Breaking Soybean Yield Barriers: Integrating Crop Production Practices & Comprehensive Fertilization Strategies – a Cropping System Approach

Argentina 2nd Report – 2015-2016 Season

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Table 1 - *SOYBEAN Treatments*

	TREATMENTS			
Agronomic management	**Famer Practices (FP)**	**Comprehensive Fertilization (CF)**	**Production Intensity (PI)**	**Ecological Intensification (CF+ PI)**
Soybean maturity	**DM 4970**	**DM 4970**	**LDC 4.7**	**LDC 4.7**
Row Spacing (cm)	**52**	**52**	**26**	**26**
Fungicide Application	**YES**	**YES**	**YES**	**YES**
Planting date	**28 Nov**	**28 Nov**	**7 Nov**	**7 Nov**
Target seeding rate (seeds/ha)	**290000**	**290000**	**440000**	**440000**
Nutrient management	**Standard**	**Advanced**	**Standard**	**Advanced**
Inoculation	**NO**	**YES**	**NO**	**YES**
P rate	**NO**	**20 kg P ha^{-1}**	**NO**	**20 kg P ha^{-1}**
Sulfur	**NO**	**20 kg S ha^{-1}**	**NO**	**20 kg S ha^{-1}**
P and S fertilization strategy	**NO**	**Broadcasted by full coverage on July**	**NO**	**Broadcasted by full coverage on July Spread by full coverage on July**
Micros	**NO**	**Foliar B @ R2-R3**	**NO**	**Foliar B @ R2-R3**
Reproductive N (R4-R5)	**NO**	**YES (50 kg N ha^{-1})**	**NO**	**YES (50 kg N ha^{-1})**

Table 2 - MAIZE Treatments

	TREATMENTS			
Agronomic management	**Famer Practices (FP)**	**Comprehensive Fertilization (CF)**	**Production Intensity (PI)**	**Ecological Intensification (CF+ PI)**
Hybrid	**Lt 626 VT 3Pro (Medium Potential)**	**Lt 626 VT 3Pro (Medium Potential)**	**DK 7210 VT3P (High potential)**	**DK 7210 VT3P (High potential)**
Row Spacing (cm)	**52**	**52**	**52**	**52**
Planting date	**16 Dec (Late)**	**16 Dec (Late)**	**6 Oct (Early)**	**6 Oct (Early)**
Target seeding rate (seeds/ha)	**75000**	**75000**	**80000**	**80000**
Nutrient management	**Standard**	**Advanced**	**Standard**	**Advanced**
N fertilization **	**N @ planting threshold = 135 kg N ha^{-1} Source= Urea**	**N @ planting threshold = 162 kg N ha^{-1} Source= Urea +NBPT**	**N @ planting threshold = 135 kg N ha^{-1} Source= Urea**	**N @ planting threshold = 162 kg N ha^{-1} Source= Urea +NBPT**
P rate	**70 kg ha^{-1} MAP**	**20 kg P ha^{-1} in winter broadcast + 70 kg ha^{-1} MAP**	**70 kg ha^{-1} MAP**	**20 kg P ha^{-1} in winter broadcast + 70 kg ha^{-1} MAP**
Sulfur	**NO**	**20 kg S ha^{-1} in winter broadcast**	**NO**	**20 kg S ha^{-1} in winter broadcast**
Micros	**NO**	**Foliar Zn and B @ V6**	**NO**	**Foliar Zn and B @ V6**

**** Planting date based on El Niño year expectative.***
***** N threshold based on N-NO_3 content at planting (Salvagiotti et al., 2011).***

1 –SOYBEAN

Weather conditions during the 2015/16 Soybean Season.

Mean temperature during the crop cycle was 24.7º, showing values 6% larger than historical values depending on the management strategy. During the seed filling period, the early planting strategy showed a mean temperature of 24.7º, however in the same period, the late planting strategy mean temperature was 5% lower.

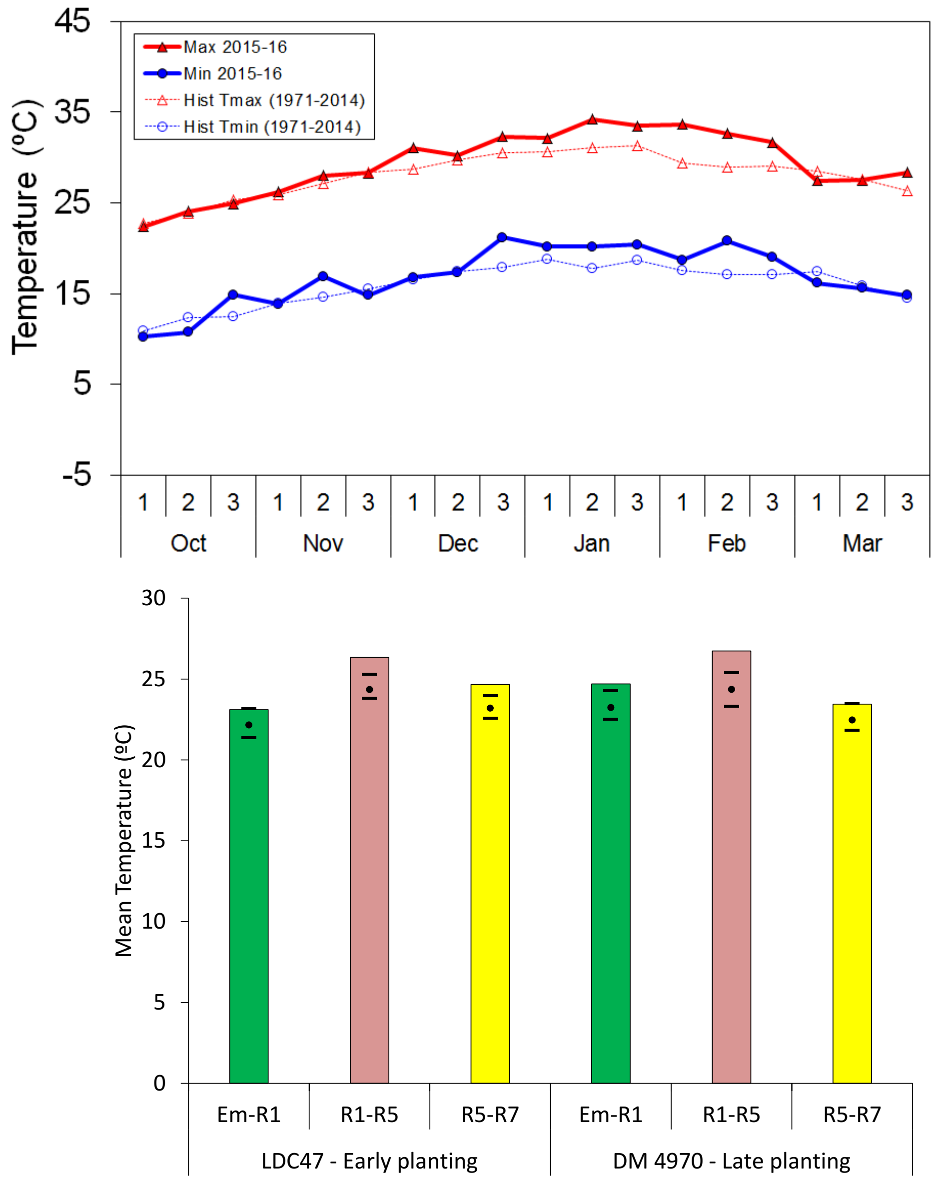

Figure 1 – Decadical maximum and minimum temperature during the crop cycle (Upper Figure) and mean temperature in three superiods during the soybean cycle (Vegetative: Em-R1; early reproductive: R1-R5; seed-filling period: R5-R7) (Lower Figure) for 2 management strategies. Horizontal lines and dots represent 25th and 75th quartile and the median, respectively. Soybean, 2015-16 season.

Rainfall during the crop cycle (emergence – R7) was 719 and 697 mm for the early and late planting treatments. These values were 43% larger than historical values (Figure 2). A peak in rainfall was registered in February (coinciding with late and early seed filling period in the early and late planting strategy, respectively)

Therefore, positive atmospheric balances were observed for both management strategies during the seed filling period (Figure 2).

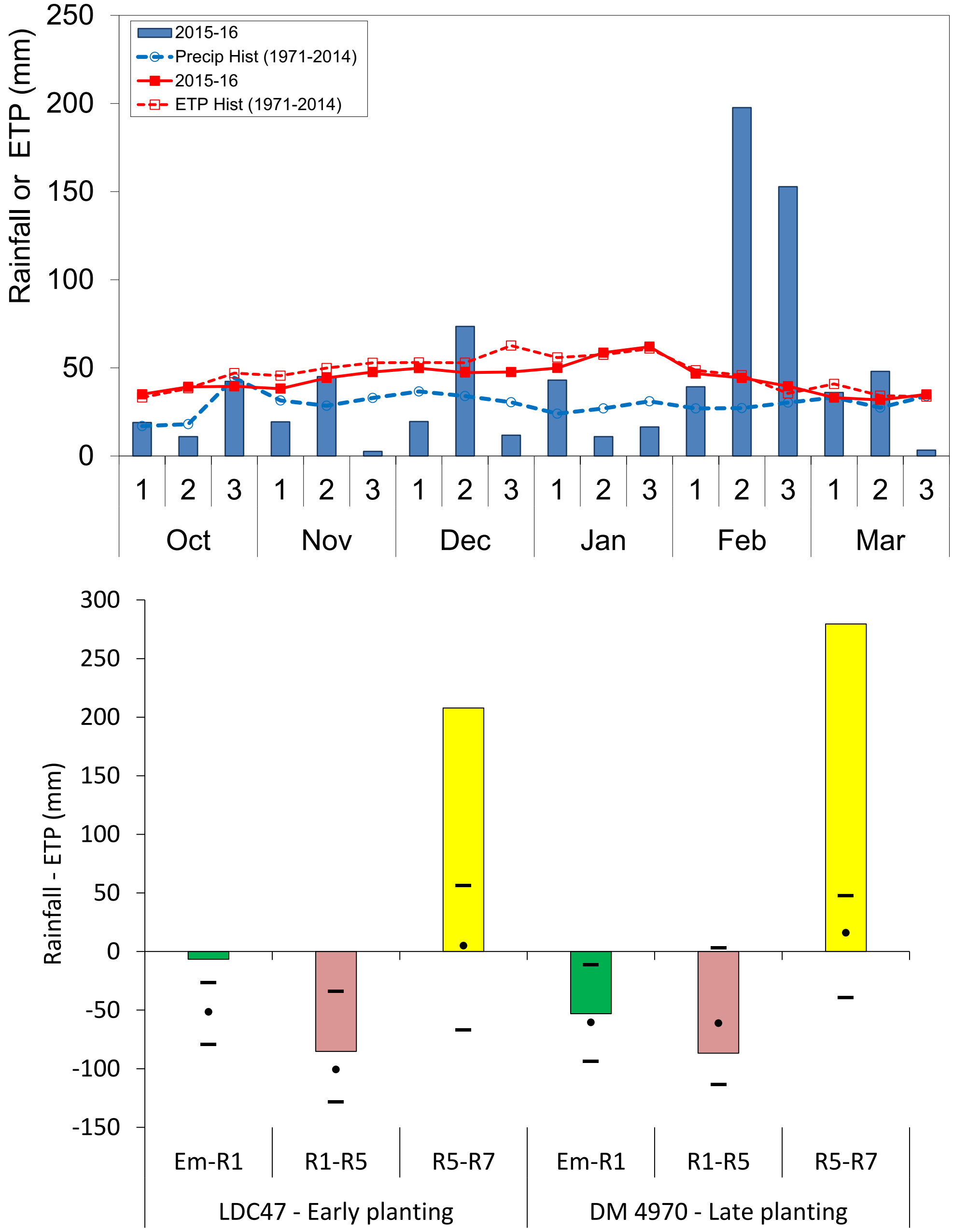

Figure 2 – Decadical rainfall and evapotranspiration (ETP) during the crop cycle (Upper Figure) and Atmospherical balance (Rainfall – ETP) in three superiods during the soybean cycle (Vegetative: Em-R1; early reproductive: R1-R5; seed-filling period: R5-R7) (Lower Figure) for 2 management strategies. Horizontal lines and crosses represent 25th and 75th quartile and the median, respectively. Soybean, 2015-16 season.

Soil conditions

The soil represents a typical chemically degraded soil in the area. Organic matter was around 2 % (Table 3).

Table 3– Soil chemical characterization before planting

depth	NO3 (ppm)	P Bray (ppm)	pH	MO (%)
0-20	102	12	5.3	2.2

Seed Yield

In average, all management and fertilizer use strategies showed seed yield above 4100 kg ha^{-1}. No interaction between management and fertilization strategy was observed, and fertilization increased seed yield by 4% (Figure 3).
A significant Management x Fertilization interaction was observed, since fertilization increase individual seed weight in the early planting strategy (ca. 3%), but no differences between fertilization strategies were observed in the late planting date. (Figure 3). In average, early planting date showed larger seed weight, increasing 5% over the late planting strategy (Figure 4).

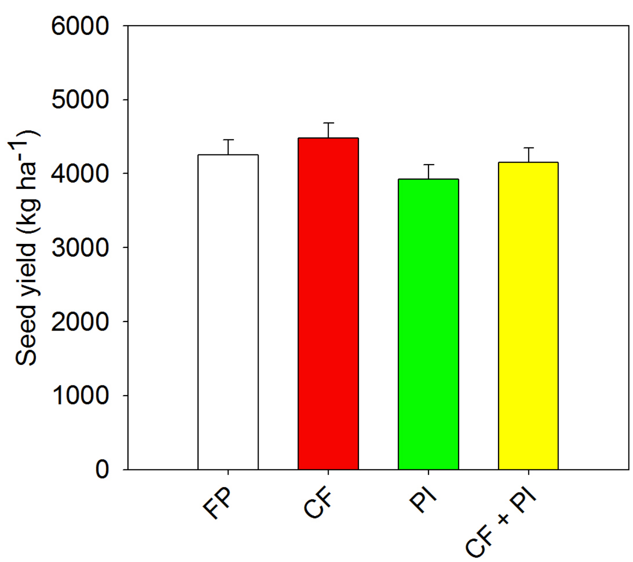

Figure 3 - Soybean seed yield (13% moisture), for different crop and fertilizer management strategies: FP = farmer practice; CF = comprehensive fertilization; PI = production intensity; CF + PI = ecological intensification.

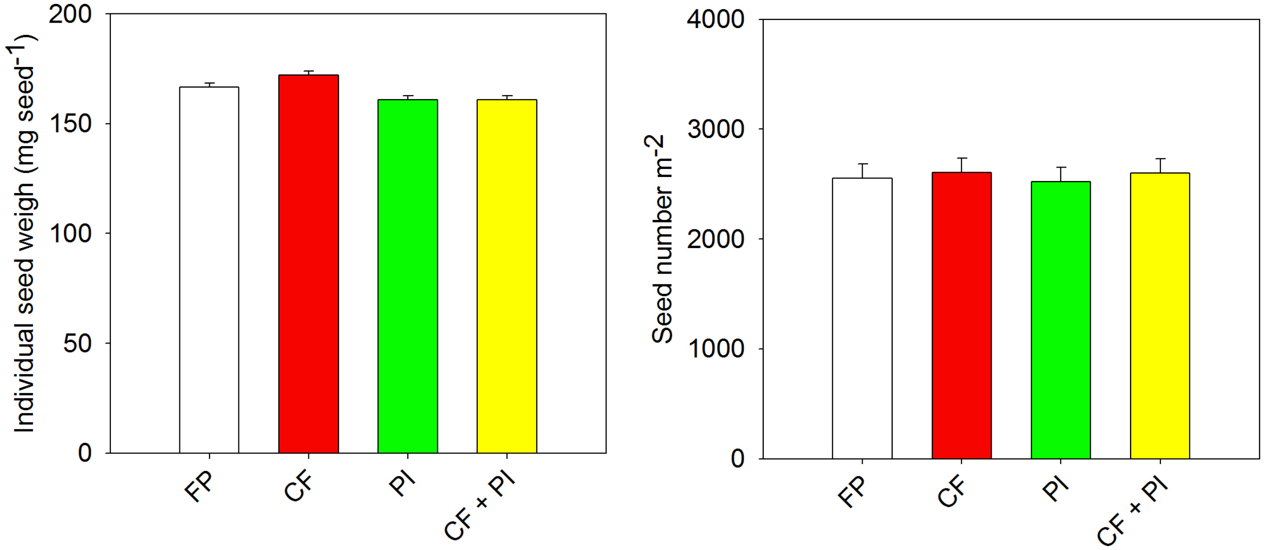

Figure 4 - Individual seed weight (left panel) and seed number (right panel) for different crop and fertilizer management strategies: FP = farmer practice; CF = comprehensive fertilization; PI = production intensity; CF + PI = ecological intensification.

2 –MAIZE

Weather conditions during the 2015/16 Maize Season.

Mean temperature during the crop cycle was 23.8 and 24.3ºC for the early and late planting strategy, showing a respective 6 and 8% increase over historical values. Mean temperature in the critical period (15 day around silking) was 25.3 and 26.1 ºC for the early and late planting strategy (6 and 11% over the historical records). During the seed filling period, the early planting strategy showed a mean temperature of 26.2º, however in the same period, the late planting strategy mean temperature was 17% lower (Figure 5).

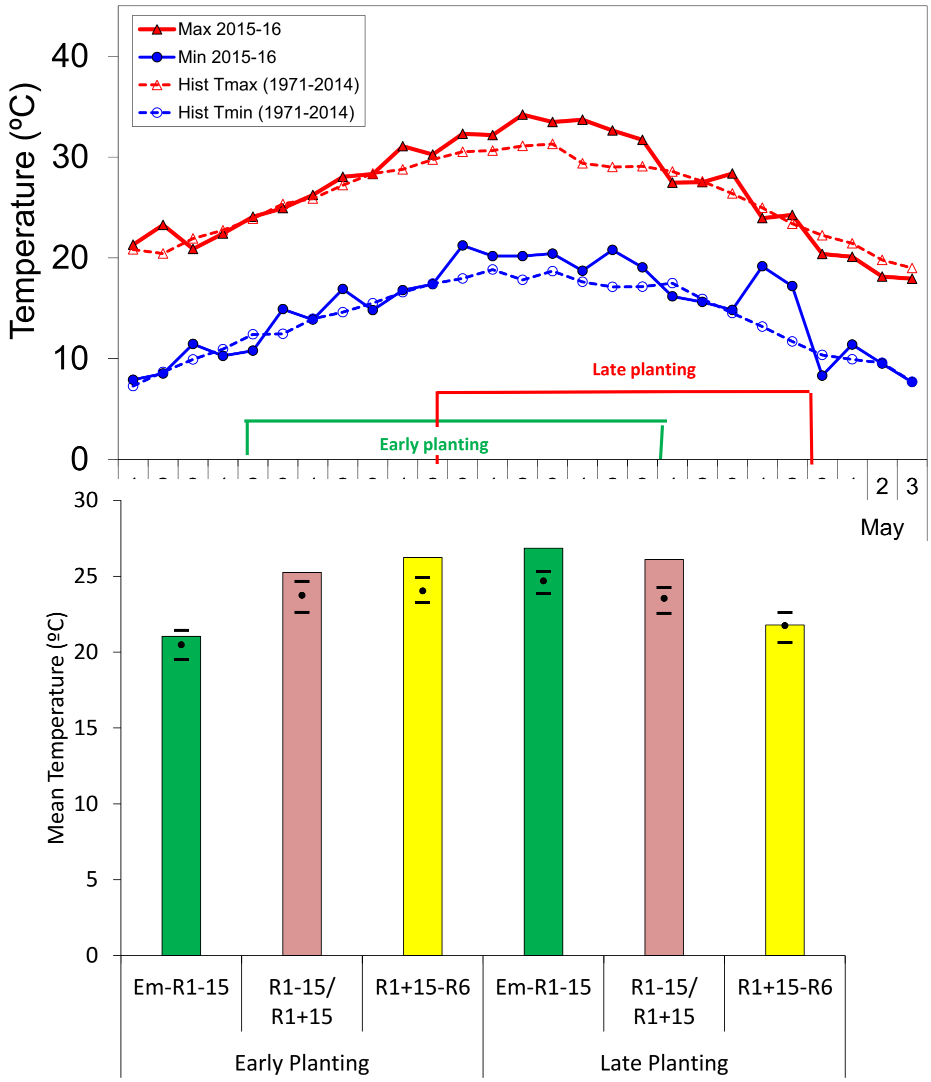

Figure 5 – Decadical maximum and minimum temperature during the crop cycle (Upper Figure) and mean temperature in three superiods during the maize cycle (Before critical period: Em-R1$_{-15}$; Critical period around silking: R1$_{-15}$/R1$_{+15}$; seed-filling period: R1$_{+15}$-R6) (Lower Figure) for 2 management strategies. Horizontal lines and dots represent 25th and 75th quartile and the median, respectively. Maize, 2015-16 season.

Rainfall during the crop cycle (emergence – R6) was 726 and 559 mm for the early and late planting treatments. These values were 38 and 43% larger than historical values (Figure 6). A peak in February (coinciding with late seed filling period in the early planting, and the critical period for the late planting strategy, respectively). Therefore, positive atmospheric balances were observed for both management strategies during these periods (Figure 6).

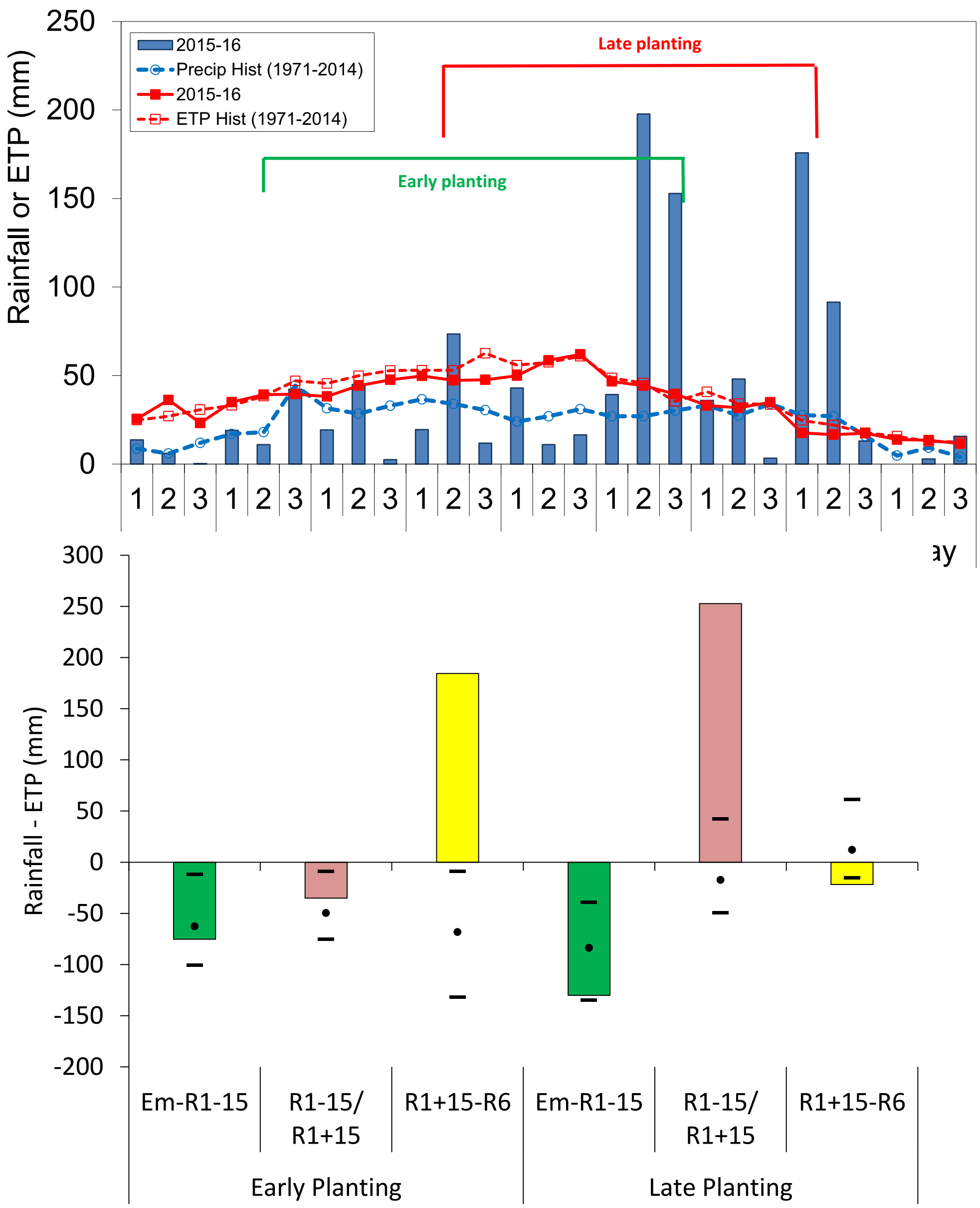

Figure 6 – Decadical rainfall and evapotranspiration (ETP) during the crop cycle (Upper Figure) and Atmospherical balance (Rainfall – ETP) in three superiods during the soybean cycle (Before critical period: Em-R1$_{-15}$; Critical period around silking: R1$_{-15}$/R1$_{+15}$; seed-filling period: R1$_{+15}$-R6) (Lower Figure) for 2 management strategies. Horizontal lines and crosses represent 25th and 75th quartile and the median, respectively. Maize, 2015-16 season.

Soil conditions

The soil conditions represent a typical chemically degraded soil in the area. Organic matter was around 2 % (Table 4). In PI and CF+PI (the early planting strategy), N content in the soil profile up to 60 cm was in average 85 kg N ha^{-1}. On the other hand, FP and CF (late planting strategy) averaged 95 kg N ha^{-1}.

Table 4– Soil chemical characterization before planting the maize plots

	NO3 (ppm)				P Bray (ppm)				pH				MO (%)			
	Treatment in soybean previous year															
Depth	FP	CF	PI	CF+PI	FP	CF	PI	CF+PI	FP	CF	PI	CF+PI	FP	CF	PI	CF+PI
0-20	81	101	100	98	46	60	32	38	5.2	5.1	5.4	5.3	1.9	2.1	2.1	2.1
20-40	48	44	28	32												
40-60	34	29	22	22												

Grain yield and numerical components

In average, all management and fertilizer use strategies showed seed yield above 10000 kg ha^{-1}. On average, the early planting strategy did not show significant increases over the late planting treatment with 10592 and 10695 kg ha^{-1}, respectively. In the other hand, a significant 13% increase was observed in response to nutrient management when maize was planted earlier, but in the late planting strategy, fertilization management did not increase grain yield (Figure 7).
No Management x Fertilization interaction was observed in individual grain weight, and a significant 7% reduction in this variable was observed when planting was delayed (Figure 8).

Conclusions

In soybean, under yielding conditions around 4000-4500 kg ha^{-1}, no significant effects of management were detected, but fertilizer management increased seed yield. This response would be associated to the soil chemical conditions, especially the low-medium soil Bray P.
In maize, grain yields were above 9900 kg ha^{-1}, and also no effects of management were observed. Fertilization treatments had a significant impact in the early planting strategy, most probably associated with low available N at planting.

Other determinations (currently under analysis and/or in lab for analysis) include biomass accumulation and leaf area index during the crop cycle, crop nutrient uptake, and biological fixation in order to make nutrient balances. This information will be available in the next report.

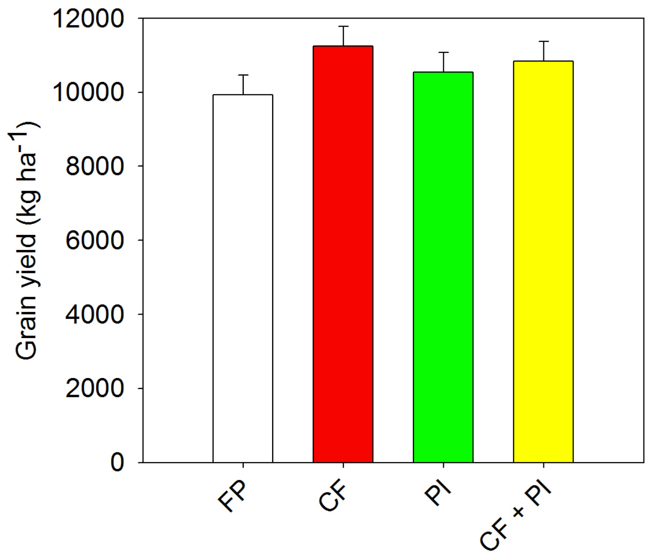

Figure 7 - Maize grain yield (14% moisture), for different crop and fertilizer management strategies: FP = farmer practice; CF = comprehensive fertilization; PI = production intensity; CF + PI = ecological intensification.

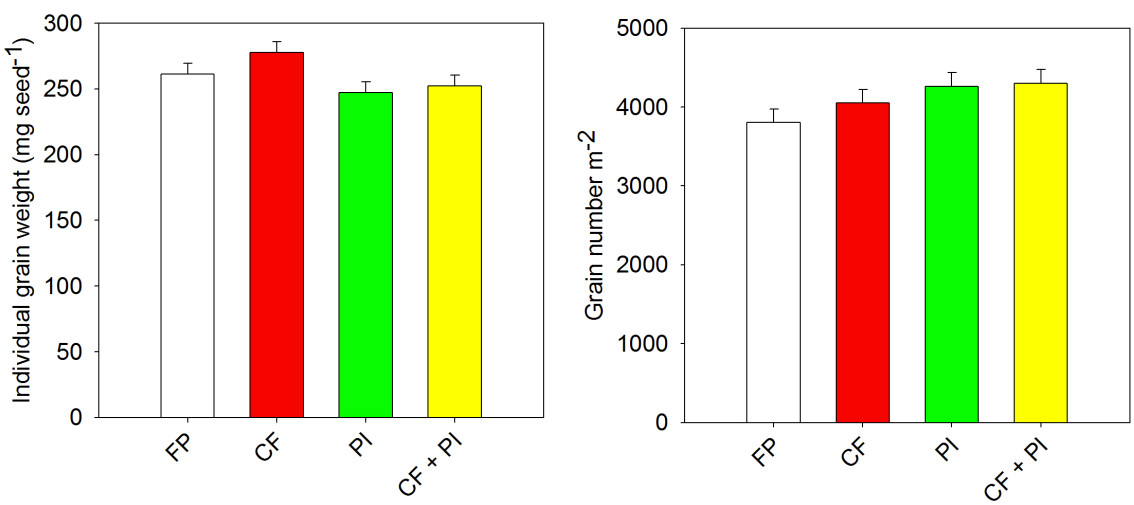

Figure 8 - Individual grain weight (left panel) and grain number (right panel) for different crop and fertilizer management strategies: FP = farmer practice; CF = comprehensive fertilization; PI = production intensity; CF + PI = ecological intensification.