GRiSP Global Rice Phenotyping Network

Gene discovery and donor development for traits through multi-phenotyping of diversity panels

Michael Dingkuhn, Lead
Julie Pasuquin, Manager

- Network initiated in 2011
- Mainly field based phenomics
- Funding by GRiSP, Syngenta, CSISA

NARS

PhilRice Ph

CAAS Ch

EMBRAPA Br

GRiSP Centers

IRRI

C4-Rice

Africa Rice

CIAT

Cirad

IRD

JIRCAS

Private sector

Syngenta

Universities

Flinders Au

Newcastle Au

Cornell US

Saudi Univ.

UPLB Ph

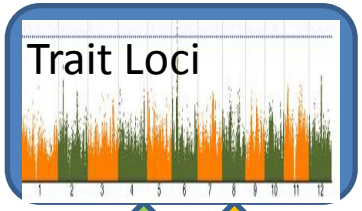
Univ. Bonn De

Colorado SU US

Basic concept

Trait measurements:

- Yield, biomass
- Phenology
- Morphology, Anatomy
- Lodging resistance
- drought, salinity, heat, cold
- Plant & grain chemistry



GWAS

Phenomics resource

Genomics resource

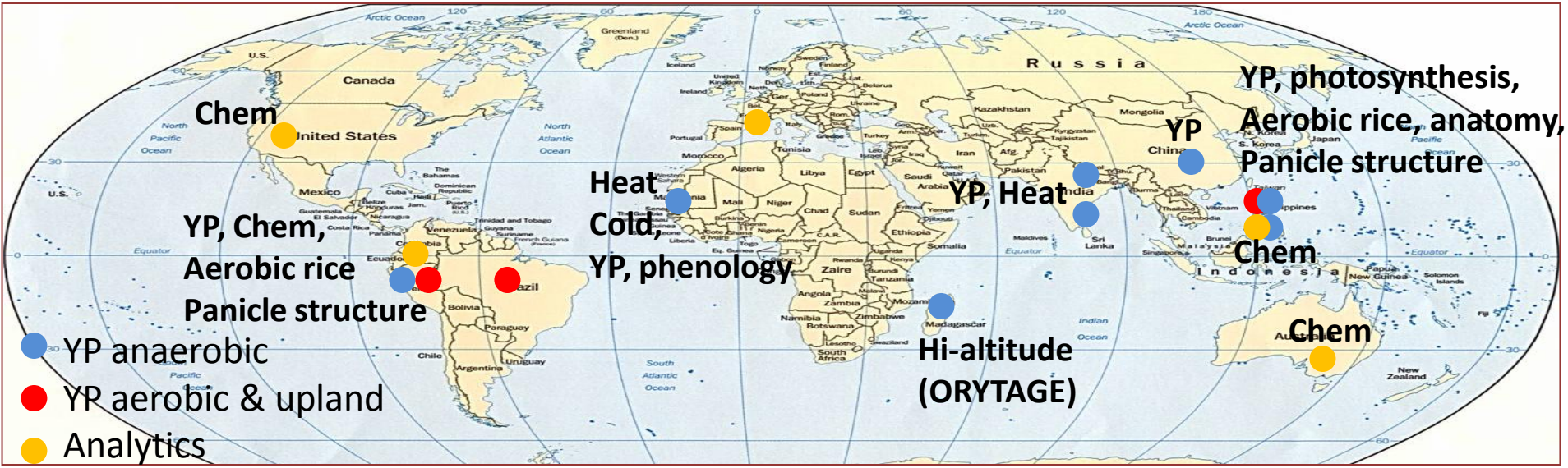
Genome-wide maps of DNA polymorphisms:

- GBS (>20k SNPs)
- ORYZA-Chip (700k SNPs)
- Resequencing

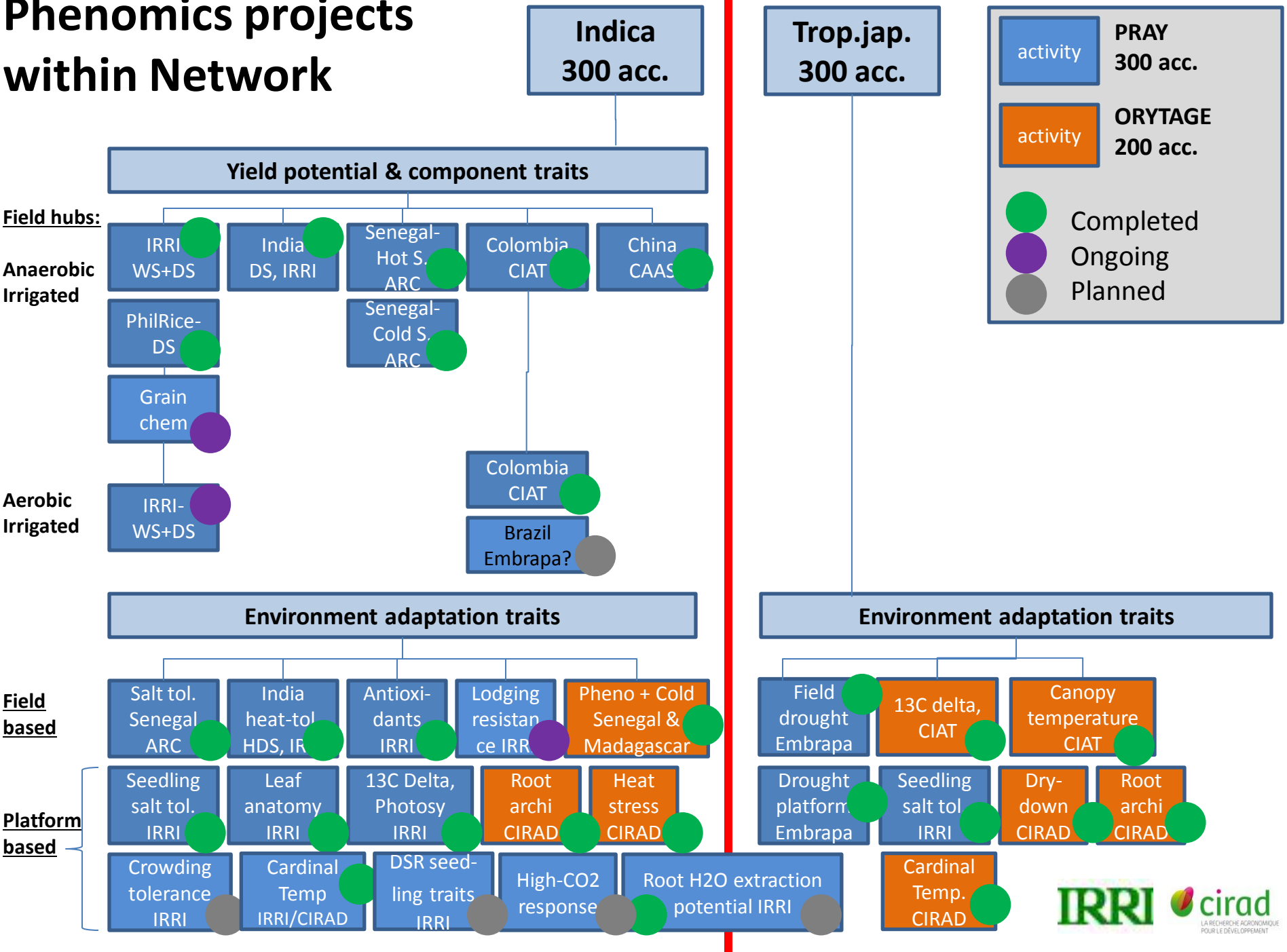
Shared panels among partners

Scope

- Gene discovery
- Emphasis on **field** and **climatic diversity**
- Y**ield potential, Lodging** and their component traits
- **Abiotic stresses**
- **(Biotic stresses: Tungro, Blast)**
- An **evolving phenomics DB,** a **rolling GWAS process**



Phenomics projects within Network



PRAY indica panel (300 acc.)

15577::IRGC 76987-1
17/79/02-005::IRGC 51080-1
849::IRGC 5970-1
91-385::IRGC 63466-C1-G1
AGAMI M 1::IRGC 4158-1
AI LAN KE 1110::IRGC 67034-1
AI-CHIAO-HONG
AN QING ZAO::IRGC 72577-1
ANAYANSI::IRGC 77474-1
ANGIFOTSY 685
APO::C1-G1
ARANG
ARC 10818::IRGC 21079-1
ARC 15872::IRGC 43249-C1-G1
B 6144 F-MR-6::IRGC 117313-1
BADA DHAN::IRGC 26540-1
BADKALAMKATI::IRGC 45011-1
BAI HE::IRGC 76437-1
BALGALA GURMATIA::IRGC 61074-1
BAMAWPYAN::IRGC 72458-1
BANDIOUROU::IRGC 15980-1
BG 301::IRGC 117315-1
BG 34-11::IRGC 15782-1
BH 2::C1-G1
BINULAWAN
BIRAIN 360::IRGC 6550-1
BODOMANO::GERVEX 8343-C1-G1
BOTRA MAITSO
BOTRIKELY::GERVEX 8404-C1-G1
BR24
BYAT KYAR::IRGC 33004-1
C 21::IRGC 331-C1-G1
CARREON
CERE AIR::IRGC 43369-1
CHANG CH'SANG HSU TAO
CHAU
CHERIVIRUPPU::IRGC 19928-C1-G1
CHI TOU HUANG 1::IRGC 51280-1
CHIEM CHANH
CHINA 98-45-1::IRGC 1598-1
CHITRAJ (DA 23)::IRGC 6208-1
CHORUA KARTIKSAIL::IRGC 77230-1
CHUA DAU::IRGC 4785-1
CICA 8
CIMARRON::IRGC 116967-1
CO 18
CO 39::IRGC 51231-1
CT6510-24-1-2
DA 29 (SR 26 B)::IRGC 25850-1
DA 5::IRGC 5855-1
DA 9::IRGC 5854-1
DA NUO (ZHAN)::IRGC 72024-1
DALIFODE::IRGC 57766-1
DANAU LAUT TAWAR
DE ABRIL::IRGC 50463-1
DENG DENG QI::IRGC 72671-1
DJOGOLON DJOGOLON::IRGC 75577-1
E 5168::IRGC 68021-1
E ZI 124::IRGC 70215-1
EA HOUM::IRGC 12925-1

ELONI
ELWEE::IRGC 15565-1
EMBRAPA 6 CHUI::IRGC 116981-1
FANDRAPOTSY::IRGC 10984-1
GAJPATI::IRGC 58981-1
GAMBIAKA KOKOUM::C1-G1
GIE 57::IRGC 8231-1
GODA HEENATI::IRGC 31393-1
GOPAL::IRGC 61953-1
GUAN-YIN-TSAN
H15-23-DA
HAO HOM::IRGC 12931-1
HASAN SERAI::IRGC 79564-C1-G1
HONG MI DONG MAO ZHAN::IRGC 68078-1
HONG ZUI ZAO::IRGC 68090-1
IAC 165 (included by error; trop-jap, replace w/ IR64)
ICTA POLOCHIC::IRGC 116997-1
INIAP 415::IRGC 117001-1
IR 2006-P12-12-2::IRGC 32675-C1-G1
IR 31917-45-3-2::IRGC 78132-1
IR 32453-20-3-2-2::IRGC 76331-1
IR 36
IR 43::IRGC 117005-1
IR 5::IRGC 10321-1
IR 50::C1-G1
IR 52::IRGC 53434-C1-G1
IR 55419-04::C1-G1
IR 59469-2B-3-2::IRGC 99703-1
IR 60::IRGC 63493-C1-G1
IR 72::C1-G1
IR 74371-3-1-1::IRGC 117373-1
IR 77298-14-1-2::IRGC 117374-1
IR 77384-12-35-3-12-1-B::IRGC 117299-1
IR 8
IR1561-228-3-3
IR19746-28-2-2
IR20
IR22
IR2344-P1PB-9-3-2B
IR28
IR53236-275-1
IR57920-AC-25-2-B
IR57924-24
IR64-21
IR74371-54-1-1
J 104::IRGC 117008-1
JAMAJIGI::C1-G1
JARIYU::IRGC 53265-1
JC 120::IRGC 9178-1
JC 91::IRGC 9177-1
JC 92::IRGC 9176-1
JINLING 78-102::IRGC 88421-1
KALINGA III::C1-G1
KANNI MURUNGA::IRGC 15432-1
KARAYAL::IRGC 51001-1
KATI::IRGC 67838-1
KAUKHMWE::IRGC 33174-1
KAUKKYI ANI::IRGC 33189-1
KHAO DAW TAI::IRGC 24108-1
KHAO DAWK MALI 105::IRGC 27748-1

KHAO PON::IRGC 48114-1
KIANG-CHOU-CHIU
KINANDANG PUTI::IRGC 44513-1
KIRIMURUNGA::IRGC 15585-1
KOGONI 91-1
KUMBI::IRGC 752-1
KUN-MIN-TSIEH-HUNAN
LAGEADO::IRGC 50490-1
LAL AMAN::IRGC 46202-1
LAL BAGDAR::IRGC 77272-1
LALBAJAM::IRGC 49227-1
LIU XU::IRGC 74099-1
LOHAMBITRO 224::GERVEX 5144-C1-G1
LOKU SAMBA::IRGC 31462-1
LONG ZI 1::IRGC 63726-1
LUA TAU DUC::IRGC 16872-1
MA GU ZI HE::IRGC 68212-1
MA WAINE OHN::IRGC 33357-1
MACAN BINUNDOK
MADAEL::IRGC 7722-1
MAHADETHE::IRGC 74762-1
MAHSURI::IRGC 10929-1
MAKALIOKA 34::IRGC 6087-1
MAKALIOKA::IRGC 77864-1
MAMORIAKA 114
MANDRIRAVINA::IRGC 69960-1
MANGAVAVA FOTSILANSTSIKA
MAURITIUS LOCAL::IRGC 5834-1
MENAKELY::IRGC 69963-1
MG 2::IRGC 79837-1
MILYANG 23::IRGC 34393-1
Minghui 63
MOTTA SAMBA::IRGC 36489-1
MTU 9::IRGC 7919-1
MTU9
NAKABAWA::IRGC 70676-1
NAM ROO
NAM SA GUI 19
NAN TE 113::IRGC 70345-1
NARGUNI::IRGC 74713-1
NARU HATHIYAL::IRGC 15547-1
NCS 130::IRGC 51879-1
NGAJA::IRGC 64917-1
NIONOKA::C1-G1
NONA BOKRA
NORUNKAN::IRGC 8934-1
NS 113::IRGC 68838-1
NS 1611::IRGC 68963-1
O-LUEN-CHEUNG
ORYZICA LLANOS 5
ORYZICA SABANA 10::IRGC 117018-1
PANAKALI::IRGC 47399-1
PAO TOU HUNG
PAPPAKU
PATCHAIPERUMAL::IRGC 15681-1
PATIK::IRGC 43530-1
PAWHTUN::IRGC 33562-1
PCT 11\0\0\2,BO 1>55-1-3-1::C1-G1
PEH PI NUO::IRGC 8266-C1-G1
PEH-KUH

PEH-KUH-TSAO-TU
PELITA JANGGUT::IRGC 43540-1
PERUM KARUPPAN::IRGC 15524-1
PETA::IRGC 32571-1
PICONEGRO::IRGC 117022-1
PIN KAEO::IRGC 5803-1
PIN TAWNG::IRGC 40673-1
PINURSIGI::IRGC 26889-1
POKKALI
POPOT::IRGC 43545-C1-G1
PSBRC 18::IRGC 117375-1
PTB 25::IRGC 6386-1
PTB 9::IRGC 6274-1
PURBIA (KALANSAR)::IRGC 59189-1
QING GU::IRGC 59839-1
QING SHUI ZAO::IRGC 72807-1
RACE::IRGC 15706-1
RAJ BHOG::IRGC 77294-1
RATHKANDIRAM::IRGC 36507-1
RATHUWEE::IRGC 8952-1
RAY JAZAYKAYZ::IRGC 62181-1
RAY NABJA::IRGC 62184-1
RED PIE BOLD 17-214::IRGC 38207-1
ROJOFOTSY 693::GERVEX 8407-C1-G1
ROJOMENA 1034::GERVEX 8412-C1-G1
RR 166-645::IRGC 117352-1
RTS 14
RTS 4::IRGC 8177-1
RTS 5::IRGC 8233-1
RUZZ (HABUR)::IRGC 55679-1
SADA DANGA BORO::IRGC 77298-1
Sadu Cho
SAHEL 108
SAHEL 159::C1-G1
SAHELIKA::C1-G1
SALUMPIKIT
SAMBALA MALO
SAN DU BAI MI HONG GU::IRGC 59849-1
SAN RI QI::IRGC 59855-1
SAO::IRGC 61467-1
SATHI 34-36::C1-G1
SERATOES HARI
SHAI-KUH
Shan-Huang-Zhan-2
SHONTH::IRGC 74717-1
SOKOU MALSIRA::IRGC 77301-1
SOM CAU 70 A::IRGC 8227-1
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SOUMBUWEE::IRGC 8972-1
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SUTHUWEE::IRGC 8915-1
SWARNA
T 26::IRGC 46768-1
TAICHUNG NATIVE 1
TD 25::IRGC 9146-1
TELIMANI::C1-G1
TELOVOLANA::IRGC 69969-1
TEQING

TETEP::IRGC 32576-1
THAPACHINIYA::IRGC 16234-1
TI KU::IRGC 1224-1
TKM 6
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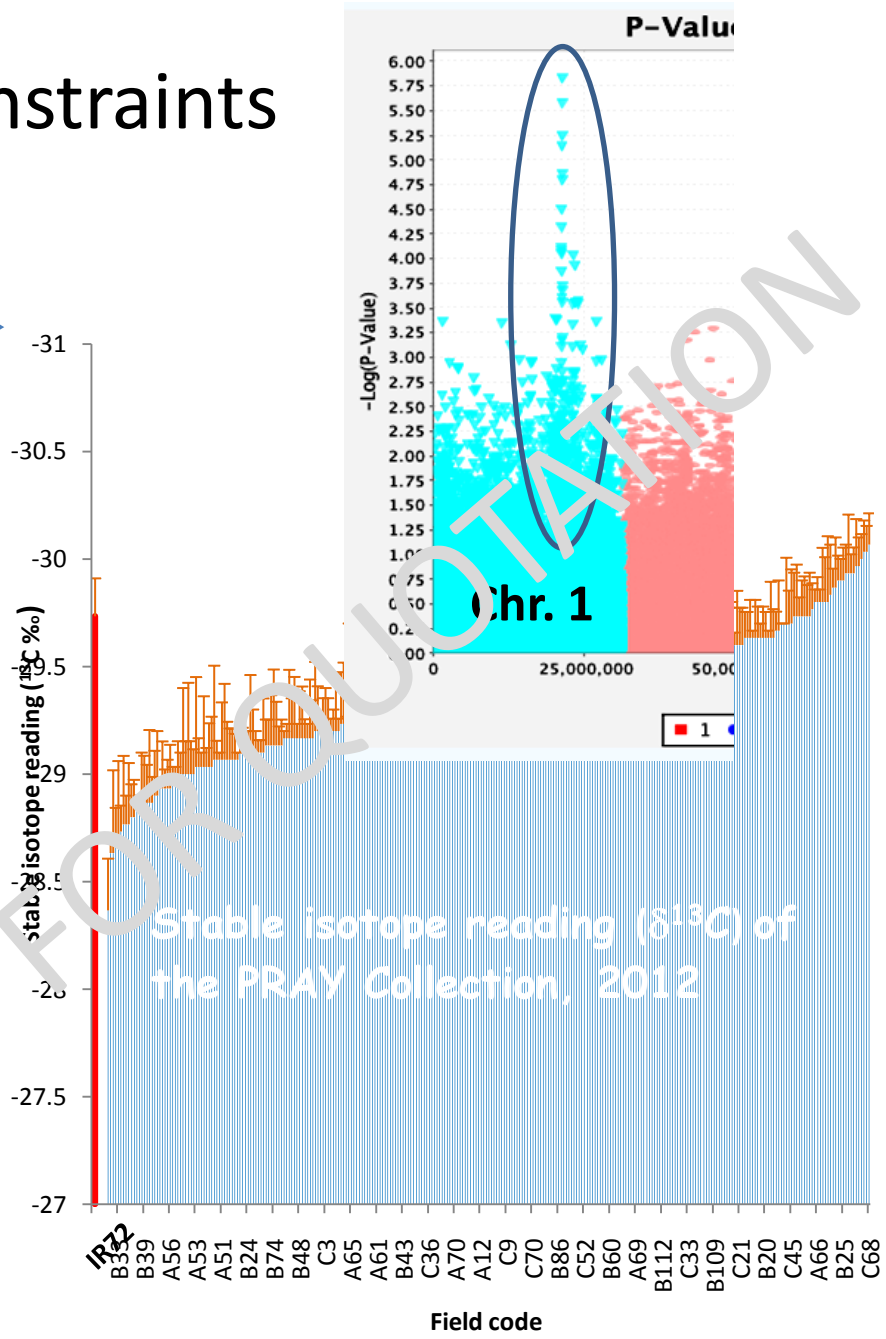
TSIPALA MENA::IRGC 69977-1
TSIPALA::IRGC 10989-1
TUNG CH'IU AI::IRGC 34265-1
UBA MURALI::IRGC 25928-1
UP 1537::IRGC 70490-1
UPL RI 5::IRTP 7034-C1-G1
UPL RI-7
VANDANA::IRGC 117398-1
VARY MADINIKA 3494::GERVEX 8318-C1-G1
VARY VATO 154::GERVEX 5429-C1-G1
VARY VATO MENAHODITRA::IRGC 69111-1
VATO MATSOAMALONA::GERVEX 8454-C1-G1
VELLAI SEENETTI::IRGC 15516-1
WAB 706-3-4-K4-KB-1::C1-G1
WANNI DAHANALA::IRGC 15721-1
WAS 169-B-B-4-2-1::C1-G1
WAS 181-B-6-3::C1-G1
WAS 182-B-1-1::C1-G1
WAS 183-B-6-2-3::C1-G1
WAS 194-B-3-2-5::C1-G1
WAS 197-B-6-3-11::C1-G1
WAS 200-B-B-1-1-1::C1-G1
WAS 202-B-B-1-1-2::C1-G1
WAS 207-B-B-3-1-1::C1-G1
WAS 208-B-B-5-1-1-3::C1-G1
WAS 20-B-B-1-2-2::C1-G1
WAS 30-11-4-6-2-2-1::C1-G1
WAS 62-B-B-17-1-1-3::C1-G1
WAS170-B-B-1-1
WAS173-B-B-6-2-2
WAS174-B-3-5
WAS198-B-3-1-3
WAS199-B-1-2-1
WAS203-B-B-2-4-1
WAS206-B-B-2-2-1
WAS21-B-B-20-4-3-3
WAS33-B-B-15-1-4-5
WAS63-22-5-9-10-1
WAY RAREM
XI GU HONG::IRGC 74226-1
XI GU ZAO::IRGC 72360-1
XI NUO ZAO::IRGC 68279-1
YAKADA::IRGC 51096-1
YE TI ZHAN::IRGC 68296-1
ZALCHA::IRGC 62190-1
ZAO SHAO ZHAN::IRGC 68318-1
ZAO SHOU 691-11::IRGC 70447-1
Zhenshan 97B
ZI GAN NAN GU::IRGC 70468-1
ZS 4::IRGC 56707-1

Adaptation to abiotic constraints

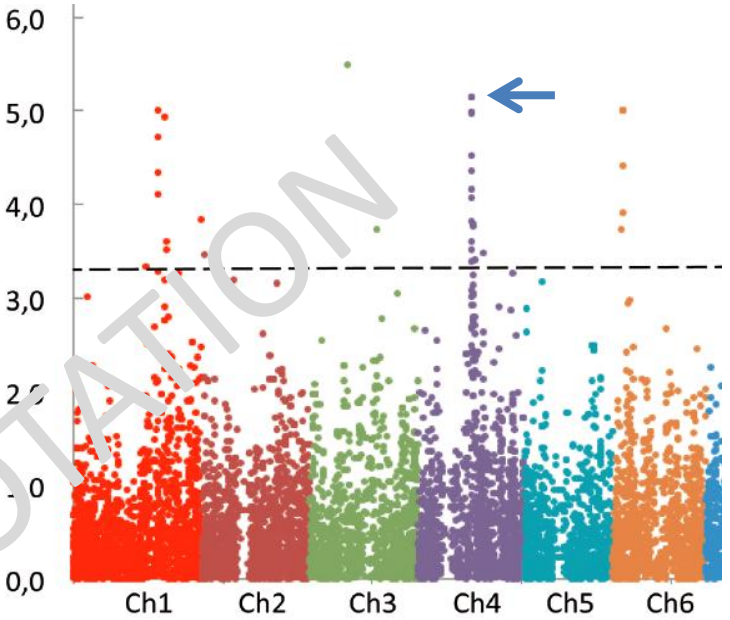
- **Water-use efficiency: IRRI (C4 Rice Project)**
- **Drought/roots: EMBRAPA, CIRAD, IRRI**
- **Salinity: IRRI, AfricaRice**
- **Cold: CIRAD, AfricaRice (ORYTAGE project)**
- **Heat: IRRI (India sites), AfricaRice, Cirad**
- **P-deficiency, JIRCAS/IRRI**
- **Crop model assisted phenotyping**



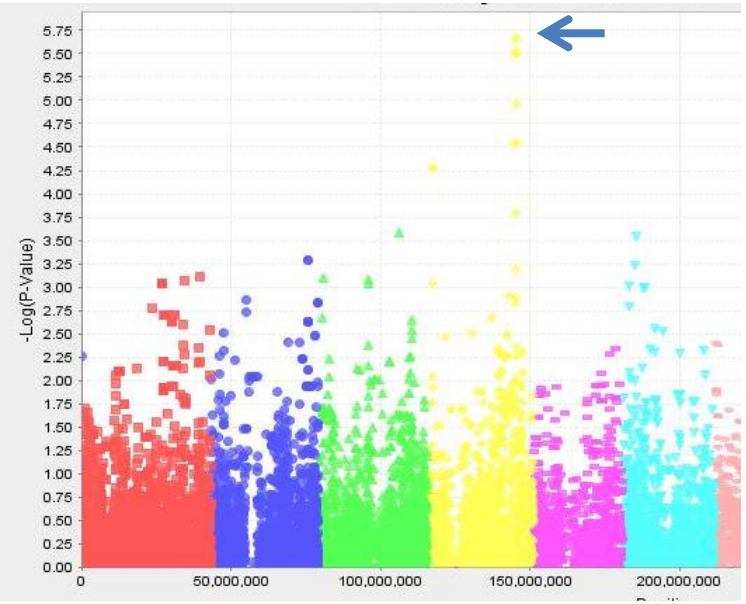
(Chr4: not same locus)

GWAS for heat induced sterility

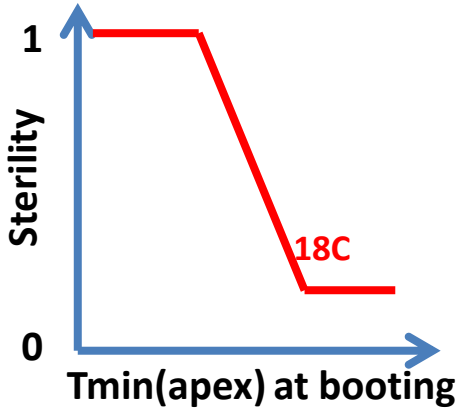
Phytotron (IRRI)
Field (Senegal),
Extracted from multi-site data by RIDEV crop model

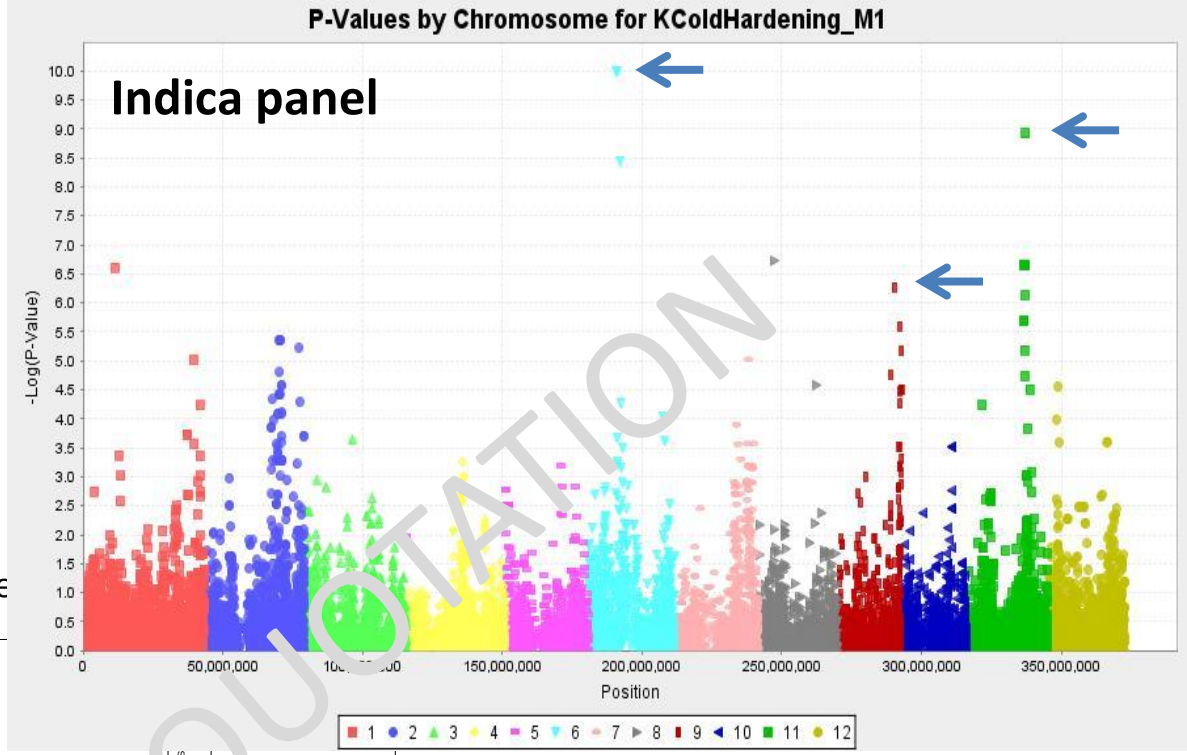


Field (Senegal),
Extracted from multi-E data by RIDEV crop model

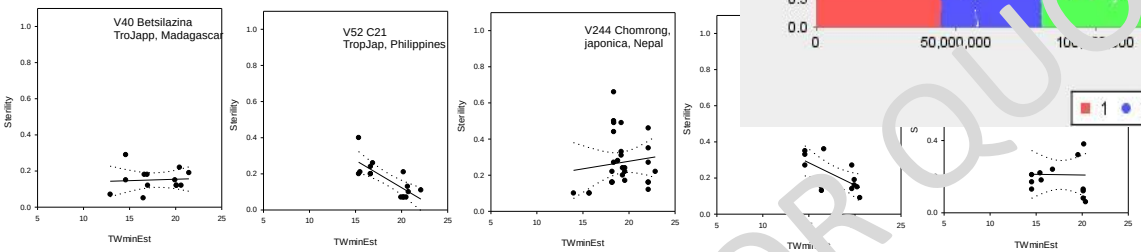


More phenomics & GWAS in progress for hot environments in India

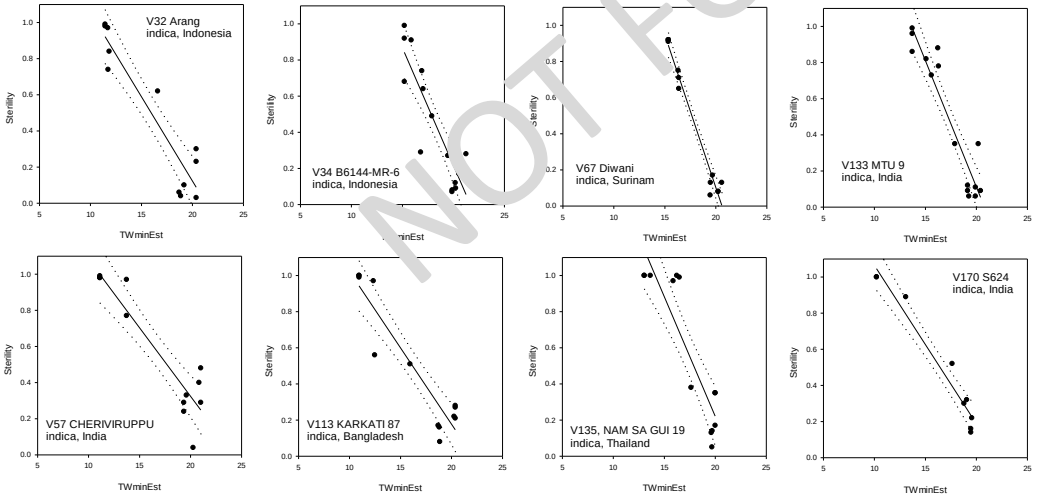




There are very good sources for cold tolerance



Most indica rices, particularly tropical landraces, are very cold sensitive



Phenomics & GWAS for cold sterility and hardening

Multi-E in Senegal & Madagascar, assisted by RIDEV model

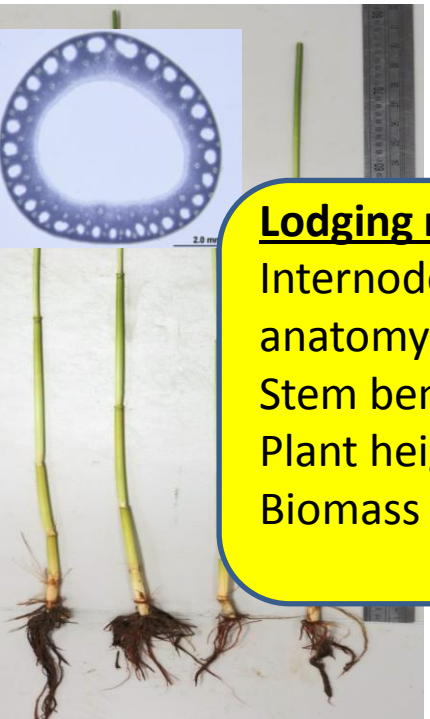
Component traits for plant type being phenotyped

Source traits
Leaf photosynthetic rate
Leaf anatomy & SLA
Biomass, LAI, Stay-green

NSC reserves & mobilisation

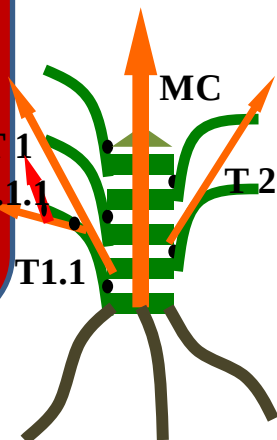
Sink traits
Grain size and filling rate
Filling duration
Panicle number, size & architecture

Trade-offs



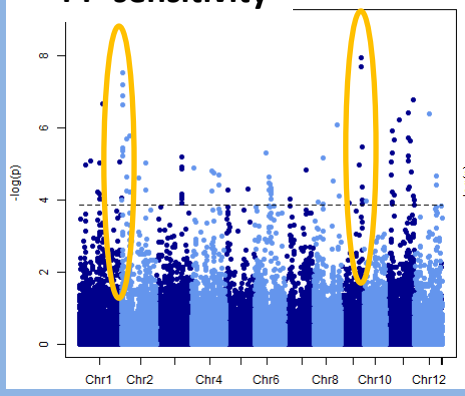
Lodging res. under high N
Internode morphology, anatomy and chemistry
Stem bending momentum
Plant height
Biomass

Phenology
Time to flowering
Phyllochron
Photoperiod sensitivity
Thermal sensitivity

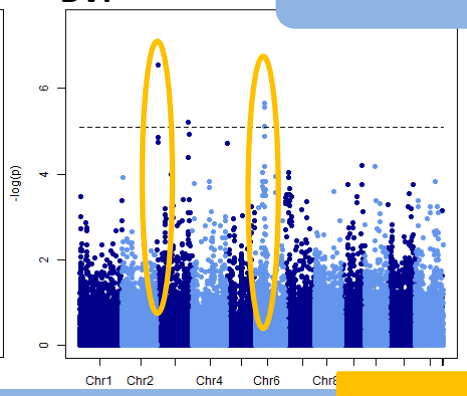


Phenology

PP-sensitivity



BVP

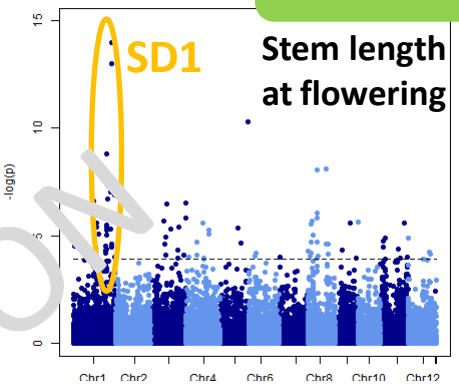


300 indica acc.: (impr. + trad.) GWAS for YP-Related traits

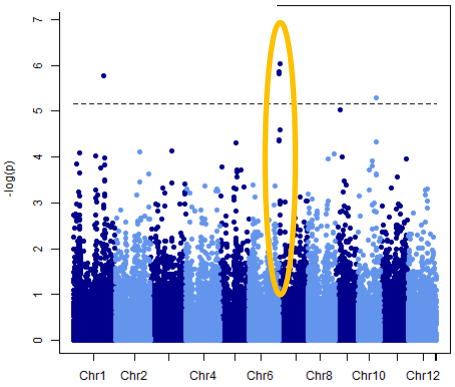
Morphology

SD1

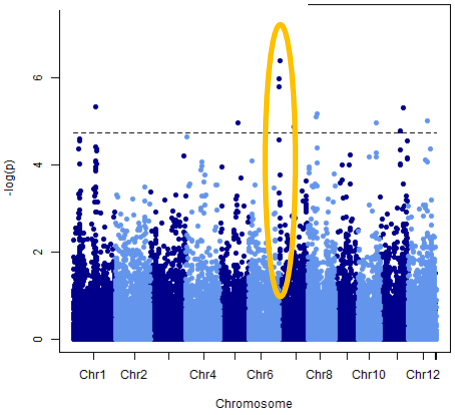
Stem length at flowering



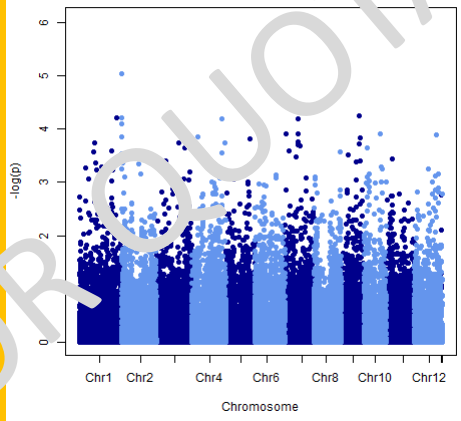
Flag leaf area



Flag-1 leaf area

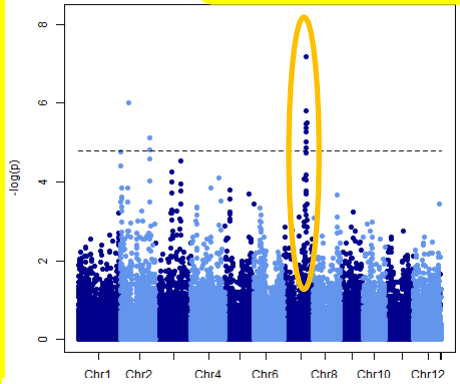


Grain yield: poor associations

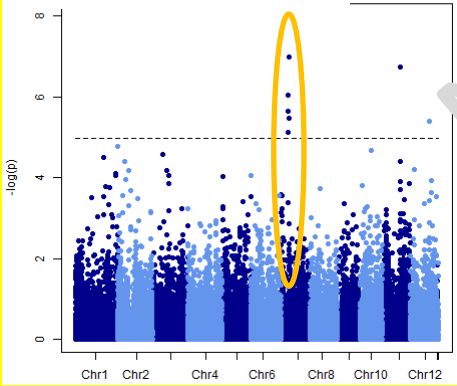


Y-components

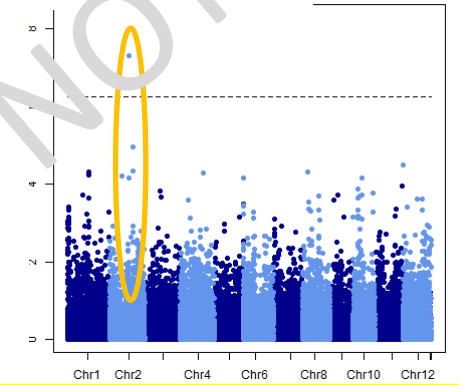
1000-GW



Spikelets/panicle



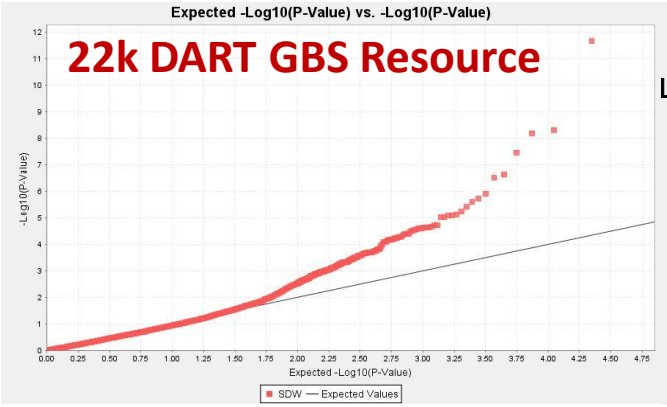
Spikelet fertility



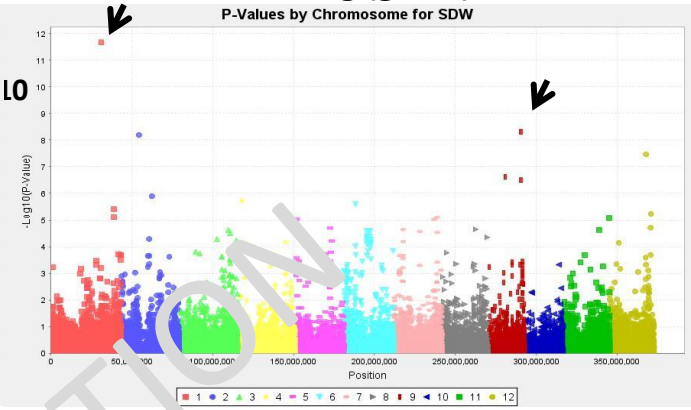
Preliminary analyses Using GBS (DART, AU) NSC traits are forthcoming

Example of new trait

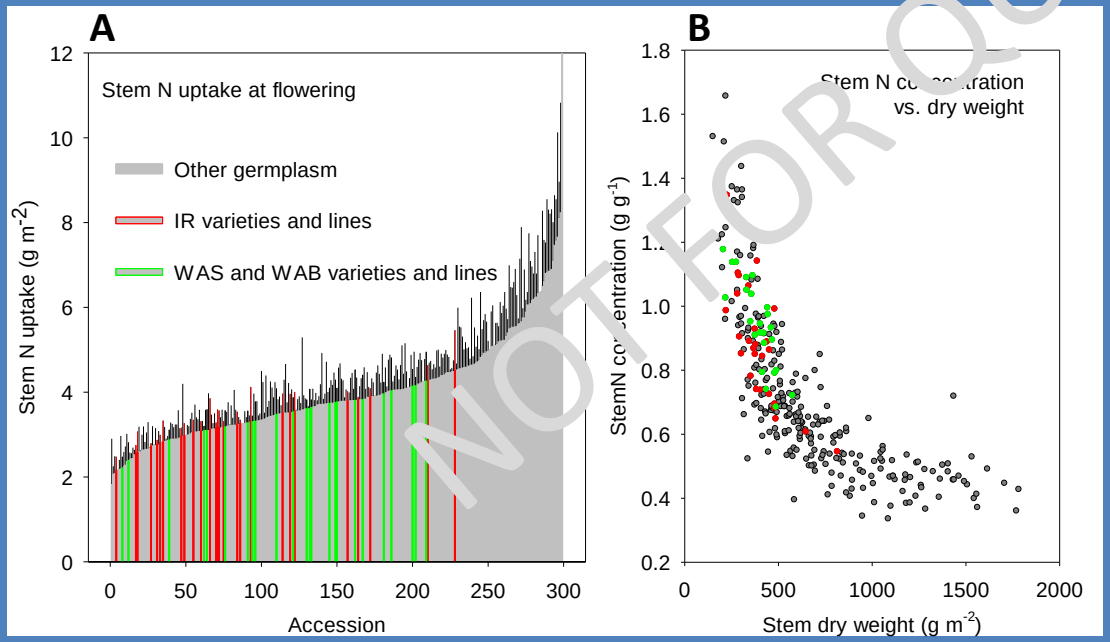
High stem N content at flowering is a candidate trait for high-yielding ideotypes having stay-green and lodging resistance



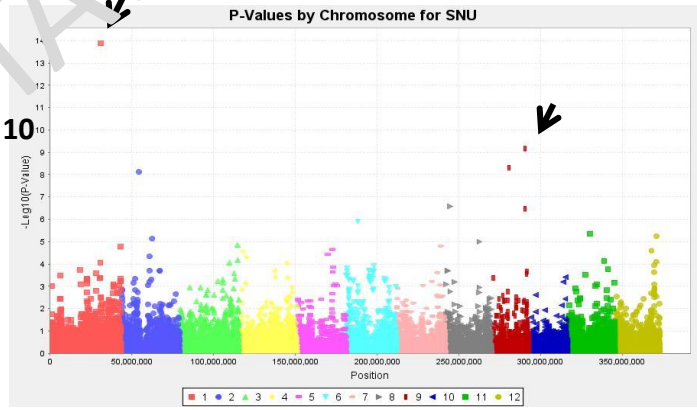
Stem dw at Flowering (g/m2)



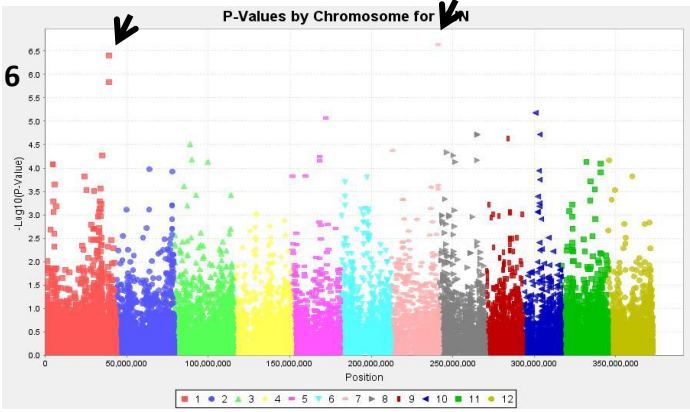
A: PRAY-indica panel has great variation for stem N content. N content is low in current HYVs.
B: Stem N concentration is negatively related to stem dw (dilution effect) but there is variation.



Stem N uptake at Flowering (g/m2)



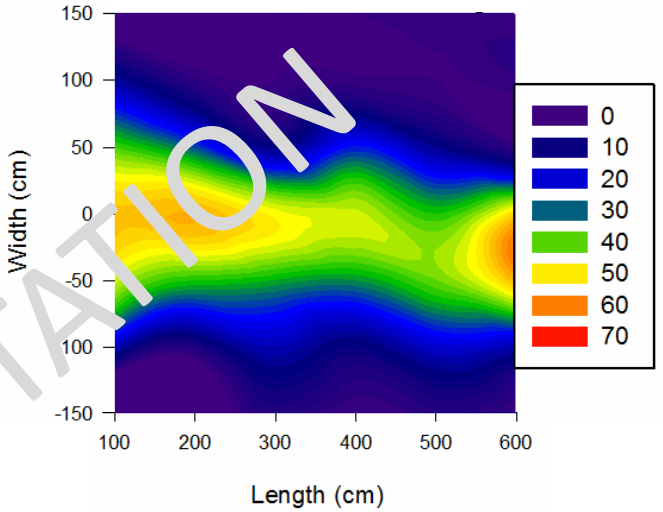
Stem N concentration at Flowering (mg/g)

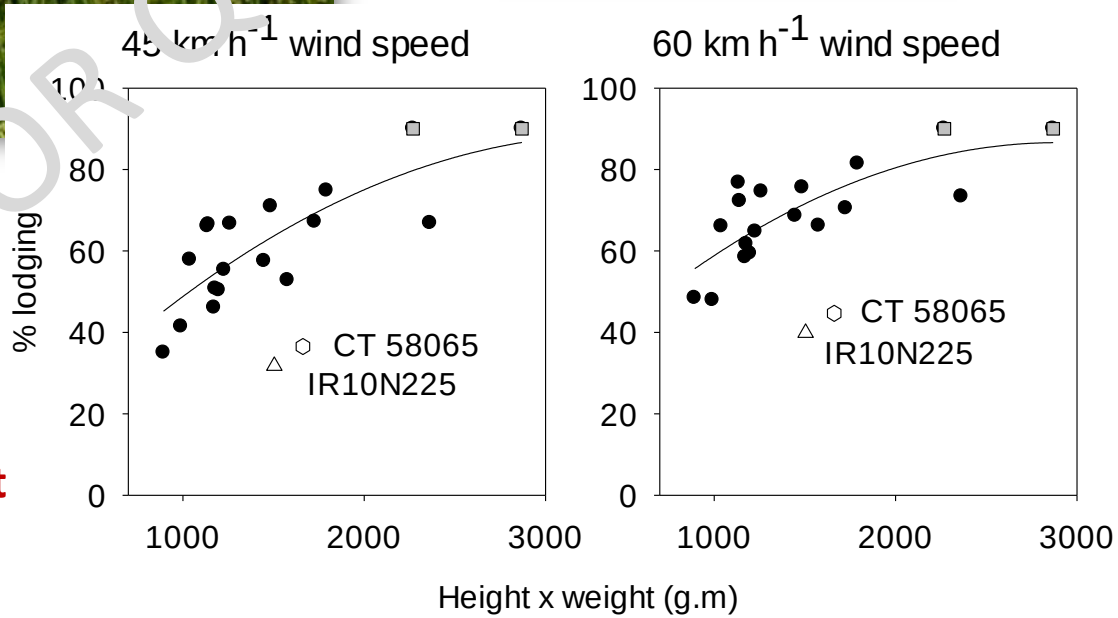


The Rice Blaster

Lodging

A 1-m wide wind channel:
Simulated rainfall = 1.5 mm/min
Max wind speed = 60 km/hr

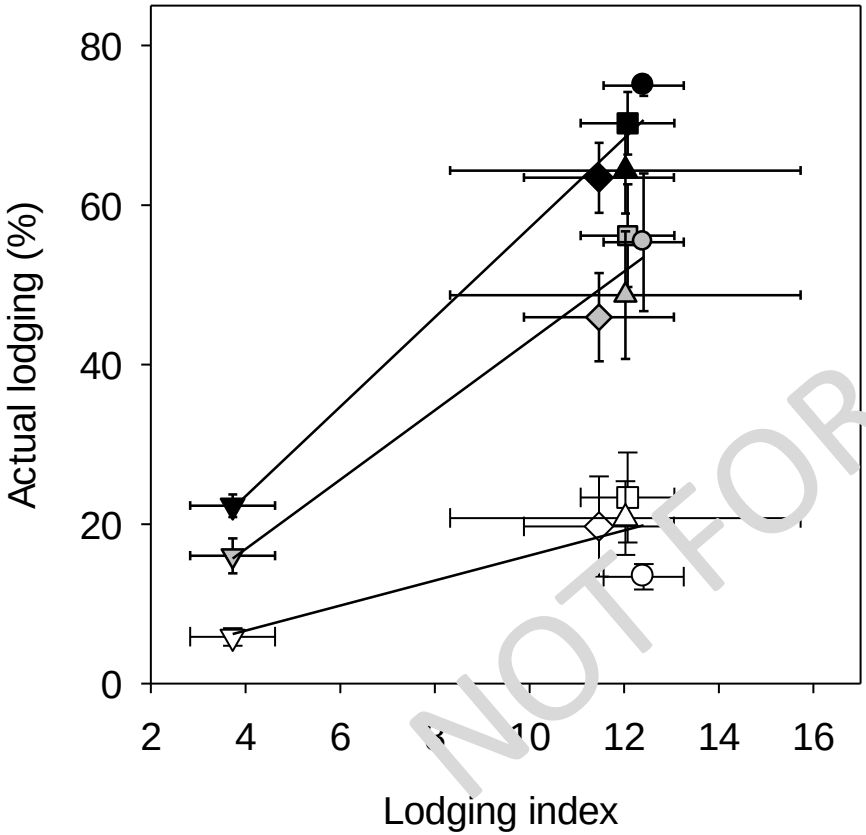


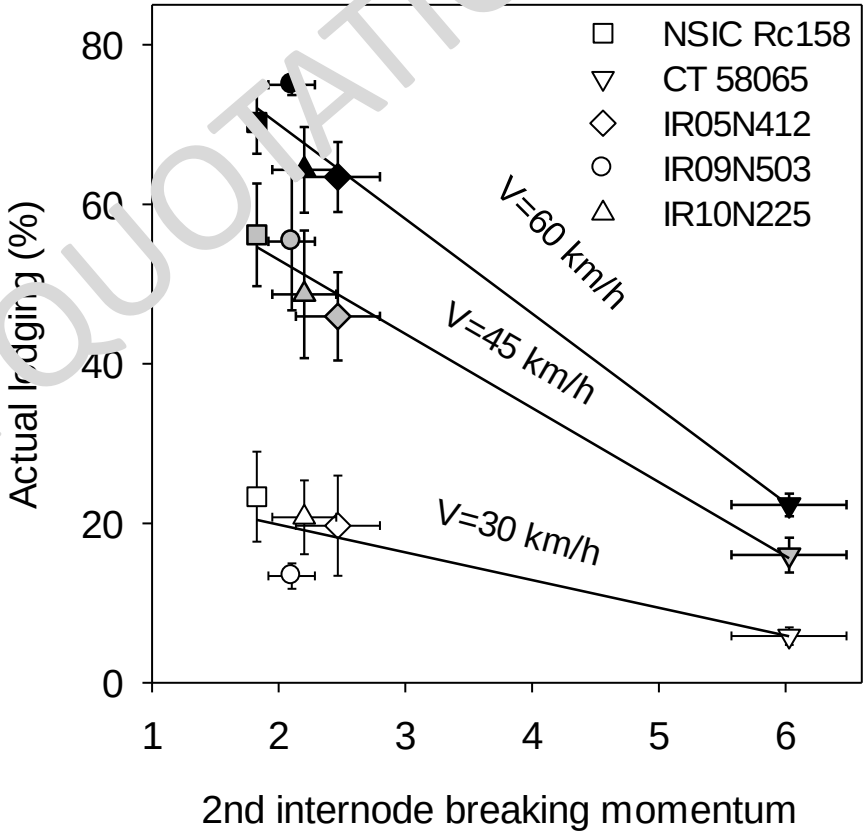


A CIAT variety stood out

2014 Wet Season induced lodging study at 15 DAF

Stem Breaking Momentum = Force to break a stem section X Length of section
Lodging Index = (Plant height X Plant mass) / Stem breaking momentum
Actual Lodging = % decrease of canopy height after artificial wind+water (Blaster)





(Study of 20 cvs, all of which lodged spontaneously except these 5 cvs)

IRRI cirad LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Robotized HTP phenomics in the field

Tractor/boom based, GPS controlled HTP phenotyping:
Spectral proxies for LAI, agBM, N; IR for Tc;
Sonar for PHT

Phenomics & GWAS of Heterosis (field visit this p.m.)

- Collaboration with Syngenta
- 300 F1 hybrids developed (indica diversity panel X tester)
- Field phenotyping for **yield potential** and **lodging resistance** component traits
  - Parent materials + hybrids
  - 3 reps, 2 sites (3600 plots)
  - Heterosis observations by F1/parent trait differentials
- Various GBS & SNP-chip resources available

Genomic resources for GWAS on PRAY panels

- 700k chip Oryza Consortium (2k acc. Incl. PRAY indica + tropjap)
- 22k DART GBS resource (PRAY-indica)
- XXk Cornell GBS resource (PRAY indica + tropjap), just came in
- 60k Infinium chip (Syngenta, restricted use)
- Full sequences from 3k panel: Only for 35 acc. **=> panel resenquencing?**

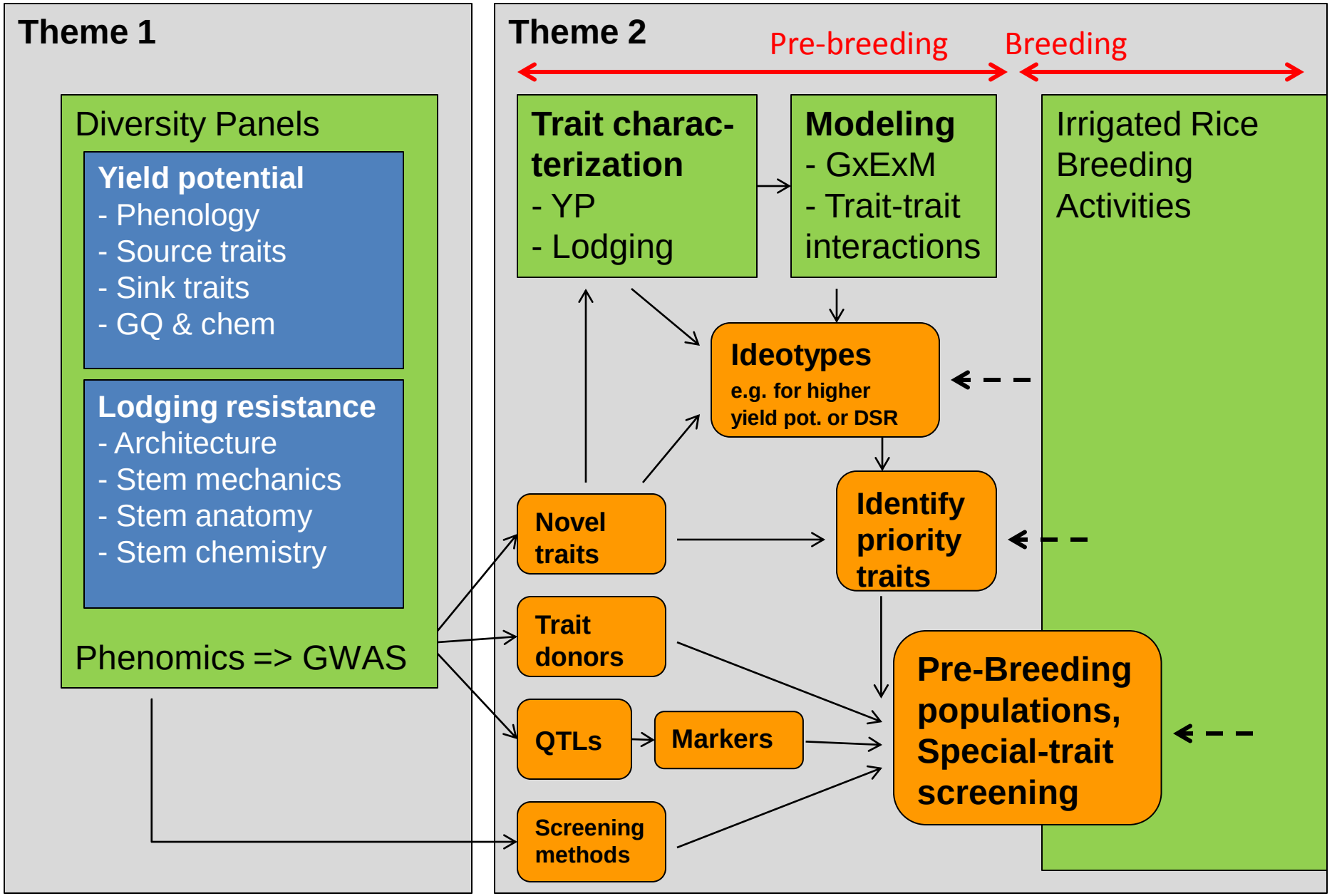
Outlook

- QTLs and candidate genes for traits
- QTLs and candidate genes for trait heterosis
- Identification of donor materials
- Development of “tamed” pre-breeding donor materials
- SNP markers

IRRI cirad LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

Outlook:

Structured Pre-Breeding (pilot case: YP for Irrigated Rice)




Salamat po
88温泉
88 HOTSPRING RESORT