

# Overview of hybrid rice in Africa

**Raafat El-Namaky**

**AfricaRice**

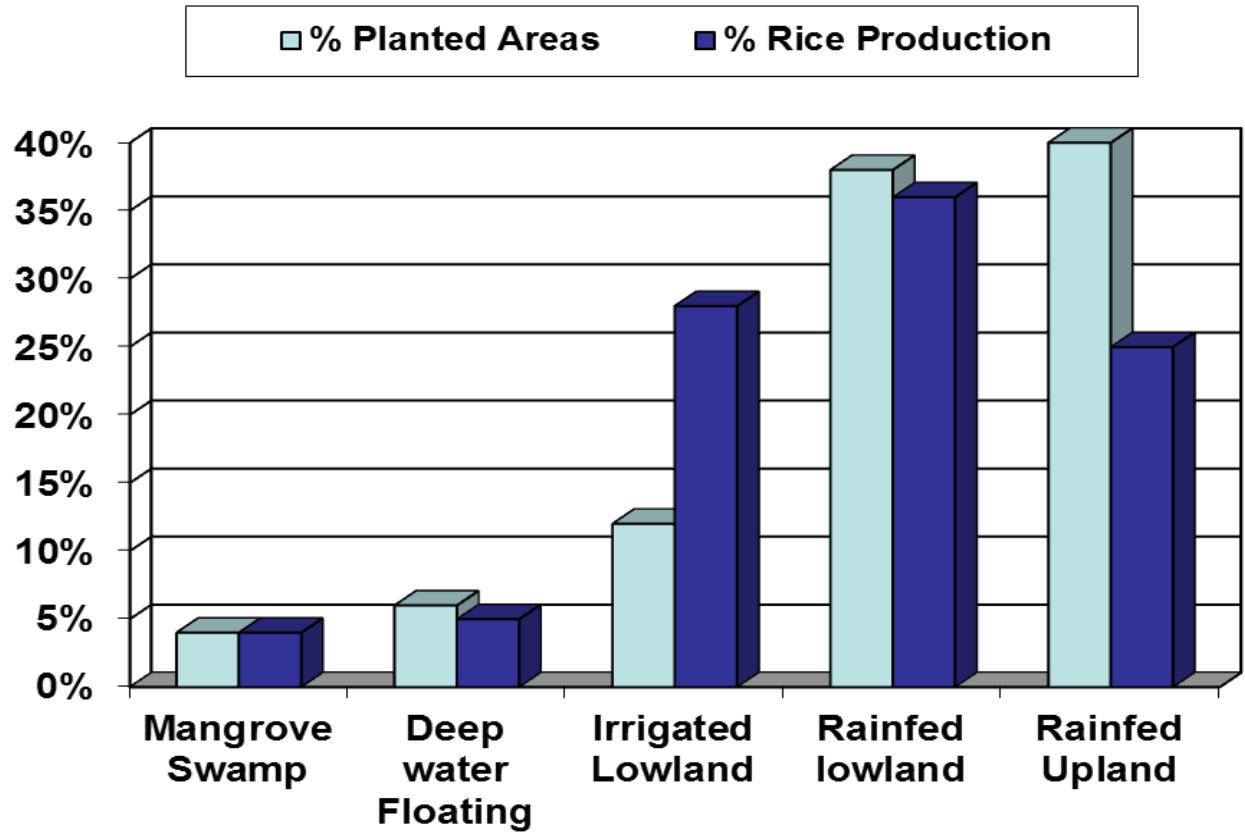
**B.P, 96 Saint Louis - Senegal**

**[r.elnamaky@cgiar.org](mailto:r.elnamaky@cgiar.org)**

# Outline

- Introduction
- Status of Hybrid rice in Africa
- AfricaRice Hybrid breeding Program
- Challenges & prospective of Hybrid Rice in Africa
- Conclusion

# Rice Production in Africa



**many types of stresses in Africa (biotic, abiotic)**

**Total area of rice cultivated 10.50 million ha**



# Position of Rice in Africa

- **From a luxury food to a daily food**
  - urbanization, changes in employment pattern, rising income level, shift in consumer preference, population growth
- **Population in urban area**
  - 38% (2012)    48% (2030)
- **Dependence on importation**
  - 37% (2009)    = 9.8 million ton = US\$ 5 billion
- **Price**
  - 2.5 fold increase between 2000 and 2012 (Food crisis in 2008)
- **Recent figure**
  - Total Consumption (2012): 29.0 M ton (milled)**
  - Total Production (2012): 19.0 M ton (paddy)**
  - Total Importation (2012): 12.0 M ton**

**Urgent Task: Increase rice production in Africa**



# Hybrid Rice in Africa – Status-1

## Hybrid Rice in Egypt

**Development:** Started in 1995 supported by collaborative projects involving **USA, FAO, and IRRI**. Available for commercial cultivation in farmer's fields since 2005.

**Dissemination status:** Area cultivated by hybrid rice still limited because the Egyptian consumer prefers Japonica type.

Hybrid / Check	Normal soils (N)		Saline soils (S)	
	yield T/ha	S % SH	yield T/ha	% SH
SK 2046 H	13.22	20.34	6.06	19.93
SK 2034 H	13.11	19.34	5.94	17.55
SK 2058 H	12.51	13.84	6.34	25.46
SK 2035 H	12.39	12.79	6.8	34.57
SK 2029 H	12.26	11.58	6.61	30.87
Giza 178	10.98	-	5.05	-



*El-Mowafi et al 2008*



**AfricaRice**

8<sup>th</sup> Annual meeting of HRDC, IRRI 25-27 March 2015

[www.AfricaRice.org](http://www.AfricaRice.org)

# Hybrid Rice in Africa – Status-2

## Two line system project: 2013

### Partners:

AATF (African Agriculture Technology Foundation),  
HEAL (Hybrids East Africa Limited) and aWhere

### Objective:

Development and distribution of hybrids and hybrid parental lines as  
“Global Public Goods”

Train seed companies and NARS on two-line hybrid and production

**Countries involved:** Kenya and Tanzania

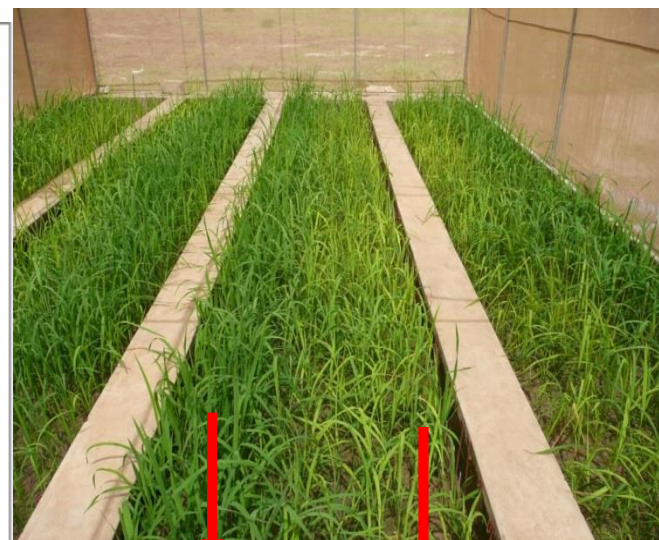
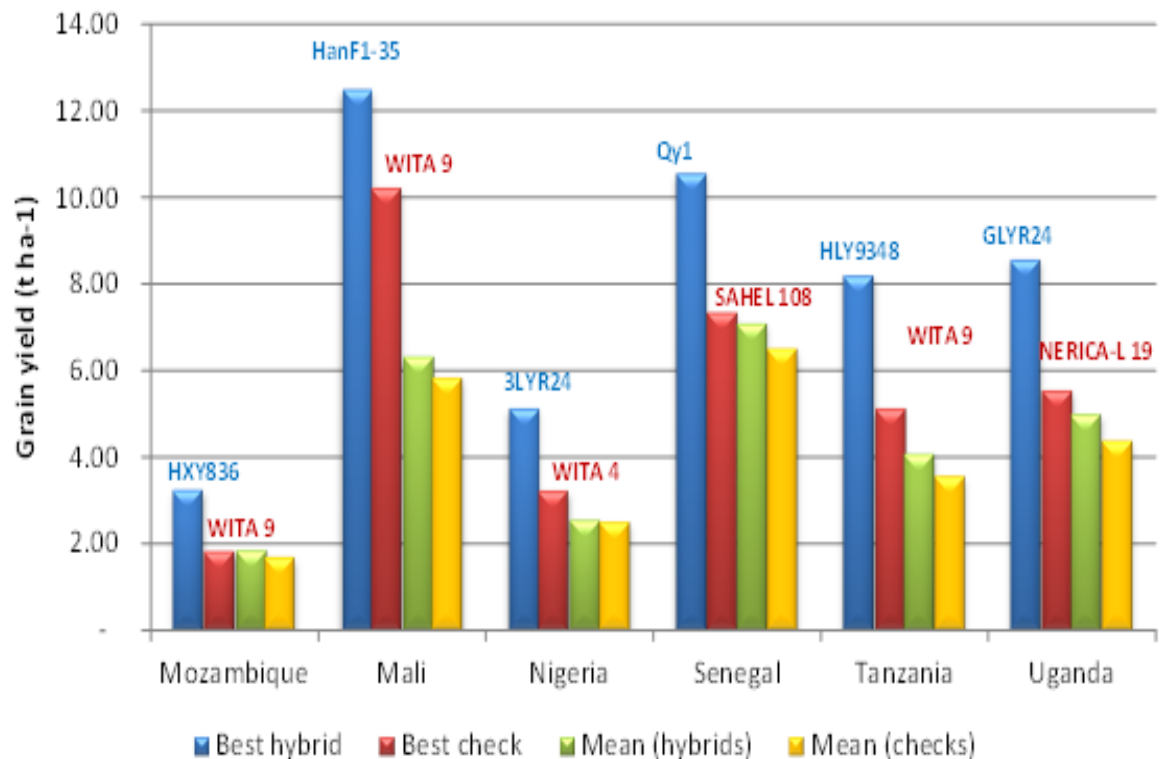
## Other activities

Chinese and Indian seed companies (**ADVANTA and Bio-seed**) tested hybrids in Nigeria, Senegal, Mali, Niger, Egypt and Mozambique.

**Major challenges :** **resistance to insect, disease**



# GSR hybrids in Africa (2009-2011) - status-3



**Non inoculated**      **Inoculated**

Resistance status of GSR hybrid RYMV

## • **Lessons learnt**

- High yield potential were observed of Chinese hybrids compared with inbred checks.
- Most of the Chinese hybrid does not have resistance especially for RYMV, AfRGM, although they showed high yield.
- Incorporation of resistance into parental lines is the key in Africa

# Hybrid Rice Program at AfricaRice 2010

## Objective

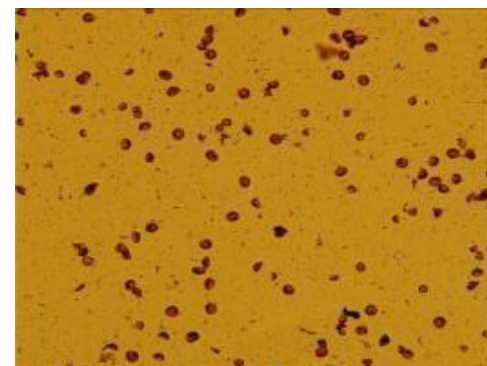
- Developing new hybrid combination and parental lines, (Maintainer, CMS, restorer, EGMS)
- Evaluate promising hybrids in multiple locations in different countries through ABTF.
- Establish hybrid rice Seed production.
- Enhance Capacity building for NARS in hybrid rice





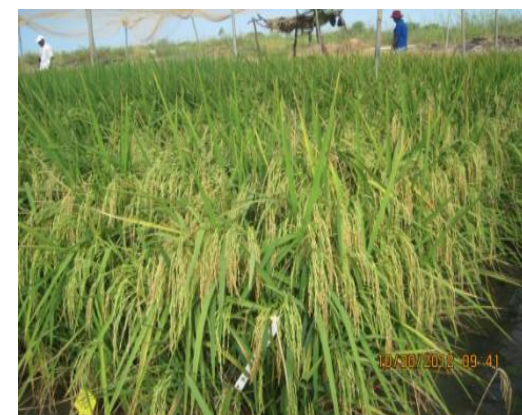
# Three line system 2010 -2015

Field	Line Number	Remarks
Testcross	600	Release varieties and breeding lines
Restorer	150	AfricaRice, N-L , Sahel, HRDC
Maintainer	100	AfricaRice - HRDC
New CMS	2	Under multiplication 2015
Backcross	50	BC4, BC3, BC2, BC1
Segregating population	1000	Restorer – maintainer, EGMS



# Hybrid rice Yield trails

Trial	Hybrid Number	Remarks
OB	600	on the station (2011 -2-15)
PYT	300	two locations (2012 -2015)
AYT	100	Two locations (2013 -2015)
MET	36	Two locations + NARS, Nigeria, Mali, Senegal Gambia and Mauritania (2014 - 2015)
PET	10	Two locations + NARS, Nigeria, Mali, Senegal Gambia am Mauritania (2015)



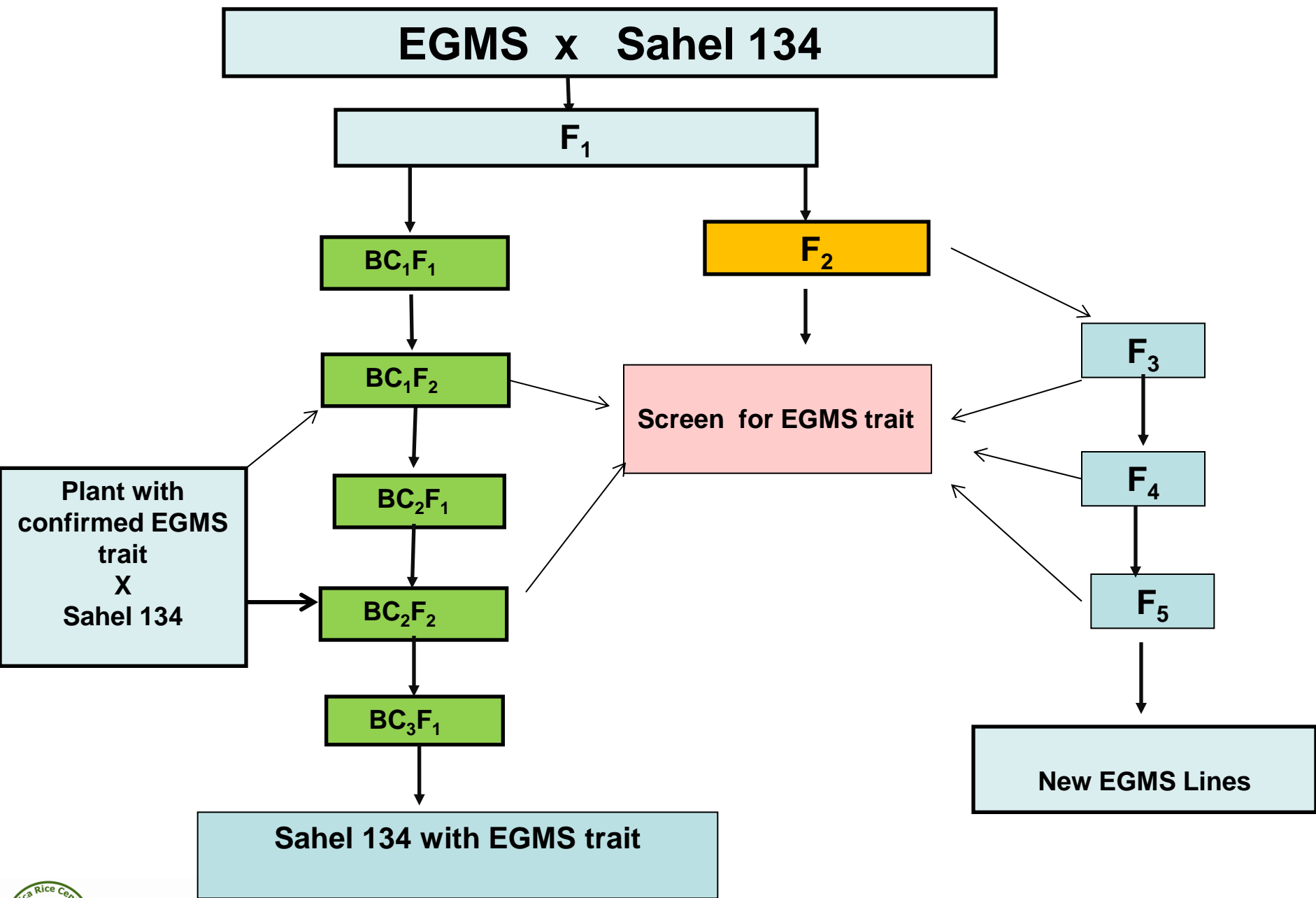
# Two line system (2013)

Breeding new EGMS lines

Three F<sub>2</sub> populations, EGMS/ Sahel 108, EGMS/ Sahel 134, EGMS/ Sahel 159.

Generation	Line number
F <sub>4</sub>	300
F <sub>3</sub>	260
BC <sub>2</sub> F <sub>1</sub>	12
BC <sub>1</sub> F <sub>2</sub>	220





# Performance of promising hybrids and check cultivars in Senegal 2012 -2013

Hybrid	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	Panicle m <sup>-2</sup>	Spikelet fertility (%)	Grain yield(t ha-1)	Hybrid advantage (%)
AR023H	85	102	24	489	82.8	10.6	20.7
AR042H	91	109	27.3	490	83.7	10.5	19.65
AR010H	91	105	26.2	517	82.7	10.3	17.43
AR013H	90	101	28.2	495	82.3	10.1	15.22
AR008H	88	107	30	415	83.7	10	13.84
AR009H	87	109	26.5	425	83.1	10	13.52
AR031H	88	104	29	395	83.7	10	14.23
AR017H	87	106	26.7	321	82.6	9.9	12.83
AR018H	87	112	24.4	407	83.6	9.9	12.96
AR062H	87	111	29.7	404	94	9.9	13.31
AR043H	85	107	30	373	81.7	9.8	11.17
AR044H	85	107	28	421	83.7	9.7	10.21
AR051H	85	108	29.3	443	81.2	9.7	10.96
Sahel 108 Ck	85	89	24.8	362	80.5	8.8	0

**LSD**                      **1.5**                      **5.6**                      **2.7**                      **91**                      **0.8**                      **1.2**

**CV (%)**                      **1.1**                      **3.3**                      **6.1**                      **13.5**                      **5.3**                      **0.9**



# Yield performance of 16 hybrid rice varieties in Kano Nigeria -2014

Variety	Days to flowering	Days to Maturity	Plant Height(cm)	No of Tiller/plant	No of panicle/plant	100grain Weight(g)	Yield(t/ha)	%Yield increase Over FARO 57
ARS034H	94.5	124.5	99.17	36	27.5	24.75	13.06	33.13
ARS035H	90	120	97.83	33.1	27.83	24.75	12.87	31.19
ARS017H	96	126	91.66	31.8	20	27.25	12.82	30.68
ARS031H	95.5	125.5	100.83	35.2	23	27.5	12.52	27.62
ARS009H	102	132	94	35	23.5	26.75	12.27	25.08
ARS002H	106.5	136.5	103.66	38.8	23.33	26	12.2	24.36
ARS033H	100.5	130.5	105	31.1	22.17	24.75	12.02	22.53
ARS010H	94	124	91.33	30.1	24.83	25	11.81	20.39
FARO57	108	138	139.17	37.9	25	29	9.81	0
FARO60	107	137	110.83	40.2	33.17	27.75	11.15	13.66
CV	2.52	1.93	4.27	7.84	10.6	5.33	6.4	
R2	0.94	0.95	0.95	0.79	0.74	0.79	0.9	
Pr>f	***	***	***	**	**	***	**	



## Yield performance of 16 hybrid varieties in Kubwa, Nigeria 2014

Variety	Days to flowering	Days to Maturity	Plant Height(cm)	No of Tiller/plant	No of panicle/plant	100grain Weight(g)	Yield(t/ha)	%Yield adv. Over FARO 57
ARS001H	90.5	120.5	124.99	14	15.5	23.5	9.82	7.68
ARS010H	95	125	118	19.5	18.5	25	9.82	7.68
ARS033H	96	126	111.66	19.63	16.5	25.25	9.01	-1.21
ARS034H	97.5	127.6	118.49	14.63	17.5	25	8.87	-2.74
ARS032H	92.5	122.5	122.5	18.8	19.5	22.75	8.86	-2.85
ARS017H	81	111	109.16	13.38	16	26	8.49	-6.91
ARS035H	91	121	121.33	16.5	18.5	25.25	8.48	-7.02
FARO57	109.5	139.5	169.83	16.38	17.5	28.75	9.12	0
ARICA 1	103.5	133.5	142.1	14.63	12.5	29	8.66	-5.04
ARICA 2	104.5	133.5	137.17	13.68	16	25.5	8.11	-11.07
ARICA 3	108.5	138	139.49	16.75	15.6	25.6	7.69	-15.68
CV	2.48	1.89	2.85	9.48	8.59	5.24	10.25	
R2	0.96	0.9	0.97	0.84	0.82	0.72	0.84	
Pr > F	***	***	***	***	**	*	***	

## Yield increase of 5 best hybrid varieties over three FARO varieties across two locations, Nigeria 2014

Variety	Yield(t/ha)	%Yield increase over Faro 44	%Yield increase over Faro 52	%Yield increase over Faro 57
FARO 44	7.90			
FARO 52	9.27			
FARO 57	9.41			
<b>ARS010H</b>	<b>11.02</b>	<b>39.49</b>	<b>18.87</b>	<b>17.11</b>
<b>ARS017H</b>	<b>10.66</b>	<b>34.93</b>	<b>14.99</b>	<b>13.28</b>
<b>ARS033H</b>	<b>10.52</b>	<b>33.16</b>	<b>13.48</b>	<b>11.80</b>
<b>ARS034H</b>	<b>11.22</b>	<b>52.89</b>	<b>21.03</b>	<b>19.23</b>
<b>ARS035H</b>	<b>10.68</b>	<b>35.18</b>	<b>15.21</b>	<b>13.50</b>
<b>Means</b>	<b>10.08</b>			



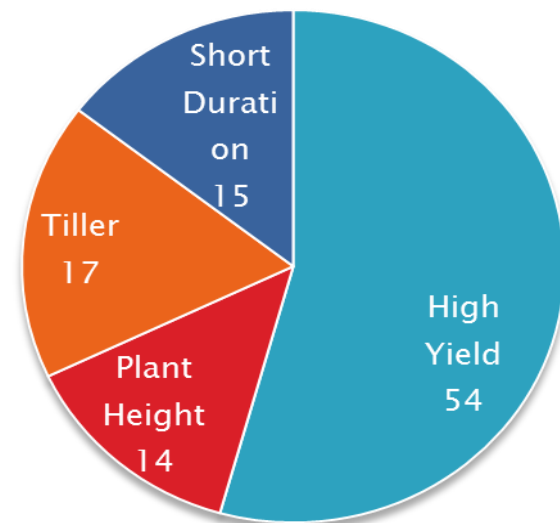


# hybrid seed production

- Seeds of 18 CMS lines and 600  $F_1$  hybrid seed were multiplied and Produced in small plots of hybrid seed production



# PVS of hybrid rice at Senegal 2012



**The most important traits for farmers when they have to choose rice varieties**

# PVS of hybrid rice at Nigeria and Senegal 2013 - 2014

Five hybrids showed high yield potential from 15 -20 %, and selected by farmers in Nigeria and Senegal



# Training in Hybrid Rice at AfricaRice

Year	Number of trainees	Number of Countries	Training area
2011	30 (GSR –IRRI)	10	Breeding and seed production
2012	5	3	
2013	10	5	

\* Four master student are trained in hybrid rice at AfricaRice



# Challenges of Hybrid Rice in Africa - 1

## - Business Aspects -

### Facts of Rice in Africa

Traditional Varieties:	90%	through Informal System
Improved Varieties:	75%	through Informal System

**Farmers are not buying seeds, producing by themselves**

- **Q1: Are rice farmers willing to buy hybrid seed for every crop season?**
- **Q2: Are rice farmers willing to pay more on hybrid seeds?**

**If these points are not met, no private company interested in**



### Solution (Technical)

- **Hybrid varieties exhibiting high yield advantages (>30%) over their best check, with necessary traits for a region (for Farmers)**
- **Hybrid seed production > 3.0 ton/ha (For Seed Company)**

# Challenges of Hybrid Rice in Africa - 2

## - Hybrid Breeding -

- **Many essential traits in Africa**
  - Pest resistance (RYMV, AfRGM): African native
  - Abiotic tolerance: drought, Fe toxicity
- **Yield advantage**
  - 30 % over the best check
- **Grain quality**
  - Wide diversity in preference (aroma, amylose)
- **Traits for seed production**
  - EGMS (two line system)
  - Stigma exertion



# Prospective:

## AfricaRice Breeding strategy

### Target Traits

#### Agronomic Traits

- **Grain Yield**
- Duration
- Plant Height
- Shattering

#### Abiotic Stress Tolerance

- Drought
- Submergence
- Heat
- Cold
- Salinity
- Fe toxicity
- P-deficiency

#### Biotic Stress Tolerance

- Blast
- Bacterial Blight
- RYMV
- AfRGM

#### Grain Quality

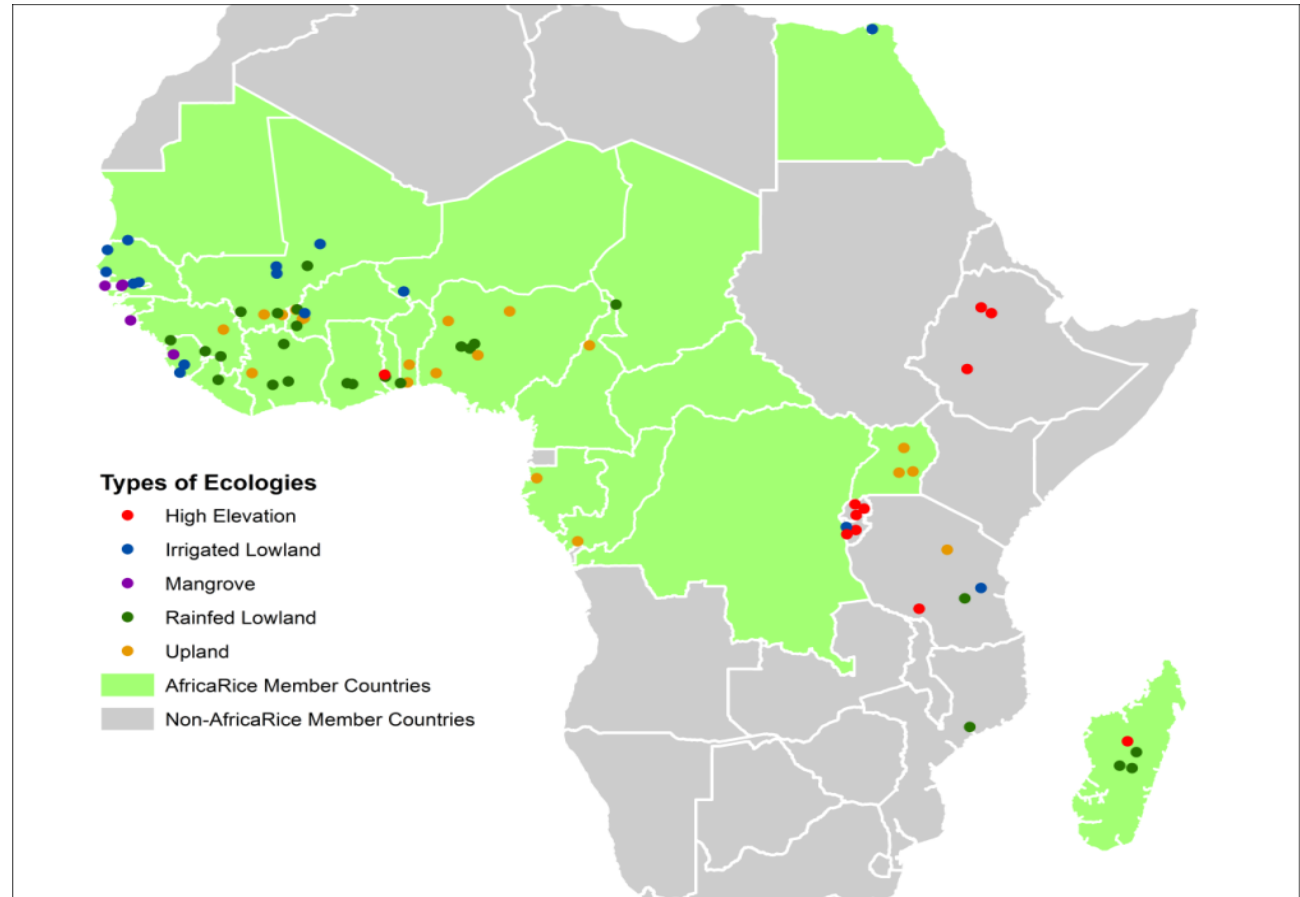
- Shape
- Milling %
- Chalkiness
- Amylose cont.

AfricaRice breeder was succeeding to introduce QTL for a biotic and abiotic stresses (*rymv-1*, *rymv-2*, *AfRGM*, *Pi2*, *Pi29*, cold Salinity) to many restorer lines (Sahel 108, Nerica L19, Giza178....)

# Africa-wide Rice Breeding Task Force

## ● Ecologies

- Irrigated lowland
- Rainfed lowland
- Upland
- High elevation
- Mangrove



- Africa has been established a good network with 35 NARS through BTF
- Standardize protocol for evaluation and varietal release



# Conclusions

- High yield potential were observed of both Chinese, and Indian in many African countries. But most of the Chinese hybrid does not have resistance especially for rymv, AfRGM.
- A good progress in hybrid program at AfricaRice, Senegal, also promising results obtained with NARS (Mali, **Nigeria, Senegal** Mauretania, Gambia). Five hybrids showed high yield potential from 15 -20 %, and selected by farmers in Nigeria and Senegal.
- AfricaRice has good network and strong system for evaluation and varietal release with NARS.



# Forward

- Many requests from public and private sector in Nigeria, Gambia, Senegal to promote hybrid rice.
- Private seed companies should play a major role to promote hybrid rice in Africa.
- Maybe initiating consortium or shuttle breeding program for hybrid rice in Africa will be more efficient to develop hybrids tolerant to biotic and abiotic stresses (BB, Blast *rymv*, *AfRGM*, cold, salinity).
- .

# Thank you

**Partners**

**IRRI**

**GRiSP**

**NARS**

**Seed companies**



**We are still looking for more partners to promote hybrid rice in Africa**



**AfricaRice**

8<sup>th</sup> Annual meeting of HRDC, IRRI 25-27 March 2015

[www.AfricaRice.org](http://www.AfricaRice.org)