# *Reconditioning of Overly Dried Soybeans with Aeration*

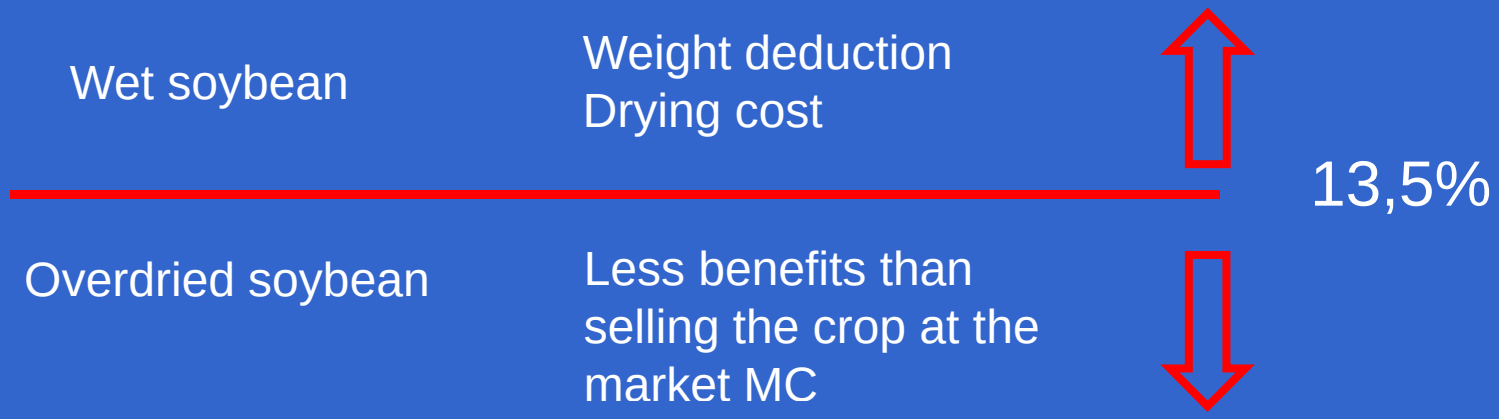
Authors: R. Bartosik, D. de la Torre, L. Cardoso, H. Urcola, J. Rodríguez

National Institute of Agricultural Technology

Balcarce Research Station, Argentina

# *Introduction*

- Soybean is the main crop of Argentina, with a production of more than 52 million tonnes in 2010.
- Commercialization standard of Argentina establishes the market (MC) limit in 13,5%.



# *Introduction*

- Any moisture added back to the overdried soybean increases the weight of the grain sold.
- Increasing the grain MC from 11 to 13.5% would imply to gain 0,0283 tonnes per tonne of grain.
- The potential benefit of increasing the MC from 11% to 13,5% is of 7,07 $/t. Soybean at U$S 250/tonne

# *Introduction*

- Reconditioning of overly dried soybean with aeration (selecting wet air conditions) is possible.
- Economic convenience of using aeration for conditioning soybean is determined by the price of soybean, the price of energy and the climatic conditions.
- NA/LT in-bin drying systems are being adopted by farmers for drying specialty grains
- Could it be used for reconditioning overly dried soybean?

# *Introduction*

- Would it be convenient to recondition soybean in the different producing regions of Argentina?
- How to study this process? Regions (climatic conditions), year to year variability, price of energy, etc
- The use of simulation model is a valid approach to study this process (Montross and Maier, 2000)

# *Objectives*

1. To use the PHAST-FDM to determine if it is feasible reconditioning overly dried soybean (from 11 to 13.5%) by selecting wet natural air conditions in a NA/LT in-bin drying system for three different locations of Argentina
2. To determine the energy consumption derived from the fan operation for conditioning overdried soybean
3. To quantify de economic incentives for conditioning overdried soybean.

# *Methodology*

- Typical bin size
- Specific airflow for in-bin drying of 1 $m^3$ $min^{-1}$ $t^{-1}$

# Methodology

- Fan sizing with the AireAr Software
- 2 Fans in parallel of 12,5 HP each
- 18,6 kW total power requirement
- Temperature increase due to the fan friction of 1.3°C

**Airflow vs. Depth Table**

**AireAr**

Crop: Soybean
Air Volume Desired: 1 m^3/(min T)

| Height (m) (*) | Weight (T) | Total Air Flow (m^3/min) | Air Flow Specific (m^3/(min T)) | Static Pressure (Pa) |
|---|---|---|---|---|
| 0.7 | 56.309 | 914.43 | 16.24 | 260.508 |
| 1.4 | 112.618 | 887.231 | 7.878 | 384.713 |
| 2.1 | 168.927 | 853.757 | 5.054 | 494.059 |
| 2.8 | 225.236 | 823.394 | 3.656 | 593.247 |
| 3.5 | 281.544 | 795.835 | 2.827 | 683.271 |
| 4.2 | 337.853 | 771.492 | 2.284 | 766.265 |
| 4.9 | 394.162 | 750.027 | 1.903 | 845.15 |
| 5.6 | 450.471 | 730.051 | 1.621 | 918.563 |
| 6.3 | 506.78 | 711.455 | 1.404 | 986.902 |
| 7 | 563.089 | 694.102 | 1.233 | 1,050.674 |
| 8.5 (Peak) | 643.53 | 660.268 | 1.026 | 1,175.017 |

Airflow is within 5% of desired value.

Fans: 2 --- Arrangement: Parallel --- Manufacturer: Gatti --- Model: RU 540 --- Type: Centrifugal --- HP: 12.5

(*) In case of selecting bin (flat storage) with cone and grain Peak, the height of the table includes the height of the bin cylinder (lateral wall of the flat storage) plus halve of the height of the cone and grain peak.

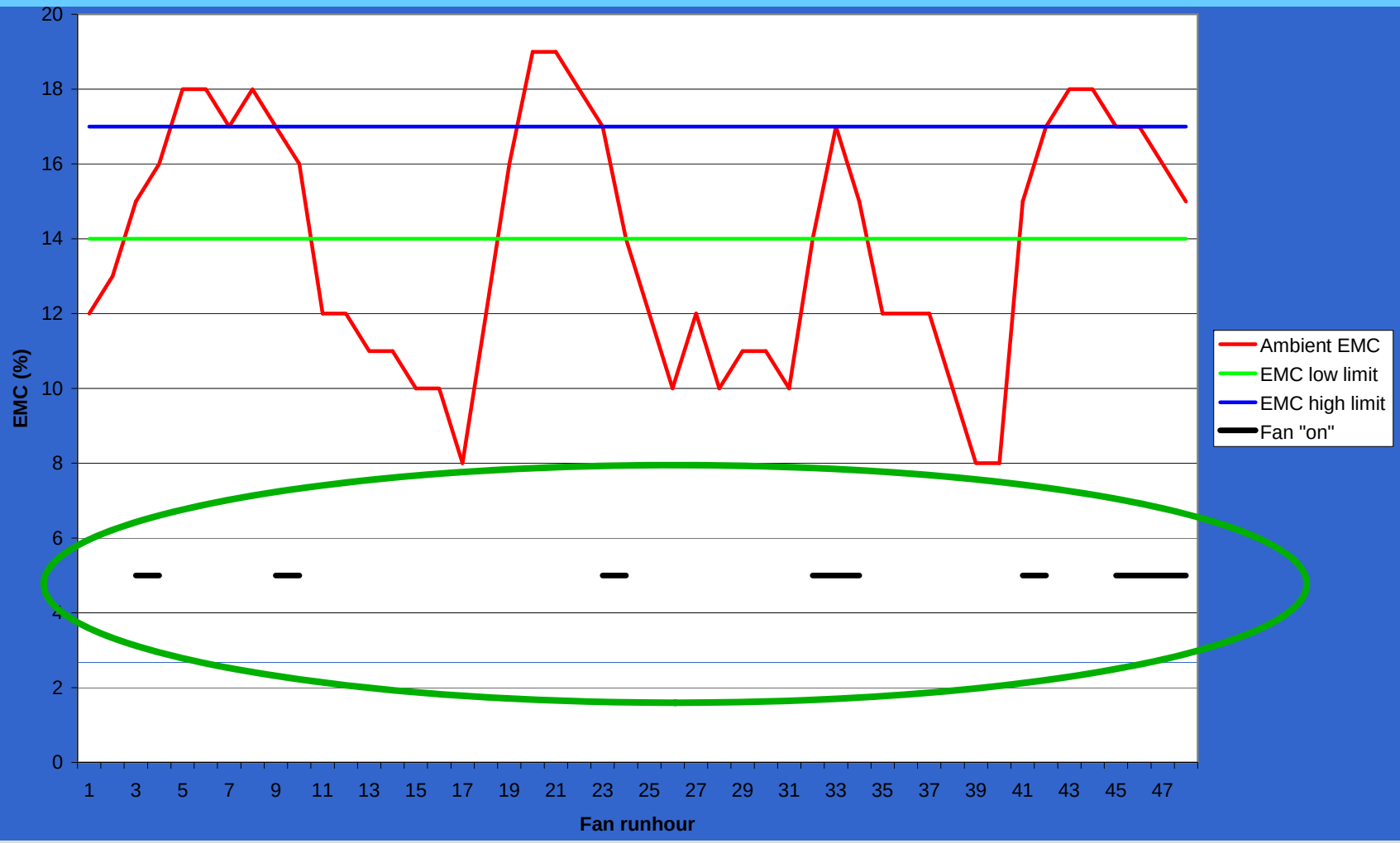
# Metho

- The Post-Harvest Aeration and S
  Difference Method (PHAST - FDI
  solves the heat and mass transf
  conditioning of the grain in two
  University)
- Historical weather data from 3 l
  Manfredi)
  - Hourly temperature
  - Hourly HR
- Simulation started on April 1°
- Kilowatt cost: 0,0765 U$S/kWh
- Soybean price: 250 U$S/t
- Annual depreciation expense of

# *Controller settings*

- EMC windows strategy
- Lower limit: 14%
- Upper limit: 17%
- EMC equation: Modified Chung-Pfost (drying and rewetting parameters)

# Methodology

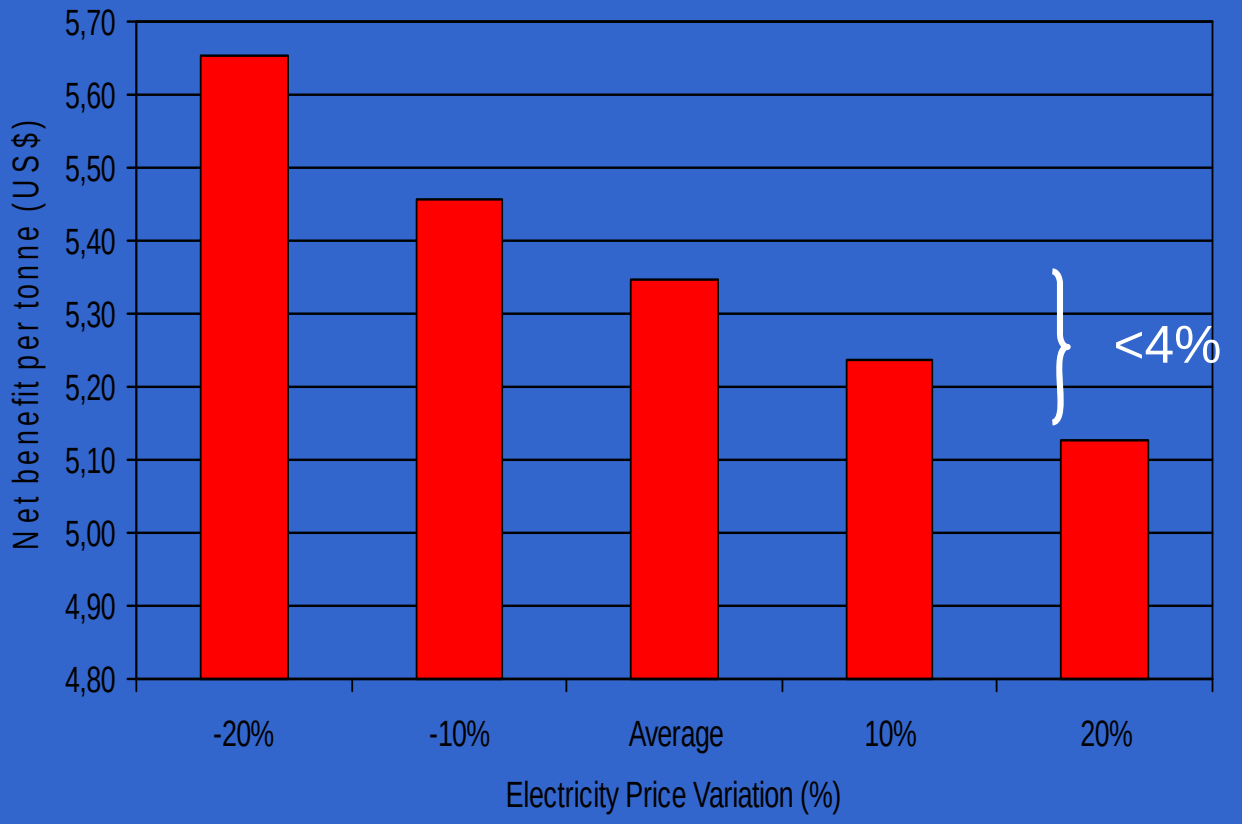


# *Results & Discussion*

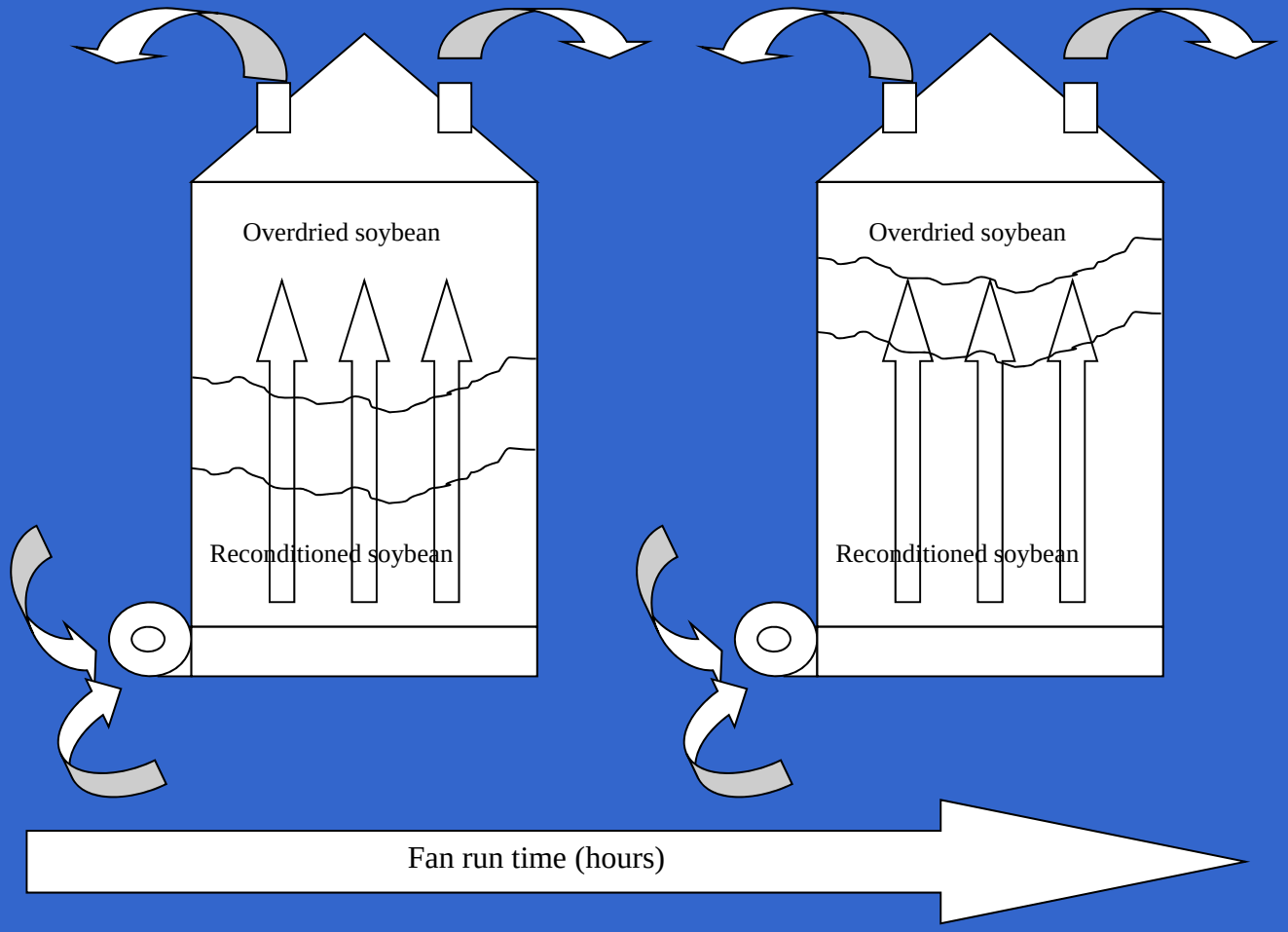
| Location | Reconditioning time (days) | Fan run time (hs) | Fan run time (%) | Fan electrical consumption (kWh) | Specific consumption (kWh/t) |
|---|---|---|---|---|---|
| Pergamino | 153 | 542 | 14.8 | 10081 | 15.75 |
| Manfredi | 153 | 443 | 12 | 8240 | 12.87 |
| Balcarce | 127 | 498 | 16.3 | 9263 | 14.47 |
| Average | 144 | 494 | 14 | 9195 | 14.37 |

# Results & Discussion

- Revenue: 7,07 US$/t
- Average energy consumption: 14.37 kWh/t
- Average total cost (energy + depreciation): 1.725 US$/t
- Average net benefit: 5.35 US$/t
- 2.14 US$/t per each percentage point of moisture added



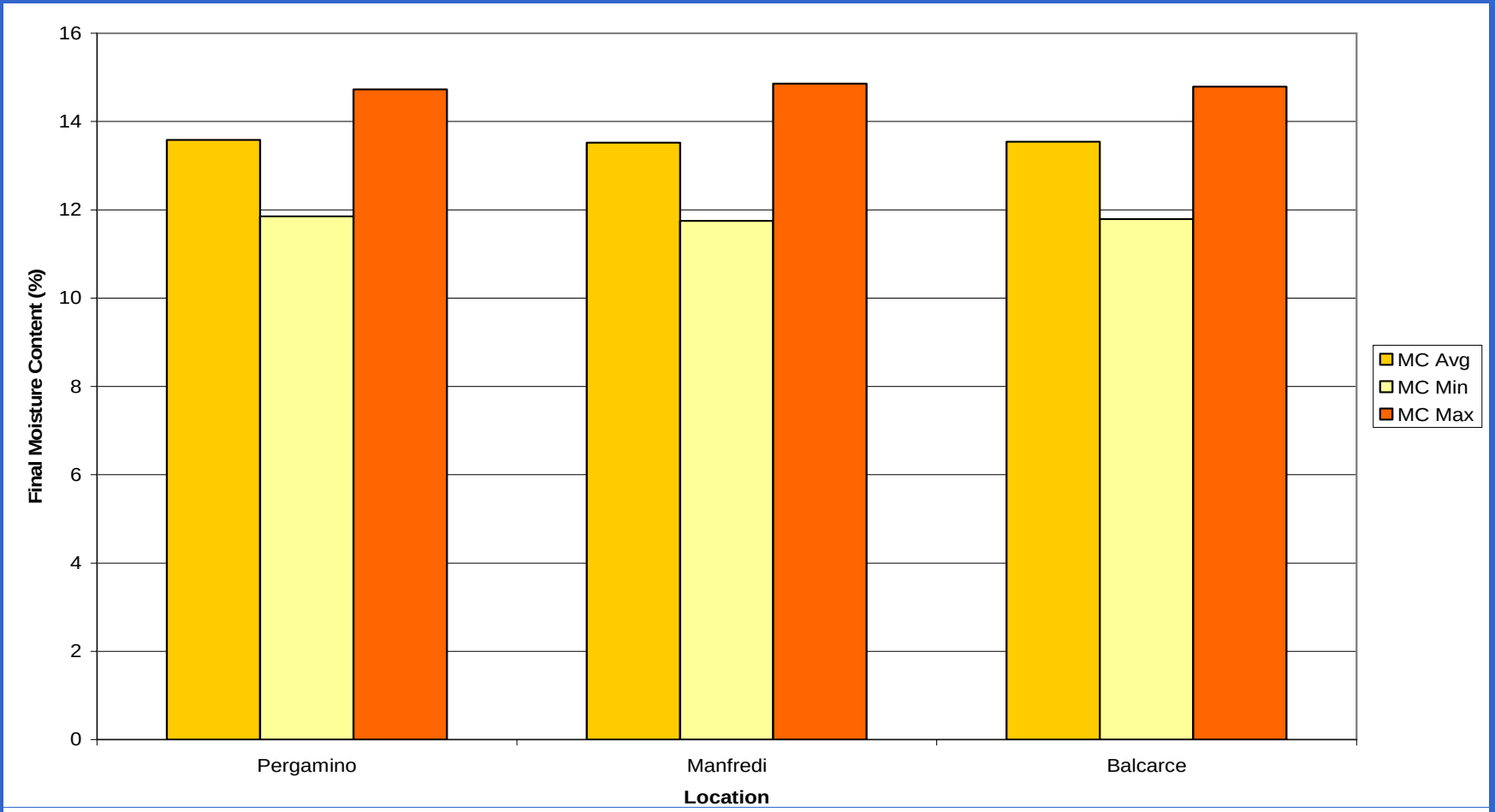
# Results & Discussion



# *Results and discussion*

- When to finish the reconditioning process?
- When the upper layer is already rewetted:
  - Too risky
- When the average MC is 13.5%:
  - Moisture unbalance

# Results & Discussion



# Results & Discussion

| Ambient Air Condition | | | Fan pre warming (°C) | Plenum Air Condition | | | |
|---|---|---|---|---|---|---|---|
| Temperature (°C) | RH (%) | EMC (%) | | Temperature (°C) | RH (%) | EMC (%) | EMC Difference (%) |
| 20 | 70 | 12.8 | 1.3 | 21.3 | 64.6 | 11.6 | 1.2 |
| 20 | 80 | 15.2 | 1.3 | 21.3 | 73.8 | 13.6 | 1.6 |
| 20 | 85 | 16.8 | 1.3 | 21.3 | 78.5 | 14.8 | 2.0 |
| 15 | 80 | 15.5 | 1.3 | 16.3 | 73.6 | 13.7 | 1.8 |
| 25 | 80 | 15.0 | 1.3 | 26.3 | 74.1 | 13.4 | 1.6 |
| 30 | 80 | 14.8 | 1.3 | 31.3 | 74.3 | 13.3 | 1.5 |

# *Conclusions*

- Reconditioning of overly dried soybean resulted in a range of energy consumption from 10081 to 8240 kWh (14.37 kWh/t )
- The total time demanded for reconditioning the soybean to an average final MC of 13.5 was 3464 hours (144 days total, 14% fan “on”)
- A different set of low and high EMC limits could be explored for increasing the fan run time and shortening the length of the conditioning process

# *Conclusions*

- Base on an electricity cost of 0.0765 US$/kWh and a selling soybean price of 250 US$/t, the net benefit of reconditioning overly dried soybean from 11 to 13.5% was of 5.35 US$/t (2.14 US$/t for each % point of moisture added)
- It is possible the reconditioning overly dried soybean from 11 to 13.5%, however better strategies should be explored to:
  - To speed up the process
  - Minimize the moisture unbalance at the end of the process
  - Reduce risk in grain quality

*Thank You!*

rbartosik@balcarce.inta.gov.ar