Cuadro 1

Cluster	n	PCR	SSbCF	IAI	ISI
1 (CC_Corn)	9	0.24±0.24 c	0.62±0.06 a	1.28±0.15 a	0.92±0.05 b
2 (CC_Soybean)	21	0.24±0.22 c	0.89±0.09 b	1.42±0.13 a	0.91±0.05 b
3	2	0.26±0.37 a	0.72±0.06 a	1.24±0.08 a	0.74±0.03 a
4 (ROT-PC)	12	1.28±0.40 b	0.90±0.08 b	1.57±0.15 b	0.96±0.04 b
5	1	2.29 c	1.00 b	1.93 c	0.99 b

Summary of land use indicators for each cluster. Different letters within columns indicate significant differences (P ≤0.05). CC_Corn= Continuous cropping that incorporate C4 photosyntesis species (mainly corn); CC_Soybean= Continues cropping with high frequency of soybean; ROT-PC= Cropping systems that rotate with perennial pastures. PCR= Pasture/crop ratio; ISI= Intensity of soil use index; IAI= Intensification of agricultural phase index; SSbCF= Summer soybean cropping frequency.

Cuadro 2. Indicadores de uso del suelo y propiedades del suelo

Variables	Units	ROT-PC	CC_Corn	CC_Soybean
N	#	17	26	22
Indicators of land use				
Years of continuous cropping	#	2.9	8.3	7.3
IAFI	#	1.3	1.3	1.4
PCR	#	1.3	0.1	0.2
SSbCF	#	0.9	0.7	1
Soil fertility				
$SOC_{0\text{-}15}$	g kg^{-1}	34 a	29 b	27 b
$EC_{0\text{-}15}$	dS m^{-1}	1.4 a	1.3 a	1.0 b
$TA_{0\text{-}15}$	meq 100 g^{-1}	4.4 a	4.0 a	4.0 a
$P_{0\text{-}15}$	mg P kg^{-1}	21.6 a	20.1 a	17.8 a
$K_{0\text{-}15}$	meq 100 g^{-1}	0.84 a	0.63 b	0.66 b
$Mg_{7,5\text{-}15}$	meq 100 g^{-1}	2.5 a	2.3 a	2.5 a
$ECa_{10\text{-}20}$*	mS cm^{-1}	792 a	797 a	725 a
Soil physical condition				
$Na_{0\text{-}15}$	meq 100 g^{-1}	1.0 a	1.0 a	1.1 a
$PR_{7,5\text{-}15}$	KPa	1302 a	1245 a	1116 a

Summary of land use indicators and soil properties by cropping system of the 64 sites. Different letters within rows indicate significant differences observed among cropping systems ($P \leq 0.05$).
*$ECa_{10\text{-}20}$ may also represent soil physical condition.

Cuadro 3. Parameters of the stochastic frontier model for soybean cultivation in the surveyed cases. Significance codes: "": p ≤ 0.05; "": p ≤ 0.01; "": p ≤ 0.001; "NS": p > 0.1.

Variables	Coefficient	Standard Error	p
Production frontier			
Intercept	12.03	1.02	***
Sowing date	-0.08	0.04	*
Cycle length	0.15	0.16	NS
Water supplied during R4-R6 (Water_PC)	0.14	0.07	*
Fertilisation strategy[1]	-0.38	0.17	*
Water_PC * fertilisation strategy[1]	0.08	0.04	*
Organic carbon in soil 0-15 cm (SOC_{0-15})	-0.10	0.13	NS
Electrical conductivity in soil 0-15 cm (EC_{0-15})	0.05	0.14	NS
Titratable acidity in soil 0-15 cm (TA_{0-15})	-0.01	0.07	NS
Phosphorus Bray in soil 0-15 cm (P_{0-15})	-0.01	0.05	NS
Exchangeable magnesium from 7.5 to 15 cm ($Mg_{7,5-15}$)	0.30	0.12	**
Exchangeable potassium from 0 to 15 cm (K_{0-15})	0.09	0.05	*
Exchangeable sodium from 0 to 15 cm (Na_{0-15})	-0.11	0.13	NS
Penetration resistance from 7.5 to 15 cm ($PR_{7.5-15}$)	-0.51	0.06	***
Apparent electrical conductivity from 10 to 20 cm (ECa_{10-20})	-0.25	0.06	***
Profile water storage capacity (WSC)	0.08	0.08	NS
Inefficiency effects			
Intercept	-0.31	0.15	*
Years under continuous cropping per soybean frequency in summer cropping phase (YCC*SSbCF)	0.37	0.09	***
Soybean as previous summer crop[1]	0.17	0.05	**
Pasture as previous summer crop[1]	0.70	0.22	***
Supplementary irrigation[1]	-0.43	0.21	*
Model evaluation			
σ^2	0.03	0.01	***
γ	1.00	0.01	***
Likelihood ratio	71.2		

n	128
Mean efficiency	0.72

[1]Dummy variable.

The gamma parameter was significantly different from zero ($p \leq 0.05$), indicating that technical inefficiencies affecting Ya were identified.

Cuadro 4

Summary of Mann-Whitney U test to compare means of each variable based on production level. Significance code "*" indicates significant differences ($p \leq 0.05$) between production levels (consecutive columns) for each continuous variable. Contingency table for dummy variables, values show adjusted residuals.

Variable	Unidades	Ysup	t-test	Ymed	t-test	Yinf
Ya	Mg ha^{-1}	4.8 ± 0.4	*	3.1 ± 0.0	*	1.7 ± 0.2
Yg^{Exp}	Mg ha^{-1}	1.3 ± 0.4	*	3.1 ± 0.1	*	4.4 ± 0.2
Yg^{Re}	Mg ha^{-1} %	1.0 ± 0.4 80	*	1.8 ± 0.7 58	*	2.3 ± 0.2 52
Yg^{Ef}	Mg ha^{-1} %	0.3 ± 0.4 20	*	1.3 ± 0.8 42	*	2.1 ± 0.2 48
Resources						
Water_PC	mm	182 ± 59	*	79 ± 33	NS	91 ± 17
$PR_{7,5-15}$	kPa	1111 ± 60	NS	1160 ± 326	*	1418 ± 115
EC_{0-15}	mS m^{-1}	127 ± 21	*	107 ± 26	NS	99 ± 19
SOC_{0-15}	g kg^{-1}	33 ± 5.6	NS	32 ± 7.3	NS	32 ± 4.9
Management efficiency						
YCC*SSbCF	#	4 ± 2	NS	5 ± 1	*	8 ± 1
C4 species as previous summer crop[1]	#	1.9	*	0.5	*	-2.4
Soybean as previous summer crop[1]	#	-3.3	*	0.2	*	3.1
Pasture as previous summer crop[1]	#	2.6	*	-1.3	*	2.6
Supplementary irrigation[1]	#	4.9	*	-2.5	*	-2.5

[1]Dummy variable

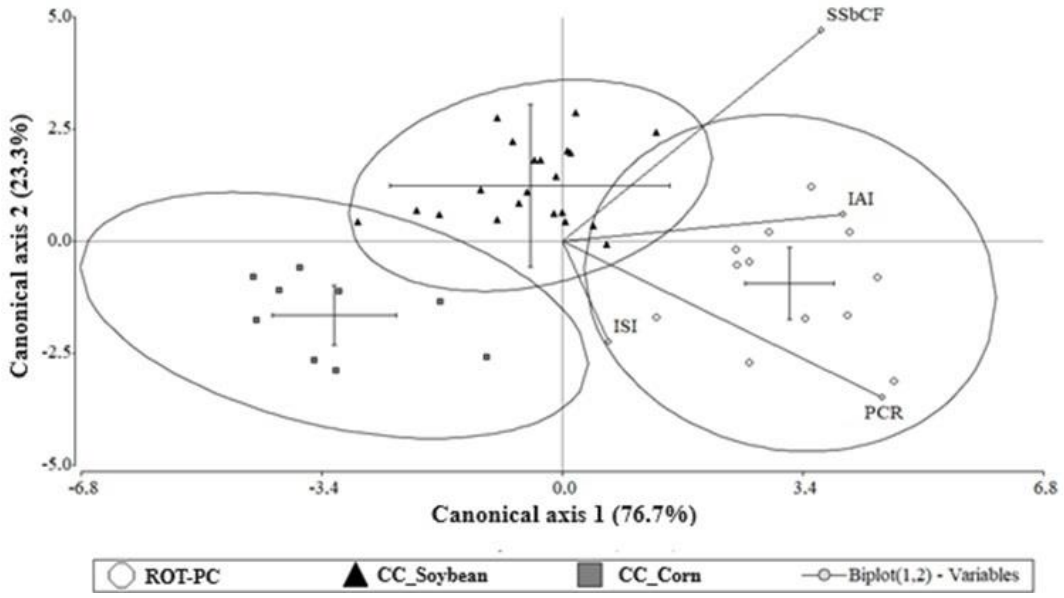

Figura 1. Biplot with linear discriminant analysis (LDA) for the CC_Soybean (black triangle), ROT-PC (empty circle) and CC_Corn (gray square) groups based on selected land use indicators. Circles represent prediction ellipses (95%) for the clusters of the three groups. Crosses indicate confidence intervals (95%).

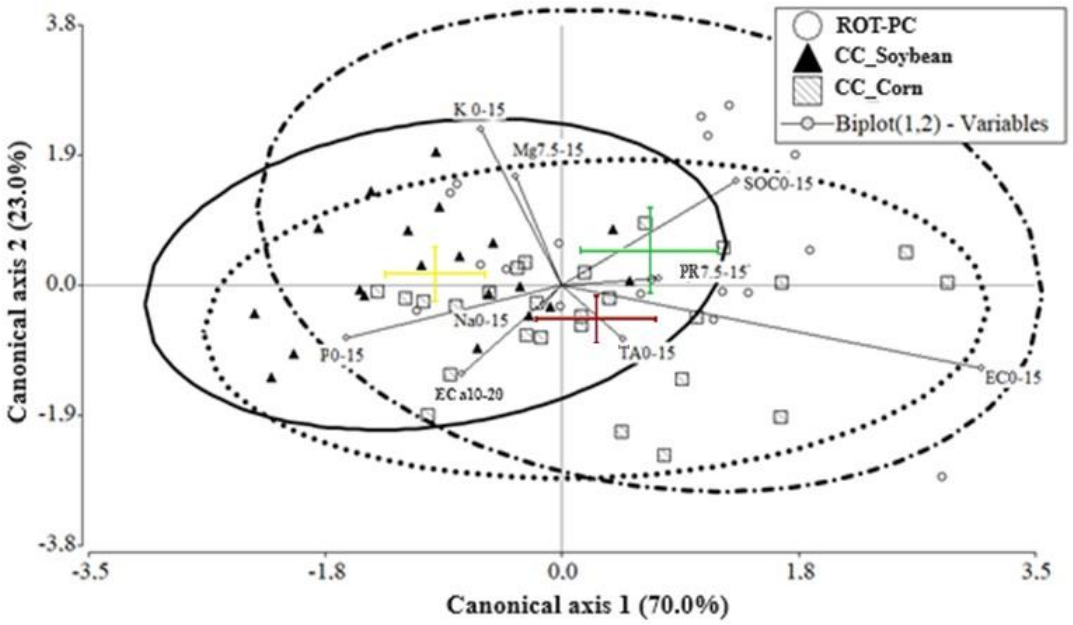

Figura 2. Biplot with linear discriminant analysis (LDA) by cropping system (CC_Corn, CC_Soybean, and ROT-PC) for the selected soil properties that best represented the surveyed soil quality information. Crosses indicate confidence intervals (95%): ROT-PC (green), CC_Corn (brown) and CC_Soybean (yellow). Circles represent prediction ellipses (95%): ROT-PC (line and dot), CC_Corn (dotted line) and CC_Soybean (solid line).

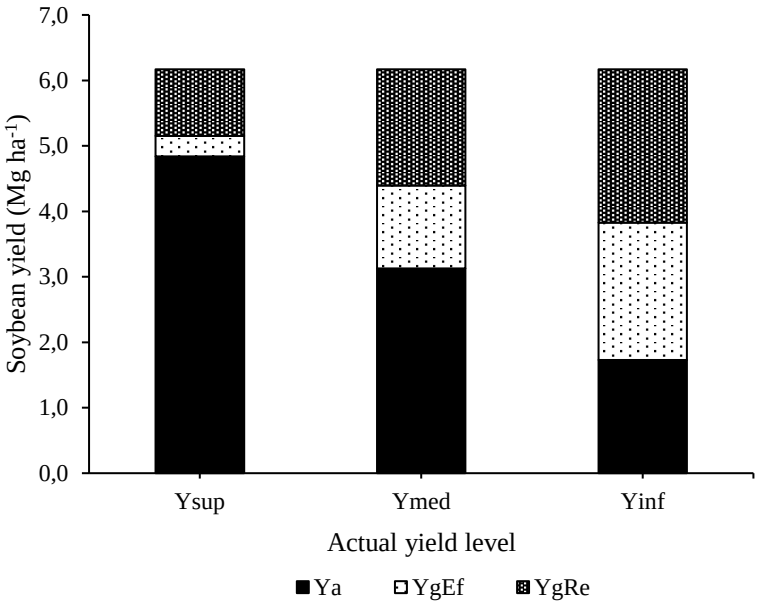

Figura 3. Stacked column chart of soybean exploitable yield gap (Yg^{Exp}), decomposed into a gap attributed to the difference in resource availability (Yg^{Re}; column with high dot density) and technical efficiency gap (Yg^{Ef}; column with low dot density), based on production level. Ysup is the mean of 90th percentile of actual yield (Ya); Ymed is the mean of Ya between P45 and P55; Yinf is the mean of 10th percentile of Ya. Significant differences in Table 5.

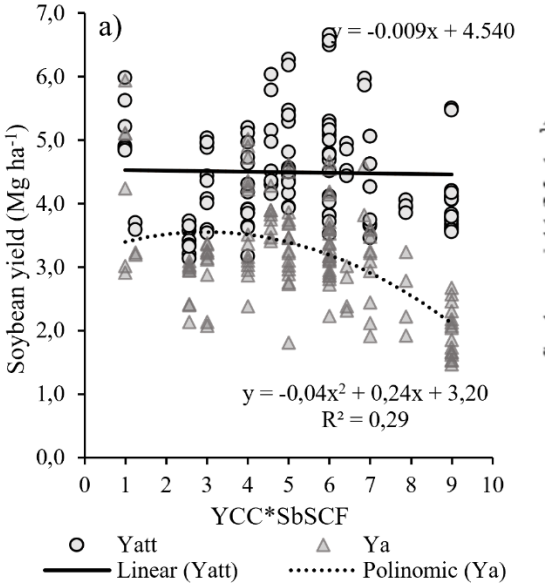

Figura 4 Actual yield (Ya; Mg ha^{-1}) (triangles) and attainable yield (Yatt; Mg ha^{-1}) (circles) based on the number of years under continuous cropping weighted by the frequency of soybeans in the summer agricultural phase (YCC*SSbCF). R^2 indicates if function is significant.

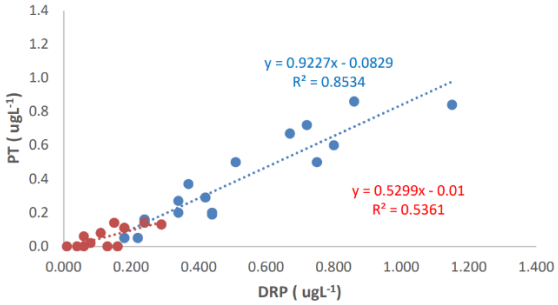

Figura 5: Concentración de DRP en función de la concentración de PT en ambas cuencas. Los círculos azules representan a la cuenca agrícola, mientras que los círculos rojos representan a la cuenca ganadera.