SCIENCE SETU WEBINARS by NIPGR

RICE GRAIN: A STAPLE FOOD FOR ALL

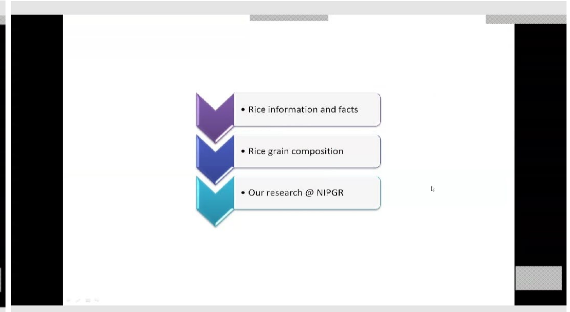
Press Note

Date: 13th August, 2021, Friday

Resource person: Dr. Pinky Agarwal, Scientist IV, NIPGR

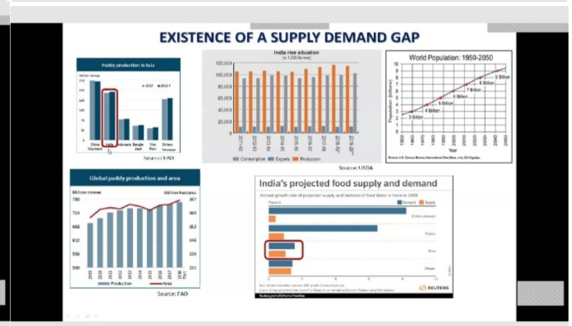
The Department of Biotechnology, Government of India, had planned "Science Setu Webinar" as a virtual platform to connect the Research Institutes with postgraduate and graduate students. Under this, our college has been assigned to National Institute of Plant Genome Research (NIPGR), New Delhi. NIPGR is an autonomous institution aided by the Department of Biotechnology. Research at NIPGR focusing on functional, structural, evolutionary and applied genomics of plants, including crop plants. Through this fourth webinar program, our students and faculty members virtually gained an amazing opportunity to connect with NIPGR, New Delhi and anticipated the effects of combined stresses of environmental factorson plant life. It was a spectacular opportunity for students at undergraduate and postgraduate level of science background on exposure to plant-based research on much higher level.

Dr. Amarjeet Singh, Scientist, NIPGR gracefully introduced the resource person with his warm words. The resource person, **Dr Pinky Agarwal**, Scientist IV, NIPGR, opened his lecture with the interesting facts of rice crop. She emphasized ongap between supply and demand of rice crop in terms of production level. She mentioned a research conducted to sequence genome of ricecrop (12 chromosome). 11th chromosome was sequenced in India with almost 50,000 genes. Rice crop is grown in almost 10 states of India with West Bengal as the largest producer. She introduced life cycle of rice crop followed by five stages of grain development. And,further categorized rice grains on the basis of their colour, stickiness and amount of starch. Her team studied the different genes responsible for quality of rice grains. She explained the importance of SS1 and GW2_RNAi. At the end of her lecture, she acknowledged her team and their publications in relation to these genes. In total 45 participants, including faculty of science and students attended the event. **Dr. Amarjeet Singh**, Scientist, NIPGR attended the questions of the participants and gave vote of thanks. It was a quite exciting and brainstorming experience for everyone.

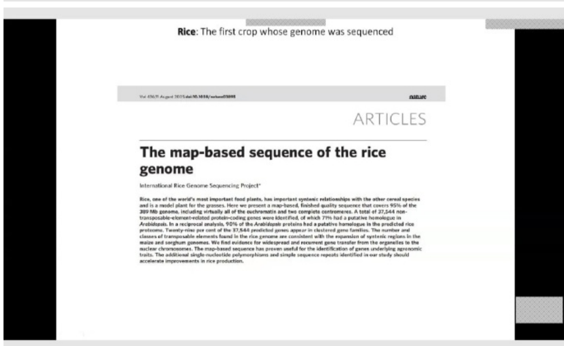


Rice information and facts
Rice grain composition
Our research @ NIPGR

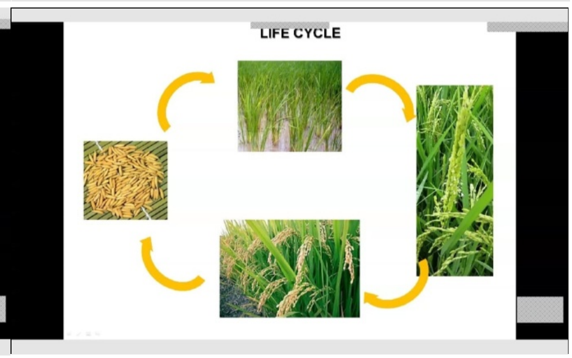
Global Rice E-Newsletter
CONSUMER DEMAND FOR RICE GRAIN QUALITY
IRRI
IDRC
The Telegraph online
Caution: Rice output lags population growth
Daily Rice e-Newsletter



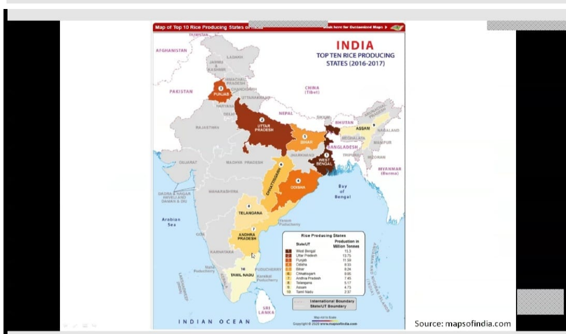
EXISTENCE OF A SUPPLY DEMAND GAP
Paddy production in Asia
India rice situation
World Population: 1950-2050
Source: FAO
Source: USDA
Global paddy production and area
India's projected food supply and demand
Source: FAO



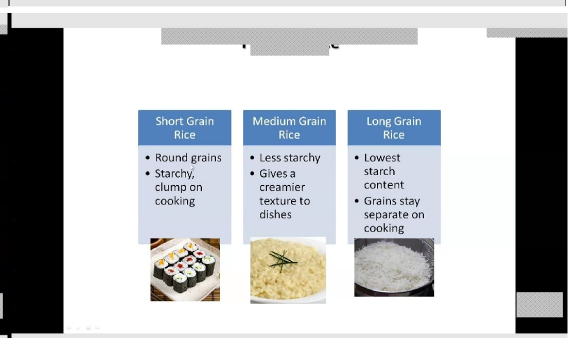
Rice: The first crop whose genome was sequenced
ARTICLES
The map-based sequence of the rice genome
International Rice Genome Sequencing Project



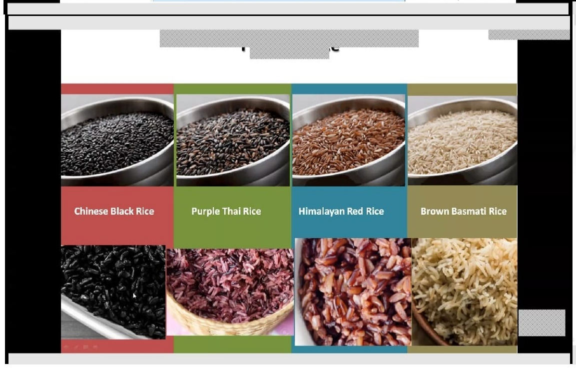
LIFE CYCLE



INDIA
TOP TEN RICE PRODUCING STATES (2016-2017)
INDIAN OCEAN
Source: mapsofindia.com

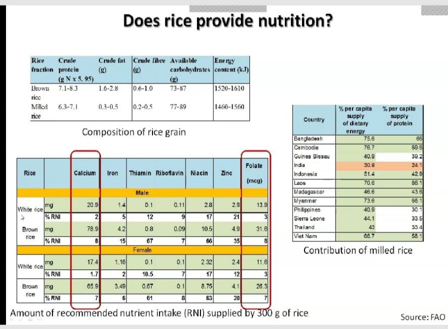


Short Grain Rice
Round grains
Starchy, clump on cooking
Medium Grain Rice
Less starchy
Gives a creamier texture to dishes
Long Grain Rice
Lowest starch content
Grains stay separate on cooking



Chinese Black Rice
Purple Thai Rice
Himalayan Red Rice
Brown Basmati Rice

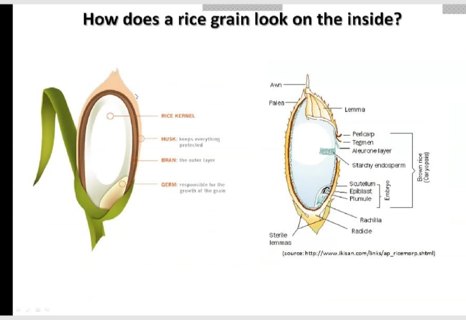
International Year of Rice: 2004
rice is life

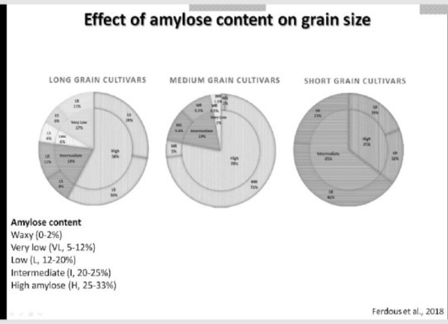


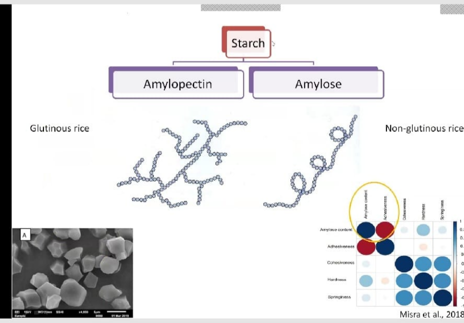
Rice fraction	Crude protein (g N x 5. 95)	Crude fat (g)	Crude fibre (g)	Available carbohydrates (g)	Energy content (kJ)
Brown rice	7.1-8.3	1.6-2.8	0.6-1.0	73-87	1520-1610
Milled rice	6.3-7.1	0.3-0.5	0.2-0.5	77-89	1460-1560

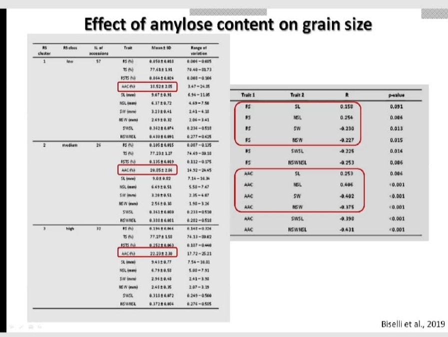
Rice		Calcium	Iron	Thiamin	Riboflavin	Niacin	Zinc	Folate (mcg)
Male								
White rice	mg	20.9	1.4	0.1	0.11	2.8	2.9	13.9
	% RNI	2	5	12	9	17	21	3
Brown rice	mg	78.9	4.2	0.8	0.09	10.5	4.9	31.6
	% RNI	8	15	67	7	66	35	8
Female								
White rice	mg	17.4	1.16	0.1	0.1	2.32	2.4	11.6
	% RNI	1.7	2	10.5	7	17	12	3
Brown rice	mg	65.9	3.49	0.67	0.1	8.75	4.1	26.3
	% RNI	7	6	61	8	63	20	7

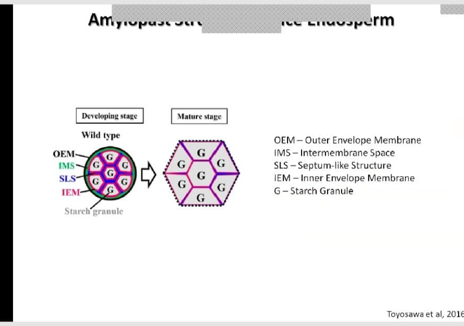
Country	% per capita supply of dietary energy	% per capita supply of protein
Bangladesh	75.6	66
Cambodia	76.7	69.6
Guinea Bissau	40.9	39.2
India	30.9	24.1
Indonesia	51.4	42.9
Laos	70.6	68.1
Madagascar	46.6	43.6
Myanmar	73.6	68.1
Philippines	40.9	30.1
Sierra Leone	44.1	33.5
Thailand	43	33.4
Viet Nam	66.7	58.1

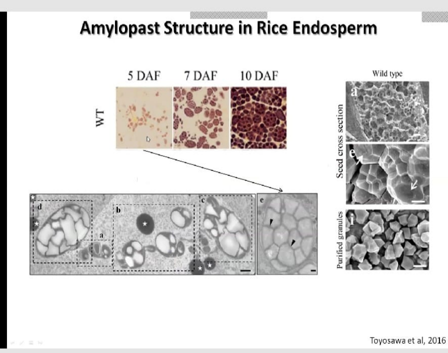


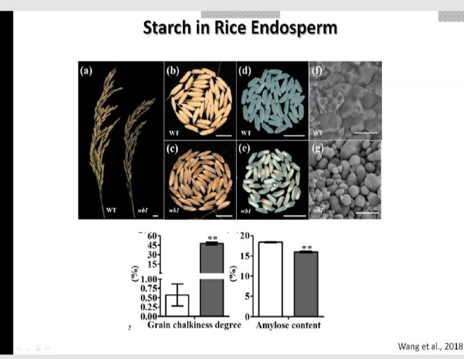


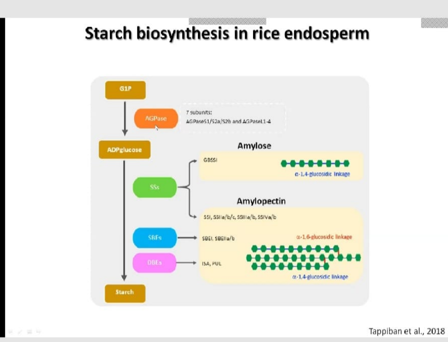


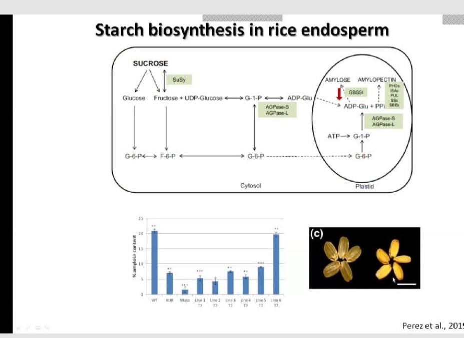




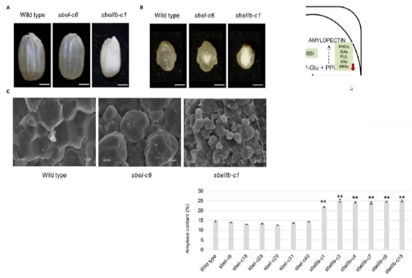








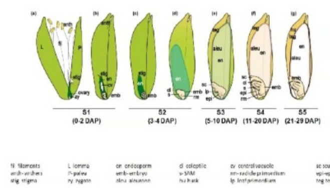
Starch biosynthesis in rice endosperm



Sun et al., 2017

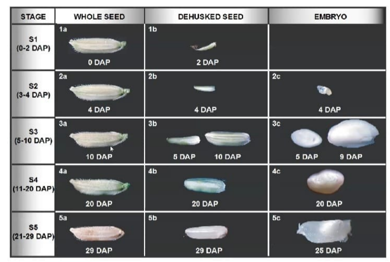
Waxy Rice	Regular (Non-waxy) Rice
Lower amylose content (0-5%)	Higher amylose content (15-30%)
Sticky	Grains stay separate
Glutinous	Non-glutinous
Chalky/floury/opaque endosperm	Translucent endosperm
High glycemic index (lower resistant starch)	Low glycemic index (higher resistant starch)
Spherical starch granules	Polyhedral starch granules
Loosely packed starch granules	Tightly packed starch granules
Grains are more round	Grains are longer

Rice Seed Development



Agarwal et al., 2011
Sharma and Agarwal et al., 2012

RICE SEED DEVELOPMENT



Sharma and Agarwal et al., 2012

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ORIGINAL RESEARCH

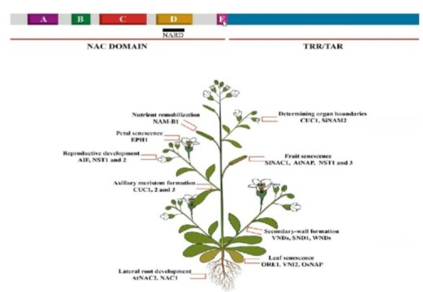
WILEY

SUPER STARCHY1/ONAC025 participates in rice grain filling

Iny Elizebeth Mathew | Richa Priyadarshini | Arunima Mahto | Priya Jaiswal | Swarup K. Parida | Pinky Agarwal

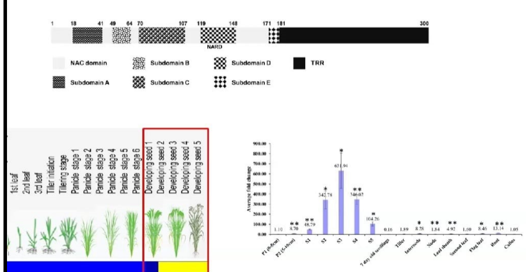
Plant Direct. 2020;00:1–25.

NAC TRANSCRIPTION FACTORS



Mathew and Agarwal, 2018

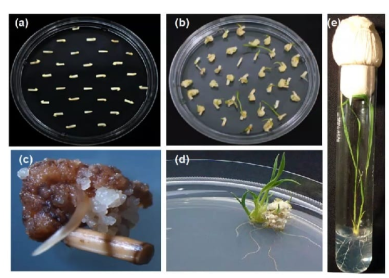
EXPRESSION PATTERN OF *SUPER STARCHY1/ ONAC025*



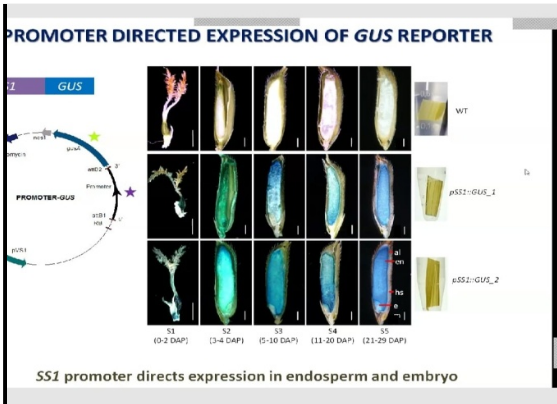
Sharma and Agarwal et al., 2012

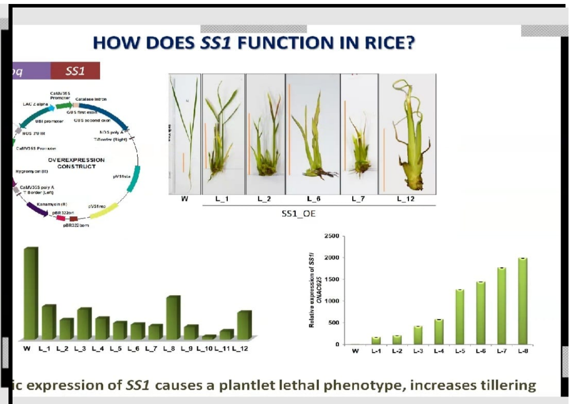
des for a NAC TF and is expressed at high levels in rice grain development

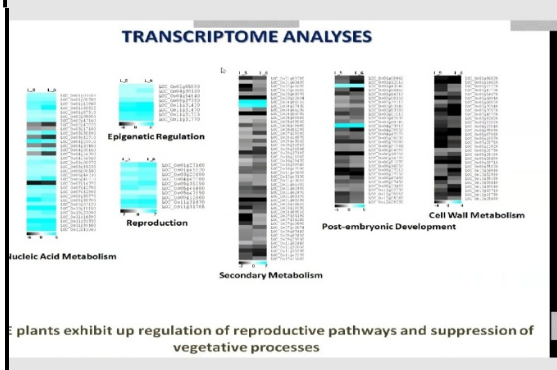
GENERATION OF GM/ TRANSGENIC PLANTS

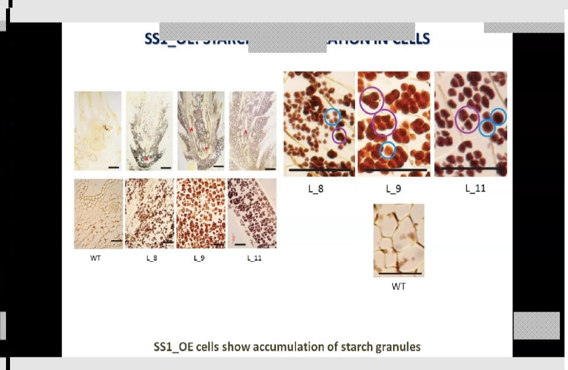


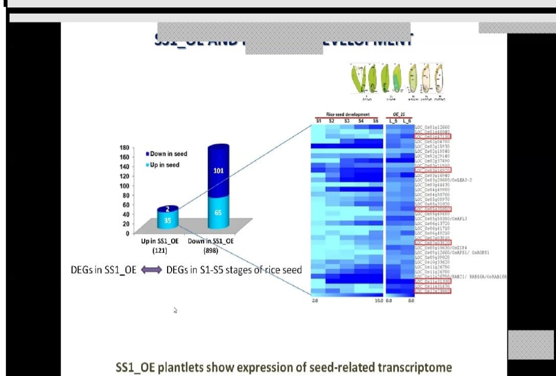
esentation of stages of rice tissue culture performed under sterile conditions. Sterilized rice seeds were inoculated on callus formation (b) and co-cultivation, the selected calli (c) were put on regeneration (d) and then allowed to form roots

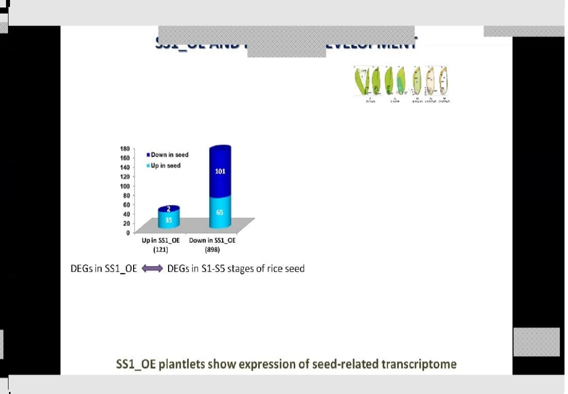

PROMOTER DIRECTED EXPRESSION OF GUS REPORTER
GUS
PROMOTER-GUS
WT
pSS1::GUS_1
pSS1::GUS_2
S1 (0-2 DAP)
S2 (3-4 DAP)
S3 (5-10 DAP)
S4 (11-20 DAP)
S5 (21-29 DAP)
SS1 promoter directs expression in endosperm and embryo


HOW DOES SS1 FUNCTION IN RICE?
SS1
OVEREXPRESSION CONSTRUCT
W
L_1
L_2
L_6
L_7
L_12
SS1_OE
W L_1 L_2 L_3 L_4 L_5 L_6 L_7 L_8 L_9 L_10 L_11 L_12
ic expression of SS1 causes a plantlet lethal phenotype, increases tillering


TRANSCRIPTOME ANALYSES
Epigenetic Regulation
Reproduction
Nucleic Acid Metabolism
Secondary Metabolism
Post-embryonic Development
Cell Wall Metabolism
plants exhibit up regulation of reproductive pathways and suppression of vegetative processes


L_8
L_9
L_11
WT
SS1_OE cells show accumulation of starch granules


Down in seed
Up in seed
Up in SS1_OE (121)
Down in SS1_OE (898)
DEGs in SS1_OE
DEGs in S1-S5 stages of rice seed
SS1_OE plantlets show expression of seed-related transcriptome


Down in seed
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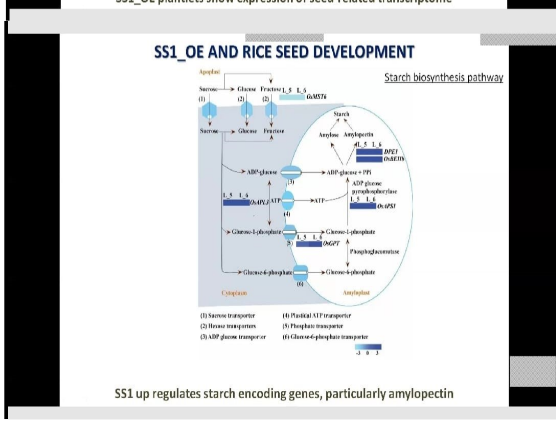
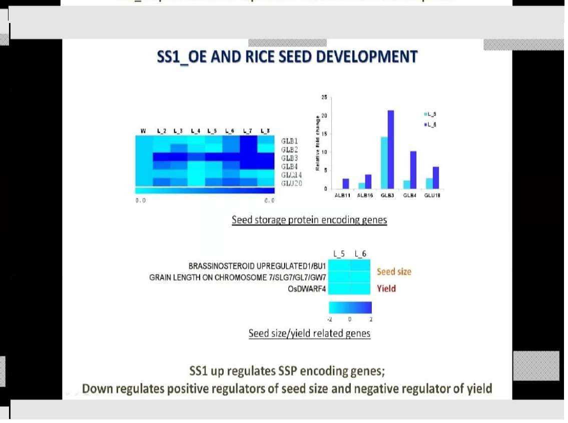
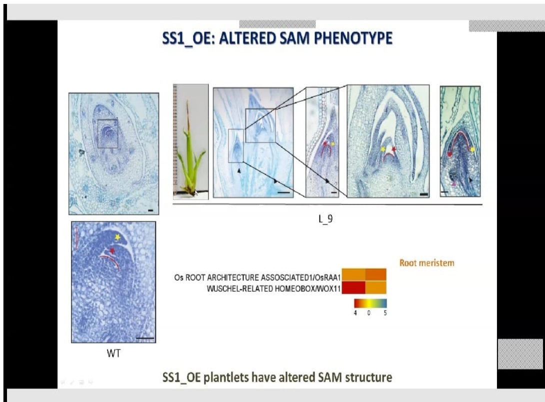
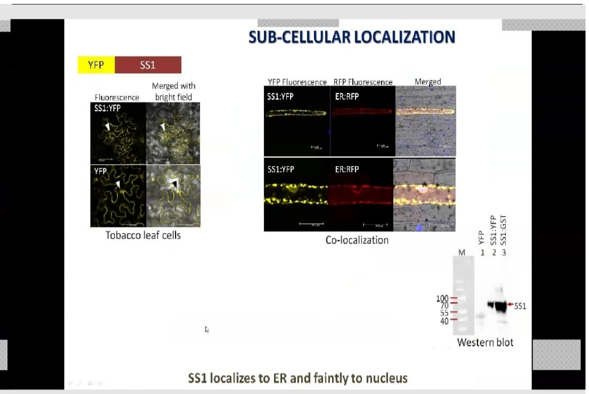
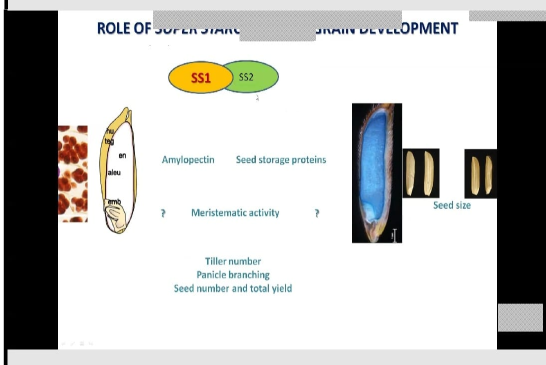
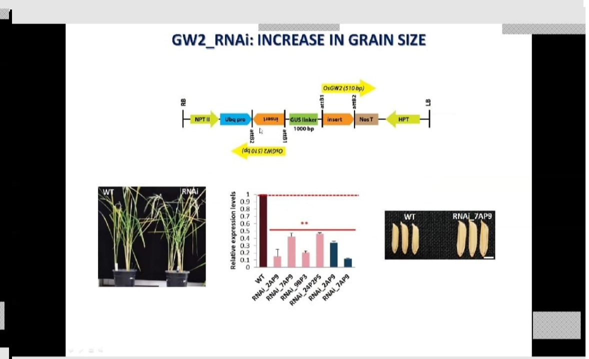

SS1_OE AND RICE SEED DEVELOPMENT
Starch biosynthesis pathway
SS1 up regulates starch encoding genes, particularly amylopectin

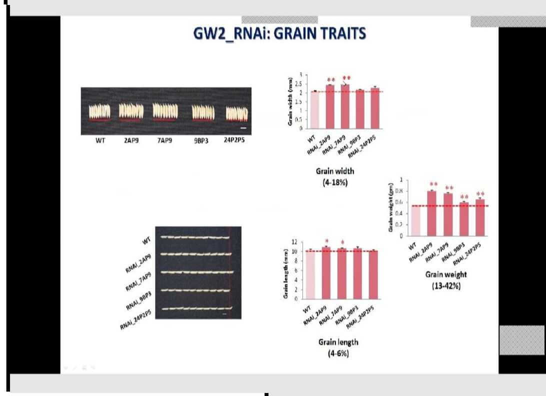

SS1_OE AND RICE SEED DEVELOPMENT
Seed storage protein encoding genes
BRASSINOSTEROID UPREGULATED1/BU1
GRAIN LENGTH ON CHROMOSOME 7/SLG7/GL7/GW7
OsDWARF4
Seed size
Yield
Seed size/yield related genes
SS1 up regulates SSP encoding genes;
Down regulates positive regulators of seed size and negative regulator of yield

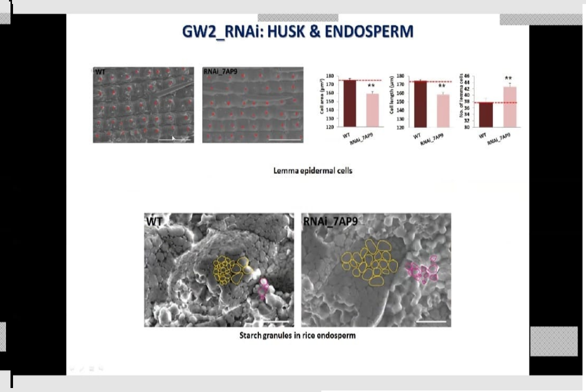

SS1_OE: ALTERED SAM PHENOTYPE
L_9
Root meristem
Os ROOT ARCHITECTURE ASSOSCIATED1/OsRAA1
WUSCHEL-RELATED HOMEOBOX/WOX11
WT
SS1_OE plantlets have altered SAM structure

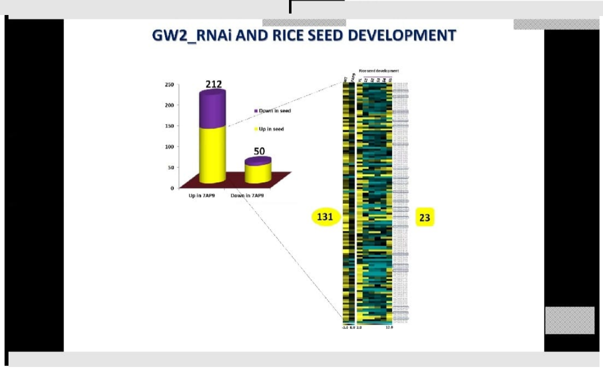

SUB-CELLULAR LOCALIZATION
YFP
SS1
Fluorescence
Merged with bright field
SS1:YFP
YFP
Tobacco leaf cells
YFP Fluorescence
RFP Fluorescence
Merged
SS1:YFP
ER:RFP
Co-localization
M
YFP
SS1:YFP
SS1:GST
1 2 3
100
70
40
SS1
Western blot
SS1 localizes to ER and faintly to nucleus

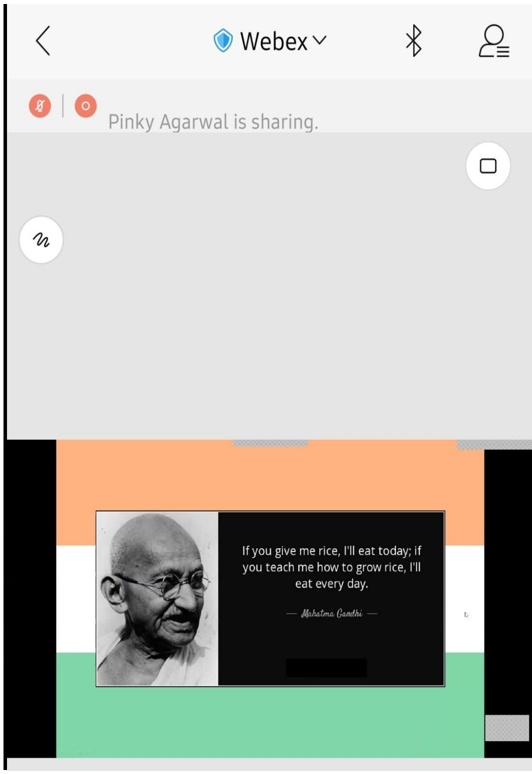

SS1
SS2
en
aleu
emb
Amylopectin
Seed storage proteins
?
Meristematic activity
?
Seed size
Tiller number
Panicle branching
Seed number and total yield

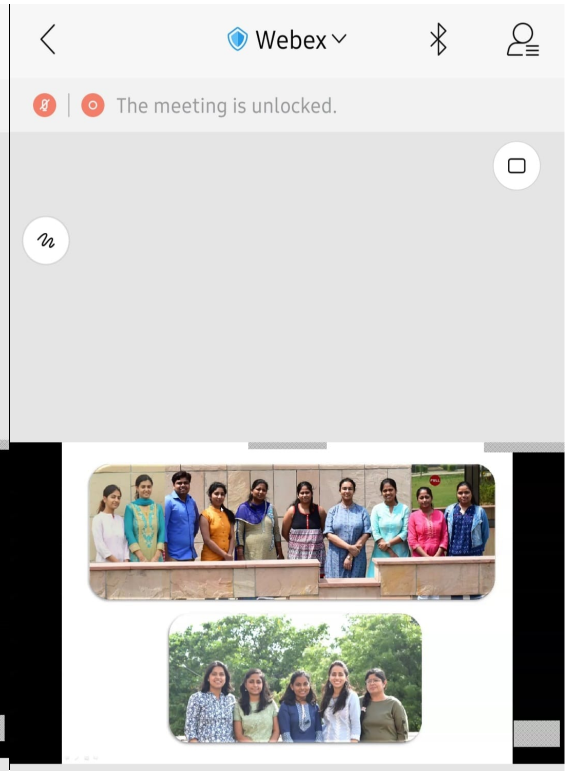

GW2_RNAi: INCREASE IN GRAIN SIZE
RB
NPT II
Ubq pro
GUS linker
1000 bp
insert
Nos T
HPT
LB
WT
RNAi
Relative expression levels
WT
RNAi_2AP9
RNAi_7AP9
RNAi_9BP3
RNAi_24P2P5
WT
RNAi_7AP9


GW2_RNAi: GRAIN TRAITS
WT
2AP9
7AP9
9BP3
24P2P5
Grain width
(4-18%)
Grain weight
(13-42%)
WT
RNAi_2AP9
RNAi_7AP9
RNAi_9BP3
RNAi_24P2P5
Grain length
(4-6%)


GW2_RNAi: HUSK & ENDOSPERM
WT
RNAi_7AP9
Lemma epidermal cells
WT
RNAi_7AP9
Starch granules in rice endosperm


GW2_RNAi AND RICE SEED DEVELOPMENT
212
50
Down in seed
Up in seed
Up in 7AP9
Down in 7AP9
131
23


Webex
Pinky Agarwal is sharing.
If you give me rice, I'll eat today; if you teach me how to grow rice, I'll eat every day.
— Mahatma Gandhi —


Webex
The meeting is unlocked.