Potential for Sustainable Resource Use In the Rice-based Production Systems In Asia

KASSA SC Meeting, CIRAD, Paris

31 May 2005

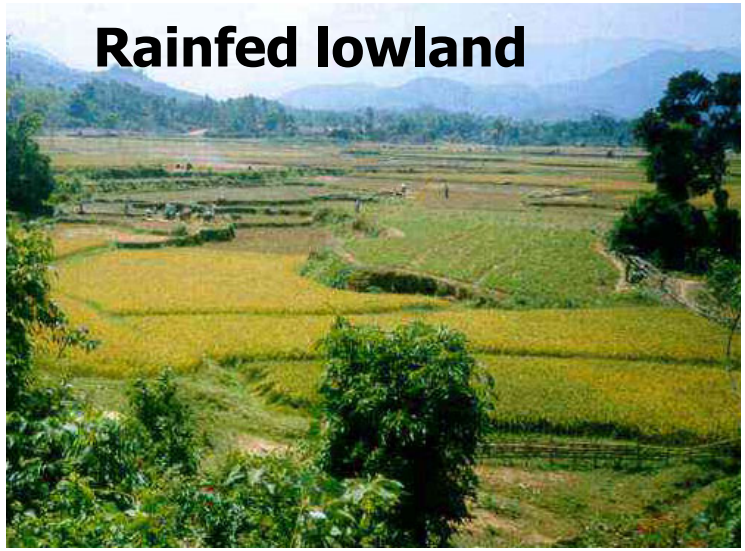
Dr. Ren Wang

Deputy Director General - Research

International Rice Research Institute

Los Baňos, Philippines

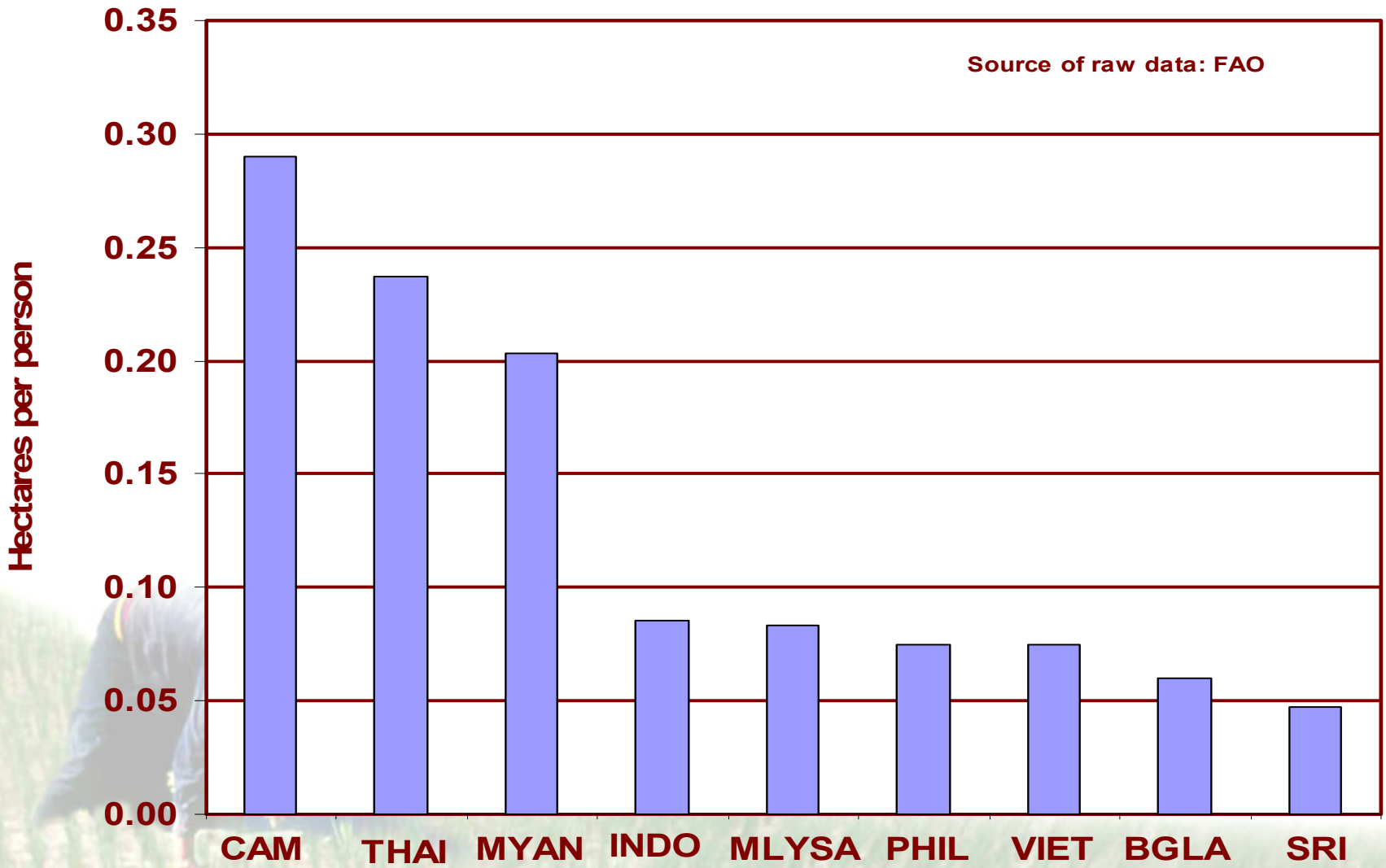
Rice ecosystems in Asia



Rice Production in Various Ecosystems

Major Ecosystems>>	Irrigated	Upland	Rainfed Lowland	Flood prone	As of 09Jan2003 FAO update
Rice Area (m ha)	83.80	16.30	46.40	10.40	156.9
(%)	53.4	10.4	29.6	6.6	100.00
Yield (t /ha)	5.44	1.30	2.52	1.65	3.9
Total Production (m ton)	456	21.2	116.9	17.2	611
(%)	74.6	3.5	19.1	2.8	100.0
Population (billion)	1.42	0.26	0.52	0.11	2.32Bn of the 5.98 bill world total

Arable land per capita, selected Asian countries



Consider five groups in Asian societies:

- Urban poor
- Non-rice farmers
- Rural landless
- Large rice farmers
- Small rice farmers

Specific challenges for sustainable natural resource use

Growing Population and demand for rice

- Asia's population will grow from 3.7 billion in 2000 to 4.6 billion in 2025, or 24%
- The world demand for rice will grow by 150 million tons by 2025, or 26%

A dilemma for the intensified rice-based production systems

- Intensification has been a choice in response to population pressure, declining resource base and opportunities for maximizing technological inputs.
  - *Focusing on what and how much will be produced (productivity)*
- Looking from a national food security and social stability view point, as well as for the long term livelihood of the farmers, *sustainability* at the local level and *resource use efficiency* should now be key issues to address.

Improving productivity will help to reduce the cost of producing rice, hence help the poor consumers.

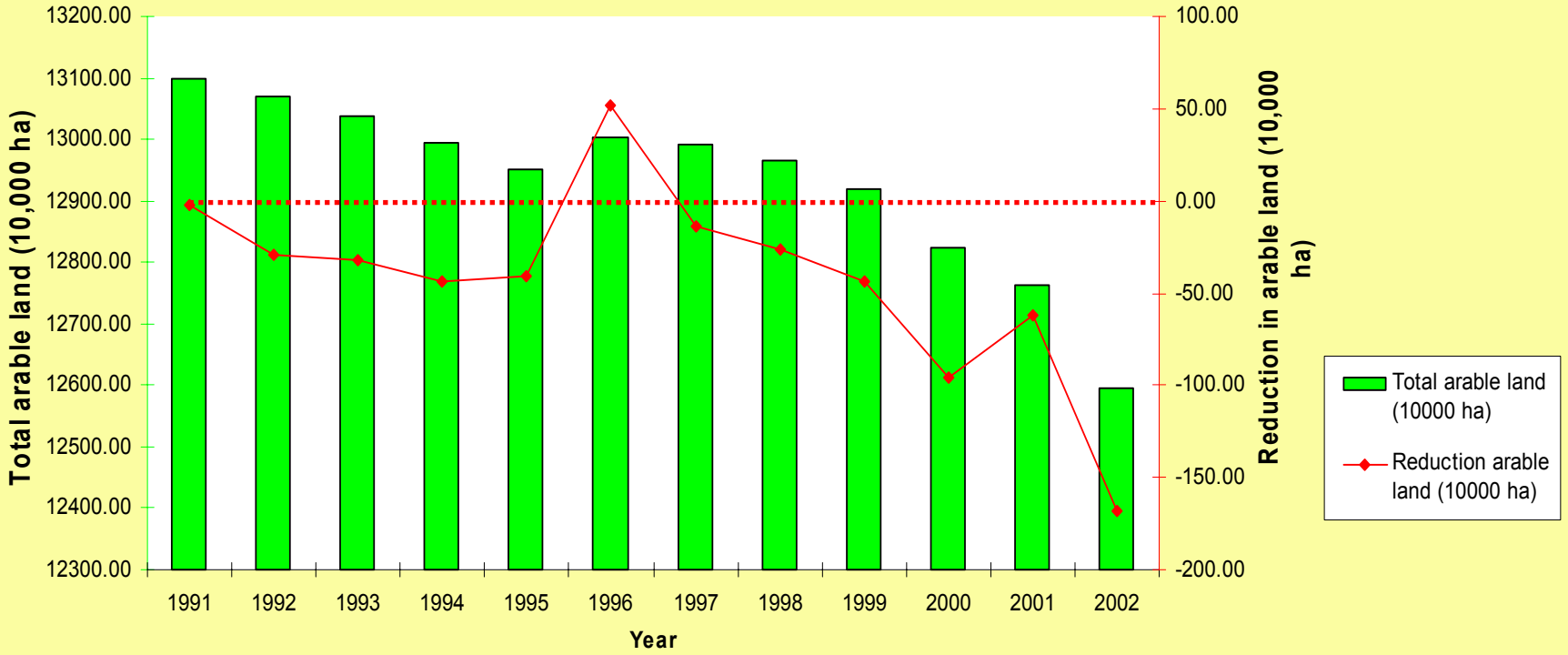
- Productivity is the output in rice production per unit of input.
- Higher productivity (lower unit cost per unit rice produced) leads to higher profit from rice farming.

Costs of cultivation of modern rice varieties, selected countries

Input	Bangladesh, Boro		Thailand		Vietnam	
	Boro	Aman	Wet season	Dry season	Wet season	Dry season
Seed	17.78	15.33	18.46	25.79	20.03	21.35
Fertilizer & manure	62.22	40.97	25.71	57.06	56.91	59.08
Pesticides	13.02	7.42	8.57	28.38	26.52	27.22
Irrigation	117.60	24.90	1.45	17.94	6.98	17.98
Machine rental/draft power	37.15	33.14	65.71	67.15	42.36	44.40
Labor	166.10	135.83	30.44	27.33	102.02	104.42
Land rental	202.52	162.58	90.00	90.00	48.00	72.00
Total cost ($/ha)	603.37	420.17	240.34	313.65	302.82	346.45
Yield (t/ha)	4.83	3.32	2.29	4.17	3.68	4.71
Unit cost ($/ton)	125	127	105	75	82	74

A key and a long-term challenge is how to achieve increased productivity under intensified production systems as well as sustainability of the natural resource base and the environment.

(2) Declining arable land

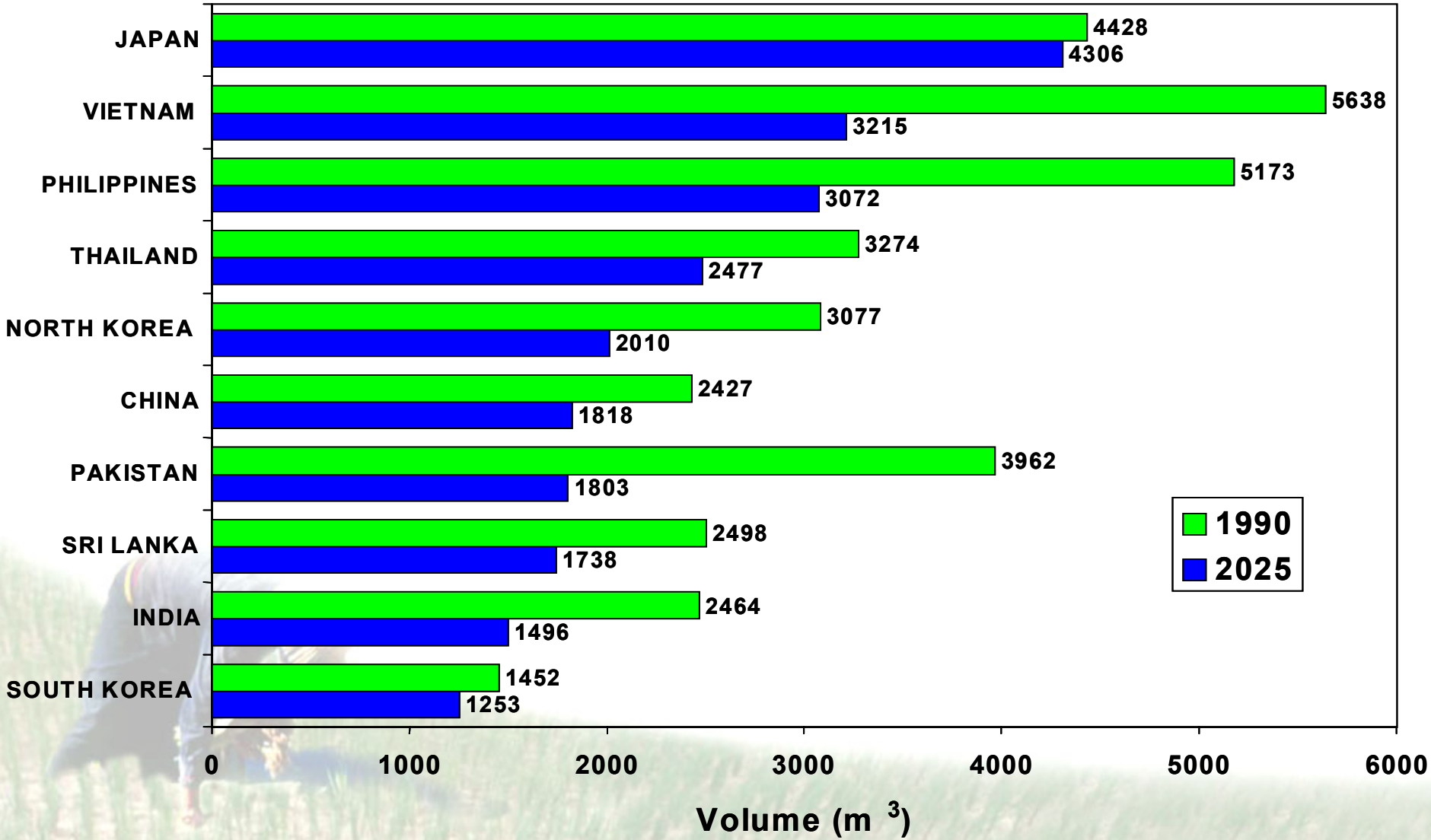


Data source: Chinese Ministry of Land Resources,
Analyzed by HJ Tang, CAAS, 2003

Water will likely be the Number one limiting factor for future rice production

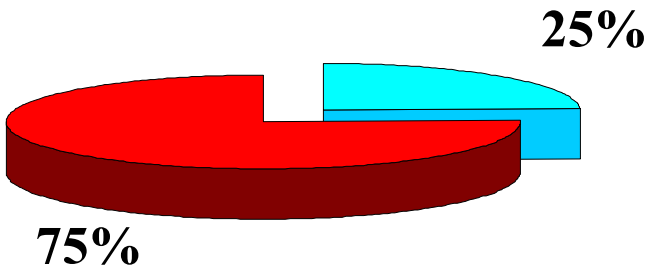
- Irrigated agriculture accounts for 90% of diverted fresh water used, 50% of which is for irrigated rice.
- Increasing water costs (energy!)
- Decreasing supply and quality
- Increasing competition (urban, industry)

Projected change in per capita water resources, selected Asian countries

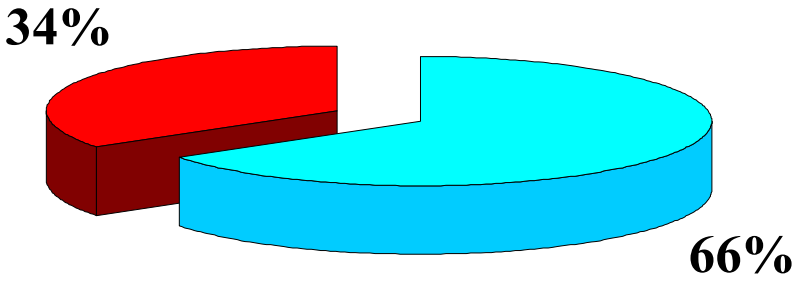


Source: Population and the Future of Renewable Water Supplies, Population Action International.

CHINA

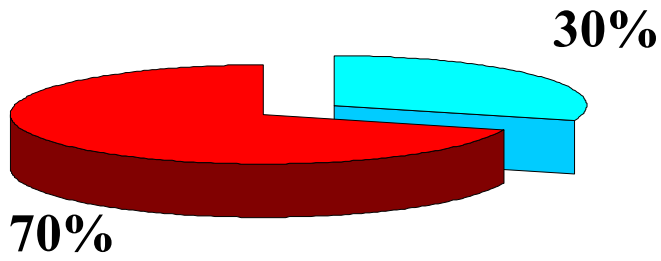


1966 Total irrigated area 33 M ha

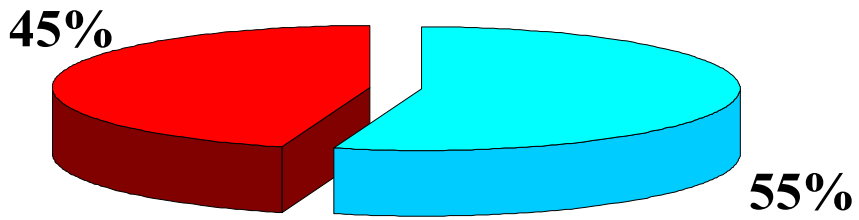


1995 Total irrigated area 49 M ha

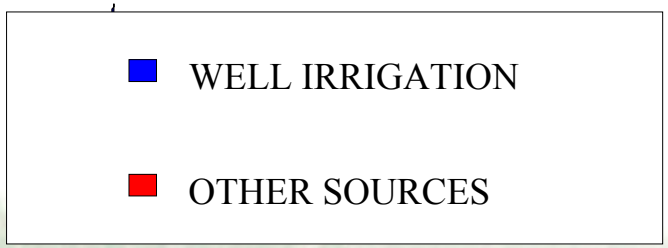
INDIA



1966 Total irrigated area 26 M ha



1995 Total irrigated area 53 M ha

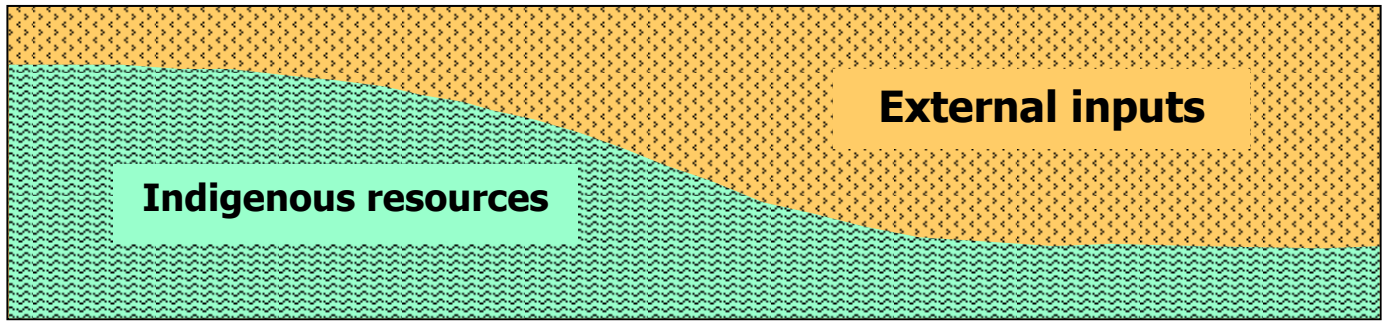


Source: Barker and Molden, 1999

Emerging issues for rice production using less water

- Reduced duration of submergence for substantial areas may lead to increased emission of CO_2 and nitrous oxide.
- Longer duration of soil drying may lead to loss of soil organic matter which may deteriorate "soil health", crop productivity and environmental quality.
- Severer weed problems, weed species displacement, and possible increase of herbicides.

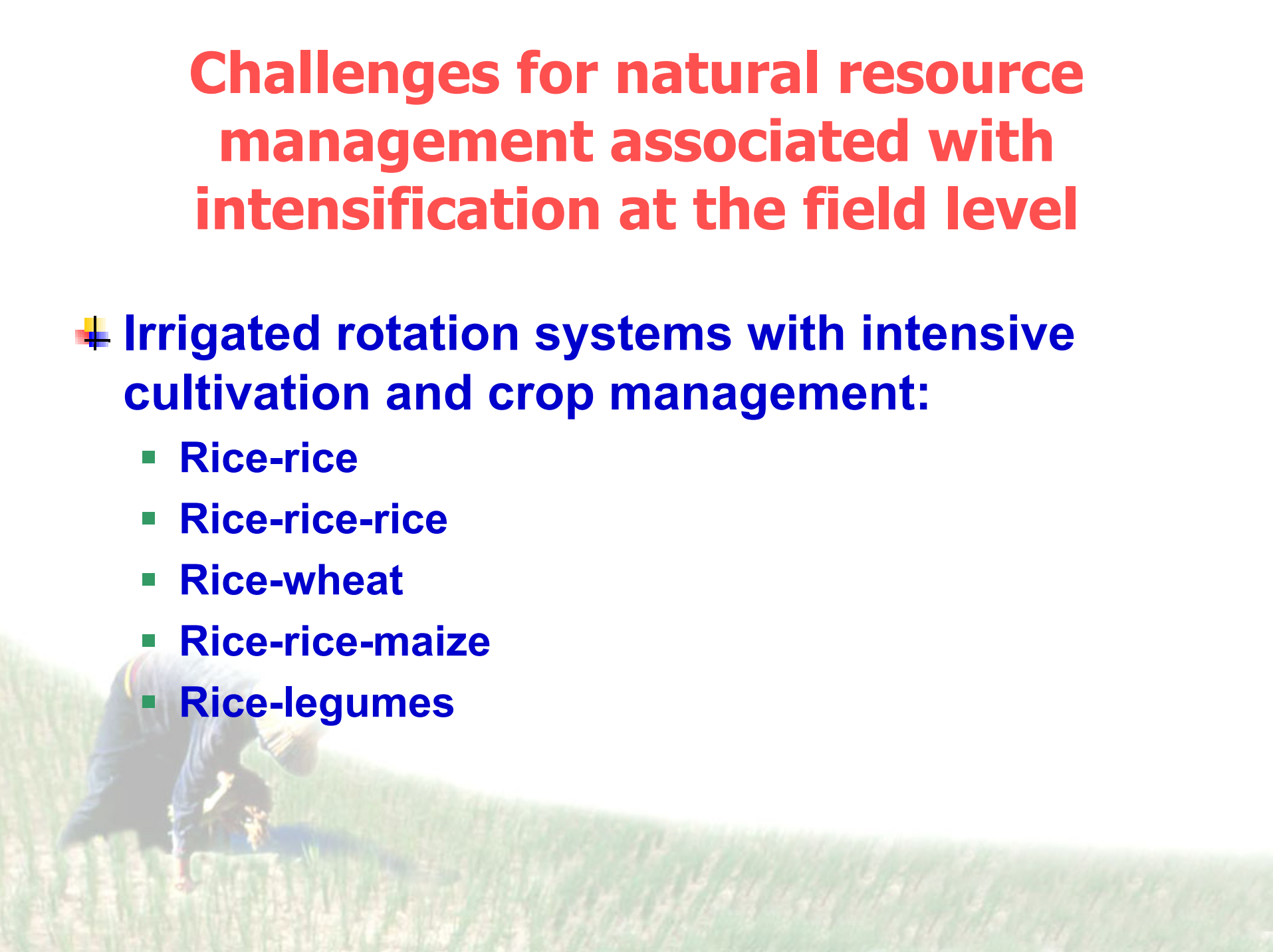
General characteristics of agricultural production systems varying in relative dependence on indigenous resources & external inputs



Low-input systems	High-input systems
Less intensive	More intensive
Mainly rainfed	Mainly irrigated
More subsistence-driven	More commercialized
Fewer controllable variables	More controlled conditions
Higher diversity	Lower diversity

Challenges for natural resource management associated with intensification at the field level

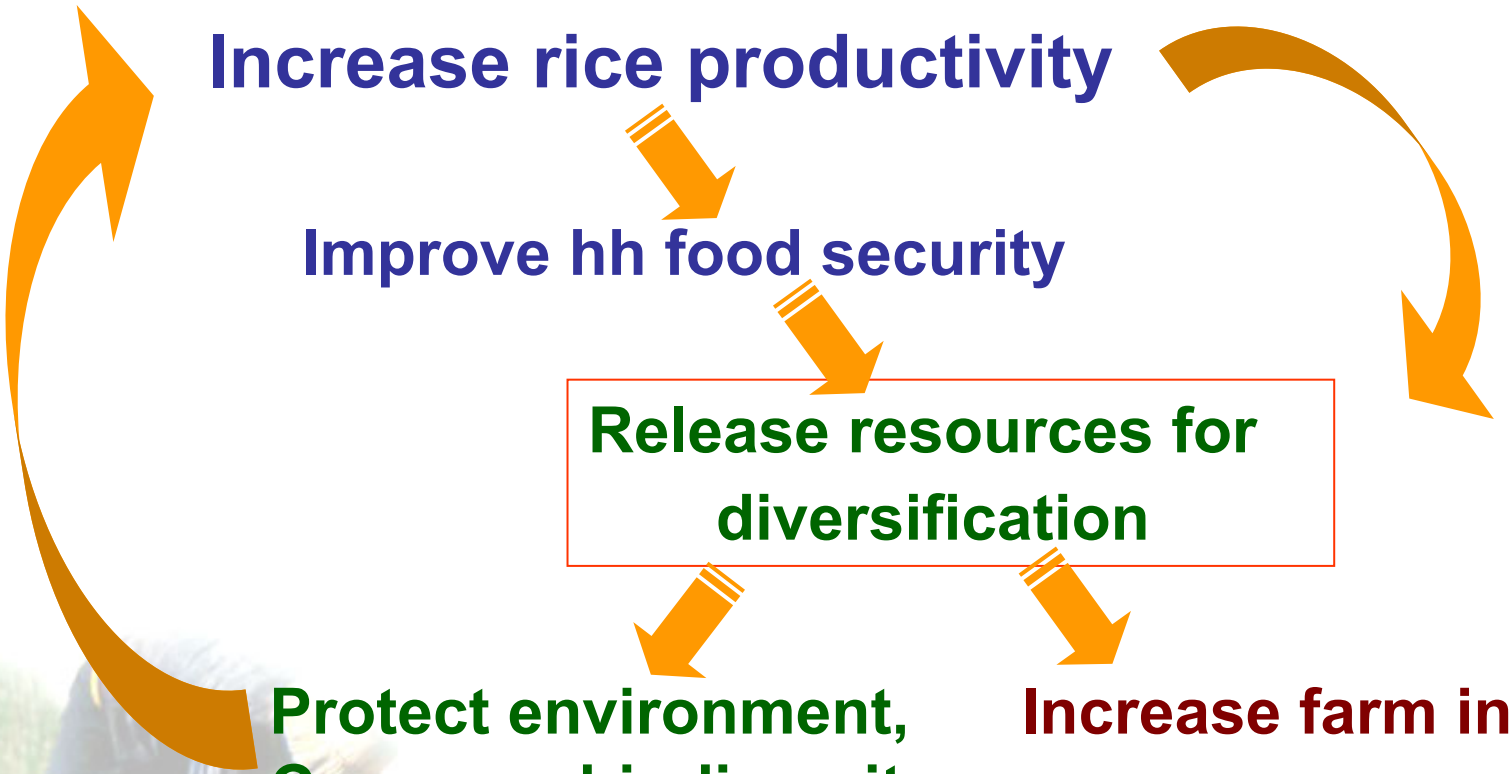
- **Irrigated rotation systems with intensive cultivation and crop management:**
  - **Rice-rice**
  - **Rice-rice-rice**
  - **Rice-wheat**
  - **Rice-rice-maize**
  - **Rice-legumes**



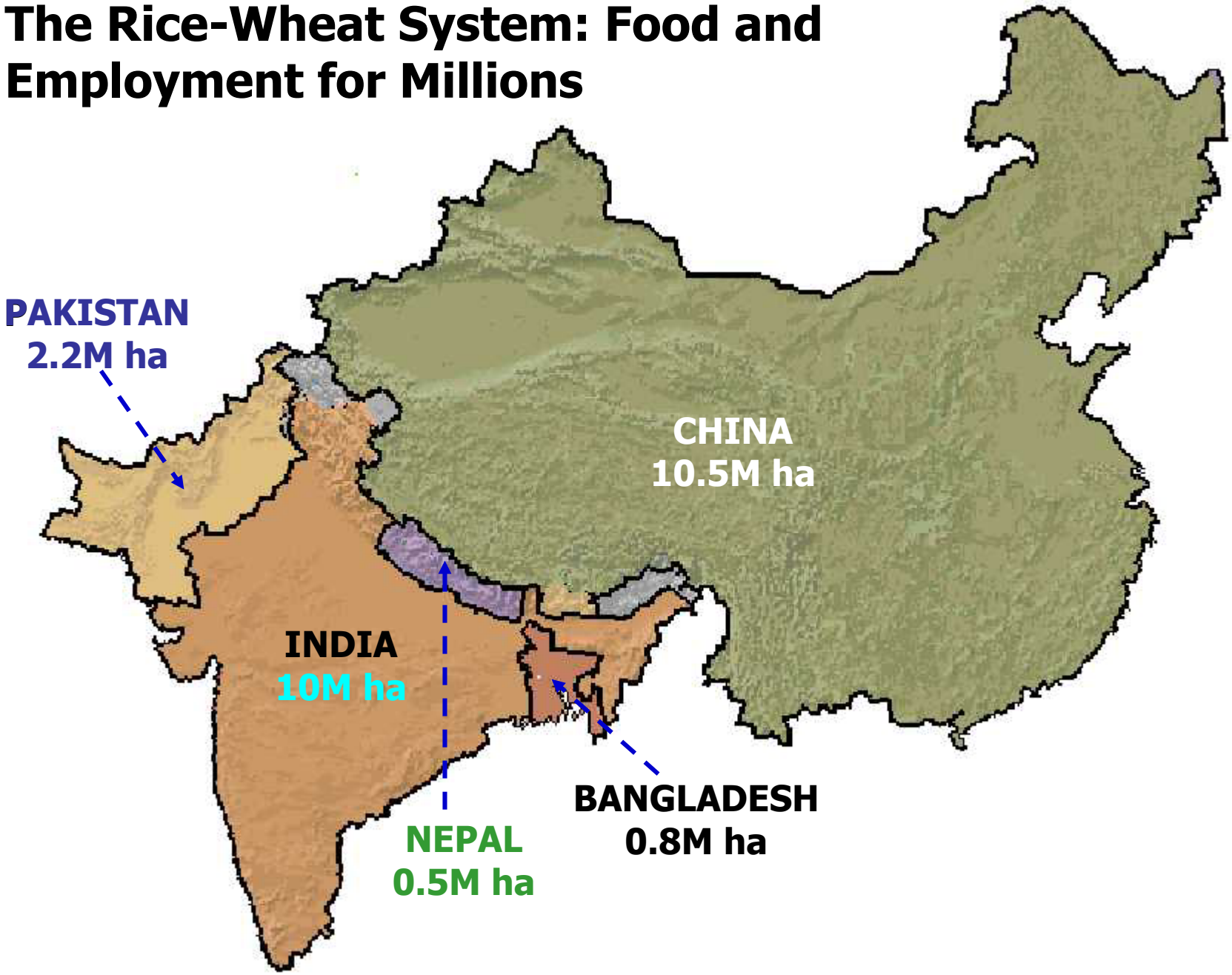
Challenges in the diverse rainfed systems

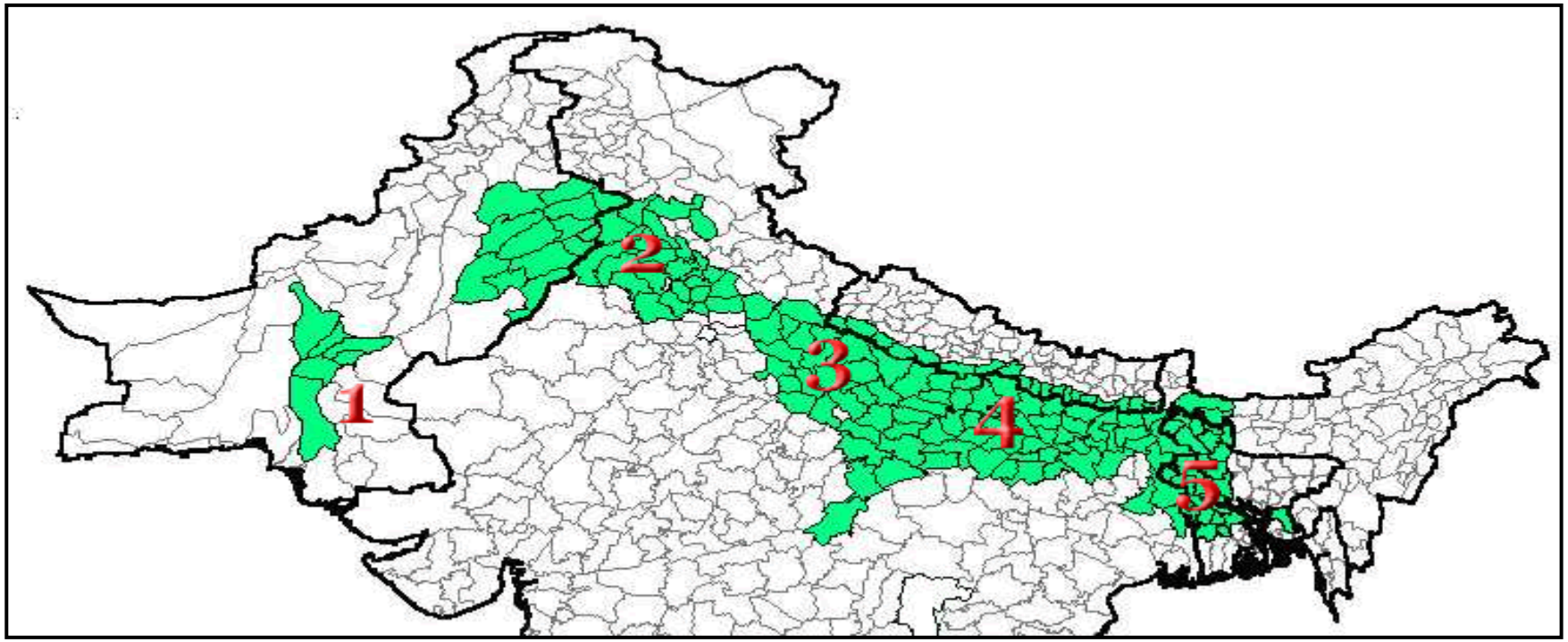
- Restricted cultivation period due to climatic constraints.
- Low input by farmers.
- Heavy dependence on and driven by availability (in location, time and quantity) of natural resources.
- Heterogeneity in nature, hence the need for location-specific technologies and the difficulties for “Green-revolution type” of breakthroughs and large scale adoption of technologies.

Rice as the entry point in the trend of diversifying livelihood strategies



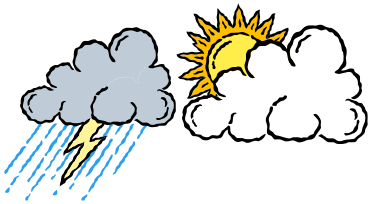
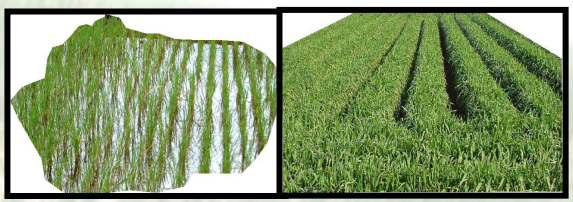
The Rice-Wheat System: Food and Employment for Millions





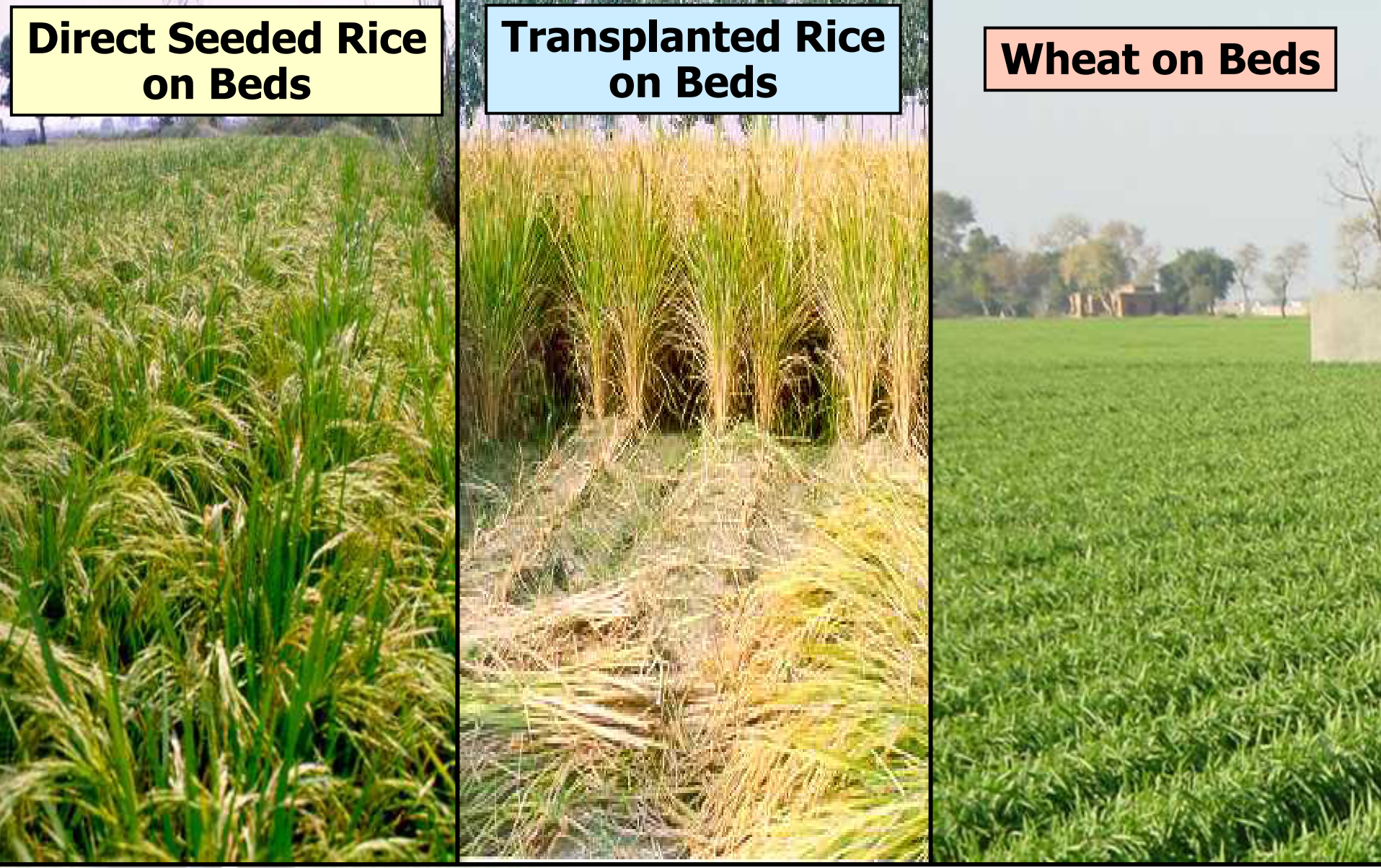
	1	2	3	4	5
Rainfall (mm)					
Rice	550	550	680	950	1450
Wheat	60	60	80	100	150
Irrigated area (%)					
Rice	99	99	60	40	25
Wheat	97	98	92	88	73
Soil					
Soils	Loamy sand	Loamy sand	Loam	Silty loam	Sandy loam
Soil C (%)	0.3	0.3	0.3	0.4	0.7
Climatic potential yield (Mg ha^{-1})					
Rice	10.7	10.7	9.5	9.2	7.7
Wheat	7.9	7.9	7.0	6.8	5.2

Antagonistic Requirements of Rice and Wheat in the System

Rice		Wheat
Warm, Wet Summer	Climatic Condition 	Cool, Dry Winters
Puddling	Land Preparation 	Dry Tillage
Anaerobic	Soil Condition 	Aerobic

Raised beds: Ghaziabad (Delhi), India

Hydrology field experiment



Saves 30-50% of the total irrigation time with same or enhanced productivity

The "Three reductions, three gains" Program for integrated nutrient and pest management in S. Vietnam

Less, but high quality seeds

Optimum N

Less pesticides

Development and dissemination of water-saving rice technologies

1. Direct seeding
2. Land leveling
3. Alternate wetting and drying
4. Planting rice on raised beds in the rice-wheat rotation systems.
5. Aerobic rice systems

A fundamental approach to reducing water requirements in rice.

Developing an "aerobic rice" that can be treated like any other (irrigated) crop: no puddling, no standing water, in aerobic soil.

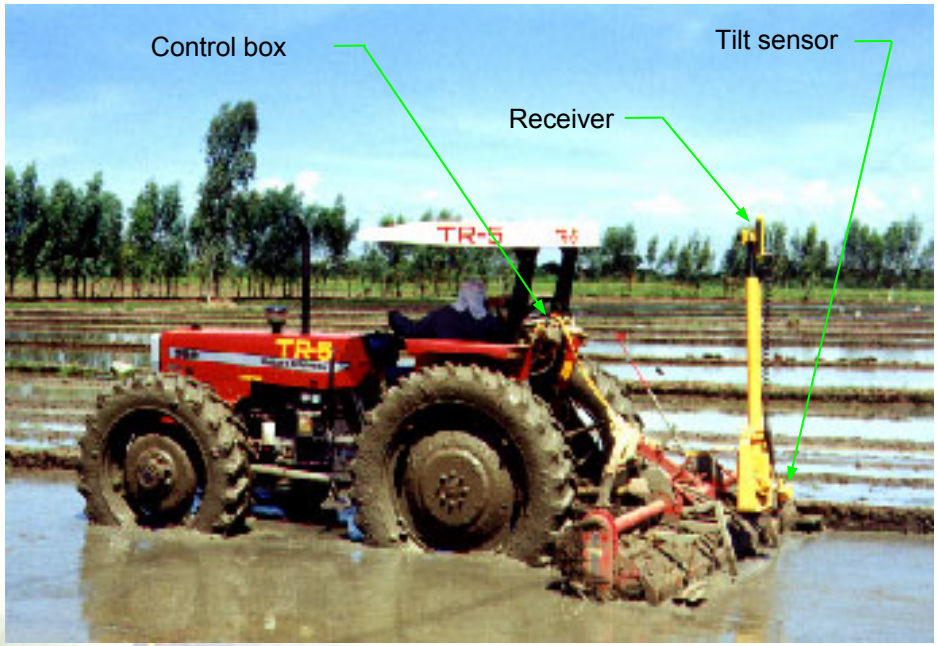
"Handao 2" direct seeded after wheat in Hebei, China,

- ✓ 2 irrigations throughout the season.
- ✓ Total water level: 1500 m^3/ha
- ✓ Yield 5.6 ton/ha

(Curtsey of H.Q. Wang, CAU)

Beijing: irrigated aerobic rice (Wang Hua Qi; CAU, 2000)

Using appropriate land leveling can reduce water use by 20-40% without yield penalty

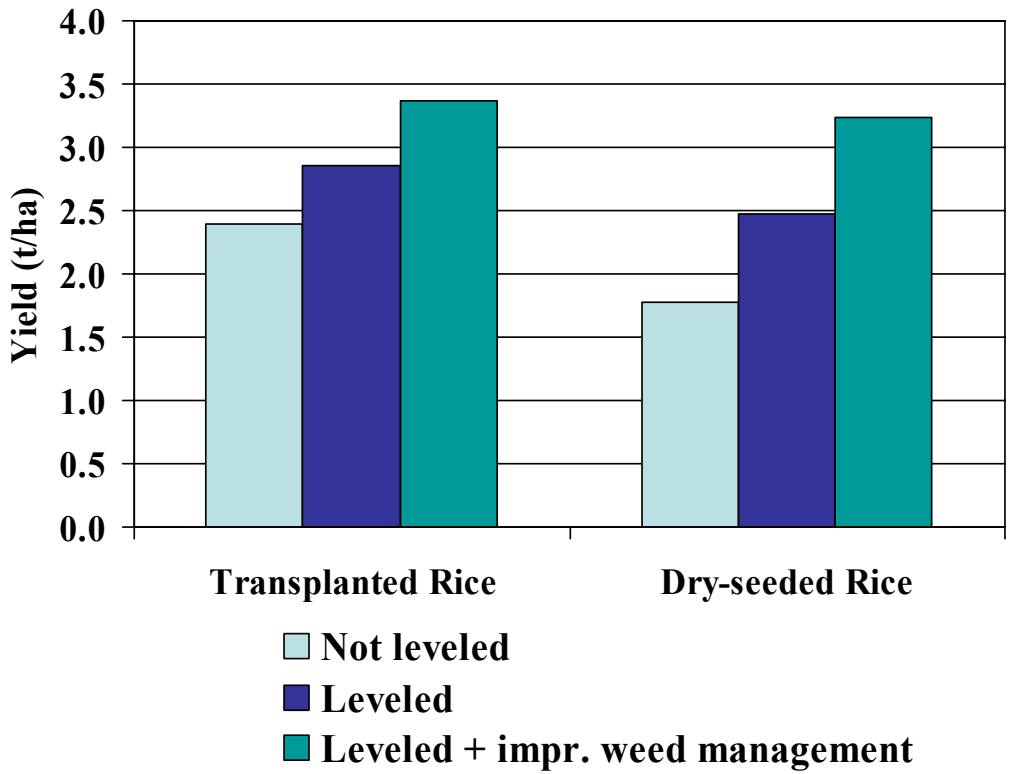


Wet laser leveling system developed at IRRI in partnership with Spectra Precision/Trimble

Rapid preparation of level seedbed

Dry soil leveling in Cambodia and India

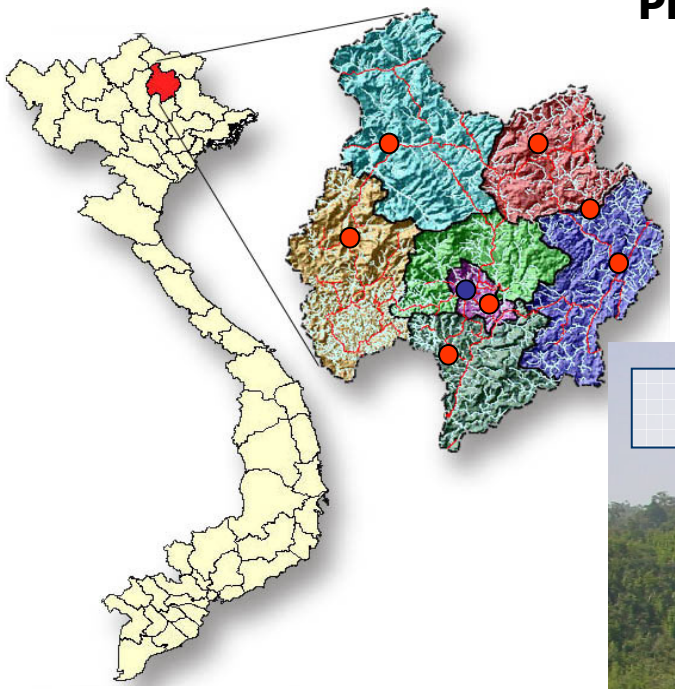
Dry laser leveling system
IRRI-Spectra-CARDI



Leveling increases rice yields and reduces weed biomass

Case example:

The Mountain Agrarian System (SAM) Project: Bac Kan Province in the uplands of the Red River Basin, Vietnam



- SAM Project research site
- Bac Kan resource center HQ

Complex topography: steep slopes & flat valley bottom …

Very diverse agro-ecological & socio-economic/multi-ethnic systems …

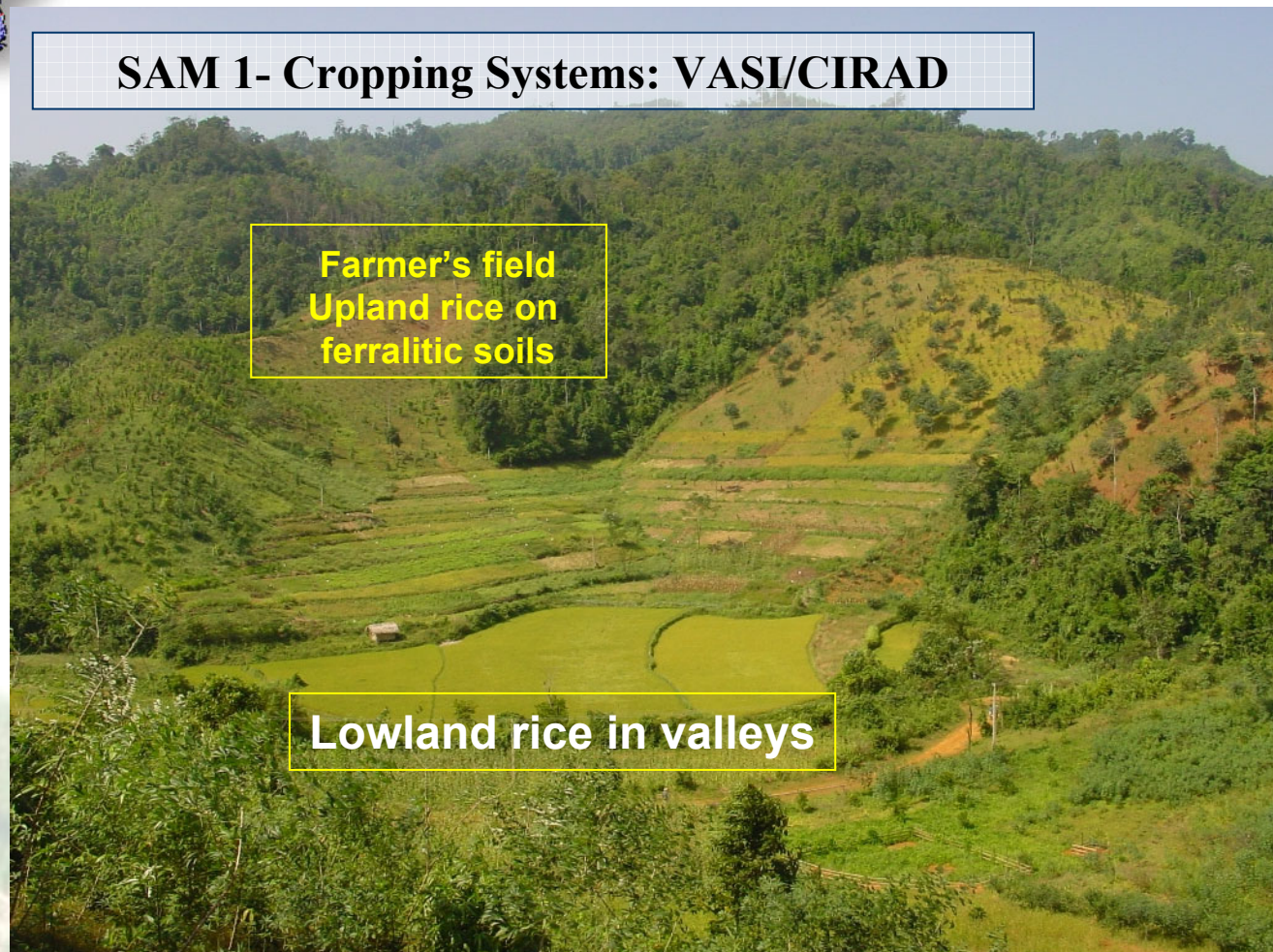


Photo courtesy CIRAD/VASI-SAM

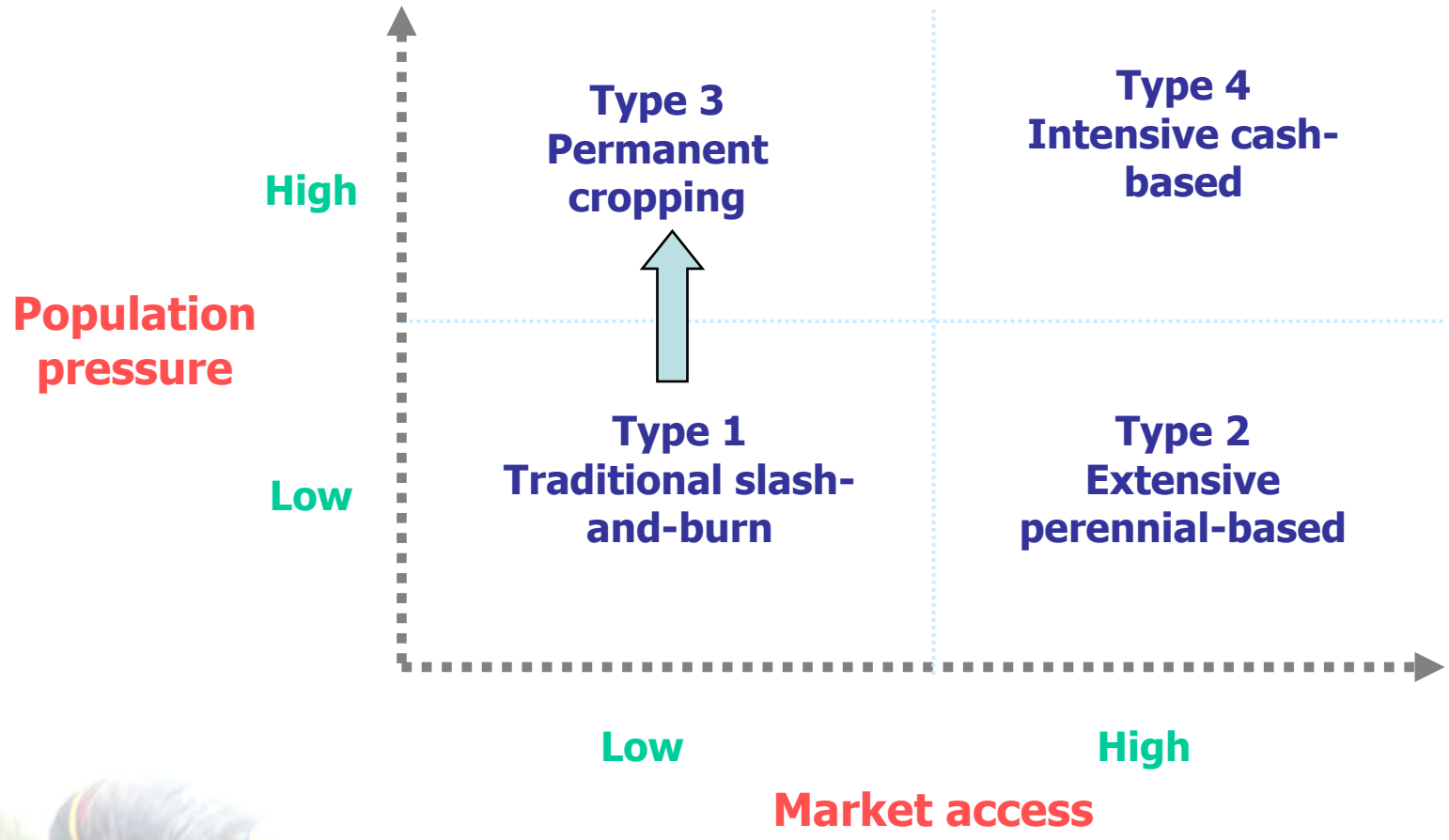
Incidence of poverty in Vietnam (%)

	1992-93	1997-98
Vietnam	**58.1**	**37.4**
Northern Upland	**78.6**	**58.6**
Red River Delta	**62.9**	**28.7**
Central Highlands	**70.0**	**52.2**
Ethnic group		
Kinh	**55.1**	**31.7**
Hmong	**100**	**91.8**
Muong	**89.6**	**80.6**
Nung	**91.8**	**72.0**
Tay	**81.3**	**63.8**
Dao	**88.5**	**100.0**
Others	**90.0**	**75.8**

Landholding of farmers facing food shortages of selected frequencies in the past 10 years

No. of years of shortage	No. of farmers	Size of lowland holding per household (ha)	Size of upland holding per household (ha)
9 or 10 years	18	0.1	0.6
1 year or none	17	0.2	0.7

Source: Pandey and Minh (1998)

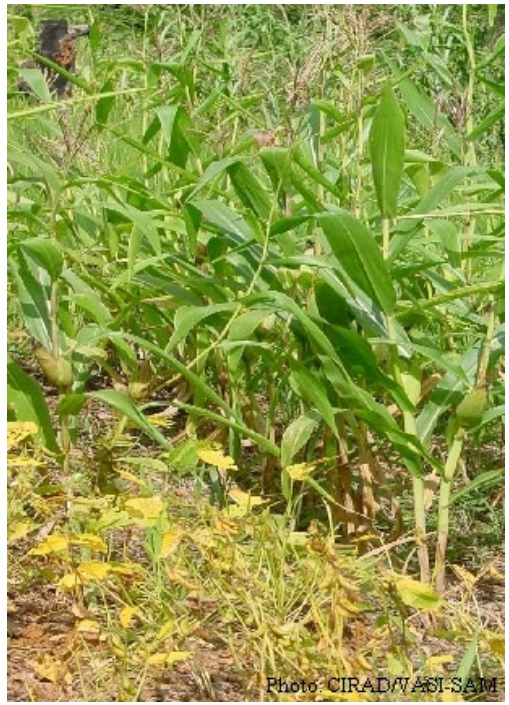


Typology of uplands

Source: Pandey, 1996

Innovation testing – an example

Alternative to slash & burn on ferralitic soils (SAM-CS)



Direct sown upland rice (LC 90-12) with mulching (*Brachiaria ruziziensis*) …

… in rotation with soybean & corn

Promising results: >2 t/ha rice without weeding & fertilizer, c.f. 300 kg/ha for conventional method

Photos courtesy CIRAD/VASI-SAM

The Yunnan Experience

Outcome of changes in Yunnan

- Higher-yielding upland rice systems
- Food secure households
- Diversified systems with cash components
- Less-intensive use of fragile sloping lands

BEFORE

AFTER

Major ingredients for success

- Input-responsive upland rice varieties
- Terraces
- Markets
- Local champions
- Support of local authorities

Back to Menu

A CIRAD Asia Initiative to Make a Difference in the Unfavourable Environments