Crop Monitoring as an
E-agricultural tool in
Developing Countries

GROUND DATA
COLLECTION REPORT

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ACRONYMS & GLOSSARY

JAAS: Jiangsu Academy of Agricultural Sciences
LAI: leaf area index
GPS: global position system
Seed-setting rate (%): empty grains as the percentage of total grains
Theoretical yield (t/ha) = ear density * grain number per ear * 1000-grain weight * seed-setting rate / 10^9
BioMA: Biophysical Models Application
CropSyst: Cropping Systems Simulation
INRA: Institut National de la Recherche Agronomique (www.inra.org.ma)
WARM: Water Accounting Rice Model
WOFOST: WOrld FOod STudies

EXECUTIVE SUMMARY

According to the requirements of WP3.1, JAAS was responsible for ground data collection of rice in the Jianghuai plain, and INRA for wheat data collection in Morocco. Information obtained from these datasets is required for the parameterization/calibration of the BioMA crop models WARM, WOFOST, and CropSyst.
JAAS had collected some fundamental data before the end of May 2011. On June 11-12, 2011, they conducted the first field survey in the study region and selected nine sites for data collection. They investigated the rice varieties, fertilization habits, water management, and yield level. At the same time, they collected soil samples for analysis of physical and chemical characteristics. In the following months till October, 2011, series of ground observation were made in 8 field surveys.
Given the availability of pre-existing datasets, INRA initially retrieved information in eight experimental stations where some soft wheat and durum wheat varieties were monitored from 2001 to 2004 and from 2002 to 2005, respectively. Those stations belongs to various environments in Morocco, ranging from semi-arid to favourable agro-ecological zones. This choice allow to evaluate genotype-environment interaction variability. They investigated different wheat varieties properties (i.e., phonological phases and yield level). On November 2011, INRA started the field experiments dedicated to BioMA models calibration, that will be completed at month 18.

1. Characterization of the study areas

1.1. Rice based cropping systems in Jiangsu

Figure 1 Map of Jiangsu

Jiangsu is located in the southeast of China, with a latitude between 30°46'N and 35°07'N, and a longitude between 116°22'E and 121°55'E. Its land area is about 102.6 thousand km^2. Jiangsu is divided into 13 administrative regions, having a population of about 78.66 millions. Cropping system is mainly rice-wheat rotation, main crops include rice, wheat, rapeseed, maize, cotton and soybean.

Table 1 Rice area and yield in Jiangsu and study region

	Area (k ha)				Yield (kg/ha)		
	Rice	*Japonica*	*Indica*	Others	Rice	*Japonica*	*Indica*
Jiangsu	2232.50	1800.57	370.72	61.21	7937	8051	7355
Huaian	281.22	183.50	93.26	4.46	8174	8323	7747
Yangzhou	203.98	169.36	28.03	6.59	7973	8198	6814
Taizhou	204.40	191.11	7.29	6.00	8871	8887	8886
Suqian	205.64	107.71	90.13	7.80	7801	7771	7815

*Source: Statistic yearbook of Jiangsu agriculture, 2009.

In 2008, rice area reached 2232.5 k ha, including 1800.57 k ha *Japonica* rice and 370.72 k ha *Indica* rice, area ratio of *Japonica* to *Indica* rice was 4.86, so *Japonica* rice was the main type in Jiangsu. We selected 4 administrative regions, i.e. Huaian, Yangzhou, Taizhou and Suqian, as the study region. Land area in this region accounted for 30.3% of that in the whole Jiangsu province, but rice area in the study region accounted for 40.1% of that in Jiangsu, *Japonica* and *Indica* areas in the same region accounted for 36.2% and 59.0% of those in Jiangsu, respectively. Rice area of Huaian was the highest in the 4 administrative regions, and *Japonica* rice area was nearly 2/3 of its total rice area. The other 3 administrative regions owned similar rice area, but Taizhou possessed the lowest *Indica* rice area which only accounted for 3.6% of its total rice area. Area of *Indica* rice was similar to that of *Japonica* rice in Suqian.

In 2008, rice yield was 7937 k/ha in Jiangsu province, yields of *Japonica* and *Indica* rice reached 8051 and 7355 k/ha, respectively. Taizhou possessed the highest rice yield, both *Japonica* and Indica rice yield could reach nearly 8900 kg/ha. Suqian had the lowest rice yield, and *Indica* rice yield was similar to its *Japonica* rice yield. *Japonica* rice yield was higher than *Indica* rice yield in both Huaian and Yangzhou.

1.2. Wheat based cropping systems in Morocco

Six agro-meteorological zones can be identified in Morocco (Figure 2), with wheat actively grown in five of them (no agriculture is allowed in the Saharan region).

Wheat cultivars grown in Morocco (Table 2) can be classified according to their features and to the way they interact with agro-climatic conditions.

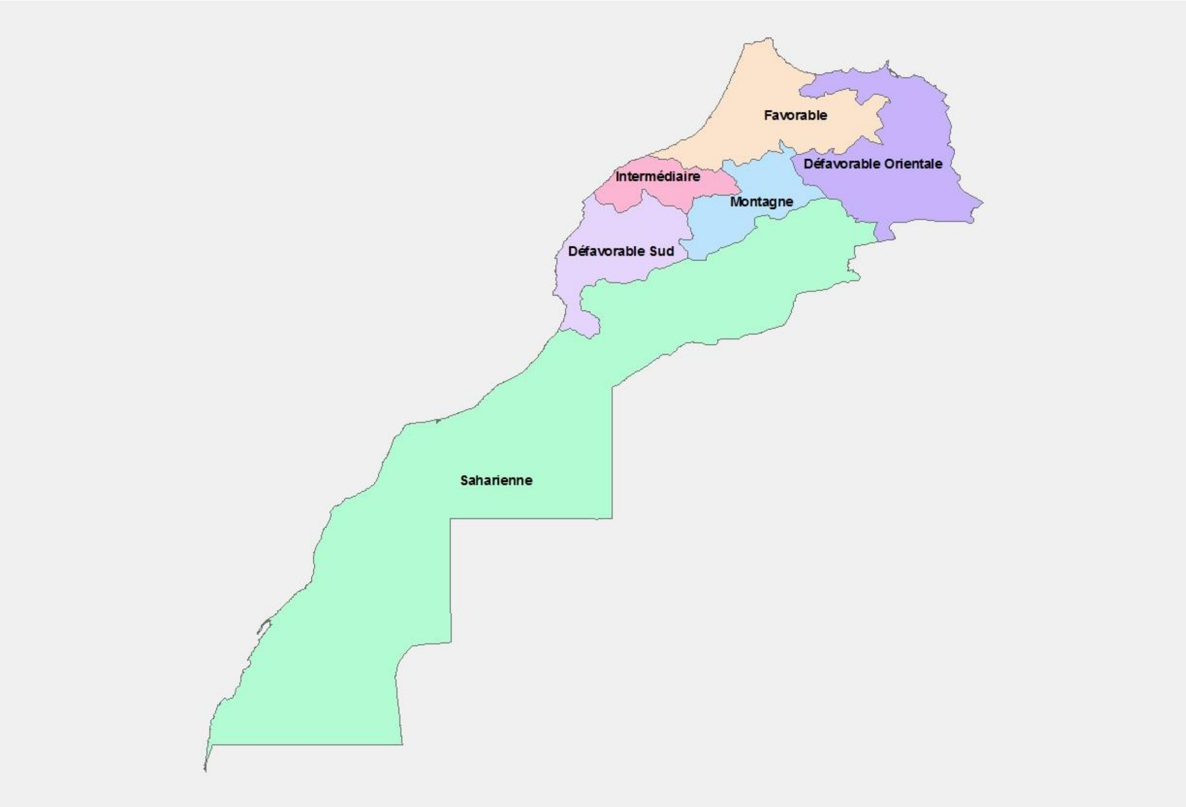


Figure 2: Agro-meteorological zonation of Morocco

The first criterion used to classify cultivars in groups with similar morphological and physiological features led to distinguish between soft and durum wheat.

For what concerns soft wheat, the sub-criterion was related to the cultivars productivity, thus leading to identify two groups of cultivars: high-hielding and medium-yielding, homogeneously distributed in the Country.

Concerning durum wheat, the sub-criteria used to define the groups of cultivars grown in Morocco reflect the two main types of agro-meteorological conditions explored by the crop in the area. In the Northern and Western parts of the Country, thermal conditions are generally more favourable for durum wheat, with milder conditions during the summer, cooler winters and more favourable rainfall distribution. The conditions explored in the Southern and Eastern regions are instead characterized by high temperatures, leading to higher atmospheric water demand which, coupled with less favourable rainfall, increases the potential exposure of the crop to suboptimal conditions for water availability.

The presence of two well-differentiated agro-meteorological regions has greatly influenced the distribution of durum wheat cultivars, leading farmers to differentiate the choice of the cultivar on the basis of the conditions explored. Consequently, the criteria for the identification of the groups of durum wheat cultivars are:

- differences in thermal requirements,

- differences in the degree of tolerance to water stress,
- productivity.

Table 2 Groups of wheat cultivars for which parameters sets will be developed

Group name	Description	Representative cultivars
Soft wheat, High yielding (SH)	High-yielding soft wheat cultivars	Arrehane
Soft wheat, Medium yielding (SM)	Medium-yielding soft wheat cultivars	Achtar
		Mehdia
		Massira
		Kanz
Durum wheat, High-yielding (DH)	High-yielding, bread cultivars, experiencing long seasons, characterized by cold winter and favourable rains	Marzak
		RGL0095
		Isly
		Sarif
		O.Rabia
		Ourgh
		Tarek
		Sebou
		Tomouh
		Marjana
		RGN0027
		Yasmine
		Jawhar
		Massa
		Anouar
		Karim
Durum wheat, Low-yielding (DL)	Low-yielding cultivars, experiencing short seasons, more adapted to warm environments and more tolerant to unfavourable rainfall distribution	IRDEN (INRA1804)
		Nassira (INRA1805)
		Telset (INRA1806)
		Amria (INRA1807)
		Chaoui (INRA1808)
		Marouane (INRA1809)

2. Ground data collection for BioMA

2.1. Rice in Jiangsu

2.1.1. Observation sites

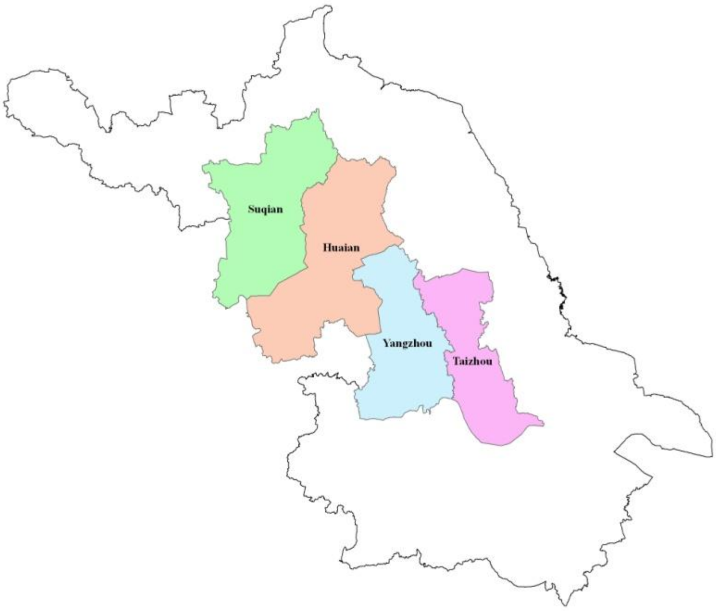


Figure 3 Location of study region in Jiangsu

The location of the observation sites in Jiangsu, shown in Figure 3 and Figure 4, were selected according to the following factors: rice variety, type, cultivated method of rice, distance from Nanjing, preservation and transportation of rice sample. Nine observation sites were finally determined and their geographical positions are indicated in Table 3.

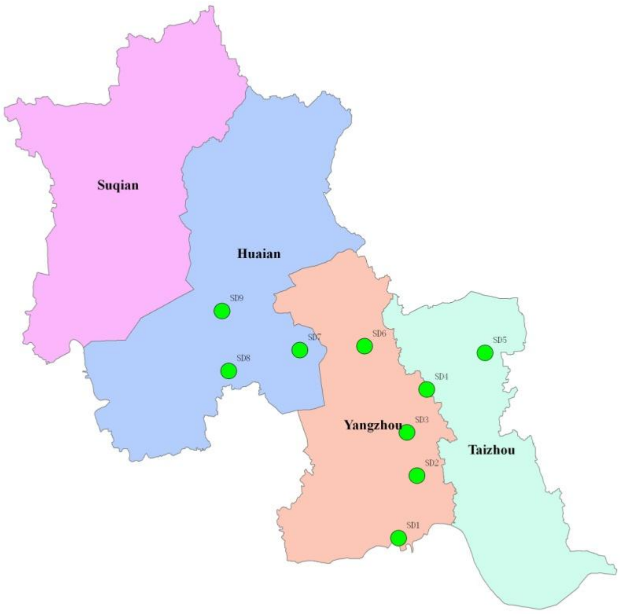


Figure 4 Distribution of observation sites in study region

Table 3 Location and GPS information of observation Jiangsu sites

	Location	GPS information
SD1	Shatou, Hanjiang, Yangzhou	32 16 57.9N 119 33 50.1E
SD2	Yiling, Jiangdu, Yangzhou	32 30 39.0N 119 41 33.4E
SD3	Fanchuan, Jiangdu, Yangzhou	32 40 55.2N 119 40 37.5E
SD4	Lincheng, Xinghua, Taizhou	32 50 02.1N 119 47 53.2E
SD5	Changrong, Xinghua, Taizhou	32 56 28.6N 120 05 51.4E
SD6	Xiaji, Baoying, Yangzhou	33 02 07.4N 119 32 16.0E
SD7	Tugou, Jinhu, Huaian	33 03 27.5N 119 13 53.4E
SD8	Dailou, Jinhu, Huaian	33 00 57.7N 118 53 01.9E
SD9	Zhuba, Hongze, Huaian	33 14 58.4N 118 53 28.6E

2.1.2. Soil samples and their analysis results

Soils of 9 observation sites were collected on June 11-12, sample depth was from 0 to 20 cm. Soil samples were air-dried and ground to pass through 20 mesh and 60 mesh sieve in order to analyze their physical and chemical characteristics.

Table 4 Results of Jiangsu soil analysis

	pH	Organic Matter (g.kg^{-1})	Total Nitrogen (g.kg^{-1})	Available N (mg.kg^{-1})	Available P (mg.kg^{-1})	Available K (mg.kg^{-1})	Soil texture
SD1	6.7	26.58	1.83	166.3	22.9	63.4	clay loam
SD2	6.7	26.9	1.84	170.1	12.3	19.3	clay loam
SD3	6.6	21.05	1.31	139.9	19.7	39.4	clay loam
SD4	6.5	25.77	1.69	186.4	17.5	43.4	clay loam
SD5	6.7	24.04	1.46	166.3	8.6	67.4	clay loam
SD6	6.8	19.75	1.24	141.8	14.8	93.5	loamy clay
SD7	6.8	21.18	1.32	166.7	8.9	113.5	loamy clay
SD8	6.8	21.1	1.45	166.3	27.1	69.4	loamy clay
SD9	6.7	17.73	1.28	139.9	24.2	77.5	loamy clay

Organic matter contents of 9 samples varied from 17.73 to 26.58 g/kg, and total nitrogen contents from 1.24 to 1.84 g/kg, so all soils had a higher fertility level. Soil available N changed from 139.9 to 186.4 mg/kg. Soil available P varied from 8.6 to 27.1 mg/ka, its content was in a medium or lower level. Soil available K varied from 19.3 to 113.5 mg/ka, its content was also in a medium or lower level except SD7. Soil texture was clay loam or loamy clay, and was suitable for rice growth.

2.1.3. Rice varieties, types and cultivation methods

We included sufficient parameters in our observations, such as rice variety, rice type and cultivation method, to ensure the representativity of our samples and fulfil subsequently the requirement of BioMA model. This study covered 5 rice varieties which were the main local cultivated varieties, including 3 *Japonica* rice and 2 *Indica* rice. *Indica* rice (SD7 and SD8) were sowed in early May and artificially transplanted on June 13. Two *Japonica* rice (SD1 and SD9) were also sowed in late May and mechanically transplanted on June 20 or so. Direct broadcasting *Japonica* rice was adopted in the other 5 observation sites.

Table 5 Rice varieties, types and cultivation methods of Jiangsu observation sites

	Rice variety	Rice type	Cultivation method
SD1	Yangjing 4227	Early-maturing *Japonica* rice	Mechanical transplanting
SD2	Zhendao 88	Medium-maturing *Japonica* rice	Direct broadcasting
SD3	Huaidao 5	Late-maturing *Japonica* rice	Direct broadcasting
SD4	Huaidao 5	Late-maturing *Japonica* rice	Direct broadcasting
SD5	Huaidao 5	Late-maturing *Japonica* rice	Direct broadcasting
SD6	Huaidao 5	Late-maturing *Japonica* rice	Direct broadcasting
SD7	C Liangyou 608	Late-maturing *Indica* rice	Artificial transplanting
SD8	Y Liangyou 1	Late-maturing *Indica* rice	Artificial transplanting
SD9	Huaidao 5	Late-maturing *Japonica* rice	Mechanical transplanting

2.1.4. Introduction to rice varieties

2.1.4.1. Yangjing 4227

- Breeding organization: Lixiahe Institute of Agricultural Sciences, JAAS
- Sources of variety: Yangjing 7057 × Huangye 9520
- Characteristics: Plant height can reach 95~100 cm. Its panicle can reach 3~3.3 million/ha, and each panicle owns about 120 grains. 1000-grain weight is about 28 g, and its potential yield can reach about 10.5 t/ha. Yangjing 4227 is featured by thick stems, high yield, lodging resistance, stripe disease resistance, strong tillering ability. Rice quality indicators are as follows: milled rice rate, 67.4%; chalky grain rate, 7.0%; chalkiness, 0.4%; gel consistency, 86 mm; amylose content, 15.8%.

2.1.4.2. Zhendao 88

- Breeding organization: Zhenjiang Institute of Agricultural Sciences, JAAS
- Sources of variety: Moonlight × Wuxiangjing 1
- Characteristics: Plant height can reach about 95 cm. Its panicle can reach 3.3~3.75 million/ha, and each panicle owns about 110~120 grains with a seed setting rate of more than 90%. 1000-grain weight is about 27 g, and its potential yield can reach about 10.5 t/ha. Zhendao 88 is featured by compact plant type, short flag leaves, small leaf angle, slight thick-color leaves, easy shattering, and suitable for manual and mechanical threshing. Rice quality indicators are as follows: milled rice rate, 74.4%; ratio of length to width, 1.73; gel consistency, 86 mm; amylose content, 17.35%; protein content, 9.39%.

2.1.4.3. Huaidao 5

- Breeding organization: Huaiyin Institute of Agricultural Sciences, JAAS
- Sources of variety: 7208 × Wuyujing 3
- Characteristics: Plant height can reach 93 cm. Its panicle can reach 3.3 million/ha, and each panicle owns about 110 grains with a seed setting rate of more than 92.5%. 1000-grain weight is about 28 g, and its potential yield can reach about 11.25 t/ha. Huaidao 5 is featured by compact plant type, coordinate grain structure, moderate tillering ability, better lodging resistance, bacterial blight resistance, and difficult threshing. Rice quality indicators are as follows: milled rice rate, 60.3%; chalky grain rate, 34%; chalkiness, 3.3%; gel consistency, 79 mm.

2.1.4.4. C Liangyou 608

- Breeding organization: Hunan Longping Seed Industry Co., Ltd.
- Sources of variety: C815S×R608
- Characteristics: Plant height can reach 110.8 cm. Its panicle can reach about 2.55 million/ha, and each panicle owns about 171 grains with a seed setting rate of more than 80.7%. 1000-grain weight is about 27.1 g, and its potential yield can reach about 10.5 t/ha. C Liangyou 608 is featured by compact plant type, and upright leaves. Rice quality indicators are as follows: milled rice rate, 57.0%; ratio of length to width, 2.8; chalky grain rate, 39%; chalkiness, 9.2%; gel consistency, 79 mm; amylose content, 14.5%.

2.1.4.5. Y Liangyou 1

- Breeding organization: Hunan Hybrid Rice Research Center
- Sources of variety: Y58S×9311
- Characteristics: Plant height can reach 120.7 cm. Its panicle can reach 2.5 million/ha, and each panicle owns about 164 grains with a seed setting rate of more than 81.0%. 1000-grain weight is about 26.6 g, and its potential yield can reach about 9.75 t/ha. Y Liangyou 1 is featured by compact plant type, and upright leaves. Rice quality indicators are as follows: milled rice rate, 66.9%; ratio of length to width, 3.2; chalky grain rate, 33%; chalkiness, 4.7%; gel consistency, 54 mm; amylose content, 16.0%.

2.1.5. Observation and record of rice growth periods

We reasonably arranged observation and sample date according to rice growth periods in the normal year. We asked farmers the exact sowing, emergence and transplanting dates of each site, and observed rice growth situation in the field to determine their booting, heading, flowering and physiological maturity dates.

Table 6 Observation of rice growth periods

	Sowing date	Emergence date	Transplanting date	Booting date	Heading date	Flowering date	Physiological maturity date
SD1	26-May	30-May	22-Jun	24-Aug	1-Sep	3-Sep	21-Oct
SD2	9-Jun	14-Jun	—	23-Aug	30-Aug	1-Sep	17-Oct
SD3	12-Jun	19-Jun	—	28-Aug	5-Sep	7-Sep	20-Oct
SD4	12-Jun	19-Jun	—	25-Aug	2-Sep	4-Sep	20-Oct
SD5	11-Jun	18-Jun	—	25-Aug	2-Sep	4-Sep	20-Oct
SD6	13-Jun	20-Jun	—	25-Aug	2-Sep	4-Sep	21-Oct
SD7	10-May	15-May	13-Jun	13-Aug	20-Aug	22-Aug	10-Oct
SD8	5-May	10-May	13-Jun	17-Aug	24-Aug	26-Aug	12-Oct
SD9	20-May	26-May	20-Jun	22-Aug	30-Aug	1-Sep	21-Oct

2.1.6. Records of fertilization

We investigated the farmers' fertilization approaches by recording the dates of fertilization, fertilizer types and fertilization amount. Synthetic (chemical) fertilizer was mainly used as the basal fertilizer, at the dosis of 375 kg/ha or more. Urea was usually used as dressing fertilizer to broadcast 2 or 3 times, its total amount was about 600 kg/ha or even more. Sometimes synthetic fertilizer was also used as dressing fertilizer.

Table 7 Records of basal fertilization situation

	Fertilization date	Fertilizer type	Fertilizer amount ($kg.ha^{-1}$)
SD1	27-Jun	Urea	150
SD2	9-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	337.5
SD3	10-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	375
SD4	12-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	375
SD5	11-Jun	Compound fertilizer ($N-P_2O_5-K_2O$ 15-15-15)	375
SD6	13-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	375
SD7	13-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	525
SD8	13-Jun	Compound fertilizer ($N-P_2O_5-K_2O$, 15-15-15)	375
SD9	18-Jun	Compound fertilizer ($N-P_2O_5-K_2O$ 15-15-15)	375

Table 8 Records of dressing fertilization situation

	Fertilization date	Fertilizer type	Fertilizer amount ($kg.ha^{-1}$)
SD1	3-Jul	Specialized fertilizer for rice	300
	8-Jul	Urea	225
	10-Aug	Urea	150
SD2	9-Jul	Urea	262.5
	2-Aug	Urea	375
SD3	9-Jul	Urea	300
	5-Aug	Urea	300
SD4	5-Jul	Urea	187.5
	5-Aug	Urea	375
SD5	3-Jul	Urea	150
	20-Jul	Urea	150
	6-Aug	Urea	375
SD6	5-Jul	Urea	337.5
	21-Jul	Compound fertilizer ($N\text{-}P_2O_5\text{-}K_2O$, 15-15-15)	375
SD7	12-Jul	Compound fertilizer ($N\text{-}P_2O_5\text{-}K_2O$, 15-15-15)	75
SD8	28-Jun	Urea	150
SD9	28-Jun	Urea	150
	21-Jul	Urea	375
	8-Aug	Compound fertilizer ($N\text{-}P_2O_5\text{-}K_2O$, 15-15-15)	225

Because *Indica* rice owned a strong ability to absorb nutrition elements from soil, and its plant density was also less than that of *Japonica*, fertilizer amount was usually less than that used on *Japonica* rice. In general, farms' fertilization approach was imbalanced, they usually focused on the use of nitrogen, but the doses of phosphorus and potassium were relatively low. although potassium is also important for the quality and yield of grains.

2.2. Wheat in Morocco

Information needed for the parameterization/calibration of the BioMA crop models were partly retrieved from an existing wide INRA database and partly from new trials, devoted to the calibration, started in 2011 and available from month 18 of the project.

This report describe the pre-existing trials conducted in eight experimental stations of INRA from 2001 to 2004 and from 2002 to 2005 for soft wheat and durum wheat, respectively (Table 9). Parameters were collected from a total of 136 (5 soft wheat varieties) and 1,728 (24 durum wheat varieties) trials. Available information is: sowing date; date of emergence, tillering, heading, and maturity; plant height and grain yield. All the datasets concerning these parameters were shared for E-AGRI activities.

Table 9 Information collected from fields trials conducted at INRA experimental stations

Species	Period	Number of years	Number of locations	Number of varieties	Number of trials	Parameters
Soft wheat	2001 to 2004	4	4	5	136	Sowing Emergence Tillering Heading Maturity Height Yield
Durum wheat	2002 to 2005	4	6	24	1728	Tillering Heading Maturity Height Yield

2.2.1. Observation sites

Soft wheat and durum wheat ground data were collected from previous field trials, conducted in eight experimental stations of INRA : Afourer, Annoceur, Jemaa Shaim, Khemiss Zmamra, Marchouch, Sidi Allal Tazi, Sidi El Aydi and Tassaout (Table 10). These experimental stations belong to various environments in Morocco, ranging from semi-arid to favourable agro-ecological zones (Figure 5 Map showing the location of INRA-Morocco experimental stations from which field experimental trials were selected.Figure 5). Marchouch, Sidi Allal Tazi, have favorable and longue growing season, Sidi El Aydi and Jemaa Shaim have dry climate and warm winter and, Khemiss Zmamra has dry climate and is semi irrigated. Tassaout and Afourer stations are very dry and completely irrigated.

Table 10 Location and vocation of the experimental stations of INRA-Morocco.

INRA Experimental Station	Coordinates		Agro-ecological zone	Major stresses
	Latitude	**Longitude**		
Afourer	32.217	-6.500	Irrigated	Rusts, terminal heat
Annoceur	33.667	-4.850	Mountain	Cold, drought, Hessian fly, rusts
Jemaa Shaim	32.350	-8.850	Semi arid	Drought, Hessian fly, Leaf rust
Khemiss Zmamra	32.633	-8.700	Semi arid	Drought, Hessian fly, Leaf rust
Marchouch	33.987	-6.496	Favourable	Rusts, septoria, Hessian fly, drought
Sidi Allal Tazi	34.520	-6.324	Favourable	Septoria, rusts, Hessian fly
Sidi El Aydi	33.167	-7.400	Intermediate	Drought, Hessian fly, rusts
Tassaout	31.420	-6.467	Irrigated	Rusts, terminal heat

Major stresses to wheat production include, in orther of importance drought, Hessian fly, yellow rust, septoria titici and helmintosporium diseases, leaf rust, terminal heat. They occur in all experiment stations, with different severity depending on the location (Table 10).
Annual rainfall increases with latitude, from 250mm in the southern Morocco to above 1000mm in the Northern parts. In relation with rainfall, length of the growing period is one month shorter South than in the Northern parts of the country. Similarly, foliar diseases severity and occurrences increase with increased rainfall. And in reverse, Hessian fly and drought severity and occurrence increase with decreased rainfall.
The eight above experimental stations were selected as varietal testing sites in order to capture most genotype by environment interaction variability (Figure 5).

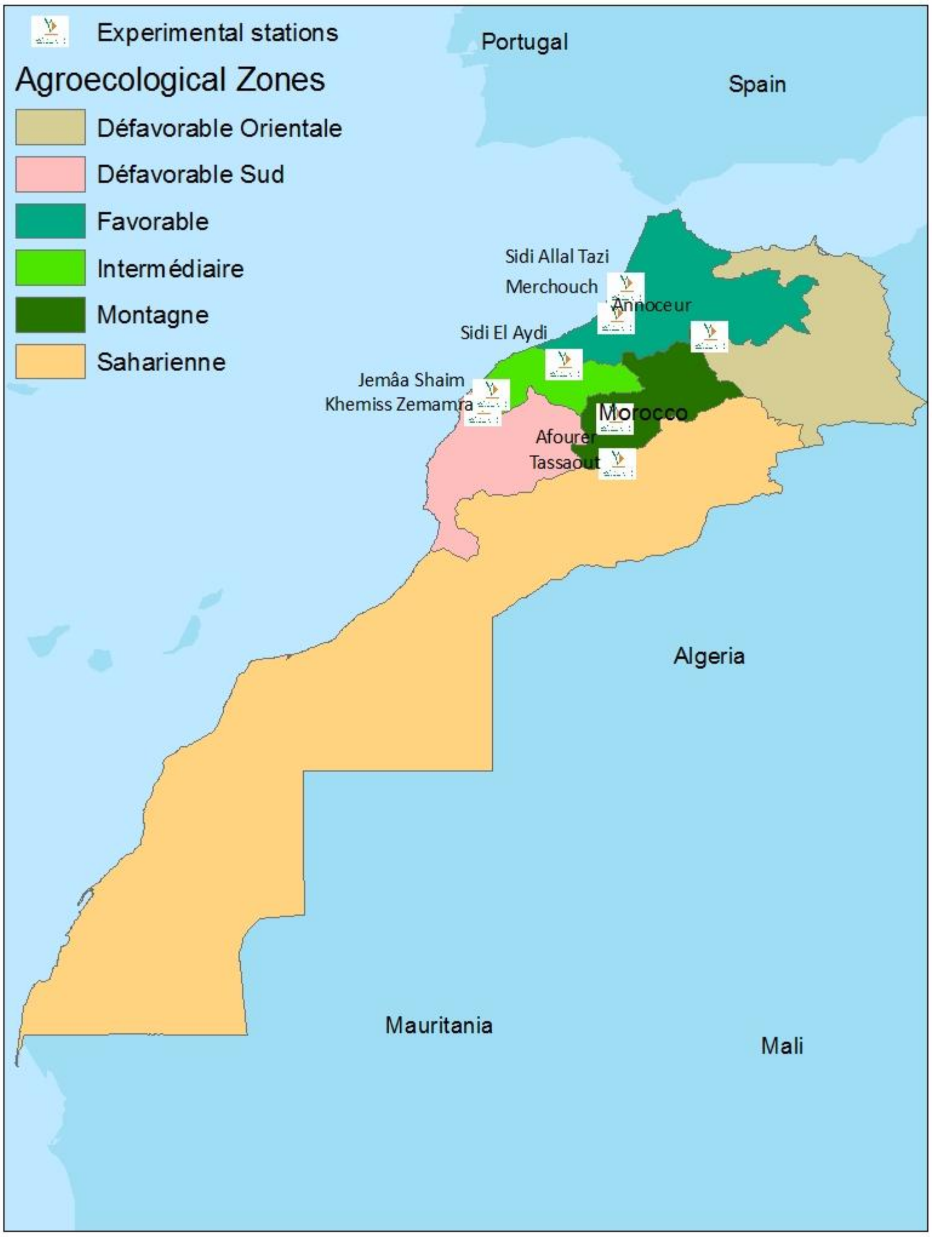


Figure 5 Map showing the location of INRA-Morocco experimental stations from which field experimental trials were selected.

2.2.2. Introduction to wheat species

2.2.2.1. Soft wheat varieties

Five soft wheat varieties were used, from the best yielding varieties released by INRA in the eighties and nineties, and which are extensively used by farmers (Table 11). These varieties are resistant to drought and are medium to resistant to Septoria. The most widely grown variety is still Achtar despite its long cultivation after release in 1987. Kanz variety was released the same year as Achtar and was highly appreciated in the favorable and intermediate zones, before loosing area to the profit of Achtar. Mehdia variety was released in 1993 because of its higher yield potential than Achtar but could not compete with Achtar. Massira variety was released the same year as the first cultivar resistant to Hessian fly. Massira was commercialized by a private firm in the Saiss region. Arrehane is the most recent variety among this group, released in 1997, as resistant to Hessian fly, higher yielding than Achtar and more drought resistant. Arrehane is spreading rapidly, seriously competing with Achtar.

Soft wheat varieties can be classified in two groups, according to their productivity :

- Highly productive cultivars: Arrehane
- Medium productive cultivars: Achtar, Mehdia, Massira, Kanz.

Table 11 Characteristics of soft wheat cultivars used for BioMA calibration

Cultivar	Year of releasе-se	Earliness	Productivity	Adaptation	Resistance to diseases and insects Hessian fly	Sensitivity to Yellow rust	Sensitivity to Septoria
Achtar	1985	Medium late	High	High	Susceptible	Susceptible	Medium
Kanz	1985	Early	Medium	Intermediate	Intermediate	Intermediate	Resistant
Mehdia	1987	Medium early	Medium	Interme-diate	Susceptible	Interme-diate	Medium
Massira	1992	Medium early	Medium	Interme-diate	Resistant	Susceptible	Resistant
Arrehane	1997	Early	High	High	Resistant	Resistant	Resistant

2.2.2.2. Durum wheat varieties

Twenty four durum wheat varieties were used, among the varieties released by INRA. These varieties are:

- Marzak, RGL0095, Isly, Sarif, O.Rabia, Amjad, Ourgh, Tarek, Sebou, Tomouh, Marjana, RGN0027, Yasmine, Jawhar, Massa, Anouar and Karim which are suitable for the

Northern and Western parts of Morocco, longer season, cooler winter and more favourable rain. These area may have Hessian fly (according to the years) they often have Septoria, leaf rust, root rot and fisarium head blight.

- Irden, Nassira, Telset, Amria, Chaoui, Marouane (INRA1804, INRA1805, INRA1806, INRA1807, INRA1808, INRA1809) which are suitable for Southern and or Eastern parts of Morocco, which are warmer, shorter season, more atmospheric water demand, and possibly with less rain. These areas have problems mainly with Hessian fly and dryland root rot, in wet years they have problems with septoria, leaf rust and and fusarium head blight and root rot.

Criteria used to split these varieties in two groups, are by priority :

- Yield in the multiyear multisite experiment. Which is influenced by:
    - Plant phenology (earliness in heading flowering maturity etc) ,
    - Plant morphology (height, tillers number)
    - Plant physiology (tolerance to drought)
- Resistance to Hessian fly
- Tolerance to root rot.

Other resistances were studied but they did not help in classification since they are intermixed in the groups. It is to remember that this classification may become completely ineffective if the year is too rainy.

2.2.3. Observation and record of wheat growth periods

The phenological phases information are related to sowing, emergence, tillering, heading, and maturity dates for each site. These information are listed from Table 12 to Table 15, obtained by averaging on the four years. When more than one year of observation and/or more trials are present, the first and the last available dates are showed. Sowing date is fixed for each specific location.

Table 12 Observations of soft wheat growth periods – Jemaa Shaim site

Wheat Variety	Obs. Years	Sowing date range	Emergence date range	Tillering date range	Heading date range	Physiological maturity date range
Acthar	2	12 Nov	18 Dec – 1 Jan	20 Jan	11 – 18 Mar	22 –30 Apr
Kanz	1	—	1 Jan	—	2 Mar	12 Apr
Massira	2	12 Nov	18 Dec – 1 Jan	20 Jan	6 – 18 Mar	22 – 28 Apr
Arrehane	2	12 Nov	18 Dec – 1 Jan	20 Jan	4 – 8 Mar	12 – 28 Apr
Mehdia	1	12 Nov	18 Dec	20 Jan	6 Mar	24 – 28 Apr

Table 13 Observations of rice growth periods – soft wheat – Marchouch site

Wheat Variety	Obs. Years	Sowing date range	Emergence date range	Tillering date range	Heading date range	Physiological maturity date range
Acthar	3	21 Nov – 12 Dec	12–21 Dec*	—	8 – 25 Mar	30 Apr – 17 May
Kanz	1	21 Nov	12 Dec	—	2 Mar	22 Apr
Massira	3	21 Nov – 12 Dec	12–21 Dec*	—	8 – 23 Mar	30 Apr – 13 May
Arrehane	3	21 Nov – 12 Dec	12–21 Dec*	—	2 – 19 Mar	23 Apr – 9 May
Mehdia	2	29 Nov – 12 Dec	21 Dec	—	10 – 20 Mar	26 Apr – 10 May

*data are not available for the 3rd year (the one with corresponding sowing date 12 Dec).

Table 14 Observations of soft wheat growth periods – Sidi Allal Tazi site

Wheat Variety	Obs. Years	Sowing date range	Emergence date range	Tillering date range	Heading date range	Physiological maturity date range
Acthar	2	14 –26 Dec	20 Dec – 6 Jan	15 –21 Jan	11 Mar – 1 Apr	12 –25 May
Kanz	1	26 Dec	6 Jan	21 Jan	22 –25 Mar	19 –25 May
Massira	2	14 – 26 Dec	20 Dec – 6 Jan	15 – 21 Jan	8 – 29 Mar	11 – 25 May
Arrehane	2	14 – 26 Dec	20 Dec – 6 Jan	15 – 21 Jan	16 Mar – 3 Apr	5 – 25 May
Mehdia	1	14 Dec	26 Dec	15 Jan	4 – 8 Mar	5 – 12 May

Table 15 Observations of soft wheat growth periods – Tassaout site

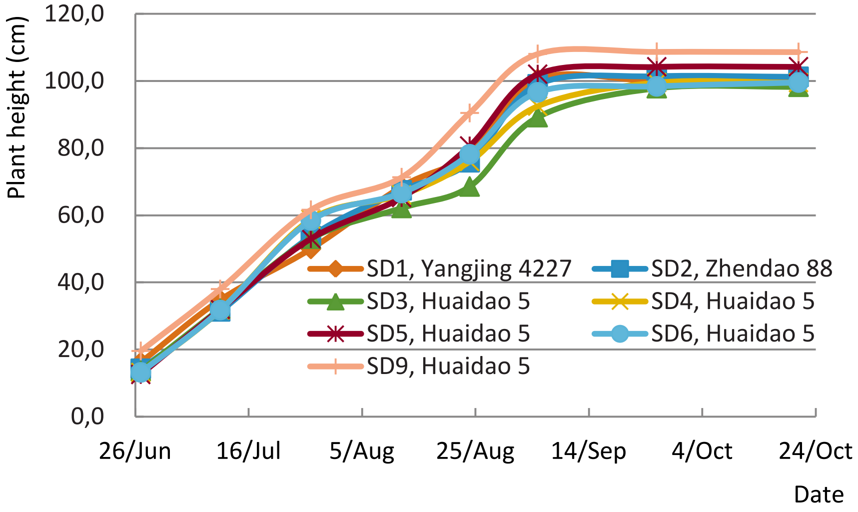
Wheat Variety	Obs. Years	Sowing date range	Emergence date range	Tillering date range	Heading date range	Physiological maturity date range
Acthar	3	21 Nov – 20 Dec	12 Dec – 13 Jan	—	23 Mar – 6 Apr	10 May – 2 Jun
Kanz	2	21 Nov – 20 Dec	12 Dec – 13 Jan	—	14 Mar – 1 Apr	7 May – 1 Jun
Massira	3	21 Nov – 20 Dec	12 Dec – 13 Jan	—	22 Mar – 5 Apr	10 May – 1 Jun
Arrehane	3	21 Nov – 20 Dec	12 Dec – 13 Jan	—	16 Mar – 3 Apr	4 – 31 May
Mehdia	1	30 Nov	15 Dec	—	20 Mar	4 – 6 May

3. Biological characteristic observations

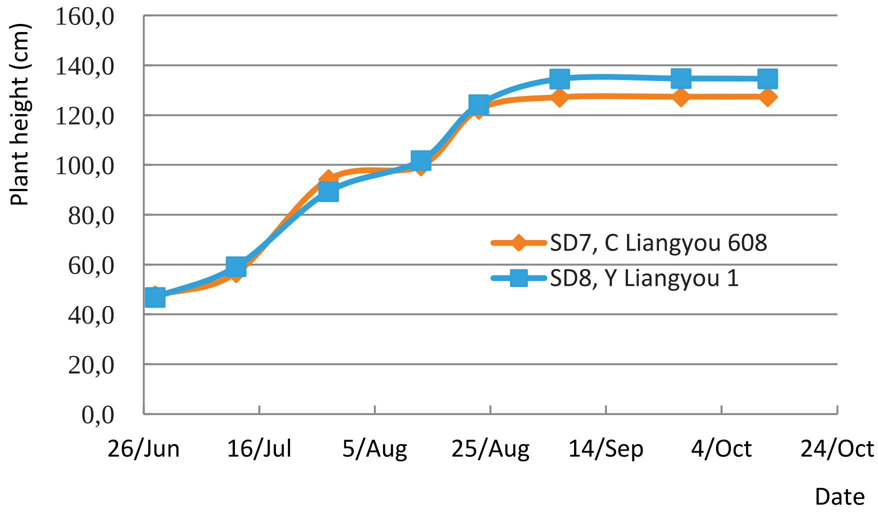
3.1. Rice in Jiangsu

3.1.1. Plant height

In the field, 20 plants were randomly selected to measure their heights from soil surface to the top of plants.



(a)

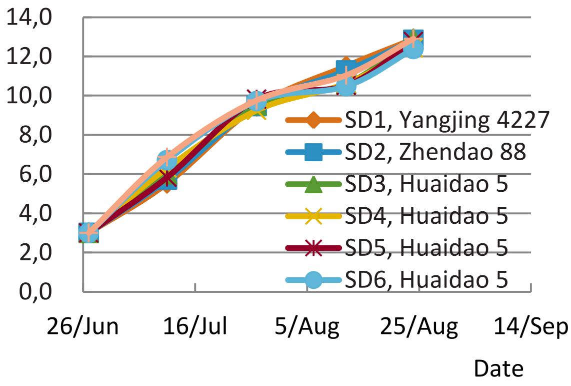


(b)

Figure 6 Dynamics of rice height (a, Japonica*; b,* Indica*)*

Figure 6 indicated that whatever *Japonica* or *Indica* rice, its height rose rapidly in the early stage, and reached their peaks on September 5, then remained stable. Height of *Indica* rice was usually higher than that of *Japonica* rice. Several Japonica varieties arrived a similar height of 100 cm at maturation.

3.1.2. Leaf age



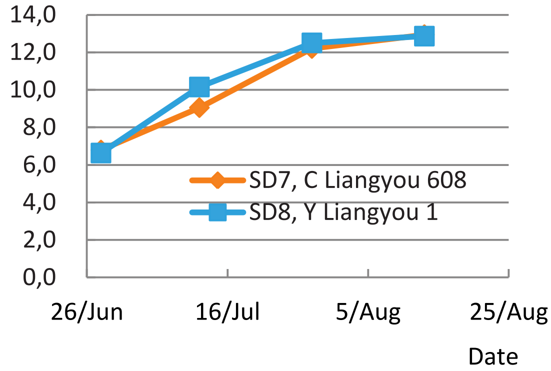
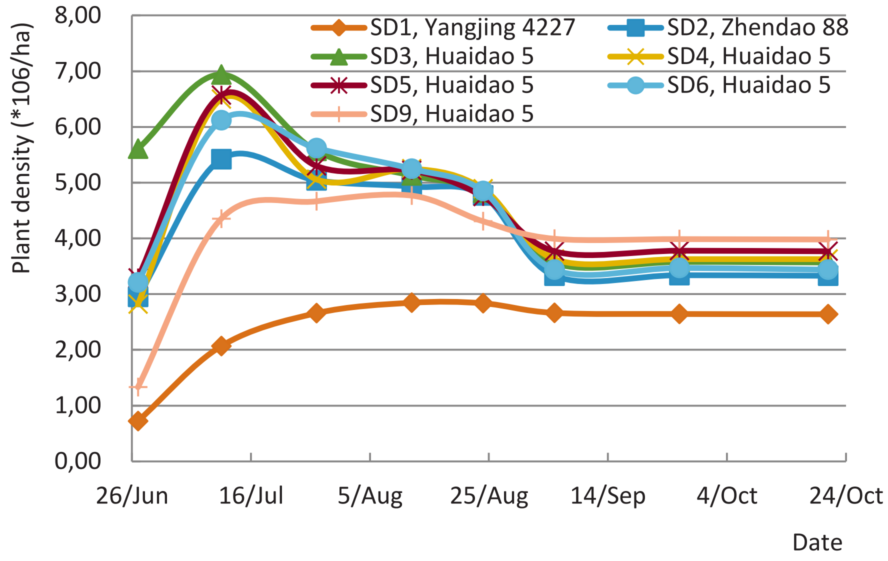


Figure 7 Dynamics of leaf age (left, Japonica*; right,* Indica*)*

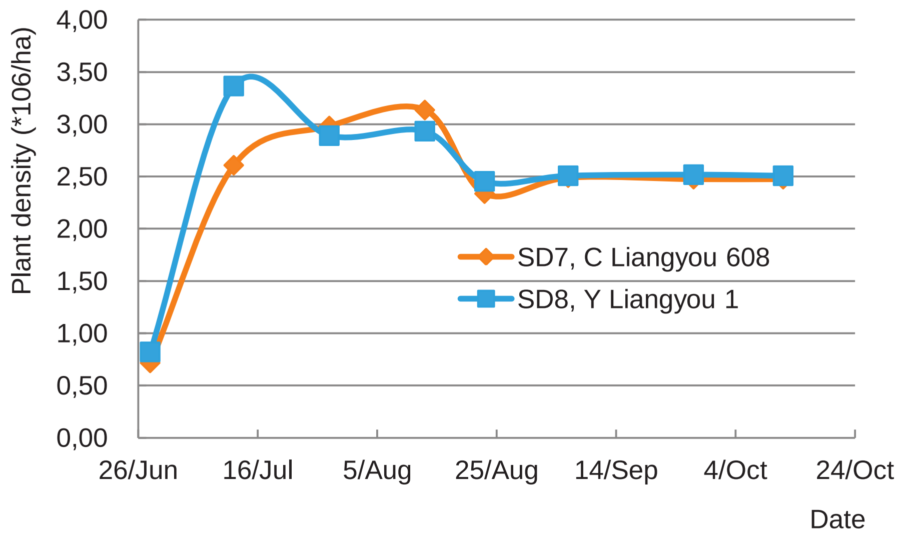
Ten plants were randomly selected to count their leaf number of main stem. From Figure 7 we can see rice leaf developed rapidly with time until the last leaf had completely opened on Aug. 24 (*Japonica* rice) and on Aug.12 (*Indica* rice), hereafter leaf age would not be observed.

3.1.3. Plant density

As for direct sowing rice, we counted rice stems within a frame of 33.3cm*33.3cm and replicated 9 times, the plant density at an area of 1m^2 can be calculated. As for transplanting rice, we counted the stem number in 5 holes and replicated 10 times, so stem number in each hole would be obtained. The plant density can be finally calculated according to row spacing and plant spacing.



(a)



(b)

Figure 8 Dynamics of plant density (a, Japonica*; b,* Indica*)*

It was observed that the plant densities increased rapidly within one month after sowing or transplanting due to tillering, peaked on July 12, then slowed down due to survival competition, and remained stable after September 5. Generally, plant densities of *Japonica* rice were higher than those of *Indica* rice, and plant densities of direct sowing rice were higher than those of transplanting rice except SD9.

3.1.4. LAI values

LAI value was measured using *weight method*. 10 individuals (direct broadcasting rice) or 3-5 holes (transplanting rice) rice were collected to laboratory at each sampling time, we selected 20 leaves and measured their lengths and widths. The leaf area can be calculated according to the equation: Leaf area = leaf length * leaf width * 0.83. The leave areas for 20 samples (leaves) were obtained. Then 20 leaves and the rest leaves were oven-dried and weighted. Area of the rest leaves could be obtained through the following equation: Area of rest leaves = area of 20 leaves * weight of rest leaves / weight of 20 leaves. We obtained in this way the total leave area for all leaves, and thus the LAI values.

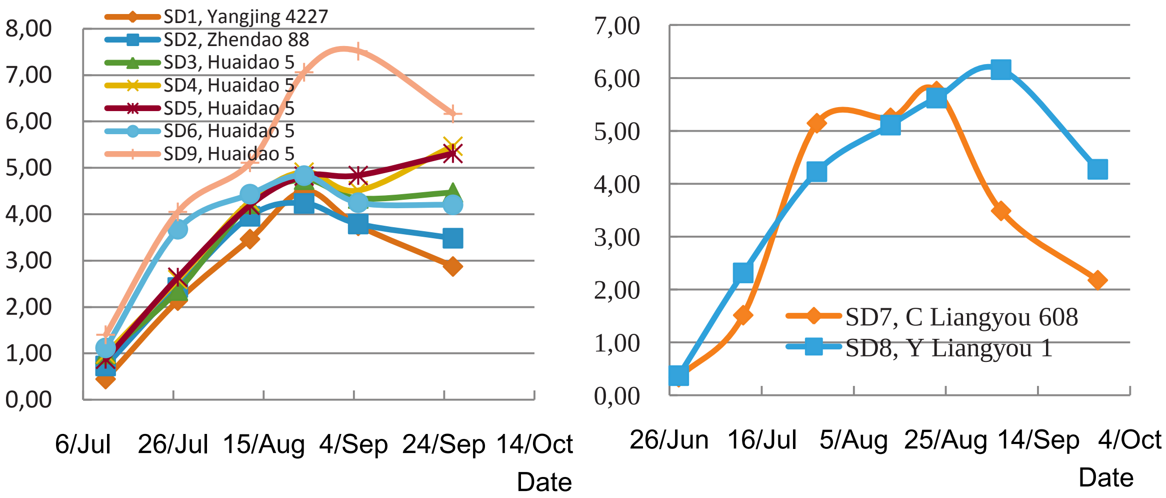
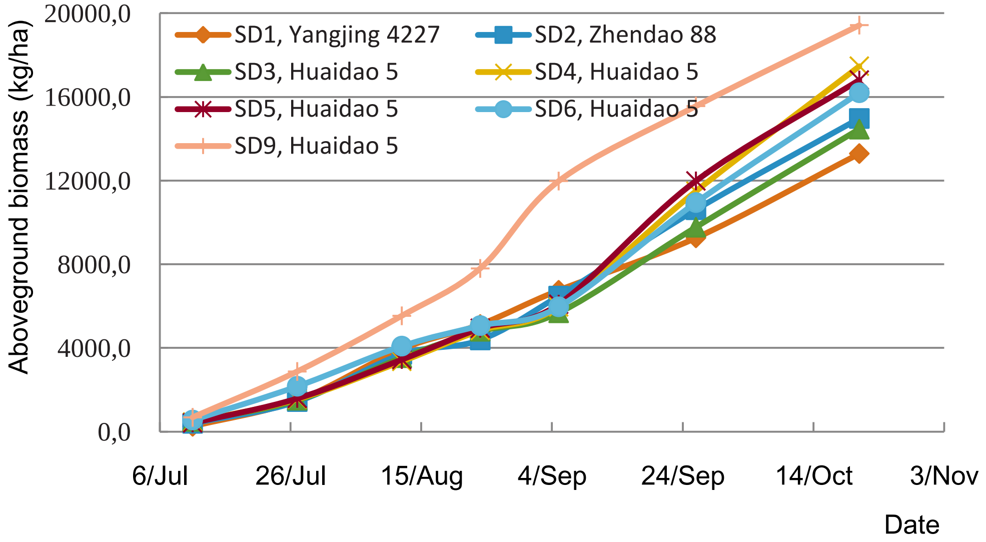


Figure 9 Dynamics of LAI values (left, Japonica; right, Indica)

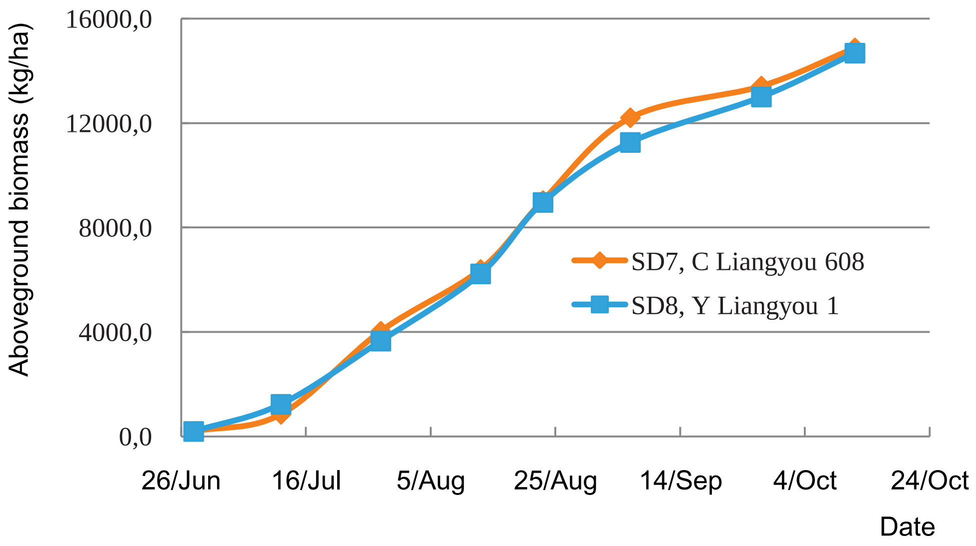
Generally, LAI values rose faster in the early stage, and reached their peaks in late August or early September, and then fell down. LAI was related to plant density and variety. LAI value of SD9 reached 7.52 on September 5 due to its higher density.

3.1.5. Aboveground biomass

10 individuals (direct broadcasting rice) or 3-5 holes (transplanting rice) rice were collected to laboratory, stem, functional leaf, withered leaf and ear were divided, oven dried and weighted. We could calculate aboveground biomass after summing up dry matter weight of different parts of rice. Dynamics of aboveground biomass of different rice varieties were shown in Figure 10.



(a)



(b)

Figure 10 Dynamics of aboveground biomass (a, Japonica*; b,* Indica*)*

3.1.6. Yield structure analysis of different rice varieties

Samples for yield structure analysis were collected on October 12 (*Indica* rice) and October 21 (*Japonica* rice), respectively.

Table 16 Yield structures of different rice varieties

		Ear Density	Ear length	Grain no. per ear	Seed-setting rate	1000-grain weight	Theoretical yield
		($*10^6$ ha^{-1})	(cm)		(%)	(g)	(tha-^{1})
Japonica	SD1, Yangjing 4227	2.64	15.1	103	94.5	31.06	8.01
	SD2, Zhendao 88	3.33	13.8	88	96.1	29.44	8.29
	SD3, Huaidao 5	3.57	13.8	92	90.9	27.42	8.18
	SD4, Huaidao 5	3.63	15.5	99	95.6	28.99	9.99
	SD5, Huaidao 5	3.77	15.2	94	96.6	27.26	9.33
	SD6, Huaidao 5	3.44	13.8	98	95.6	28.94	9.35
	SD9, Huaidao 5	3.95	15.3	100	91.2	28.27	10.22
Indica	SD7, C Liangyou 608	2.47	24.9	179	79.7	26.57	9.33
	SD8, Y Liangyou 1	2.49	22.9	162	81.5	26.26	8.65

Ear density of each observation site was similar with their respective plant density. *Indica* rice possessed higher in ear length, grain number per ear, but it was lower in plant density, 1000-grain weight and seed-setting rate, so it could not obtain the highest yield. SD9 had a highest yield, reaching 10.22 t/ha, due to its higher ear density.

3.1.7. Presentation of some field pictures

We carried out 8 field surveys and took a large number of photos during different rice growth periods. Some of them are shown in Figure 11 and Figure 12.

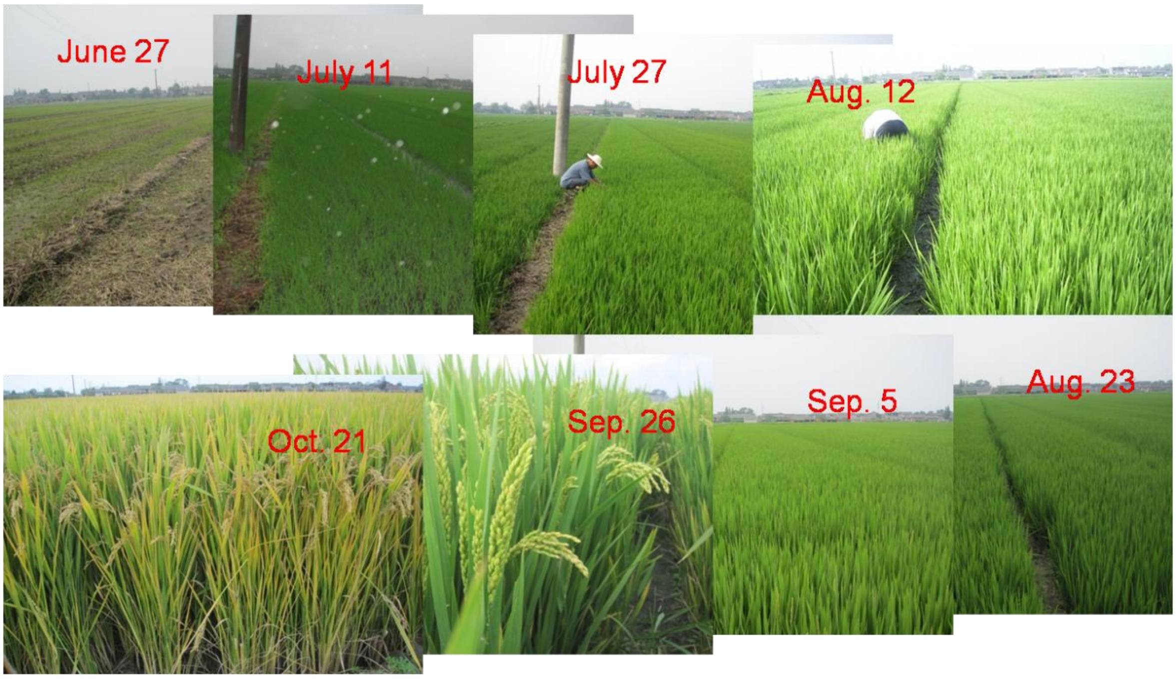


Figure 11 Picture series of Huaidao 5 (SD5, direct broadcasting Japonica *rice, Changrong, Xinhua)*

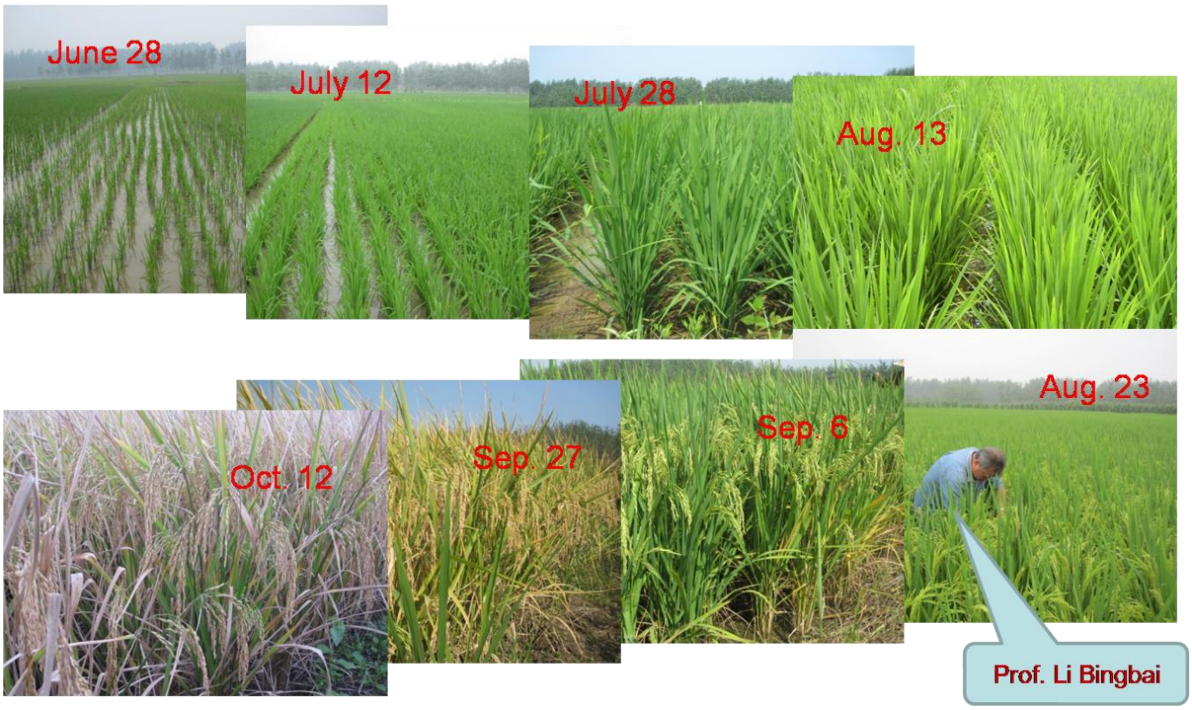


Figure 12 Picture series of C Liangyou 608 (SD7, artificial transplanting Indica *rice, Tugou, Jinhu)*

3.2. Wheat in Morocco

The ground data present in this report are a portion extracted from the wheat observations database, for 5 soft varieties and 4 sites from 2000 to 2004 (Table 17).

Table 17 Number of trials extracted in each year for 4 sites and 5 varieties.

Site	Wheat Variety	Number of trials 2000/2001	Number of trials 2001/2002	Number of trials 2002/2003	Number of trials 2003/2004
Tassaout	*Acthar*	1	2	—	7
	Kanz	1	—	—	7
	Massira	1	2	—	7
	Arrehane	1	2	—	7
	Mehdia	—	2	—	—
Marchouch	*Acthar*	1	2	10	—
	Kanz	1	—	—	—
	Massira	1	2	10	—
	Arrehane	1	2	10	—
	Mehdia	—	2	10	—
Jemaa Shaim	*Acthar*	1	2	—	—
	Kanz	1	—	—	—
	Massira	1	2	—	—
	Arrehane	1	2	—	—
	Mehdia	—	2	—	—
Sidi Allal Tazi	*Acthar*	—	4	—	4
	Kanz	—	—	—	4
	Massira	—	4	—	4
	Arrehane	—	4	—	4
	Mehdia	—	4	—	—

3.2.1. Plant height

Figure 13 and Figure 14 show plant height measured in every site for each variety, respectively in 2001 - 2002 and 2003 - 2004. In general there is a well established trend due to the different varieties. Arrehane variety showed the highest values, followed by Achtar, Massira, Kanz, and Mehdia, in descending order. By comparing different years, Marchouch site shows the highest variability, that could be due to the particularly low values observed in 2002, compared to 2001 and 2003. Data related to Jemaa Shaim site are the lowest in 2001, whereas in the following year they are comparable to the Marchouch ones. In 2004 Tassaout and Sidi Allal showed lower values with respect to 2002, and the difference between the two sites became narrow.

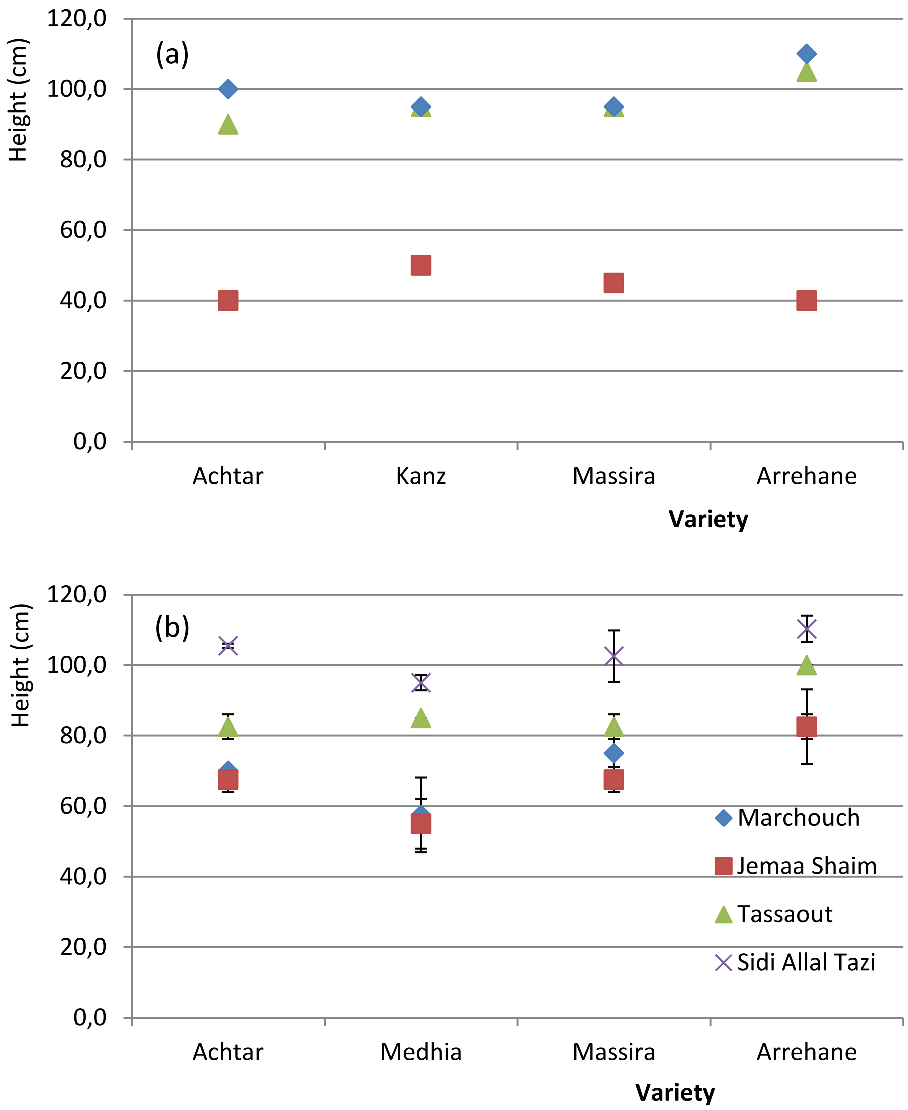


Figure 13: Observed soft wheat height at harvest for each variety (a, 2001; b, 2002). Colours indicate different experimental sites. Error bars (± 1 standard deviation) represent the variability among trials.

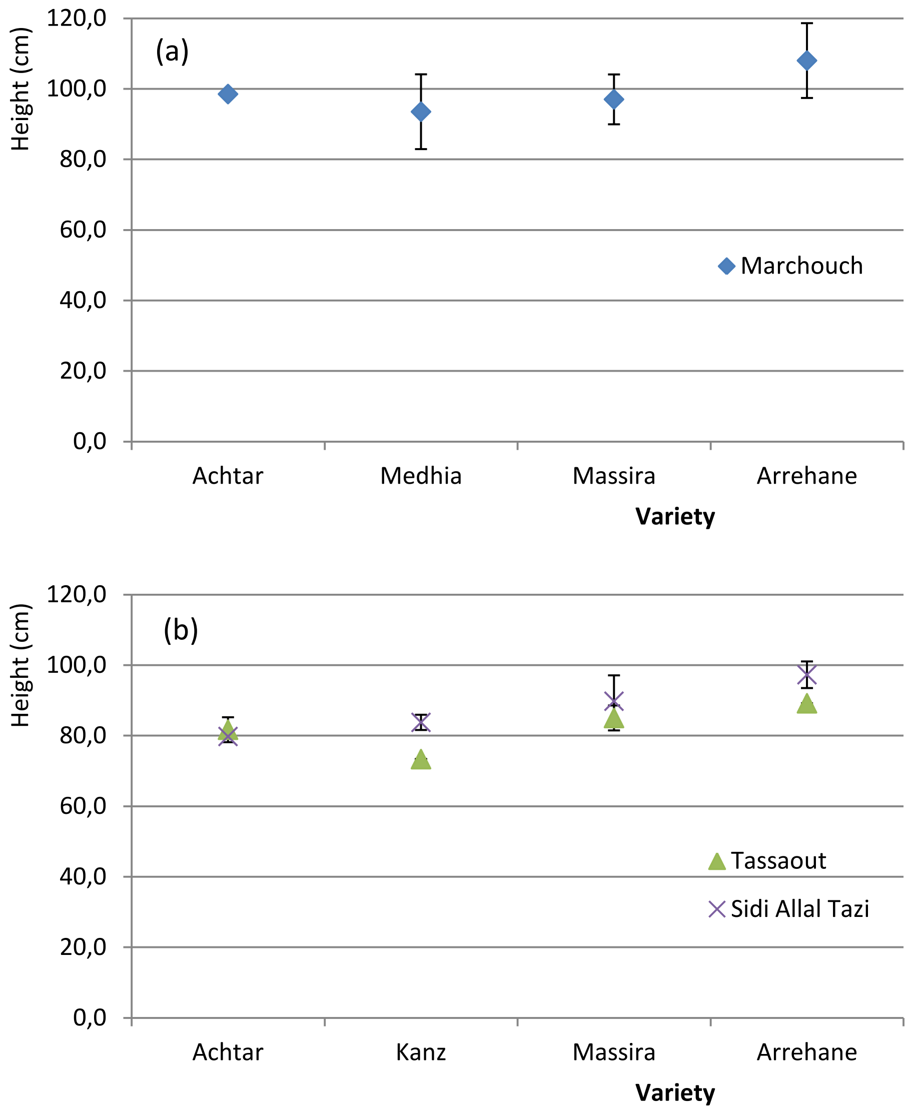


Figure 14: Observed soft wheat heights at harvest for each variety (a, 2003; b, 2004). Colours indicate different experimental sites. Error bars (± 1 standard deviation) represent the variability among trials.

3.2.2. Yield

Figure 15 and Figure 16 depict yield values according to year, site, and wheat variety. Arrehane proved to be one of the most productive variety in all sites, except the irrigated site of Tassaout, where the Massira ranked first. On the contrary, Mehdia resulted the more suitable variety for the Marchouch site. Different varieties performed similarly in Sidi Allal Tazi, considering their standard deviations. Particularly low values were recorded in

Marchouch and Jemaa Sahim in 2002, whereas the productivity was higher in the close site of Sidi Allal Tazi.

Based on low values of plant height and yield observations, Jemaa Shaim confirmed to be the less faborable site (Figure 5**Error! Reference source not found.**), regardless to the year. Marchouch and Sidi Allal Tazi are classified as favourable, although they showed an opposite yield and height trends in 2002, regardless to the variety.

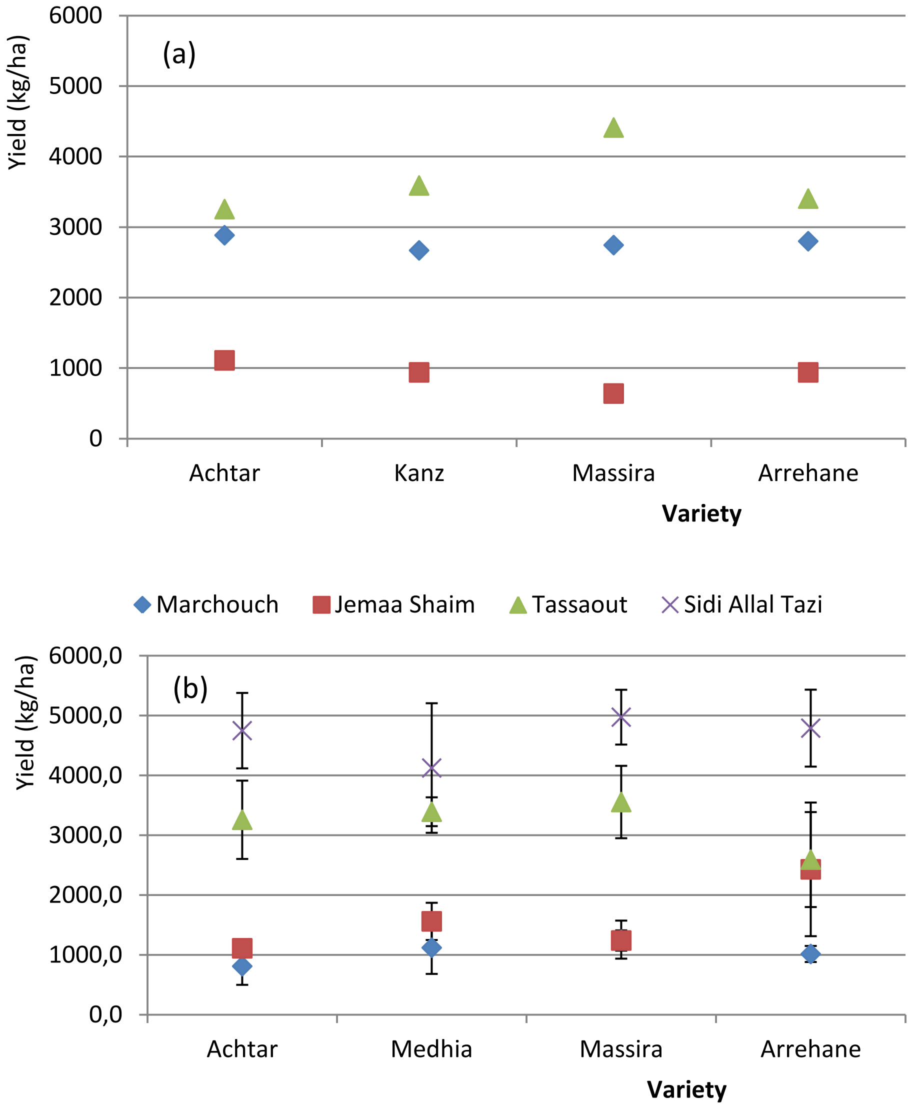
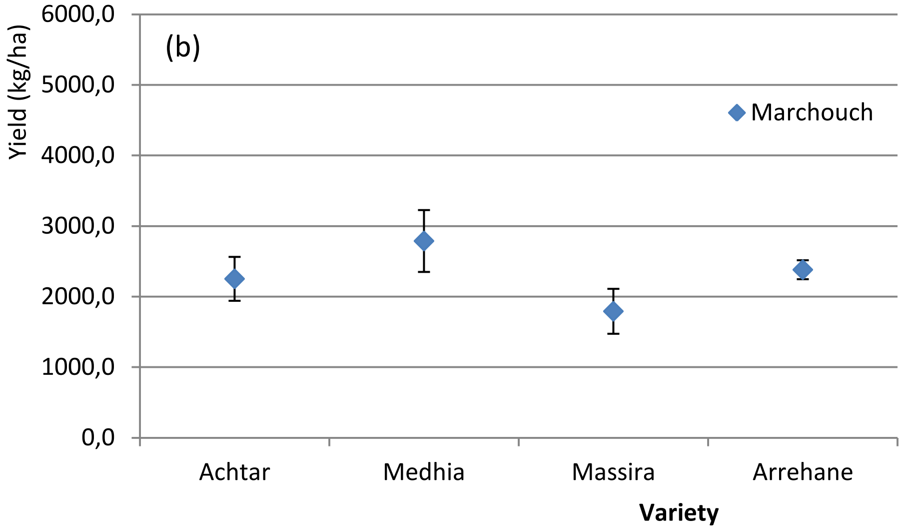


Figure 15: Observed soft wheat yield at harvest for each variety (a, 2001; b, 2002). Colors indicate different experimental sites. Error bars (± 1 standard deviation) represent the variability among trials.



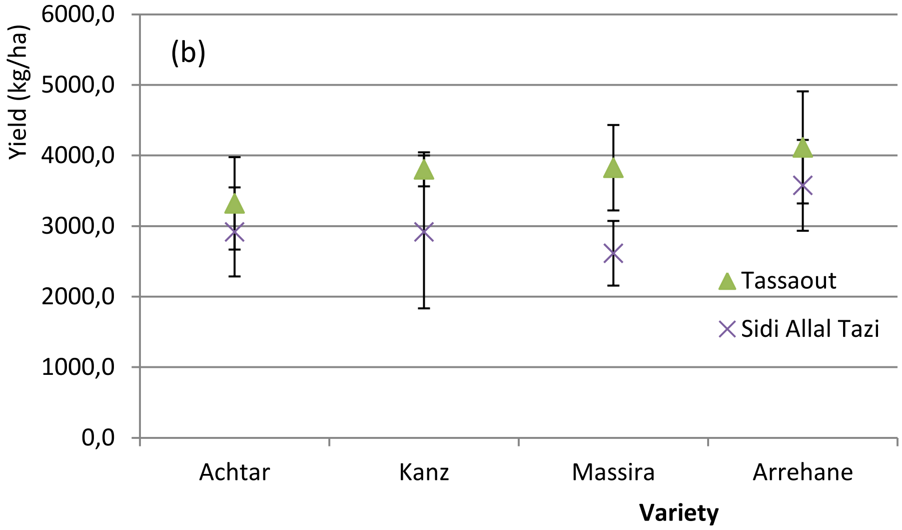


Figure 16: Observed soft wheat yields at harvest for each variety (a, 2003; b, 2004). Colours indicate different experimental sites. Error bars (± 1 standard deviation) represent the variability among trials.

4. Conclusions

The first part of the ground data collection allowed to get information on relevant traits for different rice and wheat cultivars typical of Jiangsu region and Morocco, respectively.
The criteria used to group the varieties were mainly determined by (i) differences in thermal requirements, (ii) maturing period, (iii) and production.
For rice in Jiangsu, dedicated field experiments were carried out and a first set of data explicitly collected for calibration purpose is available.
For wheat in Morocco, INRA provided different datasets already available, useful for the calibration of parameters involved with crop development. Data from new field experiments – carried out following protocols for the collection of data for model parameterization/calibration – will be available starting from Month 18.