Date	Month	Day	Module	Topic	Lecturer
08.05.2023	May	Monday	BS3	Intro/Interactions	Becker
09.05.2023	May	Tuesday	Land use	Payment for ESS	Börner
10.05.2023	May	Wednesday	systems	Forest system	Freudenberger
11.05.2023	May	Thursday	(sub)tropics	Wetland systems	Becker
12.05.2023	May	Friday		Dryland systems	Becker
13.05.2023	May	Saturday			
14.05.2023	May	Sunday			
15.05.2023	May	Monday	BS3	Ecosytem services	Freudenberger
16.05.2023	May	Tuesday	Land use	Threats to biodiversity	Freudenberger
17.05.2023	May	Wednesday	systems	Conservation issues	Freudenberger
18.05.2023	May	Thursday		Assension Day	
19.05.2023	May	Friday	(sub)tropics	Human development	Freudenberger
20.05.2023	May	Saturday			
21.05.2023	May	Sunday			
22.05.2023	May	Monday	BS3	Pasture systems	Behn
23.05.2023	May	Tuesday	Land use	Pasture management	Behn
24.05.2023	May	Wednesday	systems	Botany of plants	Behn
25.05.2023	May	Thursday	(sub)tropics	Groups of compounds	Behn
26.05.2023	May	Friday		Seminar preparation	Students
27.07.2023	July	Saturday			
28.07.2023	July	Sunday			
29.05.2023	May	Monday		Pentecoast	
30.05.2023	May	Tuesday	BS3	Rice-based systems	Becker
31.05.2023	May	Wednesday	Land use	Student presentation	All
01.06.2023	May	Thursday	systems	Student presentation	All
02.06.2023	May	Friday	(sub)tropics	Student presentation	All
03.06.2023	July	Saturday			
04.06.2023	July	Sunday			

Block 4

Rice production systems

Relevance
Diversity
Botany/morphology
Production systems
Production methods
Case study of AWD
Outlook

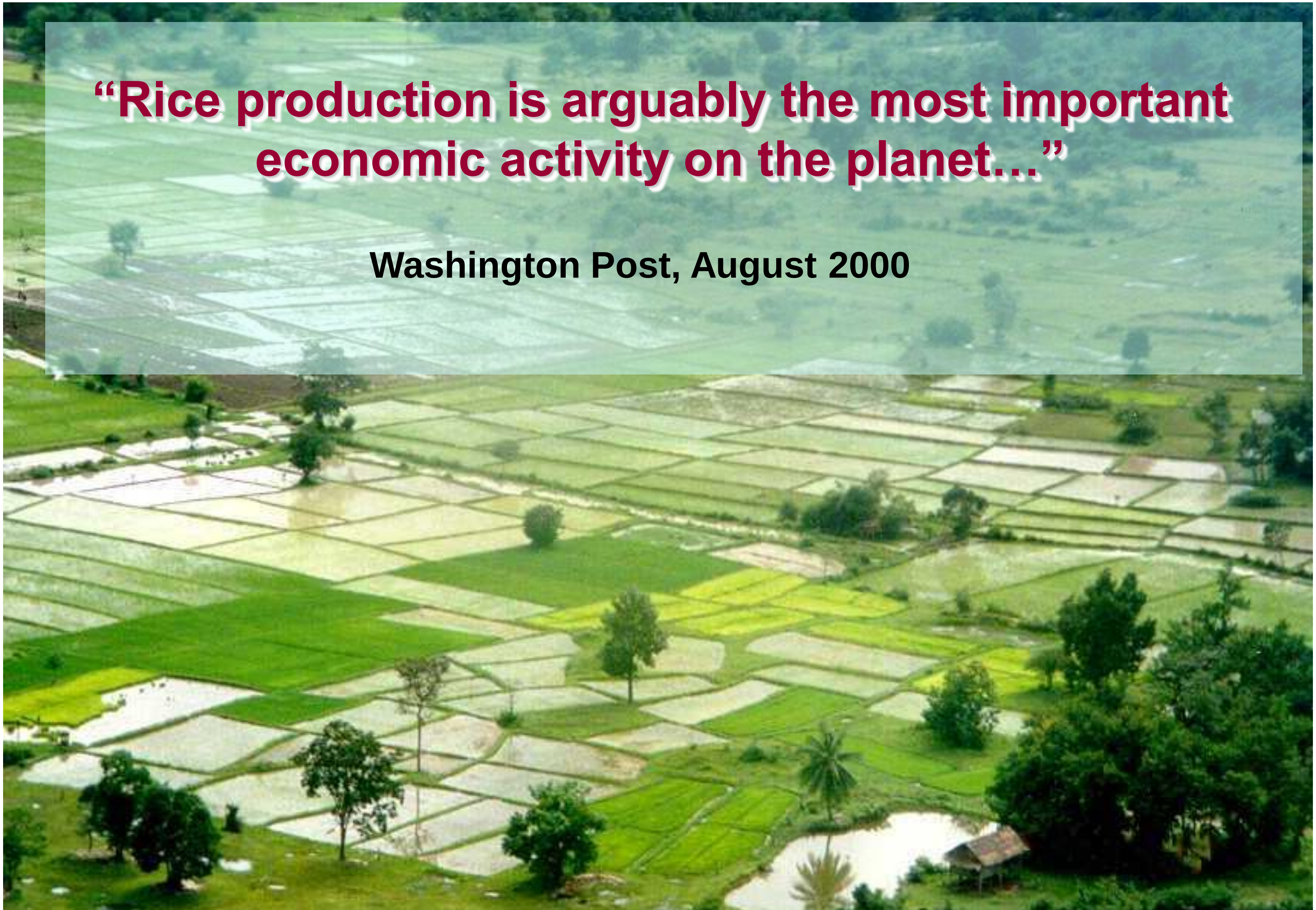
Oryza spp. (rice)

Area:	153 Millionen ha (Wheat: 222, Maize: 135)
Production:	589 Millionen t (>90% for human nutrition)
Importance:	Calories for nearly 4 billion (increase: 1.7%/year)
	80% produced & consumed in Asia

Rice is the most important food crop of the world

Oryza sativa L.

Oryza glaberrima Steud.



“Rice production is arguably the most important economic activity on the planet…”

Washington Post, August 2000

Rice is grown in a wide range of environments:

- <100 mm rain (Al Hasa oasis in Saudi Arabia)
- >5000 mm (Arakan coast in Myanmar)

- <20°C in Europe, Japan and the E-African Highland
- >35°C in Sahel and upper Sind (Pakistan)

- < 300 m^2 plots (S-India)
- >1000 ha fields in Australia

- Nearly all soil classes

Ecoregion	Rice	Wheat and maize	Other cereals	Pulses	Oilseeds
Warm arid and semiarid tropics (AEZ 1)	20.3%	8.5%	30.5%	17.9%	21.9%
Warm sub-humid tropics (AEZ 2)	69.9%	11.3%	2.2%	8.9%	6.8%
Warm humid tropics (AEZ 3)	73.7%	16.8%	0.3%	5.0%	5.7%
Warm arid and semiarid sub-tropics with summer rainfall (AEZ 5)	6.6%	49.3%	16.8%	21.4%	6.9%
Warm sub-humid sub-tropics with summer rainfall (AEZ 6)	20.6%	46.3%	4.9%	10.3%	9.3%
Warm/cool humid sub-tropics with summer rainfall (AEZ 7)	77.5%	7.0%	0.1%	7.5%	10.4%
Cool subtropics with summer rainfall (AEZ 8)	4.9%	66.2%	6.2%	11.5%	11.1%

2. Relative importance of food crops in agroecological zones in which rice is grown. (Figures indicate percent of area for each crop.)

Rice production systems

Relevance
Diversity
Botany/morphology
Production systems
Production methods

Rice is the most important food crop:

The genus Oryza has originated about 14 million years ago in Malaysia.
Since then, it has evolved, diversified, and dispersed, and 22 wild Oryza species are now distributed throughout the tropics.

22 *Oryza* species

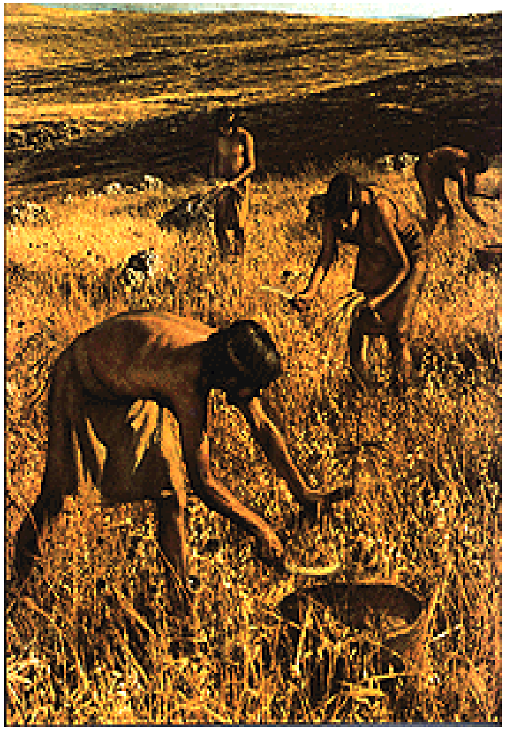
…only 2 cultivated

O. sativa	(AA) cultivated Asia rice
O. glaberrima	(AA) cultivated African rice
O. nivara	(AA) 'Indian wild rice',
O. rufipogon	(AA) 'perennial red rice',
O. meridionalis	(AA) New Guinea
O. barthii	(AA) African floodplains; ancestor of O. glaberrima
O. longistaminata	(AA) 'African perennial longstamen rice'
O. glumaepatula	(AA) perennial deepwater in South America.
O. punctata	(BB) diploid rice of tropical Africa
O. minuta	(BBCC) tetraploid perennial rice in the Philippines
O. schweinfurthiana	(BBCC) tetraploid perennial rice in Africa
O. officinalis	(CC) diploid perennial rice in Asia
O. rhizomatis	(CC) diploid perennial rice in Sri Lanka
O. eichingeri	(CC) diploid perennial rice in Africa
O. malampuzhaensis	(CCDD) tetraploid perennial rice in India
O. alta	(CCDD) deepwater rice in South America
O. grandiglumis	(CCDD) tetraploid perennial rice in South America
O. latifolia	(CCDD) tetraploid perennial rice in the Caribbean
O. australiensis	(EE) diploid rice of Australia
O. brachyantha	(FF) diploid rice of Africa
O. schlechteri	(HHKK), tetraploid rice in New Guinea island (Indonesia)
O. coarctata	(KKLL) tetraploid rice of Myanmar

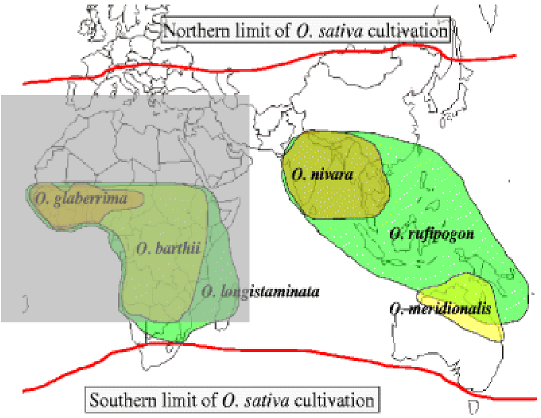
15.000 years ago:

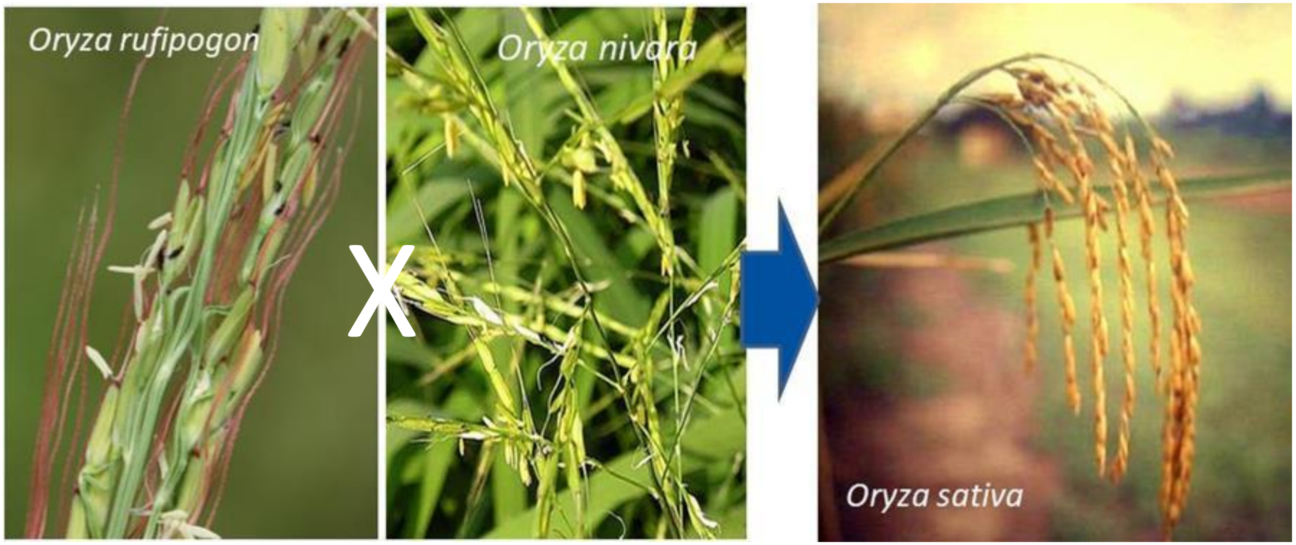
Early agriculture ….. key to the rise of sedentary human civilization

(Mesopotamia - wheat, China/India - rice)

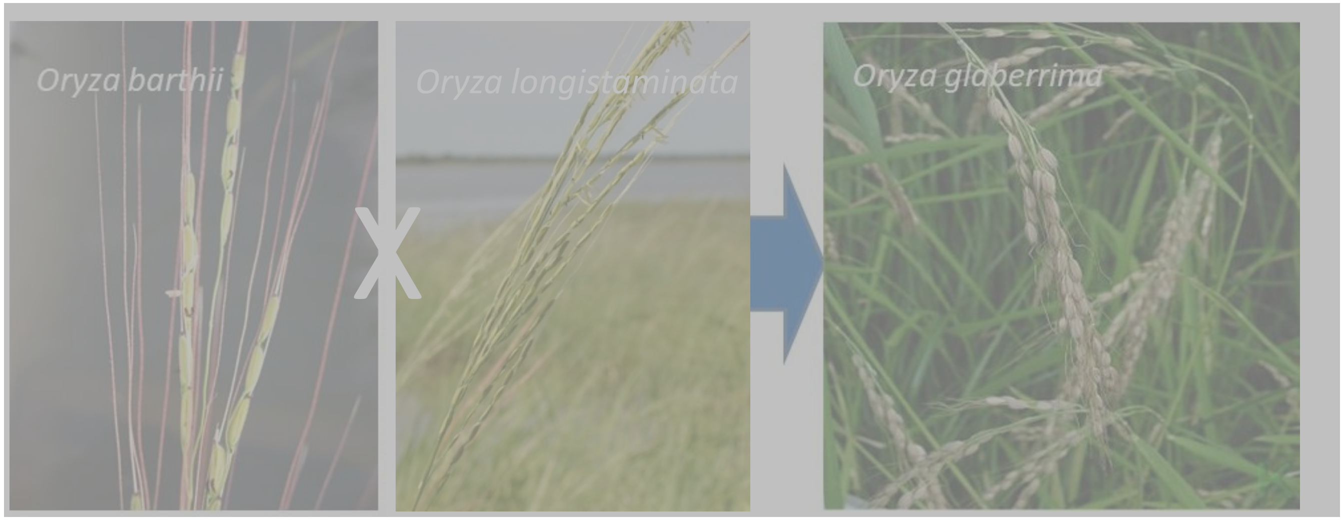


South & SE Asia





West Africa

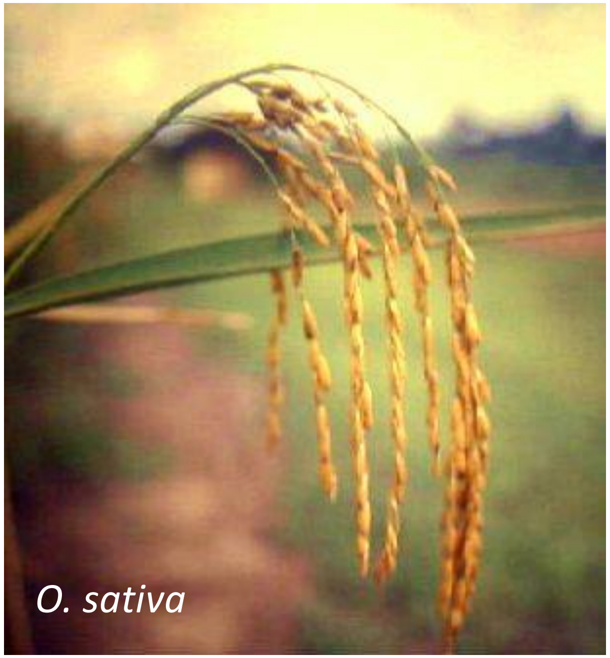


9.000 years ago: Neolithic revolution .....

- domestication of rice in Pearl River Valley, China

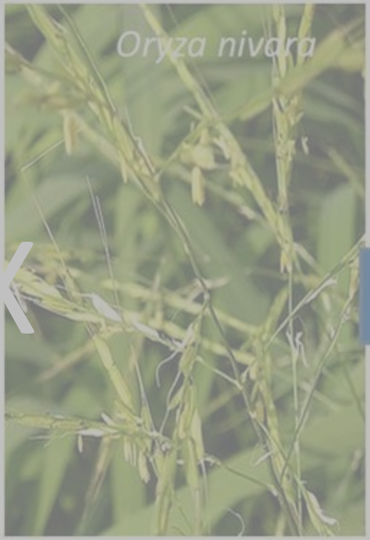
5.000 years ago: .....

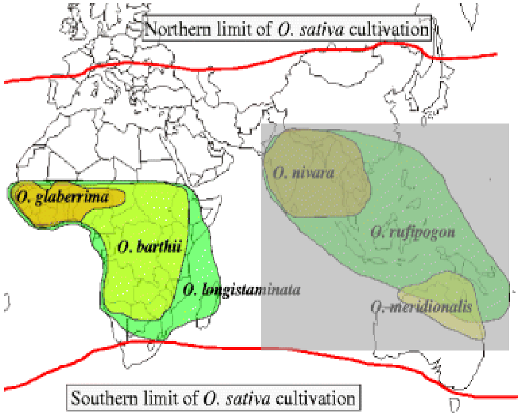
- first cultivation of rice in the Indus Valley.
- spread of rice cultivation to Yangtze and Huai rivers



South & SE Asia

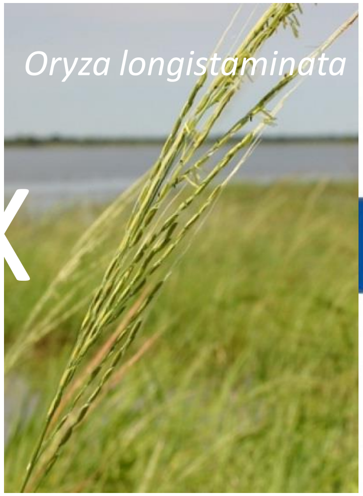
X





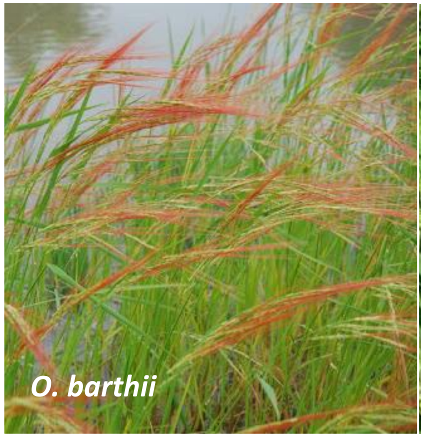
West Africa

X



3.000 ago

- Domestication of *Oryza glaberrima* in West Africa (differentiation of O. barthii?)



22 Oryza species

20 „wild" rices
(used for breeding)

O. sativa	(AA) cultivated Asia rice
O. glaberrima	(AA) cultivated African rice
O. nivara	(AA) 'Indian wild rice',
O. rufipogon	(AA) 'perennial red rice',
O. meridionalis	(AA) New Guinea
O. barthii	(AA) African floodplains; ancestor of *O. glaberrima*
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O. brachyantha	(FF) diploid rice of Africa
O. schlechteri	(HHKK), tetraploid rice in New Guinea island (Indonesia)
O. coarctata	(KKLL) tetraploid rice of Myanmar

Rice = *Oryza* spp.

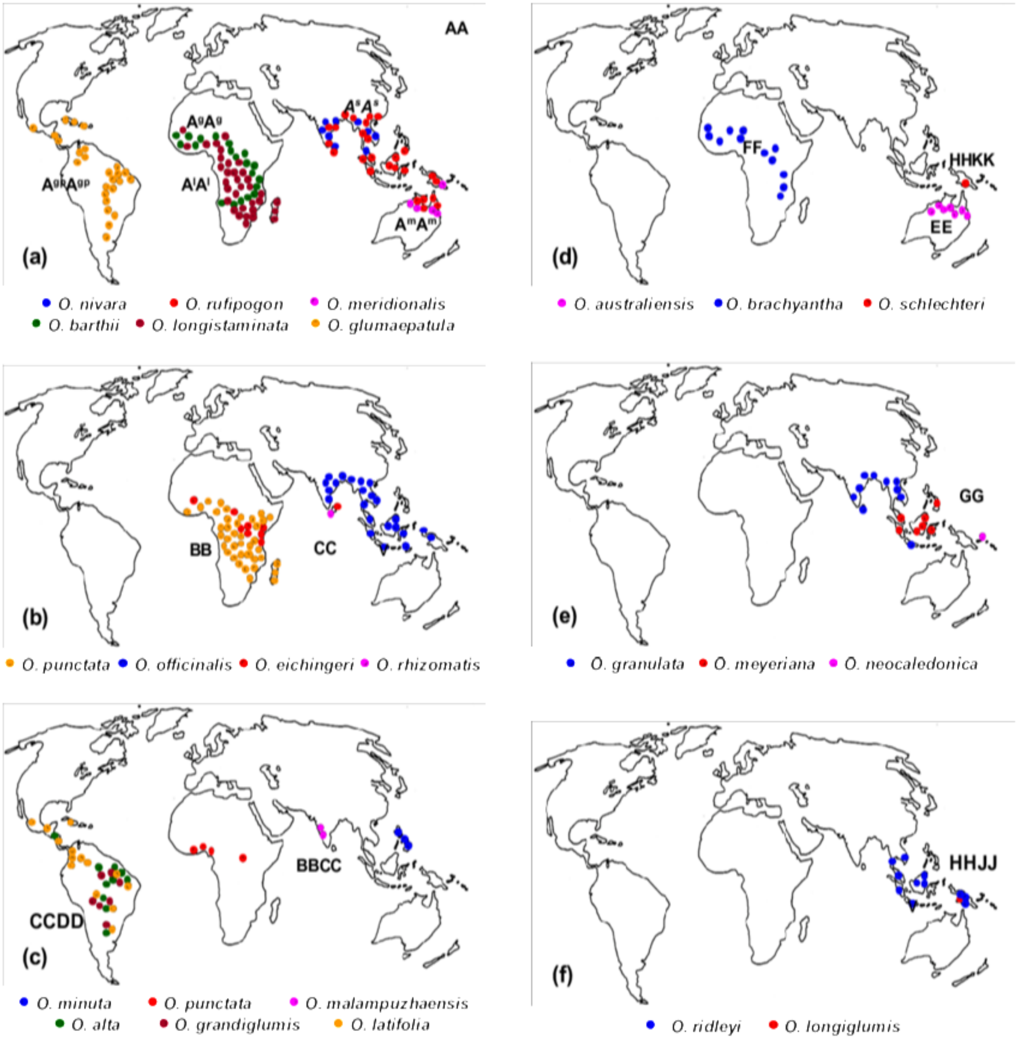
C3 grass
Wet / submerged environments

- Asia
- Africa
- Americas
- Australia

24 species of the genus Oryza

Only two cultivated species:

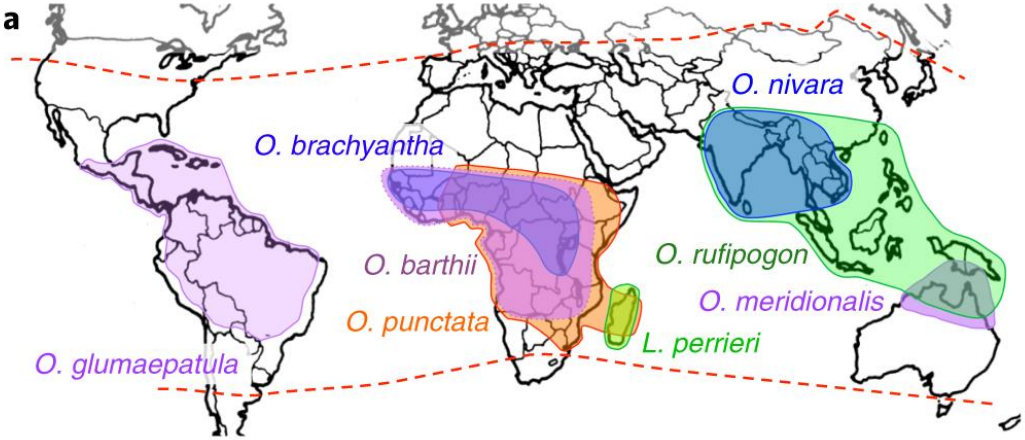
- *O. sativa* (ssp indica)
- *O. sativa* (ssp japonica)
- *O. glaberrima*



Oryza brachyantha

Oryza ridleyi

O. longistaminata



Oryza glumaepatula

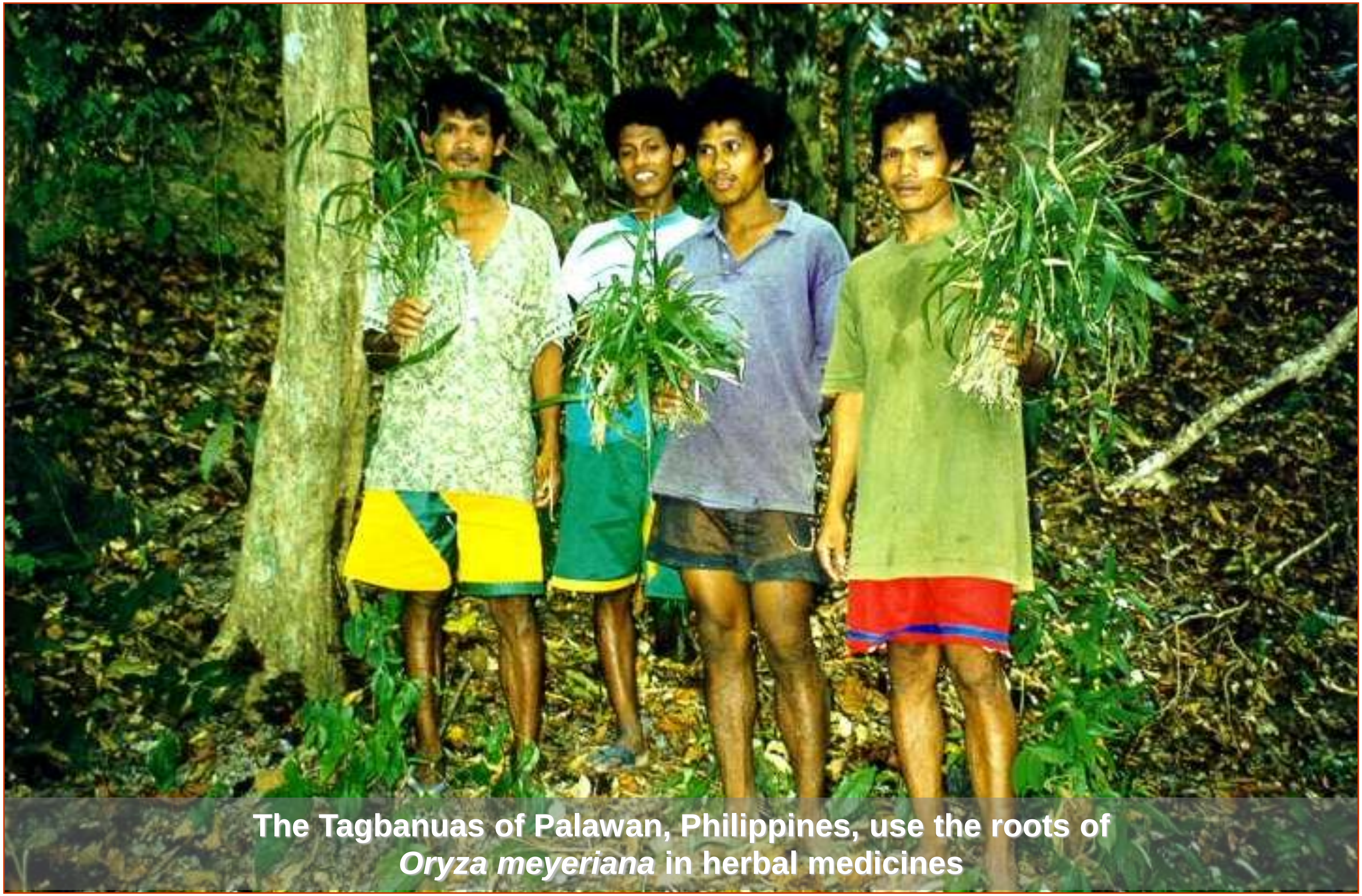
Oryza grandiglumis

Oryza meridionalis

gathering seeds of *Oryza nivara*

selling milled grains of wild rice

Oryza rufipogon used as cattle fodder in Cambodia and Nepal



The Tagbanuas of Palawan, Philippines, use the roots of *Oryza meyeriana* in herbal medicines

„Wild rice“

Zizania sp. ….. is not a rice!

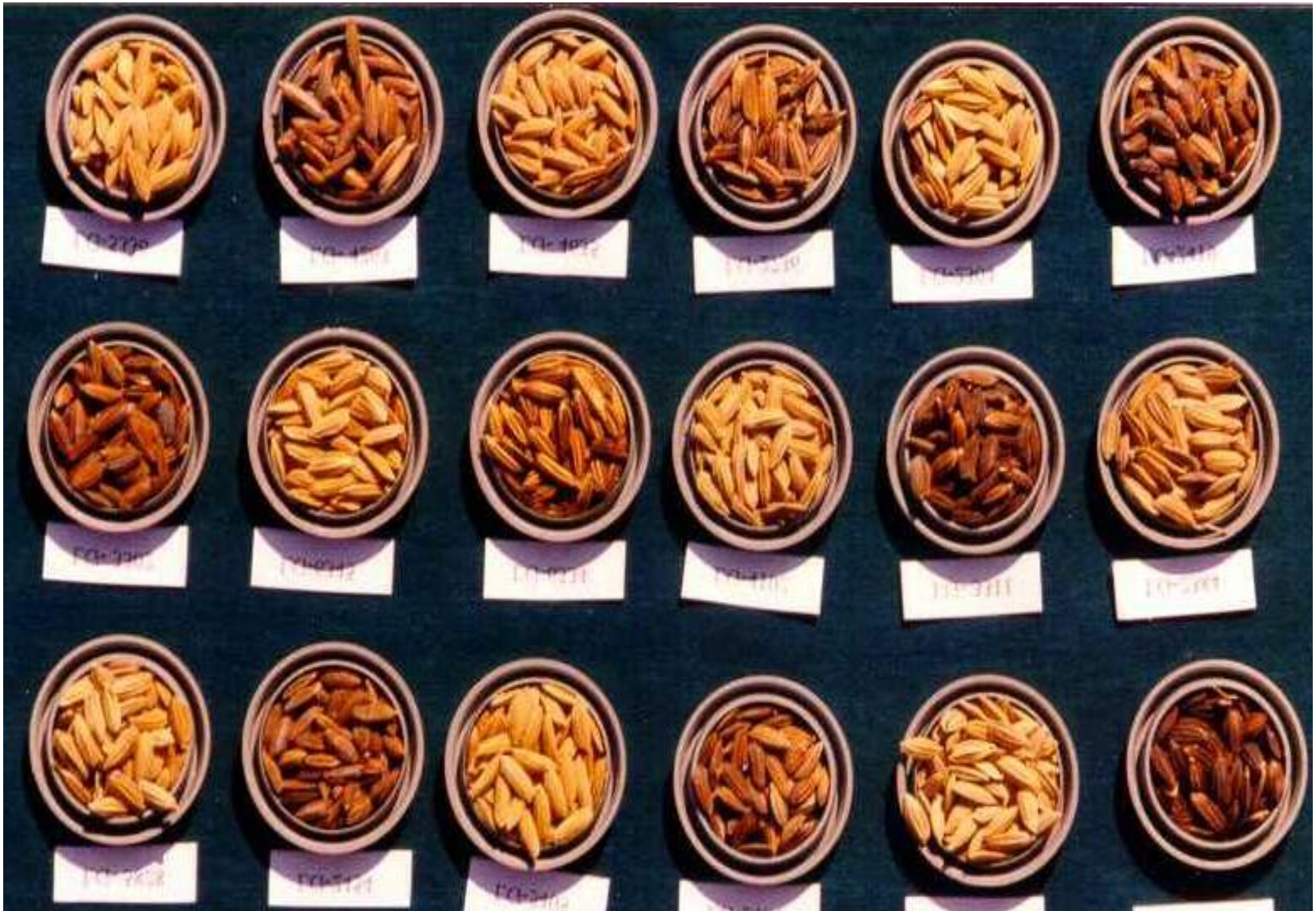
Zizania

genus of wild grass from North America
"wild rice", "Canada rice", "water oats"

Oryza sativa

Asian rice was first domesticated from the wild rice *Oryza rufipogon* 10,000 years ago. Today it is cultivated on every continent save Antarctica.

Worldwide there are more than 40,000 different varieties (>135,000 accessions in the genebanks of IRRI and Svalbard)



Rice is the most important food crop:

Most cultivated species can be grouped into four complexes of closely related species

Cultivated species (sub-groups)

- Oryza sativa (indica)
- Oryza sativa (japonica)
- Oryza sativa (javanica)
- *(Oryza sativa (aus))*
- Oryza glaberrima

Oryza sativa (sub-groups)

1. *Japonica* group (sticky, short grained)
*F*rom northern and eastern China
Adapted to cooler zones
Grains are short and round

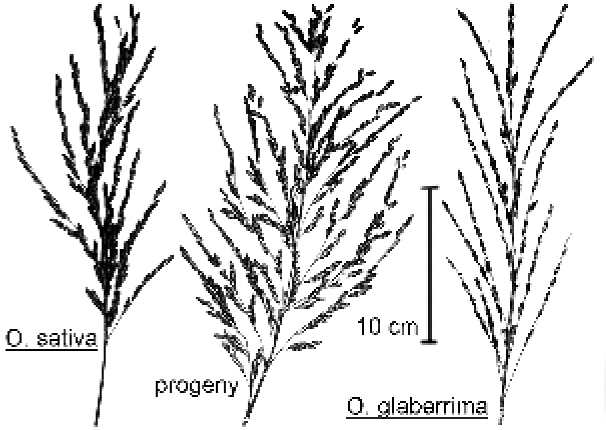
***2. Javanica* group** (also tropical *Japonica*)
Grown in high-elevation rice terraces
Leaves are broad
Grains are long

3. *Indica* group (non-sticky, long-grained)
Indica plants are tall
The grains are long and slender,
A high amylose content makes them dry and flaky

ssp indica: long grains lowland

ssp japonica: short grains upland

Rice panicle



Some differences between O. sativa and O. glaberrima:

Trait	O. sativa	O. glaberrima
plant type	erect	bushy
tiller	some	many
leaves	erect, "thick"	droopy, thin
Ligule	long, trangular	short, square
Auricle	hairy, comprising	Glabrous, partial
panicles	dense	open

Rice is the most important food crop:

Area:	156 Millionen ha (Wheat: 223, Maize: 135)
Production:	589 Millionen t (>85% for human nutrition)
Importance:	Calories for 4 billion (increase: 1.7%/year)
Characteristic:	Diversity of Production

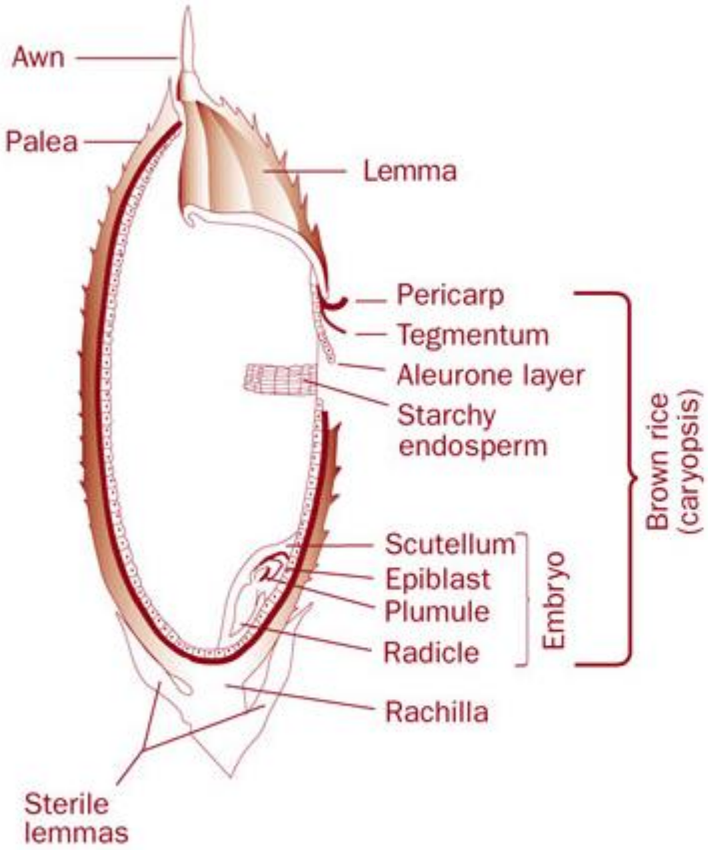
Oryza sativa

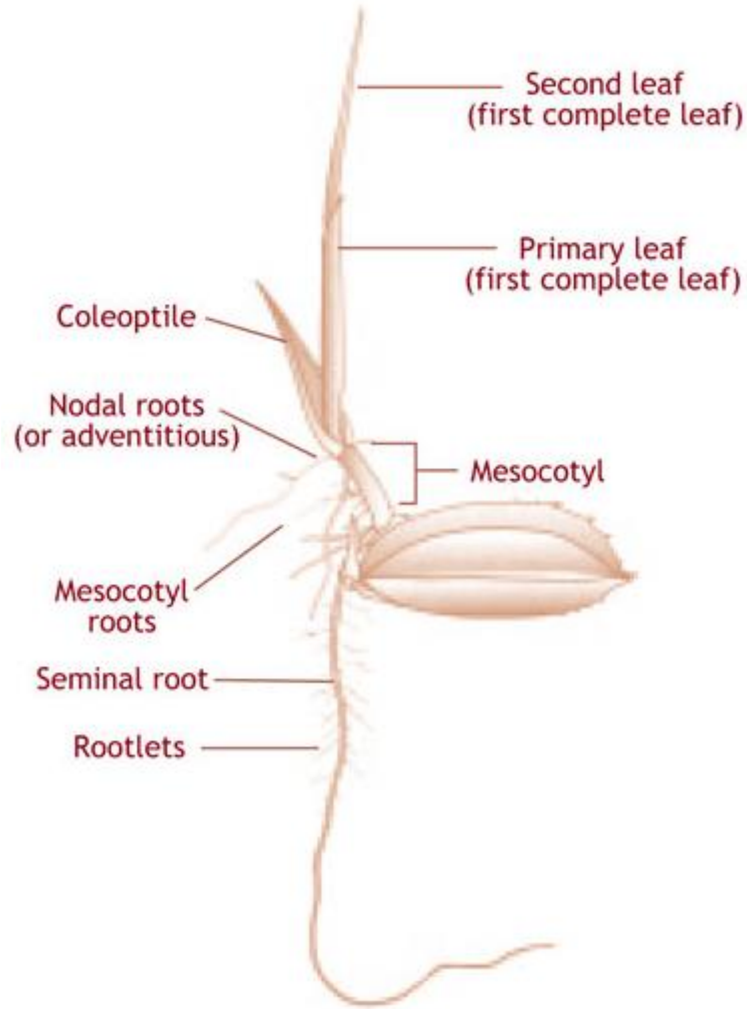
Oryza glaberrima

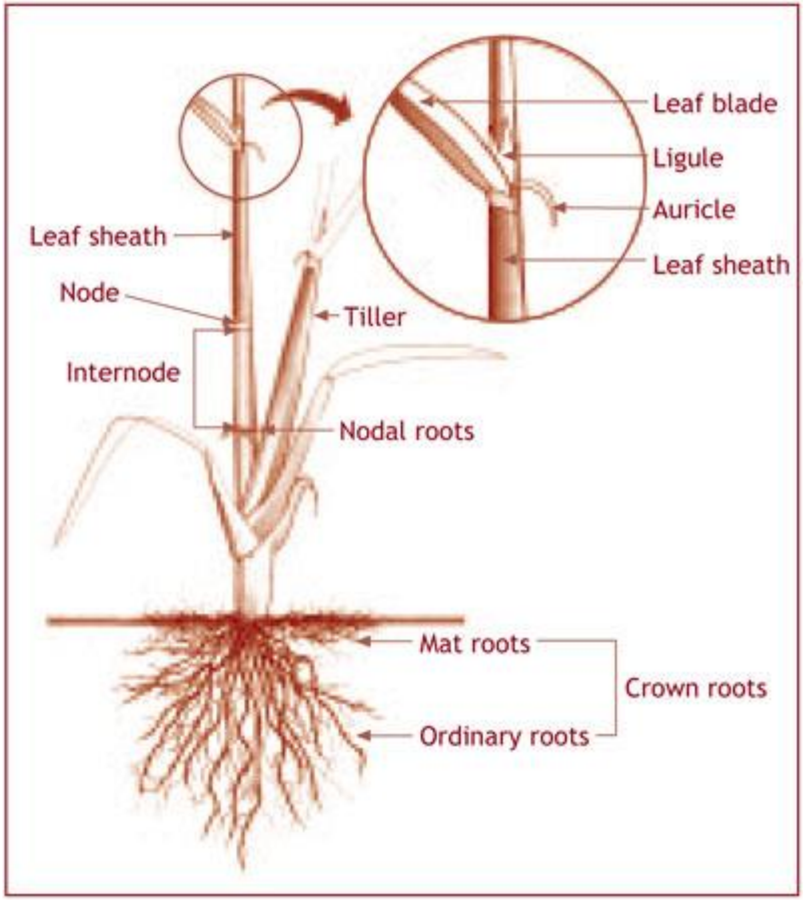
The „green revolution“ …..

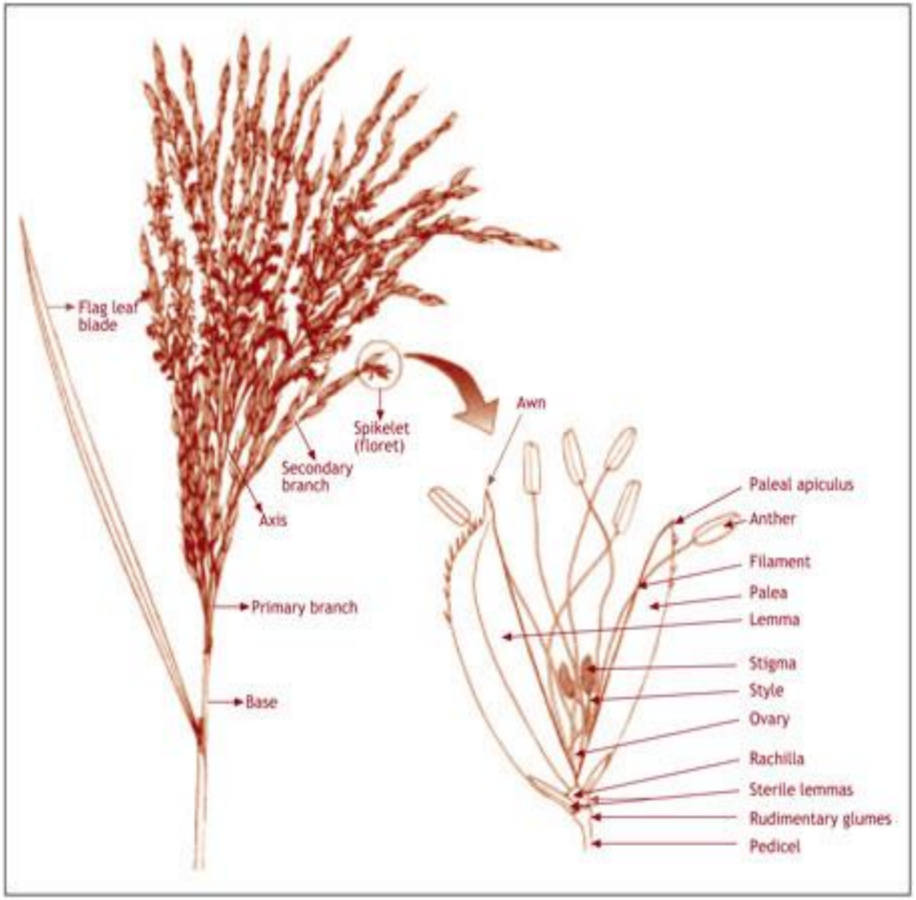
Rice production systems

Relevance
Diversity
Botany/morphology
Production systems
Production methods


Awn
Palea
Lemma
Pericarp
Tegmentum
Aleurone layer
Starchy endosperm
Scutellum
Epiblast
Plumule
Radicle
Embryo
Brown rice (caryopsis)
Rachilla
Sterile lemmas

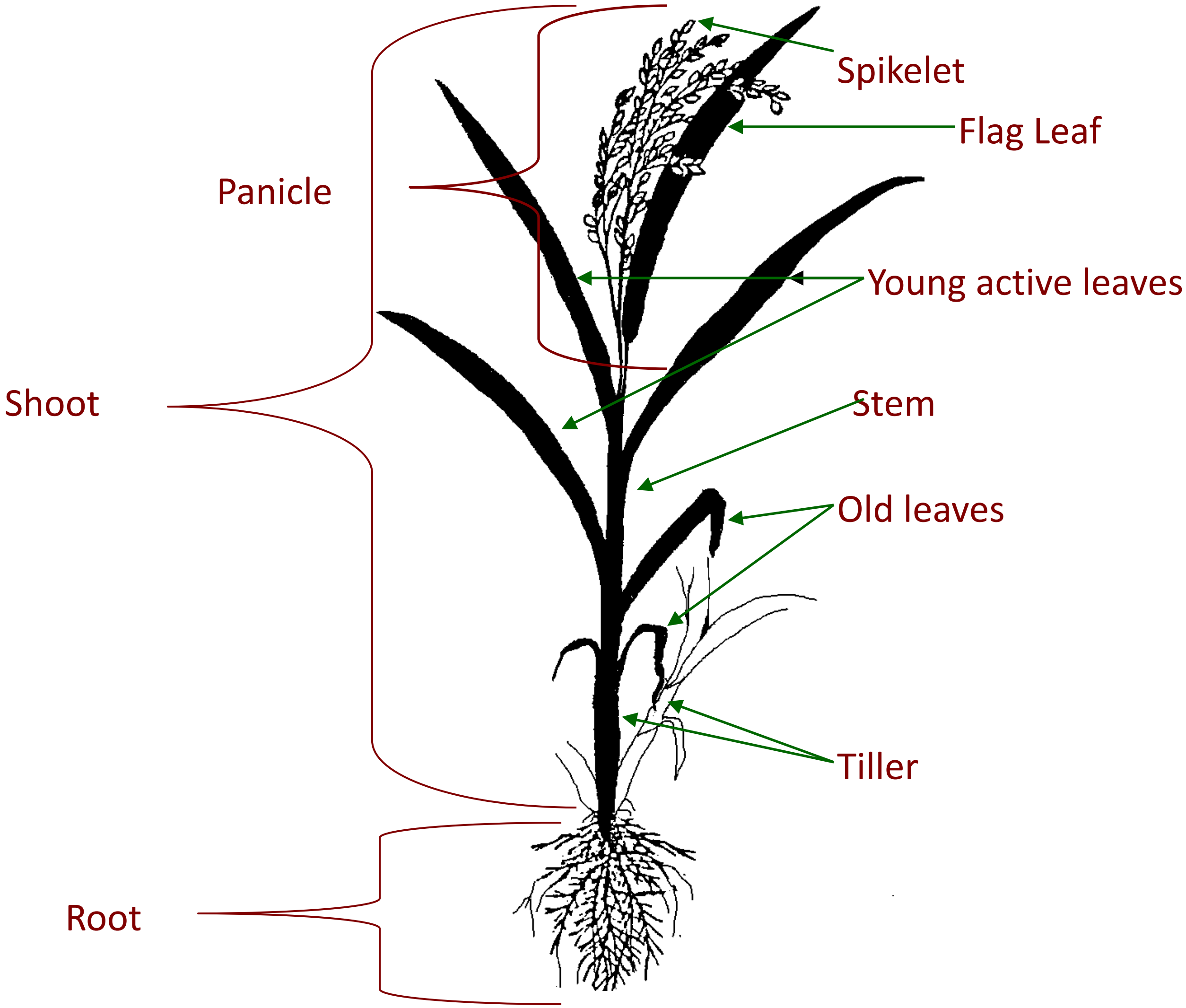

Second leaf (first complete leaf)
Primary leaf (first complete leaf)
Coleoptile
Nodal roots (or adventitious)
Mesocotyl
Mesocotyl roots
Seminal root
Rootlets


Leaf blade
Ligule
Auricle
Leaf sheath
Leaf sheath
Node
Tiller
Internode
Nodal roots
Mat roots
Crown roots
Ordinary roots

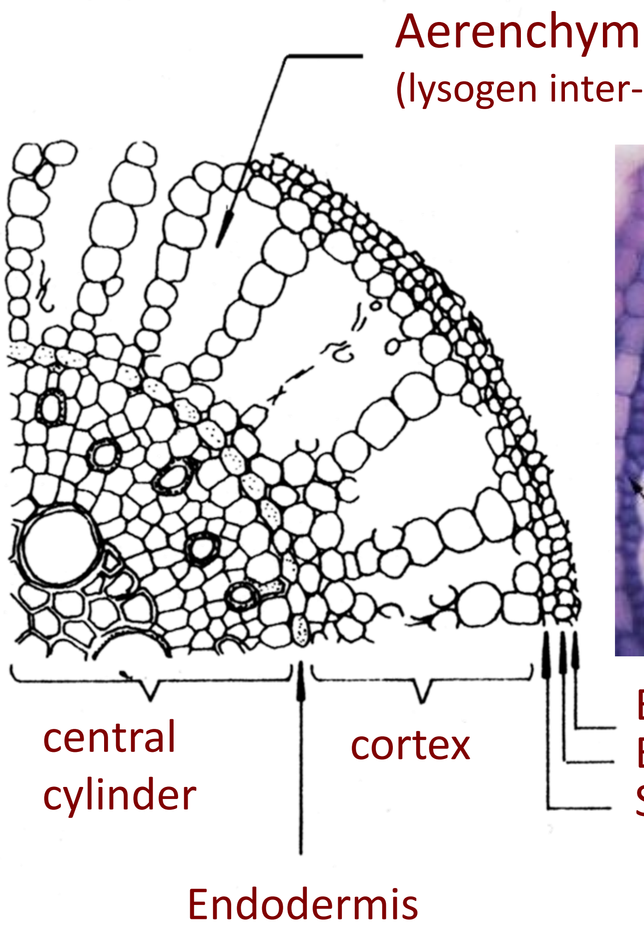

Flag leaf blade
Spikelet (floret)
Secondary branch
Axis
Primary branch
Base
Awn
Paleal apiculus
Anther
Filament
Palea
Lemma
Stigma
Style
Ovary
Rachilla
Sterile lemmas
Rudimentary glumes
Pedicel

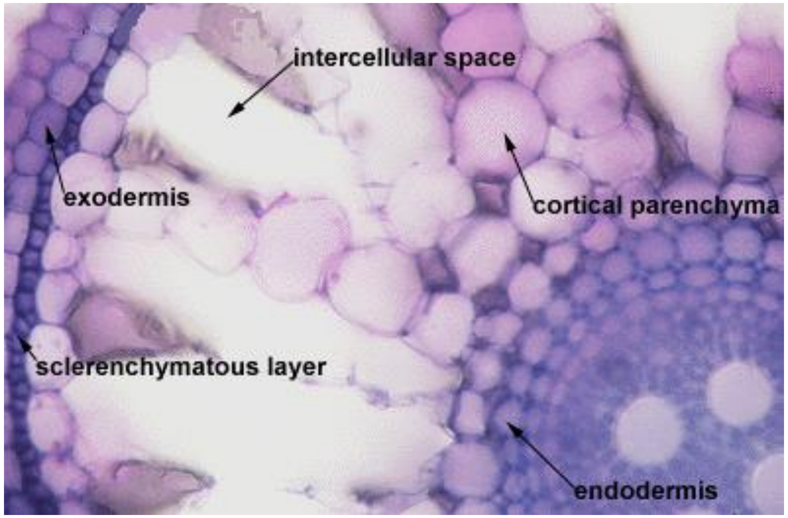
Rice Plant

C3 grass



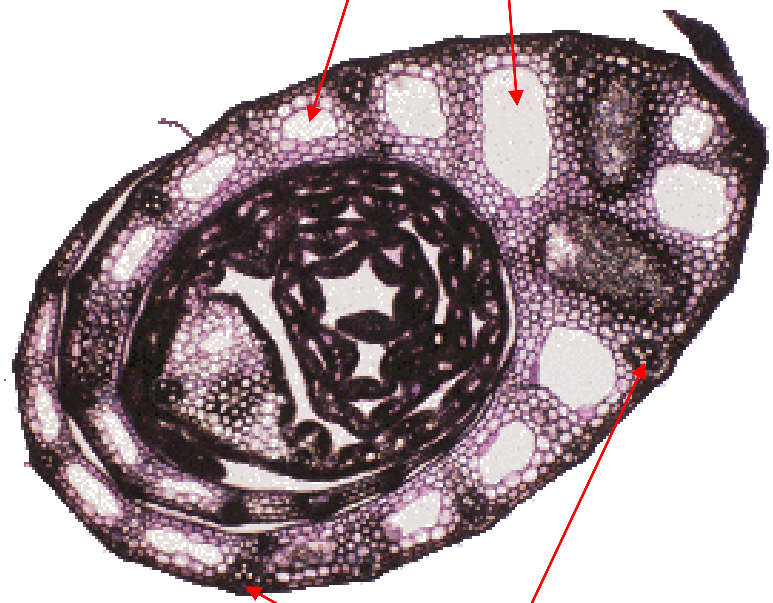
Root
Cross
Section

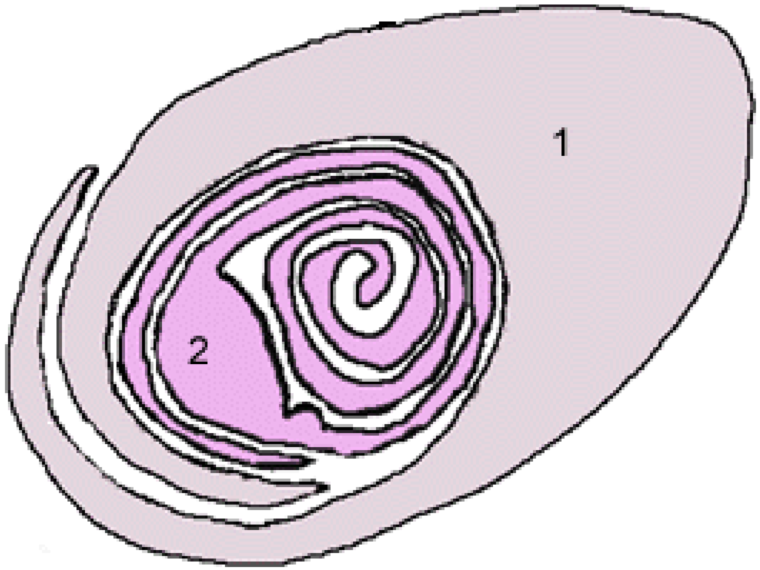




Stem
Cross
Section

Aerenchym
(lysogen inter-cellular space)





leaf veins
(xylem / phloem)

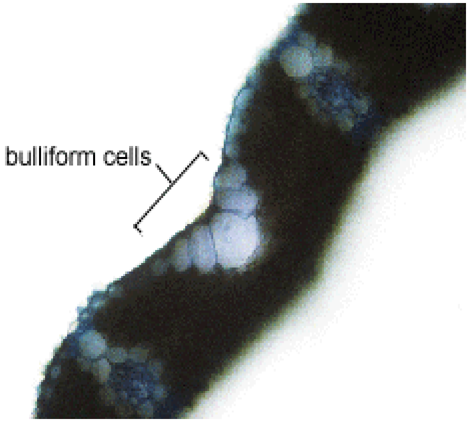
Taro (*Collocasia esculenta*)

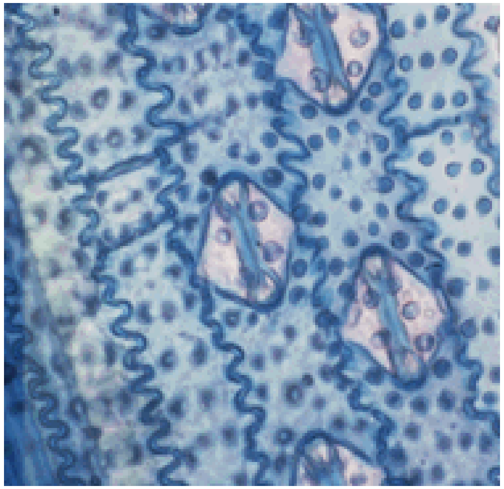
Sago (*Metroxylon revoluta*)

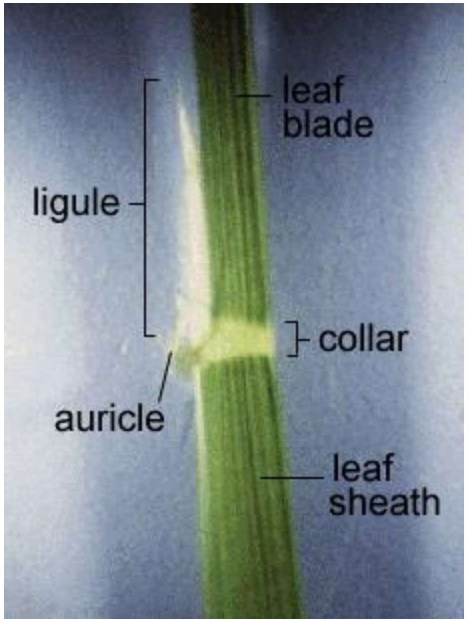
Aerenchyma permits rice to „breath“ under water

The large wetlands and floodplains of this world would not be cultivated if it was not for rice

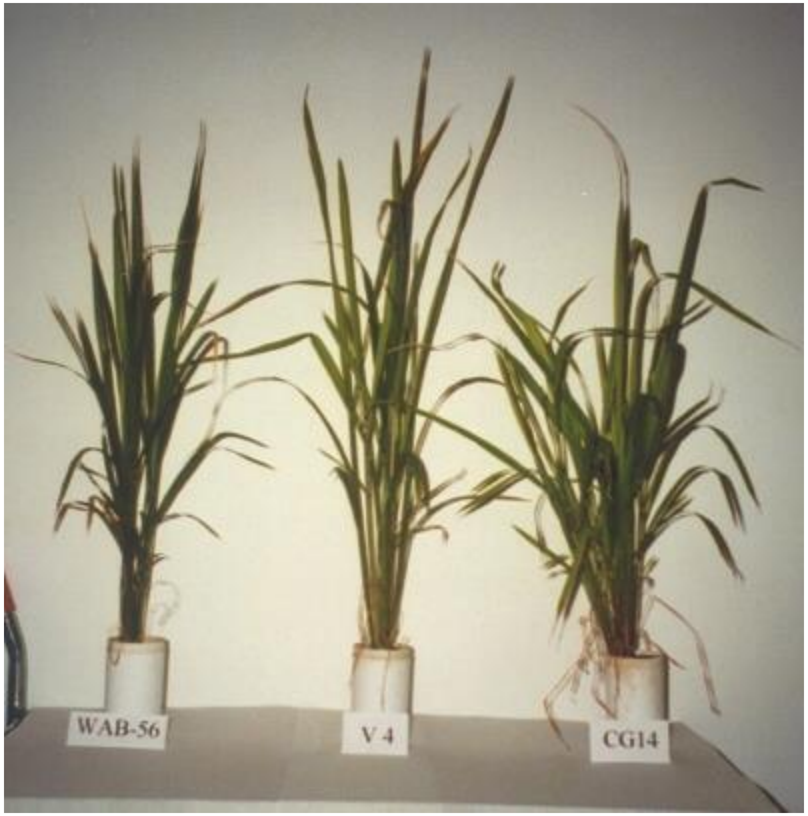
Rice leaf


bulliform cells

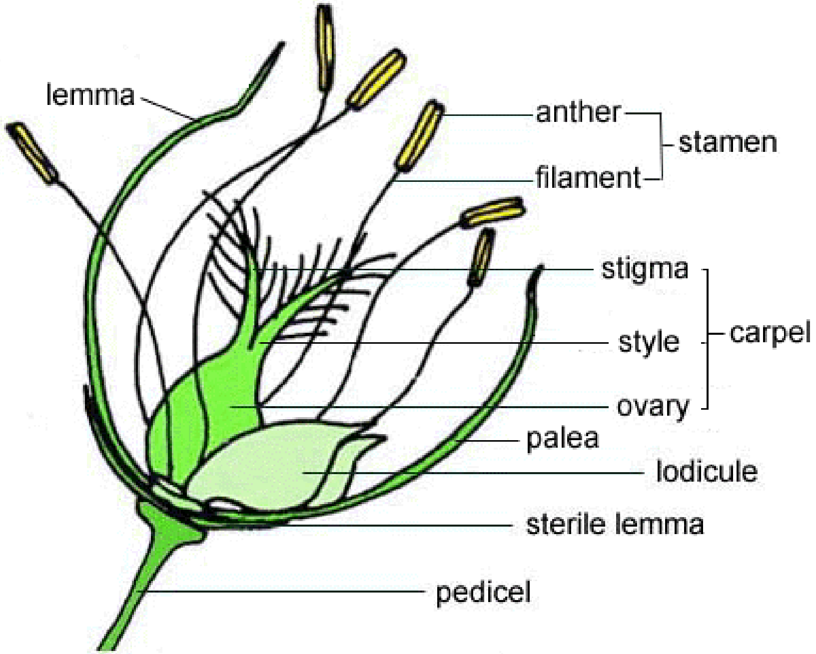



leaf
blade
ligule
collar
auricle
leaf
sheath

Rice plant



Rice flower


lemma
anther
stamen
filament
stigma
style
carpel
ovary
palea
lodicule
sterile lemma
pedicel

Developmental stages

DVS	Description	Duration
0.0	germination	7-14
	seedling	7-14
	active tillering	25-60
.65	panicle initiation	1-2
	booting	20
	heading	10
1.0	flowering	5
	maturation	30
2.0		95-170

Developmental stages

DVS	Description	Duration
0.0	germination	7-14
	seedling	7-14
	active tillering	25-60
.65	panicle initiation	1-2
	booting	20
	heading	10
1.0	flowering	5
	maturation	30
2.0		95-170

Developmental stages

DVS	Description	Duration
0.0	germination	7-14
	seedling	7-14
	active tillering	25-60
0.6	panicle initiation	1
	booting	20
	heading	10
1.0	flowering	5
	maturation	30
2.0		95-170

Developmental stages

DVS	Description	Duration
0.0	germination	7-14
	seedling	7-14
	active tillering	25-60
.65	panicle initiation	1-2
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Developmental stages

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Developmental stages

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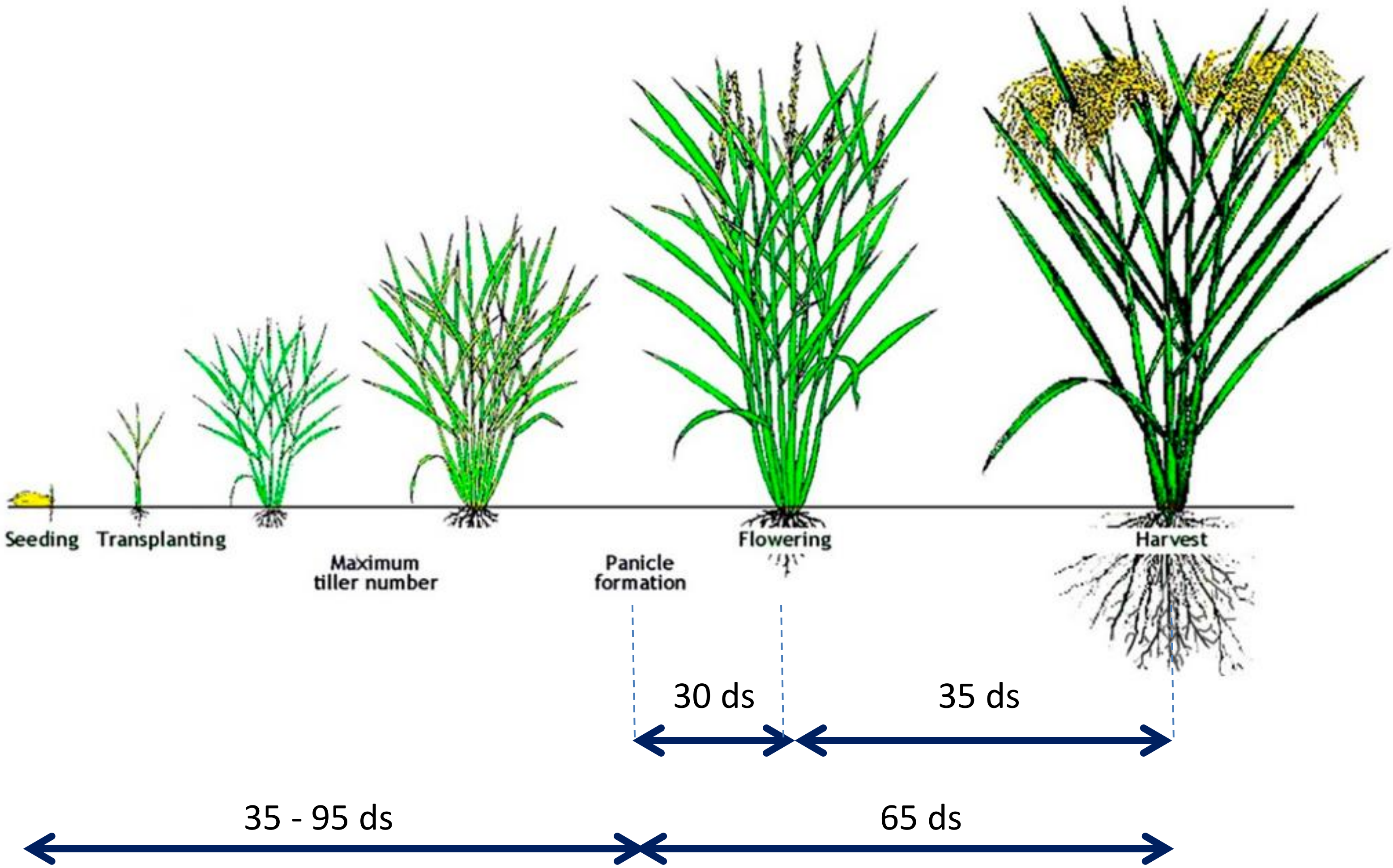

Seeding
Transplanting
Maximum tiller number
Panicle formation
Flowering
Harvest
30 ds
35 ds
35 - 95 ds
65 ds

Rice production systems

Relevance
Diversity
Botany/morphology
Production systems
Production methods

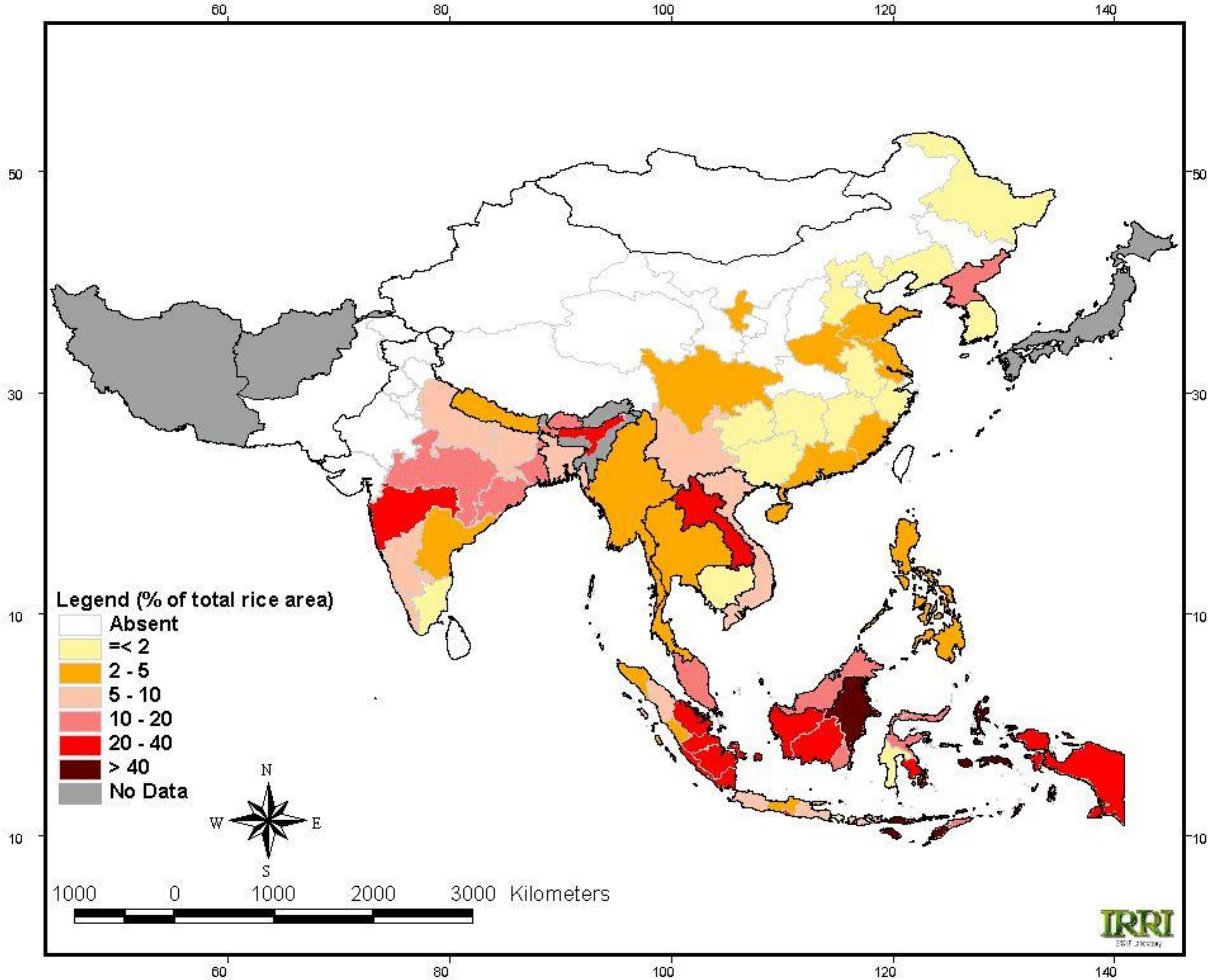
155 million ha

Upland rice: about 29 Mio ha world-wide

- 13 % of the world's harvested rice area.
- 4 % of rice production.
- subsistence level.
- yields are very low (<1 – 1.5 t ha^{-1}).

- Drought, weeds P deficiency.

- Like any other upland cereal, rotational requirements


60
80
100
120
140
50
30
10
10
Legend (% of total rice area)
Absent
=< 2
2 - 5
5 - 10
10 - 20
20 - 40
> 40
No Data
N
W
E
S
1000 0 1000 2000 3000 Kilometers
IRRI

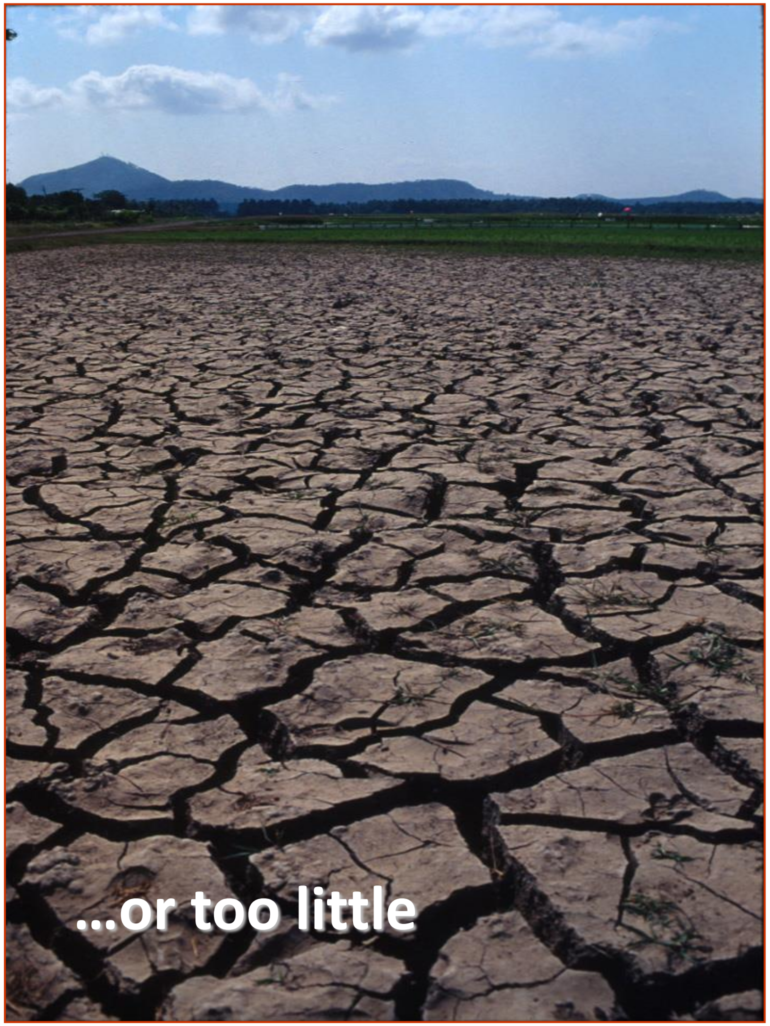
RICE

RICE

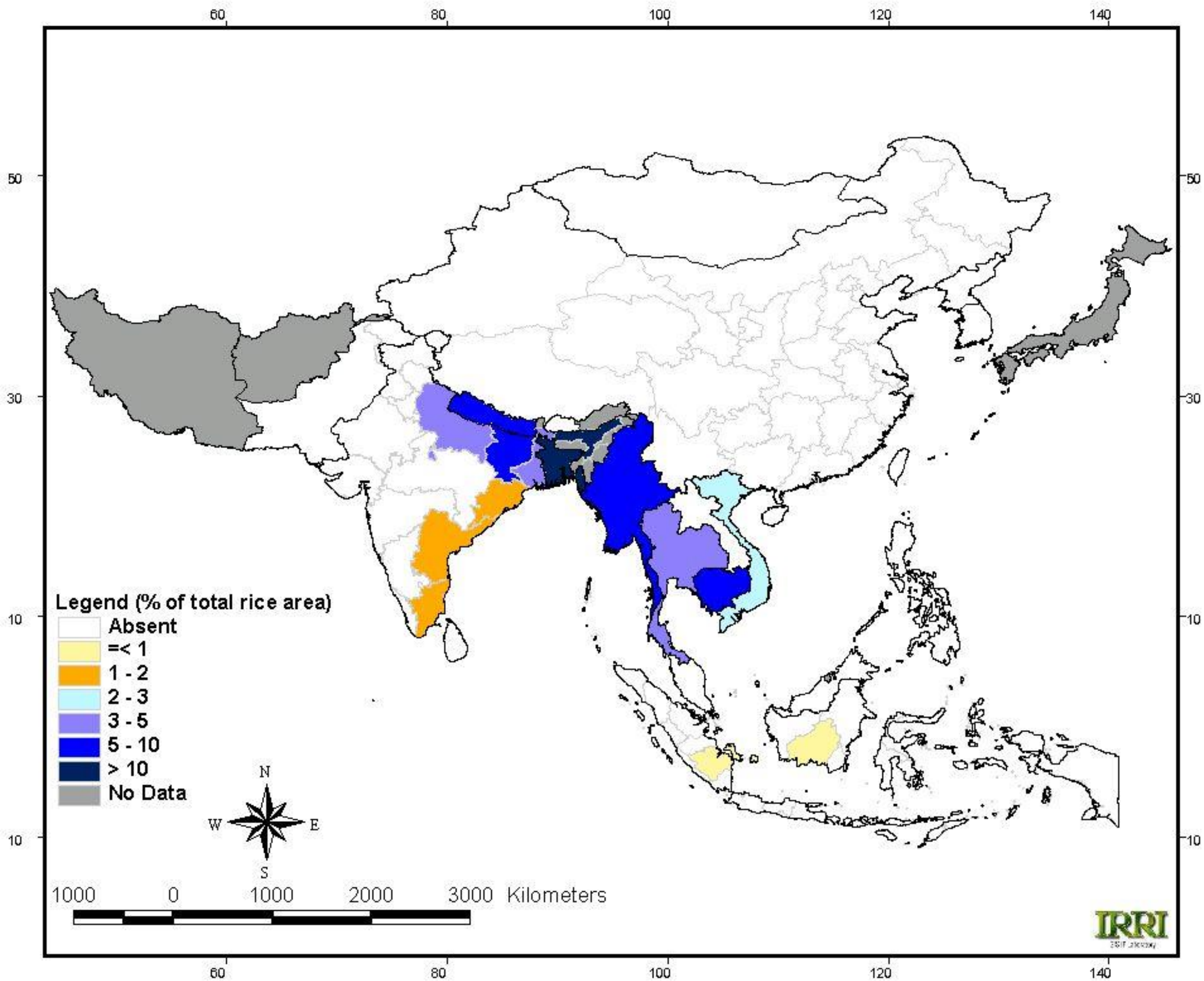
Rainfed lowland rice: about 47 Mio ha worldwide:

- 25 % of the world's harvested rice area.
- 17 % of world production.
- Low-input production.
- low yields (< 2.3 t ha^{-1})
- dominant in humid and subhumid tropics.

- soils alternate from flooded to non-flooded.
- low input use efficiency
- yields vary depending on rainfall,.


…or too little

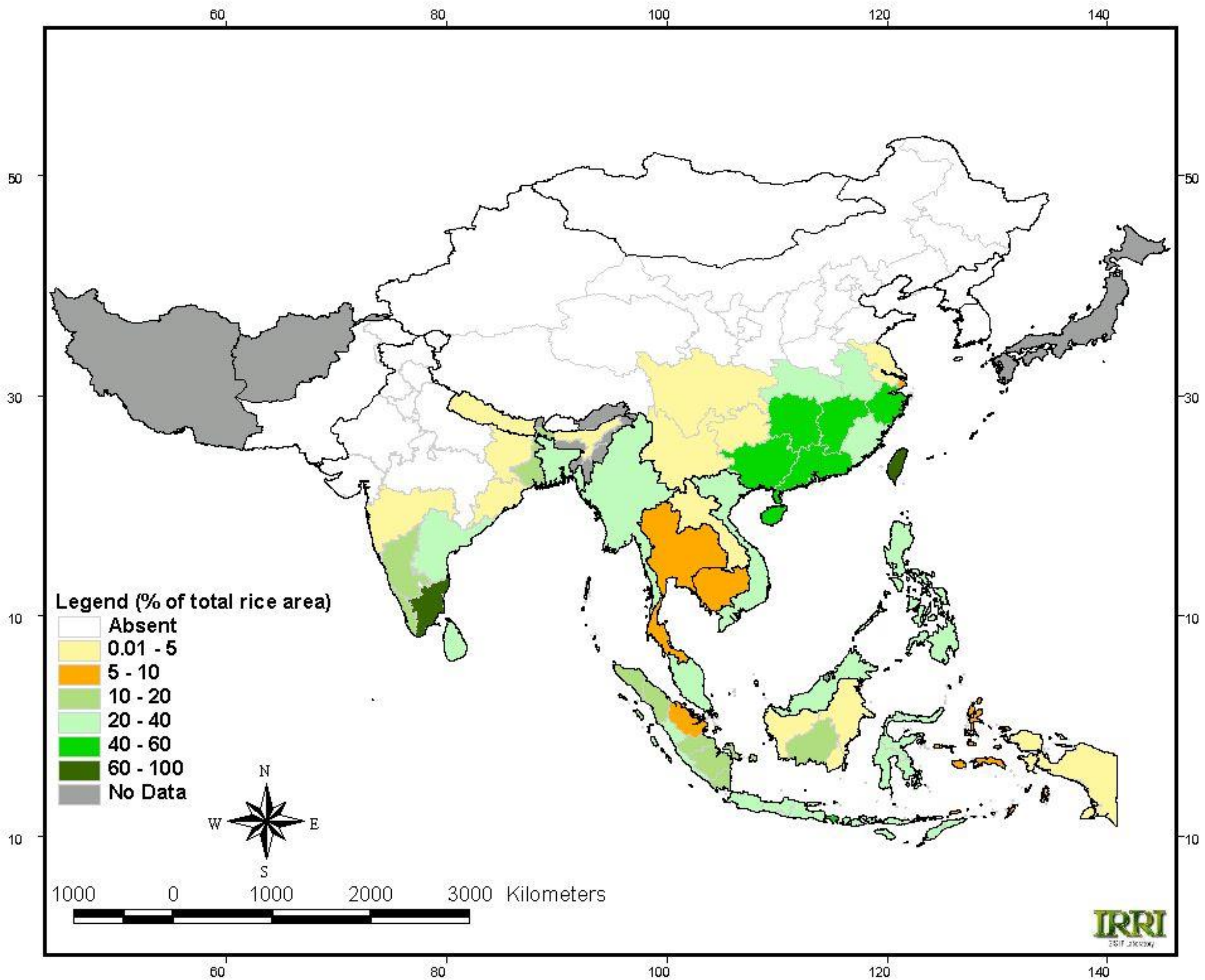

Too much….


60
80
100
120
140
50
30
10
10
Legend (% of total rice area)
Absent
=< 1
1 - 2
2 - 3
3 - 5
5 - 10
> 10
No Data
N
W
E
S
1000 0 1000 2000 3000 Kilometers
IRRI

Irrigated rice: about 80 Mio ha worldwide:

- 55 % of all of the world's harvested area.
- 76% of global rice production.
- High-input systems.
- High potential yields (7 t ha^{-1} WS; > 11 t ha^{-1} DS).

- Input use efficiency
- Biotic and abiotic stresses


60
80
100
120
140
50
30
10
10
Legend (% of total rice area)
Absent
0.01 - 5
5 - 10
10 - 20
20 - 40
40 - 60
60 - 100
No Data
N
W
E
S
1000 0 1000 2000 3000 Kilometers
IRRI

RICE

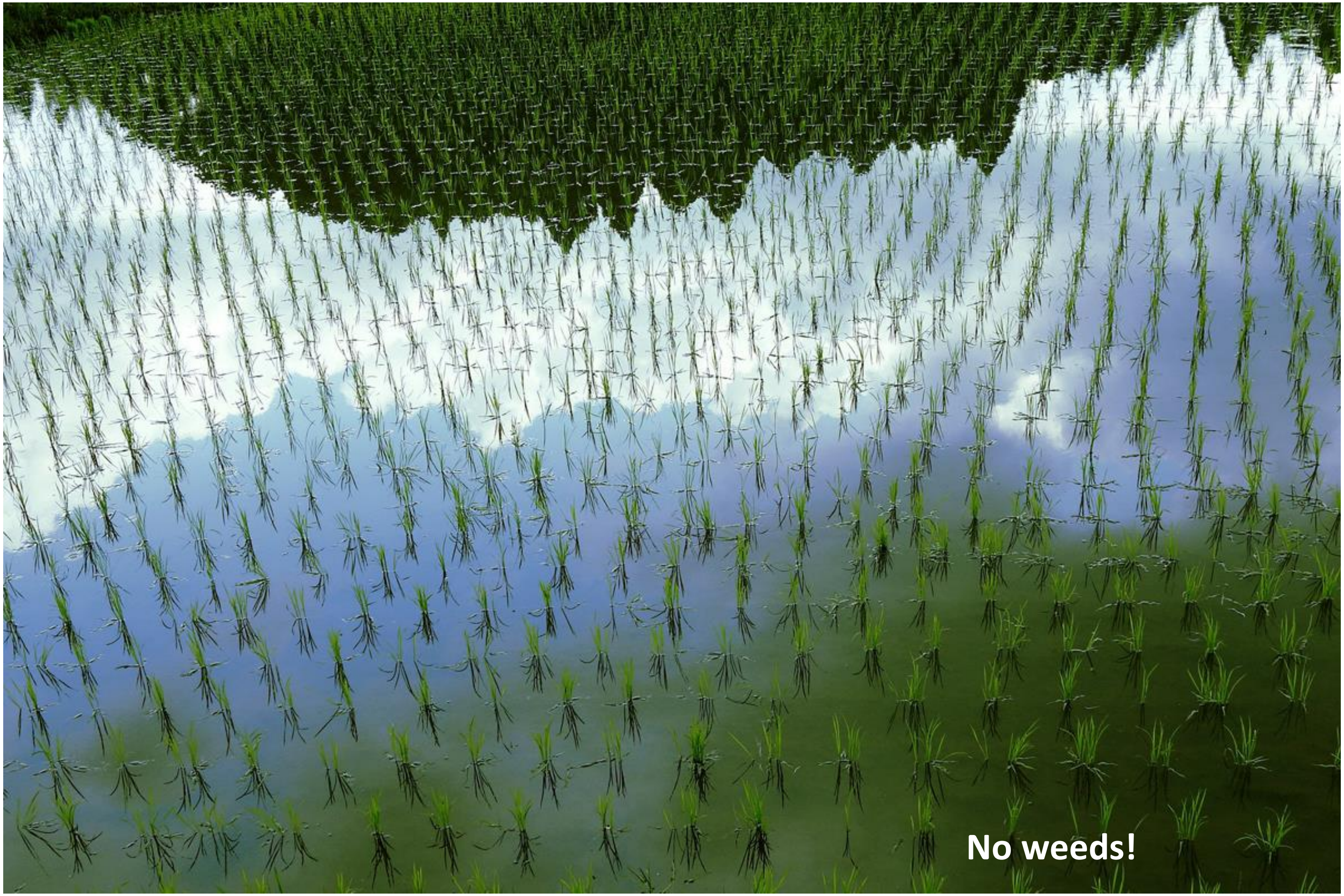

Laser leveling


9

RICE

Why is irigation / soil submergence good for rice?

Why is irigation / soil submergence good for rice?



Rice is harvested...

- mannually
- by stripper harvester
- by combined harvester

…depending on the field size and the economic means of the farmer.

Where there is no thresher...


JOHN DEERE
C670

Rice is grown in very diverse production systems….

Upland
Rainfed lowland
Irrigated
Deep water

12 Mio ha
1.5 t/ha

Rice is grown in very diverse production systems….

Upland
Rainfed lowland
Irrigated
Deep water
Mangrove

6 Mio ha
2.8 t/ha

Rice production systems

Relevance
Diversity
Botany/morphology
Production systems
Production methods
Outlook

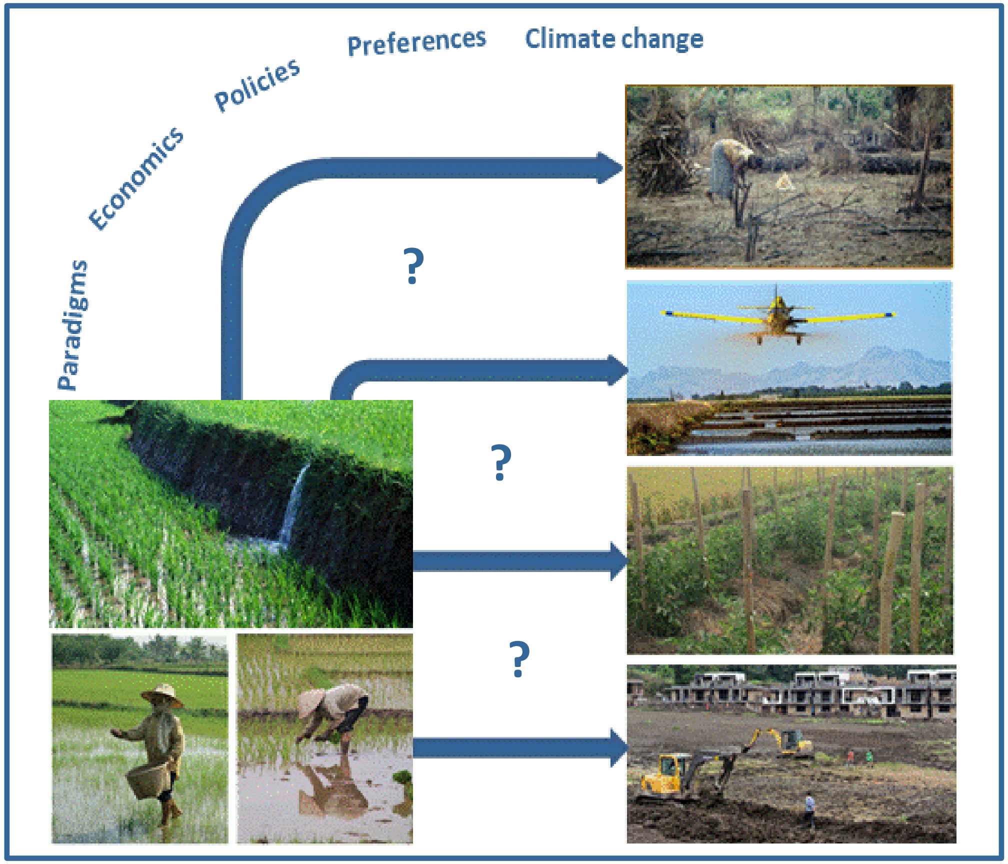
Rice production systems in Asia

- changes, determinants, effects -

System-immanent Drivers

External pressures

→ System shifts



Projecting future food security requires to understand

(1) why systems change → ***determinants and drivers***

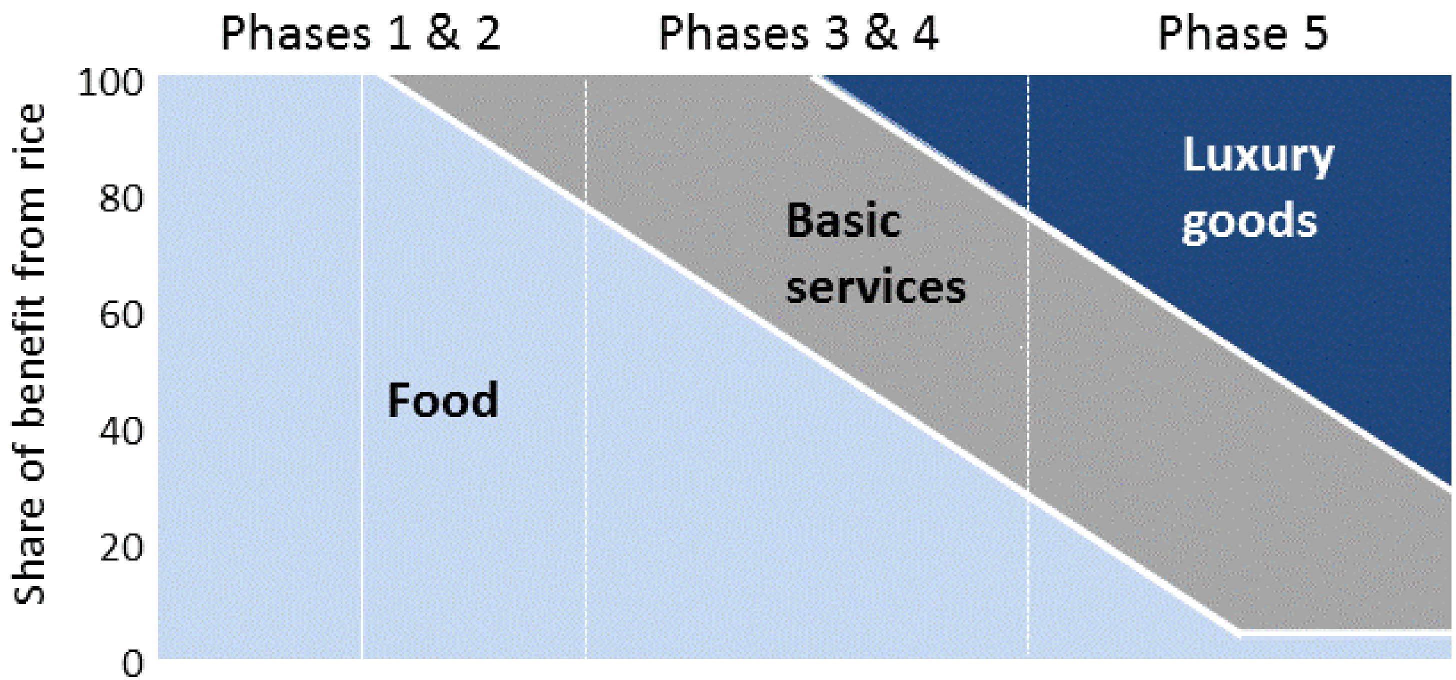
(2) how systems change → ***processes and pathways***

(3) which new configurations → ***patterns, implications***

System-immanent drivers of change (on-farm resource endowment, aspitations)

External pressures for change (climate change, prices, conflicts, policies)

Shifting expectations (differential evolution)



Adapted from Becker & Angulo 2018

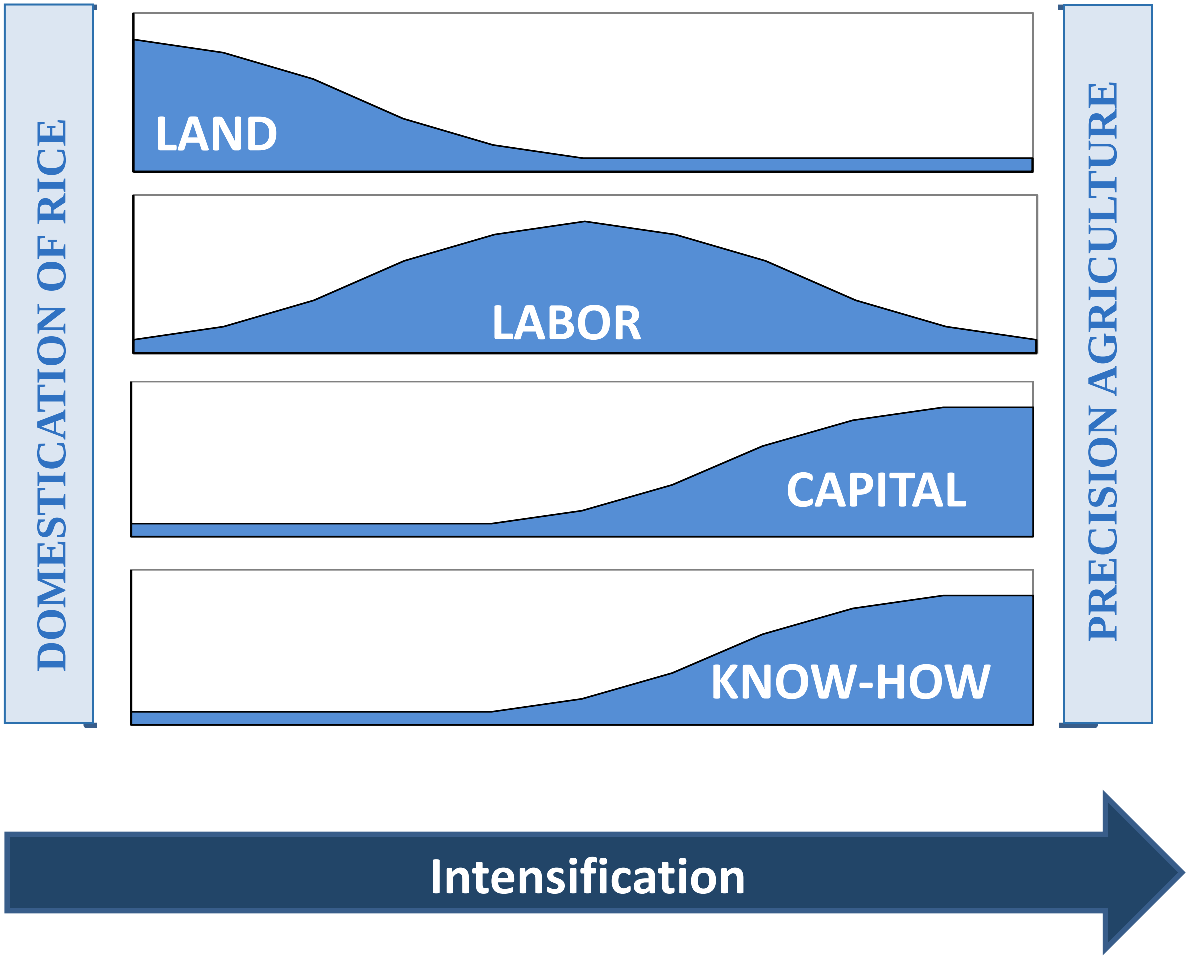
Shifting benefits expected from rice farming

„food“ refers to the satisfaction of subsistence needs, seed requirements , market demand

„basic services“ refer to amenities i.e. electricity, communication, schooling, medical services;

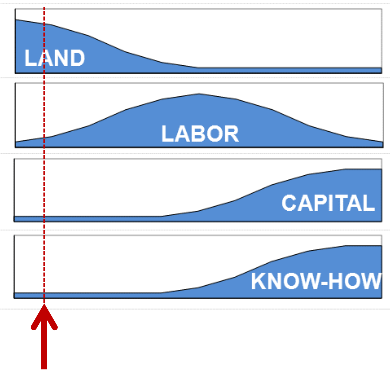
„luxury goods“ refer to perceived modernity needs such as smartphones, vehicles, fashon

Drivers of change: availability of production factors



Adapted from Becker & Angulo 2018

Drivers of change: availability of production factors (stage 1)

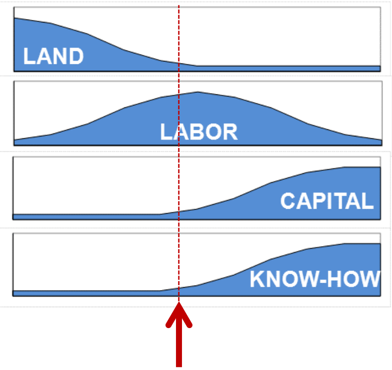


Shifting cultivation

- Subsistence
- Labor-limited
- Capital-limited
- Extensive single rainfed crop

Manual, no-input, subsistence single rainfed rice system

Drivers of change: availability of production factors (stage 2)

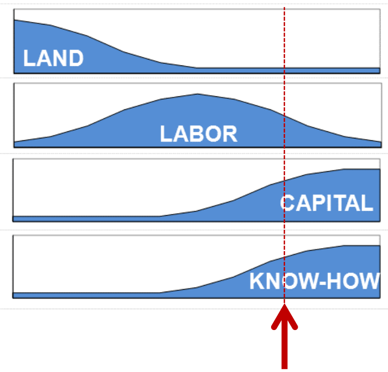


Transplanted paddy

- Partial subsistence
- Land-limited
- Labor-intense
- Bunded rainfed crop

Manual, low-input, bunded single rainfed rice system

Drivers of change: availability of production factors (stage 3)

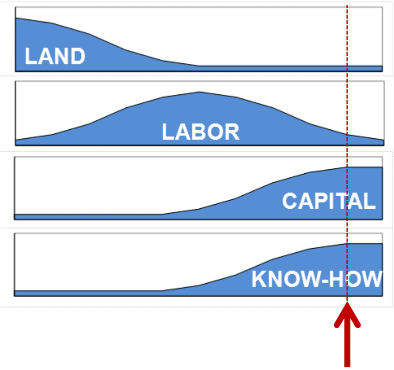


Irrigated lowland rice

- Marker-oriented
- Land-limited
- Labor-intense
- Capital use
- Input-intense double/triple cropping

Manual, medium/high-input, irrigated double rice system

Drivers of change: availability of production factors (stage 4)



Direct seeded rice

- Market-oriented
- Capital-intense (agrochemicals, mechanization)
- Multiple crops

Direct seeded, mechanized, high-input, irrigated double rice systems

External pressures for change: (stage 5)

Water limitations
(over-extraction and climate change)

Water-saving rice
Replace DS rice with upland crops

External pressures for change

Water limitations

→ Diversified production

- Water-saving rice
- → yield loss

- High-value crops
- → less rice

→ Lower yields, no more dry season rice

Replace dry season rice crop by less water demanding high value commo

More weed pressure with water limitations

	Humid		Sub-humid		Semi-arid	
	Wet-dry	Flooding	Wet-dry	Flooding	Wet-dry	Flooding
Cumulative weed biomss	---(t/ha) ---					
Becker et al., 2003	0,92	0,80	1,58	0,86	0,73	0,66
Becker and Johnson, 2001	1,23	1,00	1,78	1,29	2,25	1,02
Kent et al., 2001	1,81	1,11				
Becker et al., 1999	0,96	0,89	1,38	0,88		
Mean difference	***0,23***		***0,49***		***1,23***	
Yield gap due to weeds	**0,15**		**0,45**		**1,02**	

Permanent flooding reduces weed biomass and increases grain yields
(Becker et al., 2003; Howell et al. 2015)

Aerobic soil phase enhances SOM mineralization

		Alternate wetting	Permanent flooding
Soil organic Carbon		---- SOC (%) ----	
Becker and Johnson, 2001	E Africa	1.53	1.79
Becker et al., 2003	SE Asia	1.23	1.93
Shrestha et al., 2021	S Asia	1.81	2.54
Touré et al., 2007	W Africa	1.60	2.03
Niang et al., 2017	Africa	1.70	2.10
Mean difference		***0,52***	

(n=216)

With temporary aerobic conditions: higher respiration, 0.5% less SOC

External pressures for change: (stage 5)

Water limitations (over-extraction and climate change)	Water-saving rice Replace DS rice with upland crops
Rice Tarifs (cheap imports for urban voters)	**Rice no longer profitable Land sale, real estate**

External pressures for change: (stage 5)

Import Tarifs
(i.e., Philippines)

Abandoning rice

- Land sale

→ Loss of rice lands

Income-generation through land sale for real estate

External pressures for change: (stage 5)

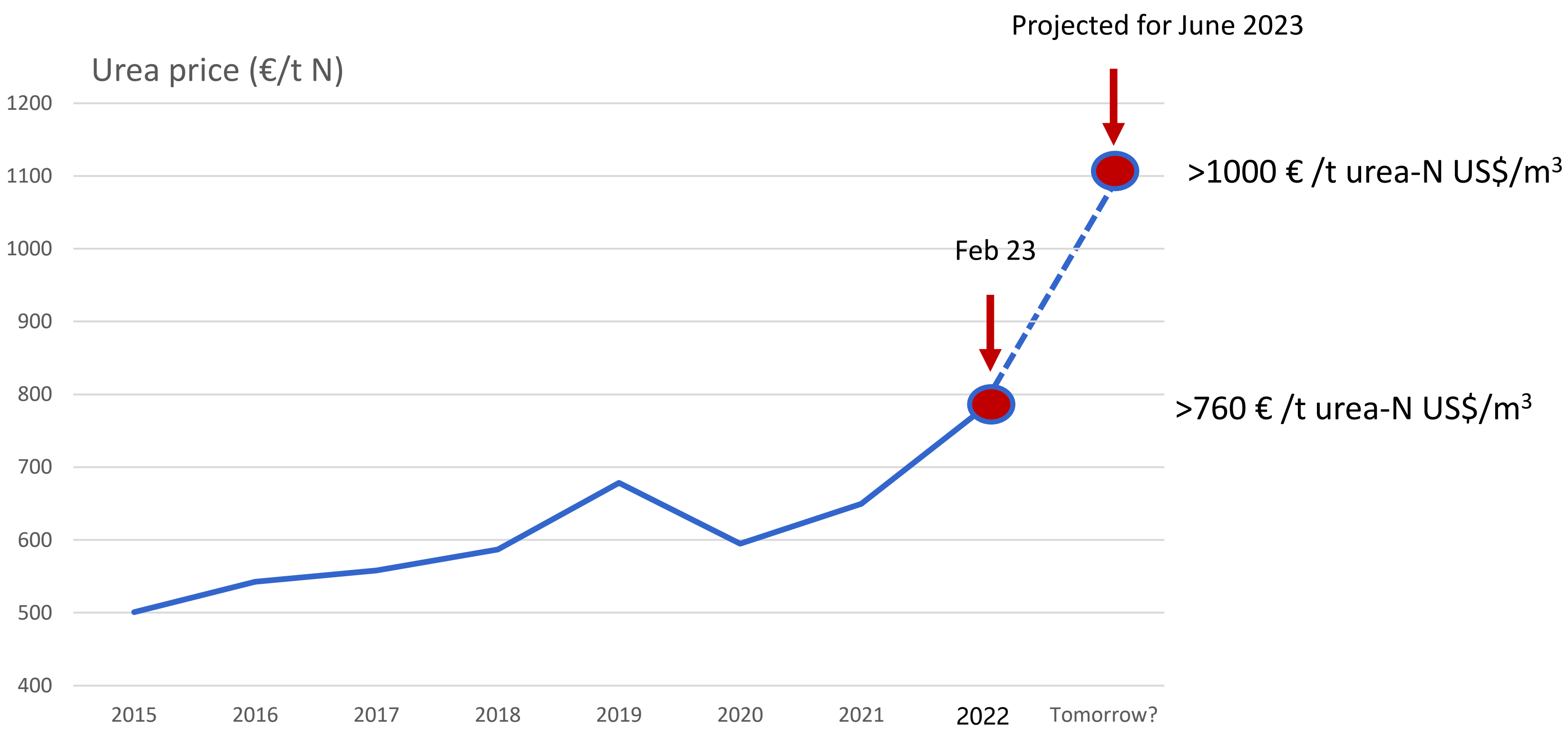
Water limitations
(over-extraction and climate change)

Water-saving rice
Replace DS rice with upland crops

Rice Tarrifs
(cheap imports for urban voters)

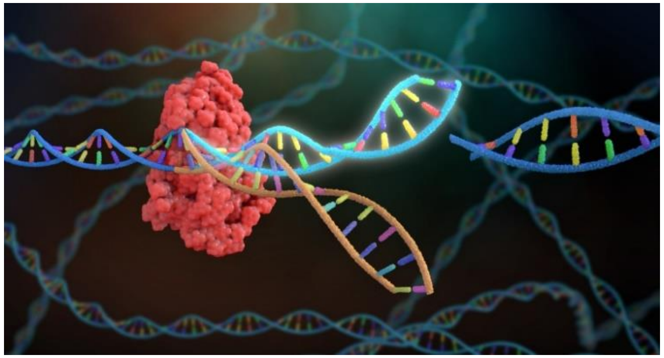
Rice no longer profitable
Land sale, real estate

Russia - Ukraine war
(Price for N fertilizer)


Projected for June 2023
Urea price (€/t N)
1200
1100
1000
900
800
700
600
500
400
>1000 € /t urea-N US$/m³
Feb 23
>760 € /t urea-N US$/m³
2015
2016
2017
2018
2019
2020
2021
2022
Tomorrow?

External pressures for change: (stage 5)

Water limitations (over-extraction and climate change)	Water-saving rice Replace DS rice with upland crops
Rice Tarrifs (cheap imports for urban voters)	Rice no longer profitable Land sale, real estate
Russia - Ukraine war **(Price for N fertilizer)**	**Reduce N inputs** **Increase input efficiency (hybrids, GMOs)**



→ Lower yields, more GMs

External pressures for change: (stage 5)

Water limitations (over-extraction and climate change)	Water-saving rice Replace DS rice with upland crops
Rice Tarrifs (cheap imports for urban voters)	Rice no longer profitable Land sale, real estate
Russia - Ukraine war (Price for N fertilizer)	Reduce N inputs → yield reduction Increase input efficiency (hybrids)
Social standards **(Minimum wage for agric. labor)**	**Mechanization** **Labor-saving production**

→ High investments for machinery, less opportunities for rural employment, migration

External pressures for change: (stage 5)

Water limitations (over-extraction and climate change)	Water-saving rice Replace DS rice with upland crops
Rice Tarrifs (cheap imports for urban voters)	Rice no longer profitable Land sale, real estate
Russia - Ukraine war (Price for N fertilizer)	Reduce N inputs → yield reduction Increase input efficiency (hybrids)
Social standards (Minimum wage for agric. labor)	Mechanization Labor-saving production
Consumer demand **(Organic, specialty rice)**	**Organic manuring** **Low-yielding specialty rice**

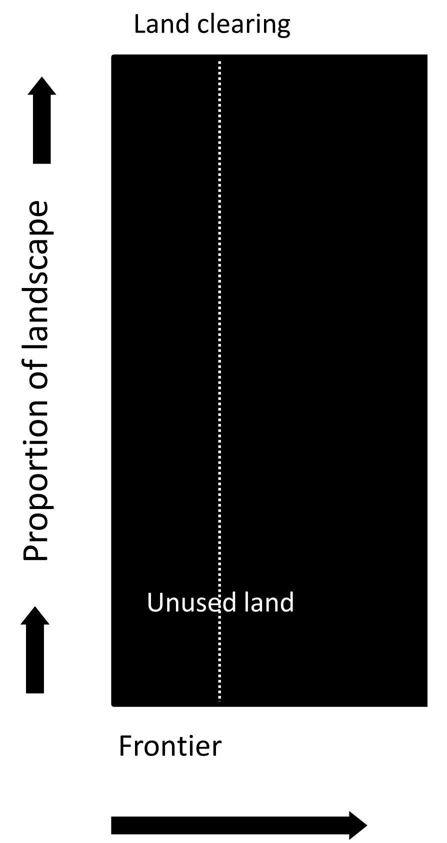
→ Lower yield of organically-grown rice

External pressures for change: (stage 5)

Water limitations (over-extraction and climate change)	Water-saving rice Replace DS rice with upland crops
Rice Tarrifs (cheap imports for urban voters)	Rice no longer profitable Land sale, real estate
Russia - Ukraine war (Price for N fertilizer)	Reduce N inputs → yield reduction Increase input efficiency (hybrids)
Social standards (Minimum wage for agric. labor)	Mechanization Labor-saving production
Consumer demand (Organic, specialty rice)	Organic manuring Low-yielding specialty rice
Aging farm population (>65 years)	**Land sale** **Make rice farming "sexy" again**

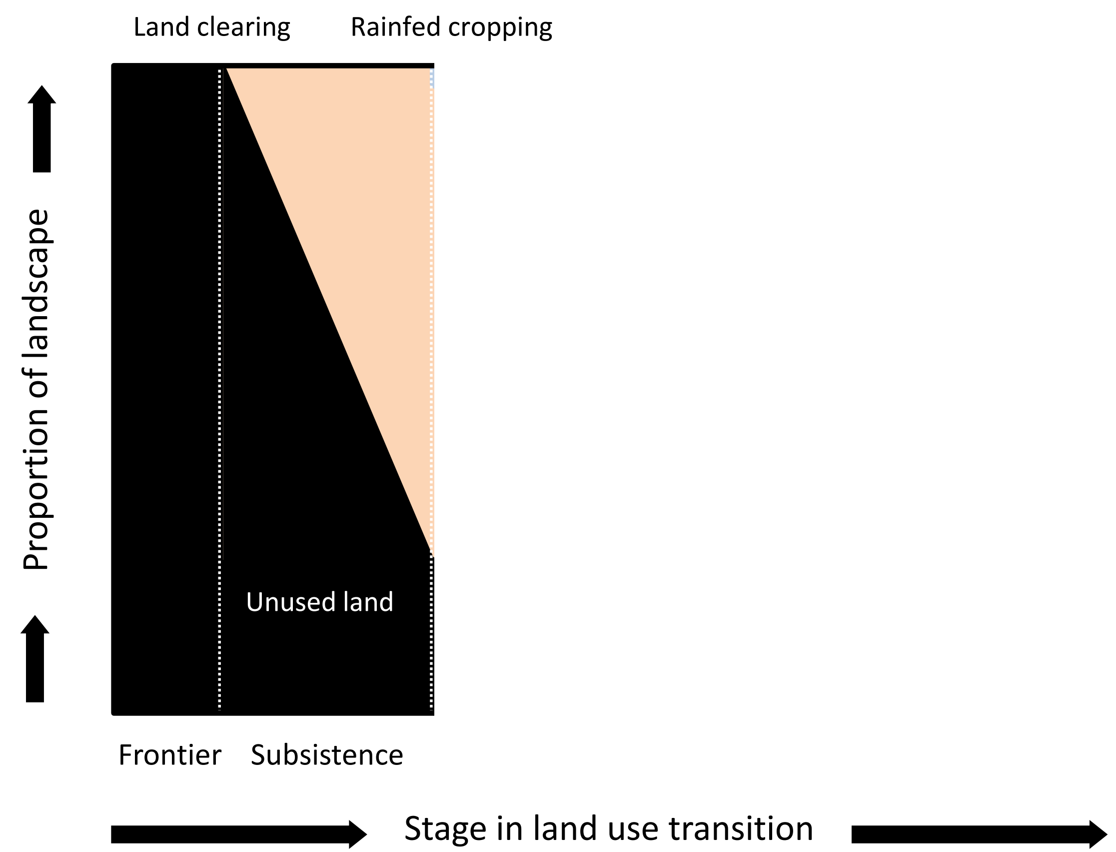
→ Aging farmers, youth migrate

Land use transitions in rice (stage 1: land clearing)



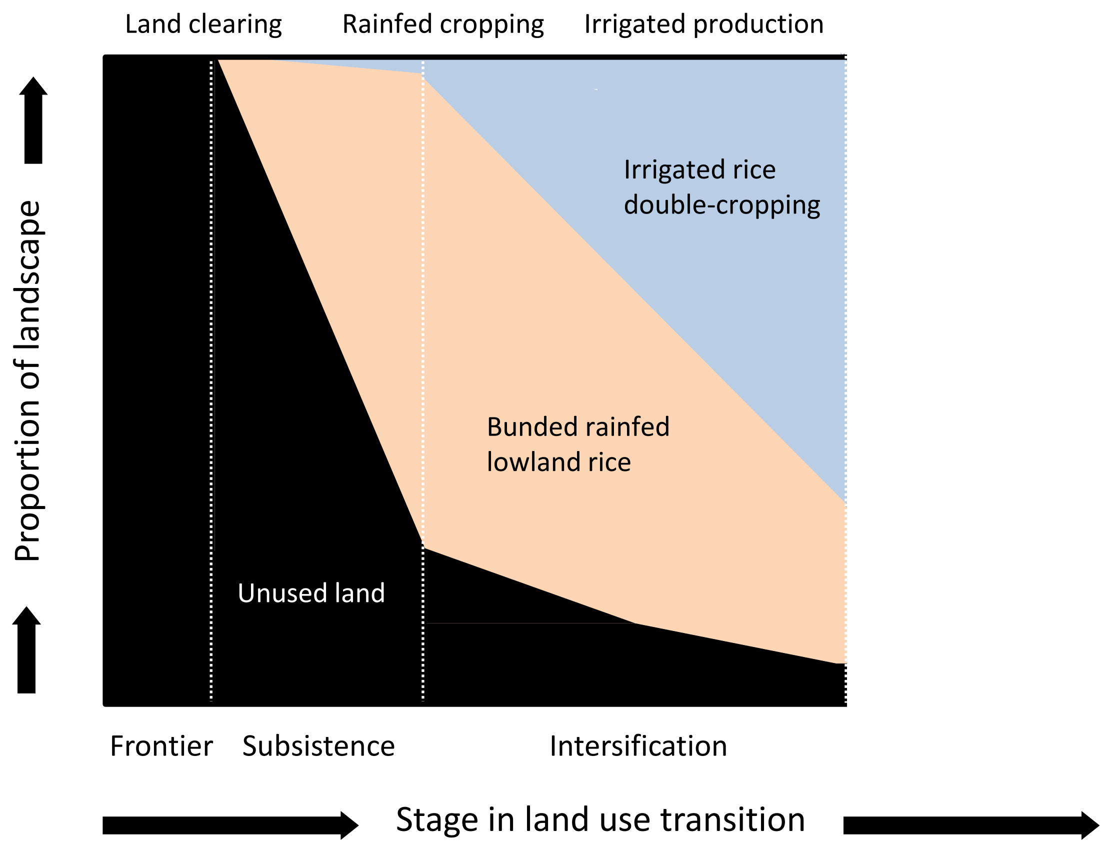
Adapted from Foley et al. (2005)
Global Consequences of Land Use. Science, 309, 570–574

Land use transitions in rice (stage 2: crop expansion)



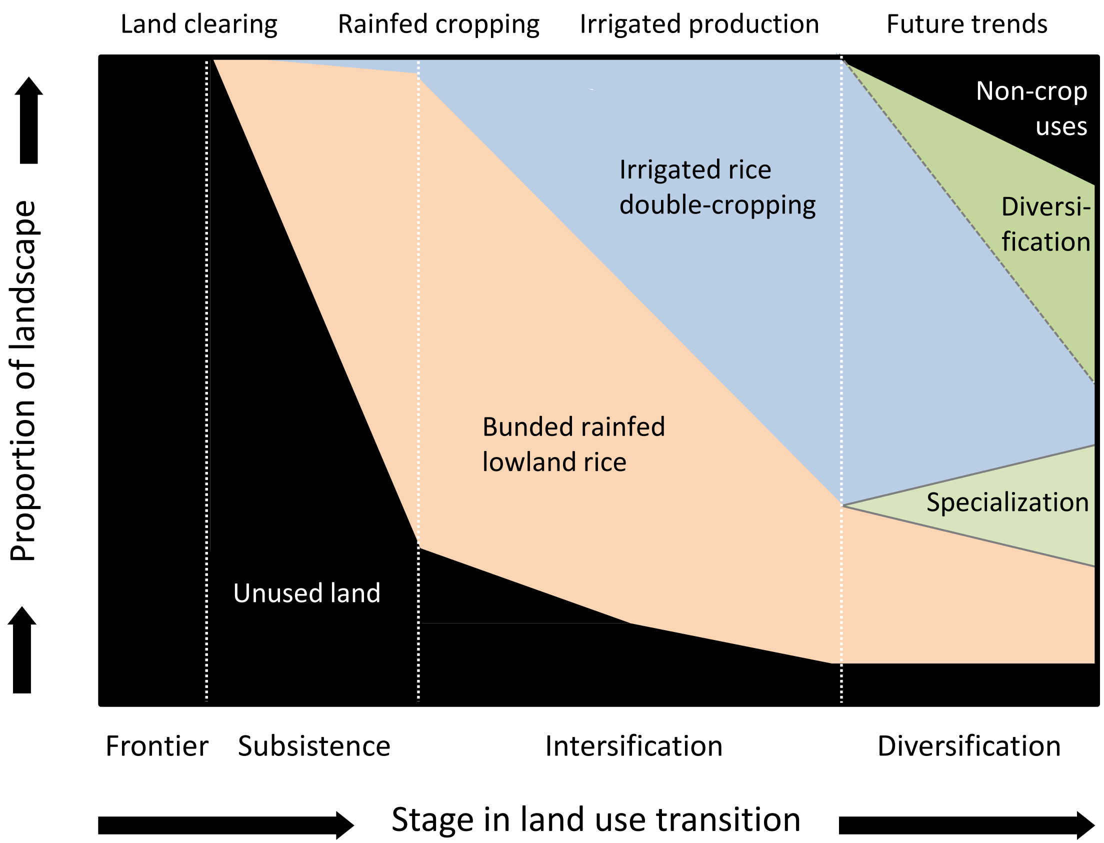
Adapted from Foley et al. (2005)
Global Consequences of Land Use. Science, 309, 570–574

Land use transitions in rice (stage 3: intensification)



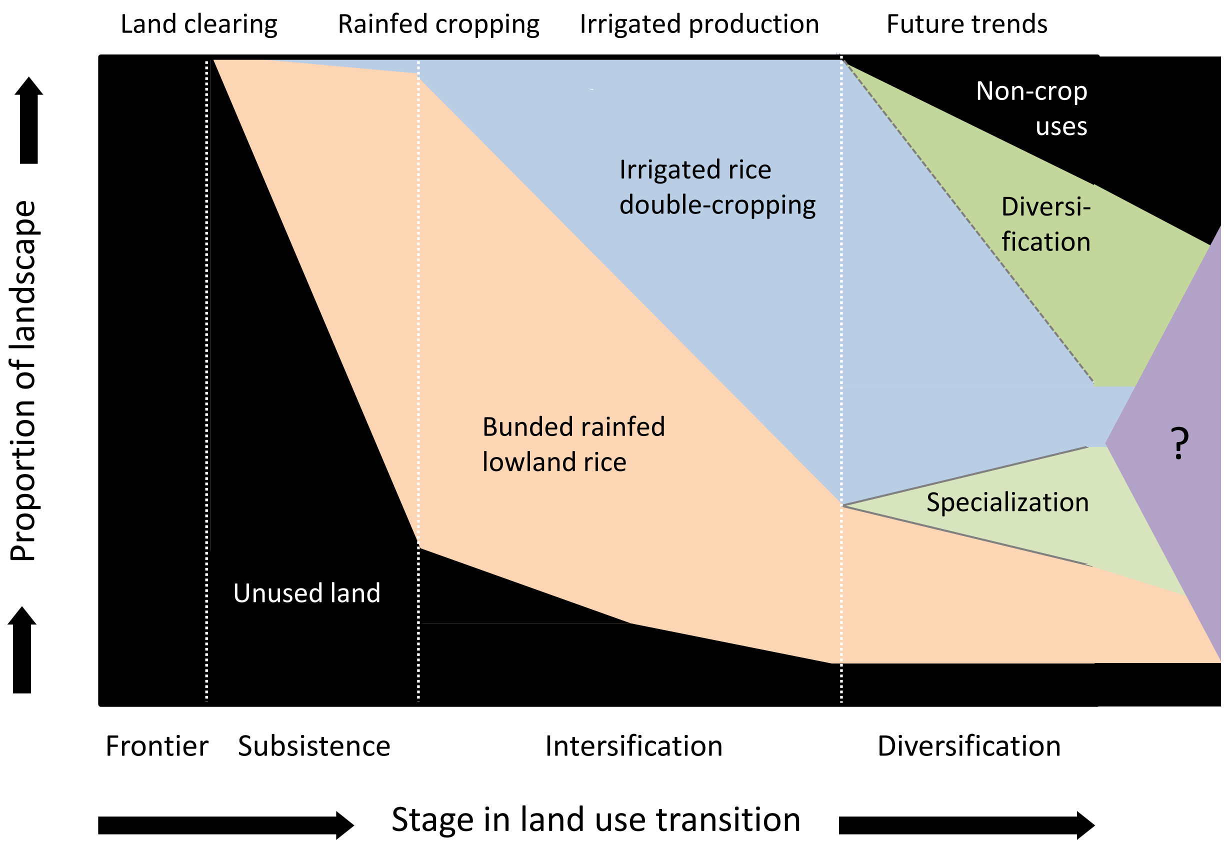
Adapted from Foley et al. (2005)
Global Consequences of Land Use. Science, 309, 570–574

Land use transitions in rice (stage 4: diversification)



Adapted from Becker & Angulo 2018

Land use transitions in rice (stage 5: ??????)



Real estate?
Industry?
Nature?
Non-rice crop

Adapted from Becker & Angulo 2018

Projecting future food security requires to understand

(1) why systems change → *determinants and drivers*

(2) how systems change → *processes and pathways*

(3) which future configurations → *patterns* ?????

Most current trends (system-immanent and external pressures) point to a reduction in rice production in the foreseeable future ......

Awareness
Research
Policies


the end

Date	Month	Day	Module	Topic	Lecturer
08.05.2023	May	Monday	BS3 Land use systems (sub)tropics	Intro/Interactions	Becker
09.05.2023	May	Tuesday		Payment for ESS	Börner
10.05.2023	May	Wednesday		Forest system	Freudenberger
11.05.2023	May	Thursday		Wetland systems	Becker
12.05.2023	May	Friday		Dryland systems	Becker
13.05.2023	May	Saturday			
14.05.2023	May	Sunday			
15.05.2023	May	Monday	BS3 Land use systems	Ecosytem services	Freudenberger
16.05.2023	May	Tuesday		Threats to biodiversity	Freudenberger
17.05.2023	May	Wednesday		Conservation issues	Freudenberger
18.05.2023	May	Thursday		Assension Day	
19.05.2023	May	Friday	(sub)tropics	Human development	Freudenberger
20.05.2023	May	Saturday			
21.05.2023	May	Sunday			
22.05.2023	May	Monday	BS3 Land use systems (sub)tropics	Pasture systems	Behn
23.05.2023	May	Tuesday		Pasture management	Behn
24.05.2023	May	Wednesday		Botany of plants	Behn
25.05.2023	May	Thursday		Groups of compounds	Behn
26.05.2023	May	Friday		Seminar preparation	Students
27.07.2023	July	Saturday			
28.07.2023	July	Sunday			
29.05.2023	May	Monday		Pentecoast	
30.05.2023	May	Tuesday	BS3 Land use systems (sub)tropics	Rice-based systems	Becker
31.05.2023	May	Wednesday		Student presentation	All
01.06.2023	May	Thursday		Student presentation	All
03.06.2023	July	Saturday			
04.06.2023	July	Sunday			

Block 4

Topics and schedule for seminar presentations

#. Topic	Student 1	Student 2	Date
1. Algal production	Nathalie	Steven	Wednesday 31.05.23
2. Rose production	Caroline	Kalu	
3. Biopesticides	Grace	Santosh	
4. Medicinal plants	Abisoye	Kentsa	
5. Leavy vegetables	Norinia	Inkyin	Thursday 01.06.23
6. Range land conflicts	Karin	Marina	
7. Ecotourism	Novira	Sineenad	
8. Bishmeat hunting	Lian	...	