

# OPPORTUNITIES AND IMPEDIMENTS FOR EFFECTIVE USE OF CLIMATE INFORMATION IN AGRICULTURAL SYSTEMS OF THE ARGENTINEAN PAMPAS

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Seasonal climate forecasts and projections of future climate offer the potential to improve decision-making in agriculture. We focus on crop production in the Argentine Pampas, one of the world's major agricultural regions. Climate of the Pampas shows marked variability at both inter-annual (Podestá et al. 1999; Grimm et al. 2000) and decadal time scales (Castañeda y Barros 1994; Minetti et al. 2004). We explored opportunities and impediments for use of climate information in agricultural production in a participatory assessment with farmers and their technical advisors.

El Niño Southern Oscillation (ENSO) is the most important source of inter-annual climate variability and predictability in the Pampas (Grimm et al. 2000). Further, links between ENSO-related climate variability and agricultural outcomes have been shown in the Pampas, mainly for soybean and maize, the most important crops in the region (Podestá et al. 1999). Through interaction with farmers and experts in the region we build “decision maps” that identified decisions sensitive to inter-annual climate variability in maize and soybean production, and realistic management options under various scenarios (ENSO phases). Decision-makers perceive potential benefits from adapting crop management (land assignment and crop management decisions) in response forecasts. For instance, expected environmental conditions associated with ENSO phases lead to changes in genotypes selection (Fig. 1). However, we found different management actions (e.g. genotypes used) under the same forecast environment (a given ENSO phase). Consequently, simulation outcomes showed that adaptive management strategies proposed in response to ENSO information may produce diverging economic outcomes (both positive and negative; Table 1). There are at least 2 possible reasons for the apparent misapplication of climate information: (a) incomplete knowledge of ENSO-related environments (i.e. climate signatures of a given ENSO phase for a particular regional climate) and (b) difficulties in envisioning outcomes of interactions between management, genotype and environment.

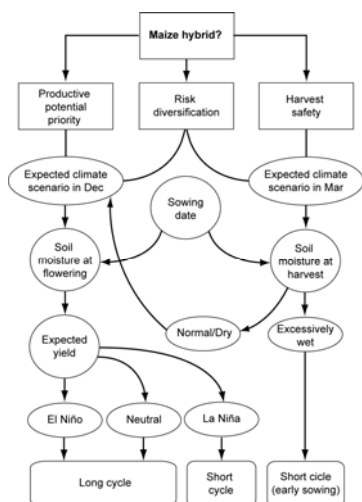


Fig 1. Conceptual diagrammatic representation of climate influences on deciding maize hybrid.

Table 1. Average economic result (USD ha<sup>-1</sup>) for the “climatological management” (i.e. ignoring forecasts) and expected value of an El Niño forecast for three different soybean adaptive strategies (S1, S2 and S3).

Management	Economic Result
Climatological (long MG*, normal SD**)	366
<i>Adaptive managements</i>	
S1: short MG, early SD	11 <sup>‡</sup>
S2: short MG, no change in SD	2
S3: long MG, early SD	-2 <sup>‡</sup>

\* Genotypes Maturity Group; \*\* Sowing Date; <sup>‡</sup> Statistical significant differences (p<0.05).

We explored the possible reasons for the misuse of climate information. Decision-makers were presented with detailed information about ENSO impacts on the local climate. Additionally, crop models were used to simulate several management options and climate scenarios, and outcomes were subsequently presented to farmers in a decision exercise. Farmers were asked to define crop

management with the opportunity of taking advantage of the presented information. Access to simulation outcomes allowed enhanced use of forecasts in some cases by triggering previously unobserved responses, and by allowing fine-tuning of earlier decisions based on climate forecasts alone (i.e. without complementary information about ENSO impacts or simulation outcomes; Fig 2). Modelled outcomes were useful in improving the use of climate information since they allowed decision-makers to quantify management (genotypes, sowing dates) x environment (ENSO phases) interactions.

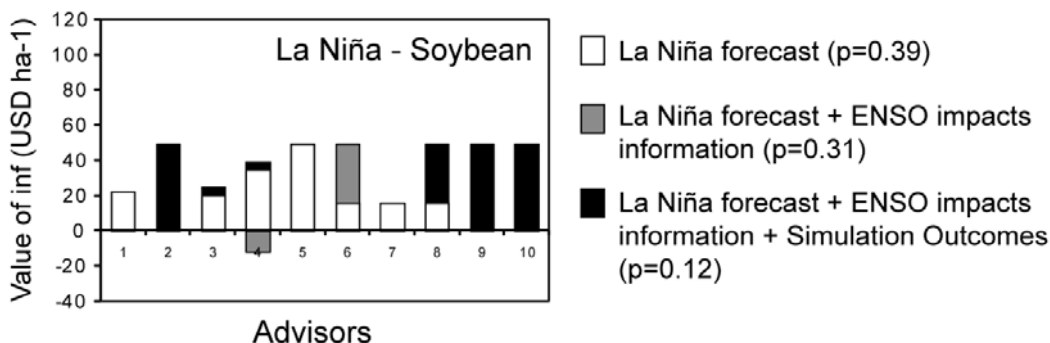


Fig 2. Expected value of using a La Niña forecast and forecast's complementary information (parts of the decision exercise) in soybean production. *P-values* in the legend indicate differences between the adaptive managements (parts of the decision exercise) and the climatological management.

A marked increase in precipitation since the 1970s, together with new production technologies, led to major changes in agricultural systems in the Pampas. Nevertheless, production systems that have evolved partly in response to increased rainfall may not be viable if climate reverts to a drier epoch. We evaluated a plausible climate scenario: a decrease in precipitation over the next 25 years. We used weather generators to downscale the regional scenario and crop and decision-making models to determine economic sustainability and optimal management of current production systems under the proposed scenario. Climatically optimal and marginal locations show differential responses: impacts of the decreasing precipitation sequence are much higher in currently marginal areas if precipitations decrease (Fig. 3). In addition to the simple but unrealistic assumption of constant technology, we plan to simulate the interaction of changing climate and technological innovations (e.g., simulation of anticipated biotechnological innovations by modifying parameters of crop models).

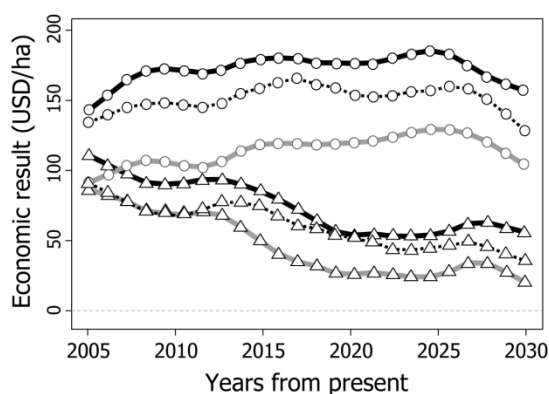


Fig 2. Temporal evolution of economic results (averaged over 100 realizations for each year in the sequence) in Pergamino (circles) and Pilar (triangles). The dark line corresponds to full-cycle soybean, the dashed line indicates the wheat-soybean double crop, and the grey line is for maize. The lines have been smoothed to facilitate visualization of trends.

REFERENCES: **Castañeda and Barros**, Las tendencias de la precipitación en el Cono Sur de América al este de los Andes, 1994. *Meteorológica* 19, 23–32; **Grimm et al.**, Climate variability in southern South America associated with El Niño and La Niña events, 2000. *J Climate* 13, 53–58; **Minetti et al.**, Non-linear trends and low frequency oscillation in annual precipitation over Argentina and Chile, 1931–1999, 2004. *Atmósfera* 16, 119–135; **Podestá et al.**, Associations between grain crop yield in central–eastern Argentina and El Niño southern oscillation, 1999. *J Appl Meteorol* 38, 1488–1498.