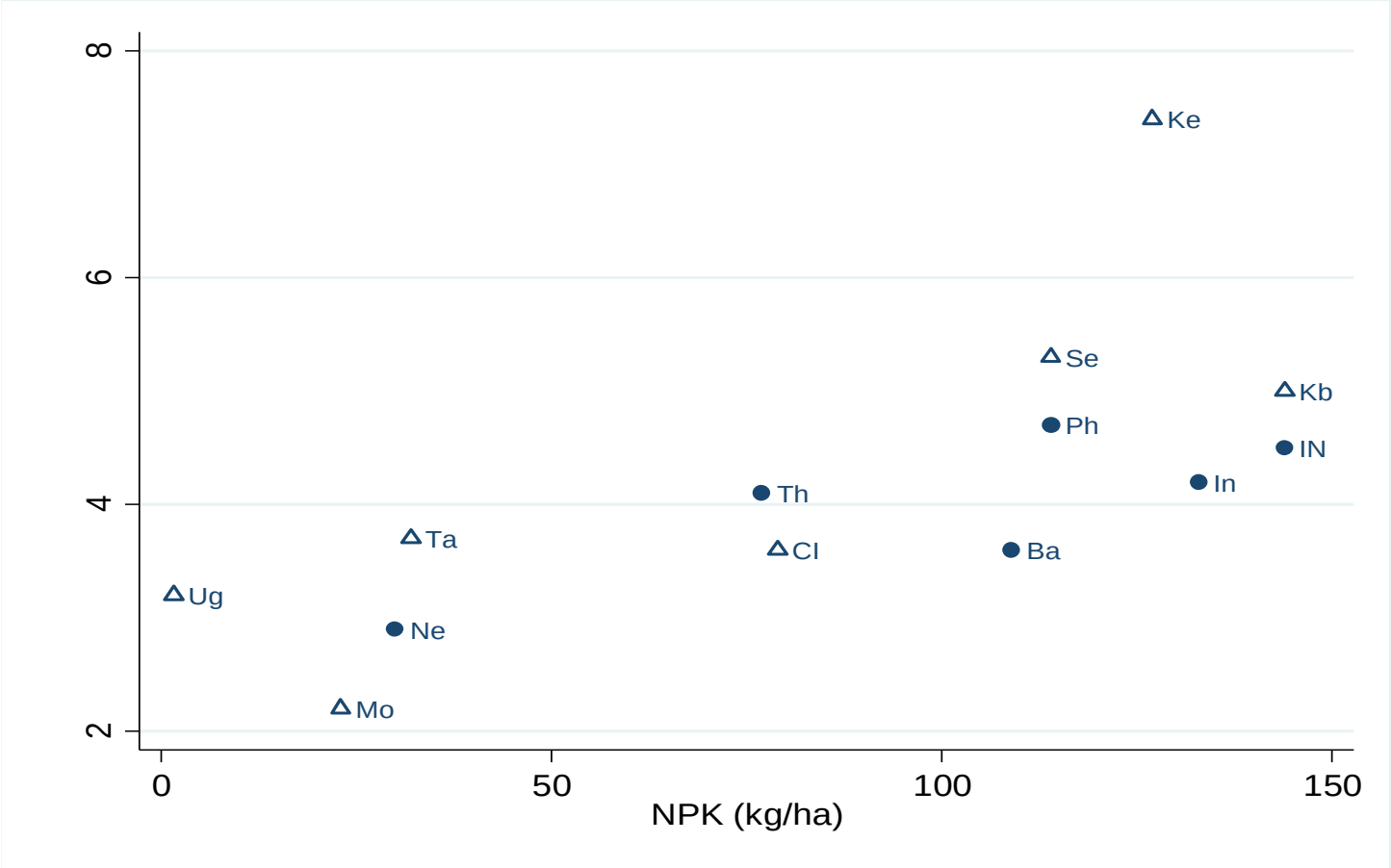


Sub-Saharan Africa

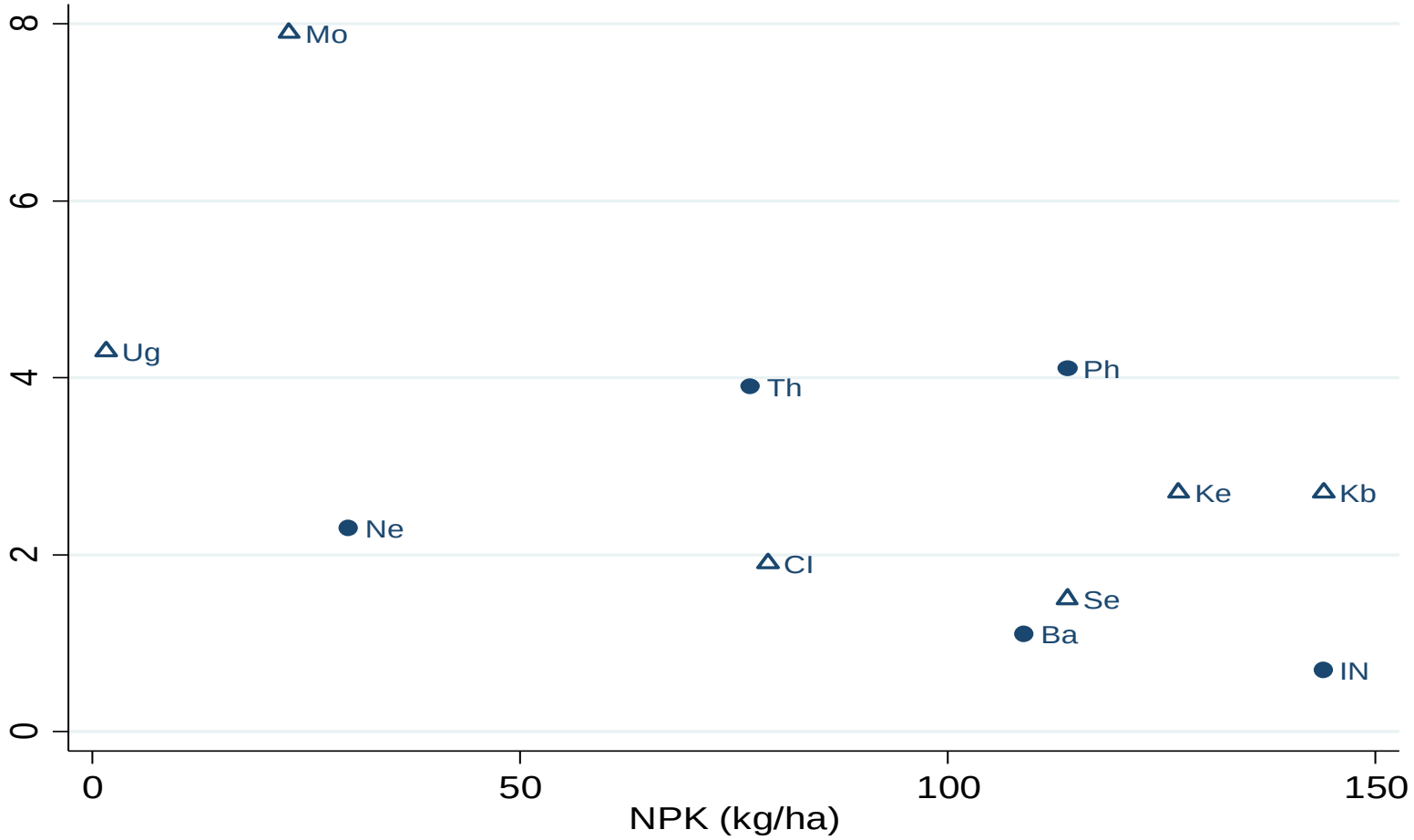
Yield (Ton/ha)



After all, as far as irrigated areas are concerned, productivity of rice farming in SSA is comparable to that in Asia



Fertilizer application is less in SSA importantly because its price is higher than in Asia



Supplementary but more Important Hypothesis

- *Asian Rice Green Revolution technology can be transferred even to rainfed areas in SSA.*

-- It is remarkable to observe that paddy yield in SSA increased from 1.2 tons/ha to 1.8 tons/ha in the last several decades, despite the dominance of rainfed areas.

-- Judging from substantial yield gap between Asia and SSA, it seems possible to boost rice productivity in rainfed areas in SSA much further.

Table 1. Paddy yields and production practices in Mozambique

	Chokwe irrigation scheme	Rainfed areas in central region		
		Bottom 1/3	Middle 1/3	Top 1/3
Yield per ha (tons)	2.1	0.3	0.8	2.2
Use of MVs (%)	92	0.0	0.0.	3.0
Fertilizer use (%)	52	0.0	0.0	0.0
Plot with bund (%)	100	52	41	43
Animal use (%)	48	0	2	5
Tractor use (%)	55	2	5	2
No. of sample households	176	66	66	65

Rice farmers and a tall local variety in Mozambique

Low yield (1 ton/ha) importantly due to lack of weed and water control

Assessment of Mozambique

- Rainfed areas: Very low yield, average being 1.1 tons/ha. No MVs, no fertilizer, and little use of draft animals and tractors leading to the absence of leveling and firmly built bunds.
- Irrigated areas: Very low yield importantly because of poor irrigation facilities and the use of old MVs developed in the 1960s and 70s. Top 20% of farmers, however, achieve 3.9 tons/ha, indicating high yield potential with proper water and production management.

The importance of bund

No bund→lack of water →weed growth

The importance of leveling and straight-row transplanting

to avoid uneven growth / facilitate weeding

Why harvesting by knife?

Table 2. Rice yield, the use of modern inputs and improved production practices by region and irrigation status in Tanzania

	Morogoro		Mbeya		Shinyanga	
	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated
Paddy yield (t/ha)	2.0	3.8	1.6	3.5	1.7	4.6
Modern inputs use						
Share of MVs (%)	17.8	87.5	0.0	2.1	1.9	13.1
Chemical fertilizer use (kg/ha)	11.7	40.4	10.7	31.7	0.9	0.0
Share of bunded plot (%)	8.2	84.8	16.3	89.6	95.3	100.0
Share of leveled plot (%)	22.0	69.6	38.5	78.1	87.6	100.0
Share of straight row transplanting plot	4.4	47.8	3.8	22.9	6.4	0.0
No. of sample households	182	46	104	96	234	10

Assessment of Tanzania

- Rainfed areas: Yields range from 1.6 tons/ha to 2.0 tons/ha, which are much higher than in Mozambique. This can be explained by some adoption of MVs, some fertilizer use, and the adoption of some improved production practices.
- Irrigated areas: Yields are high and comparable to Asian average of 4 tons/ha. A combination of improved seeds, improved production practices, and the availability of irrigation results in “mini” Green Revolution.

Table 3. Rice yields (ton/ha) according to the cultivation practices adopted in 2008-2009 in Uganda

	All	Bugiri	Mayuge	Bukedea	Pallisa
4 practices	4.13	4.47	2.89	1.22	0.37
3 practices	3.20	4.15	1.89	---	1.54
2 practices	2.25	3.07	2.00	3.95	2.26
1 practice	1.81	2.30	1.91	1.89	1.38
Non-adopters	1.33	---	0.79[b]	1.42	0.66[c]
Fertilizer use	7.55c	7.55[d]	---	---	---
Adoption of MVs (%)	19.6	43.8	40.0	5.0	1.6
No. of sample households	300	75	75	75	75

The adoption of 4 practices means bunding, leveling, proper timing of transplanting, and straight-row planting.

Assessment of Uganda

- Bugiri, participatory training program with simple irrigation: High yields particularly when improved production practices are adopted.
- Mayuge, participatory training program with no irrigation, i.e., rainfed: Yields are lower but with adoption of improved production practices, yields reach 2 tons/ha.
- Bukeda and Pallisa, rainfed areas with no training: Low adoption rates of improved practices and their unclear yield effects.
- The results strongly indicate the importance of extension activities and farmer training.

Table 4. Technology adoption, paddy yield, labor inputs, and factor share of labor in Northern Ghana

	No adoption	Partial adoption				Full adoption
		Modern inputs only[a]	At least modern inputs	Modern inputs, bunding, & leveling	At least modern inputs, bunding & leveling	
No. of households (%)	63 (11.6)	78 (14.3)	349 (64.0)	37 (6.8)	84 (15.4)	47 (8.6)
Yield (ton/ha)	1.46	1.70	1.95	1.98	2.33	2.59
Labor (days/ha)	102	152	187	204	238	264
Factor share of labor (%)	61.5	62.6	54.6	52.8	49.5	47.6

Modern inputs refer to the adoption of MVs and chemical fertilizer application.

Assessment of Central region of Ghana, which is completely rainfed

- Selected 20 villages with the Lowland Rice Development Project, which attempted to transfer "Asian Green Revolution" technologies (MVs, fertilizer, bunding, leveling, and dibbling). Also elected 20 nearby villages within 20 km, and another 20 remote villages.
- Clear effects of improved production practices on yields.
- Improved technologies are labor-using but share of labor cost does not increase because yield effect is larger.
- As in the case of Uganda, we observe clear effects of rice production and management training programs on the improvement of production efficiency.

A Summary

- Rice yield is much higher in Asia than in SSA (1.8 t/ha vs. 4.0 t/ha), suggesting the potential of transferring Asian rice technologies to SSA.
- But the yield difference is already very small in irrigated areas, indicating that Green Revolution has taken place in SSA. In fact, high yields are found in irrigated areas in Uganda, Tanzania, Kenya (Mwea), and Mozambique where "Asian" technologies are adopted.

A Summary (continued)

- Yield and profitability of rice farming increase significantly even under rainfed conditions, if improved Asian-Type technologies are adopted, as shown in Uganda, Ghana, and Tanzania in contrast to the case of Mozambique.
- Demonstration projects of improved rice production technologies and practices are found to be successful in Uganda and Ghana.
- Although not discussed in this presentation, improved low-land rice production seems much more promising than upland rice production in SSA.

Policy Implications

1. Develop adaptive research capacity in SSA so as to facilitate the transfer of Asian rice Green Revolution technologies
2. Strengthen capacity building for dissemination of improved technologies
3. In particular, promote improved water management practices and accelerate irrigation investments

Thank you very much
for your attention