ABSTRACT: 136

"EL NIÑO SOUTHERN OSCILLATION" (ENSO) INFLUENCE ON SOYBEAN YIELDS

SIERRA E[1,2], COSTA R[1] & LÓPEZ E[2]

[1] Buenos Aires Grains Exchange, Argentina. rcosta@bc.org.ar
[2] School of Agronomy, University of Buenos Aires, Argentina
E-mails: edmasi@fibertel.com.ar; elsielopez@fibertel.com.ar

World soybean (*Glycine max*. L. Merrill) production has significantly increased during the last two decades, jumping from about 108 million metric tons, in 1990, to more than 260 million metric tons, in 2010. Due to climate change, "El Niño Southern Oscillation" (Enso) phases have increased in frequency, producing an oscillating pattern with no equivalent in the near past. Very intense "El Niño" episodes, and double and triple "La Niña" episodes have become common. As most of the main soybean producing countries have been affected, this research was undertaken with the intention of exploring associations between soybean yield and the ENSO phases. Historical soybean yield data, from 1990 to 2010, from official government sources and the FAO, for Argentina, Bolivia, Brazil, Canada, China, India, Indonesia, Paraguay, the Russian Federation, South Africa, the Ukraine, the United States of America, Uruguay, Africa Total, Northern America Total, South America Total, Asia Total, Europe Total and World Total, were employed. Yields were detrended to remove the effects of technological advances, and yield residuals were computed. It was observed that "El Niño" positively affects Argentina, Brazil, India and Paraguay, while it negatively affects China, the Russian Federation, South Africa and South America Total. Simple "La Niña" positively affects Canada, China, India and Africa Total, while it adversely affects Bolivia, the Russian Federation, South Africa and the Ukraine. Double "La Niña" proved to have the most intense effects, with Brazil, the Russian Federation, South Africa, Africa Total and Europe Total, being positively affected, and Argentina, Canada, India, Paraguay, Ukraine and Asia Total, being adversely affected. Significant Enso influence must be taken into consideration in technological innovation to help increase production during the expected climate change process. At the same time, signs of development of ENSO phases may be used as efficient tools in early yield forecasting.

"EL NIÑO SOUTHERN OSCILLATION" (ENSO) INFLUENCE ON SOYBEAN YIELDS

E. Sierra (1 & 2), R. Costa (1) and Elsa López (2)

1 Buenos Aires Grain Exchange, Argentina. rcosta@bc.org.ar
2 School of Agronomy, University of Buenos Aires, Argentina
edmasi@fibertel.com.ar ; elsielopez@fibertel.com.ar

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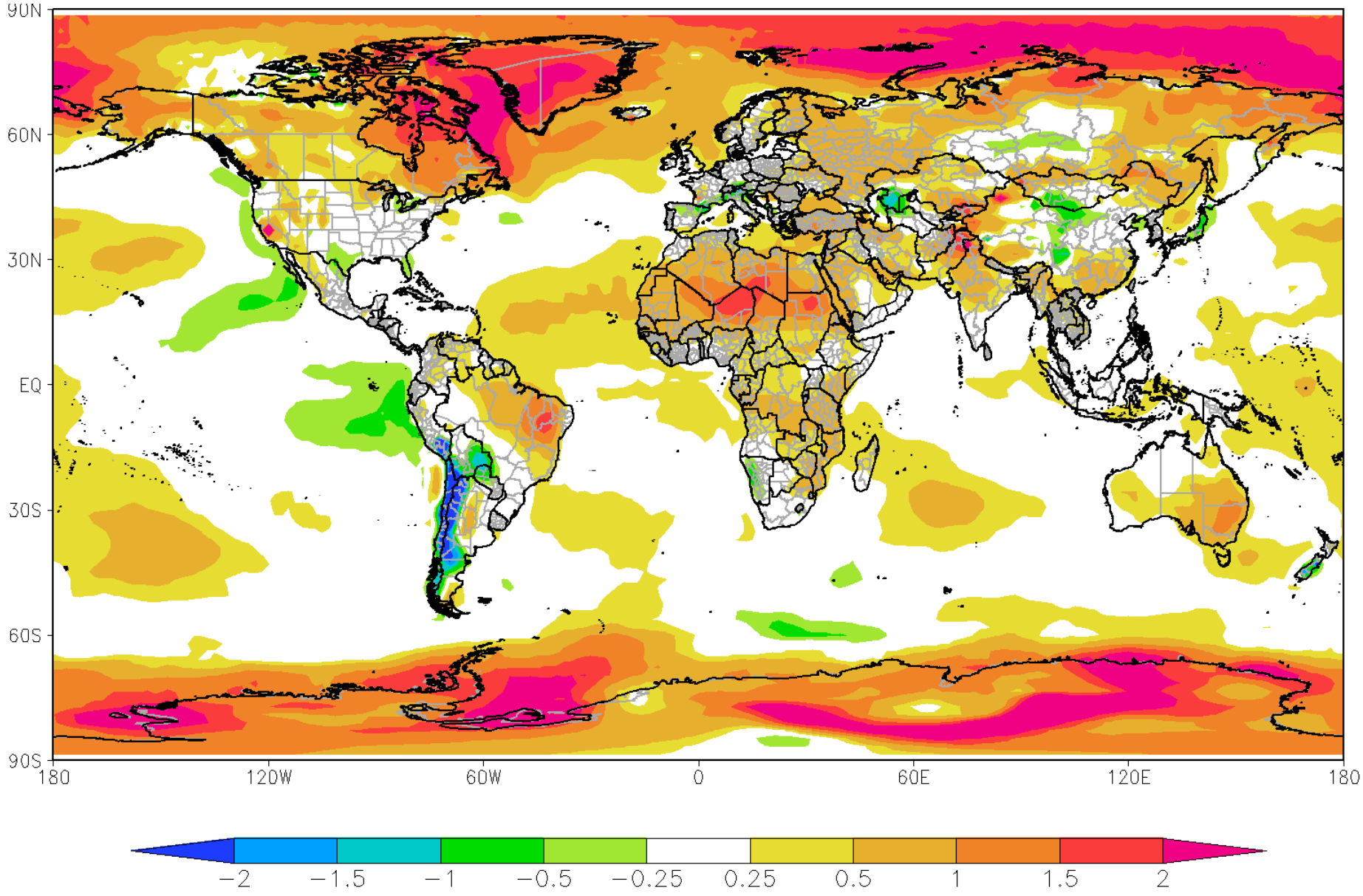
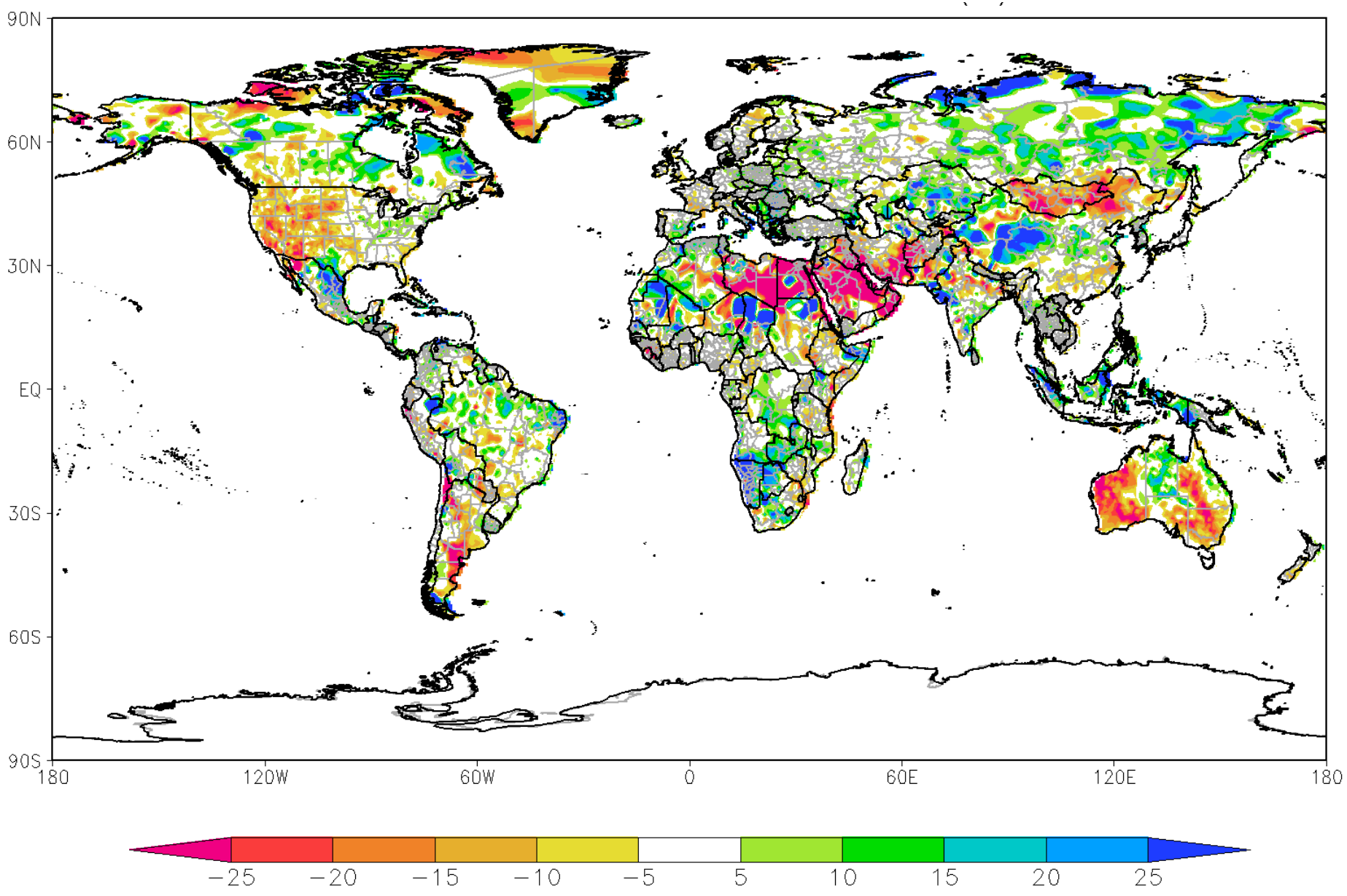
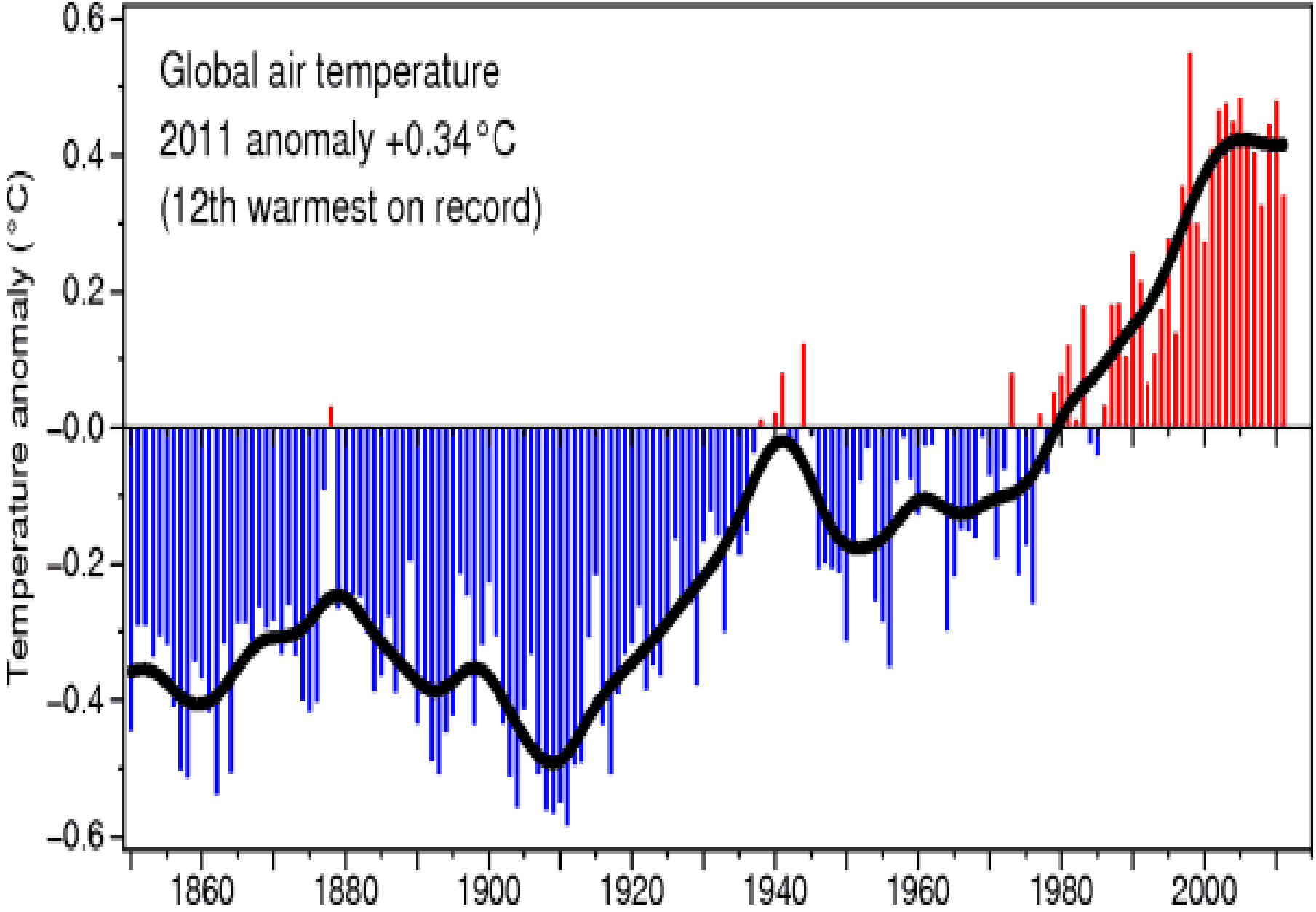
February 17-22, 2013.

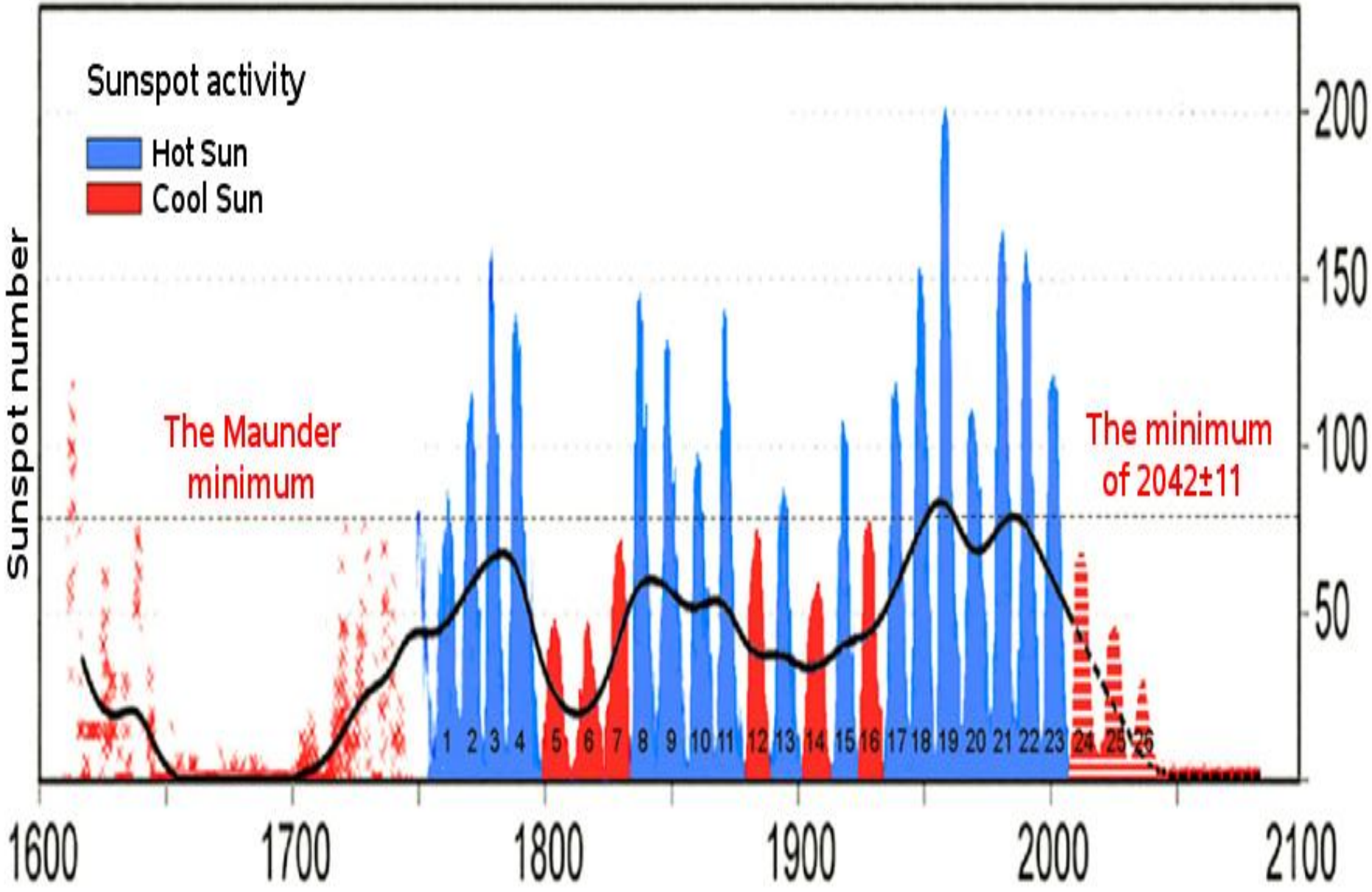
CHANGE IN SURFACE AVERAGE TEMPERATURE FROM THE 1990s TO THE 2000s (C)

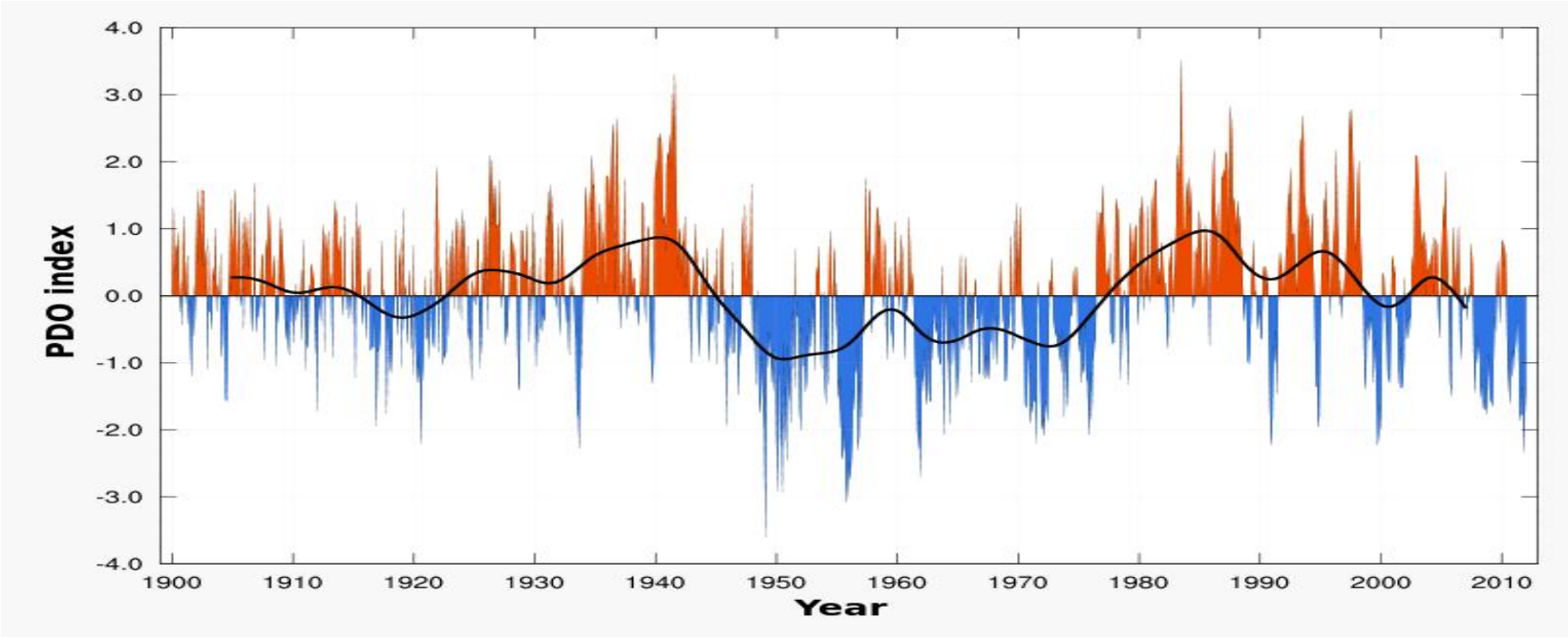


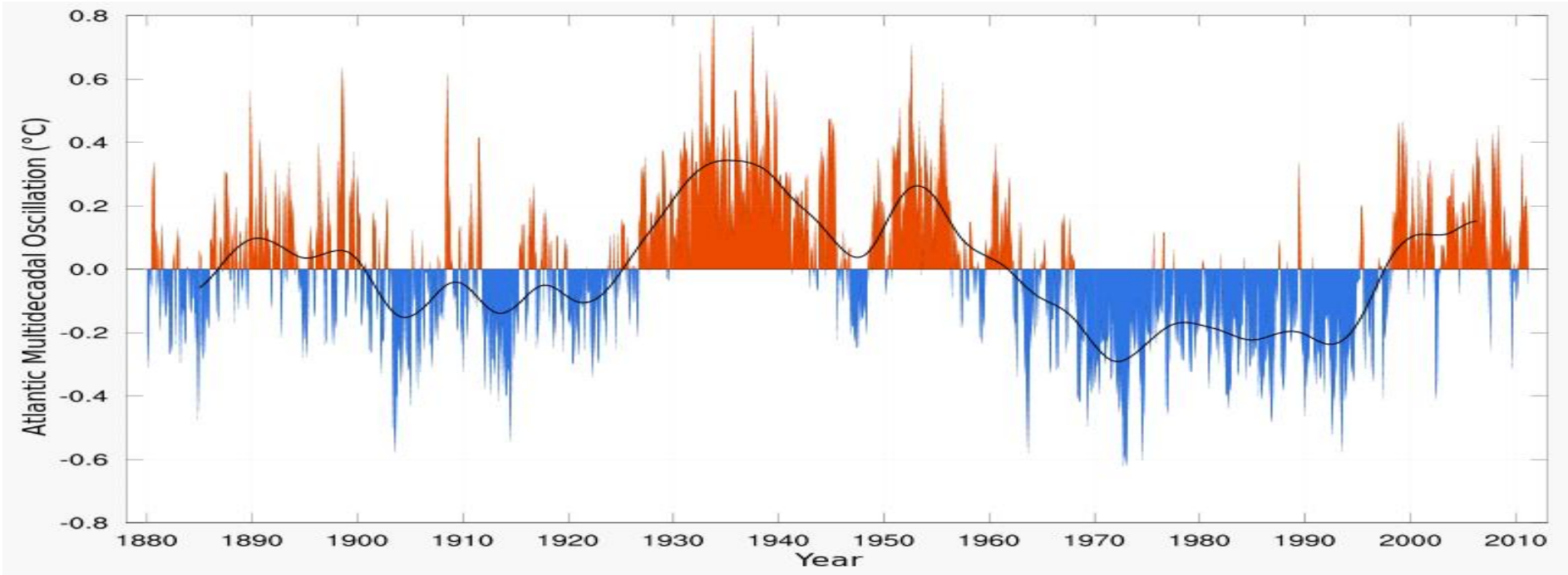
CHANGE IN AVERAGE ANNUAL RAINFALL FROM THE 1990s TO THE 2000s (%)




Global air temperature
2011 anomaly +0.34 °C
(12th warmest on record)
Temperature anomaly (°C)
0.6
0.4
0.2
-0.0
-0.2
-0.4
-0.6
1860
1880
1900
1920
1940
1960
1980
2000


Sunspot activity
Hot Sun
Cool Sun
Sunspot number
The Maunder minimum
The minimum of 2042±11
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
200
150
100
50
1600
1700
1800
1900
2000
2100

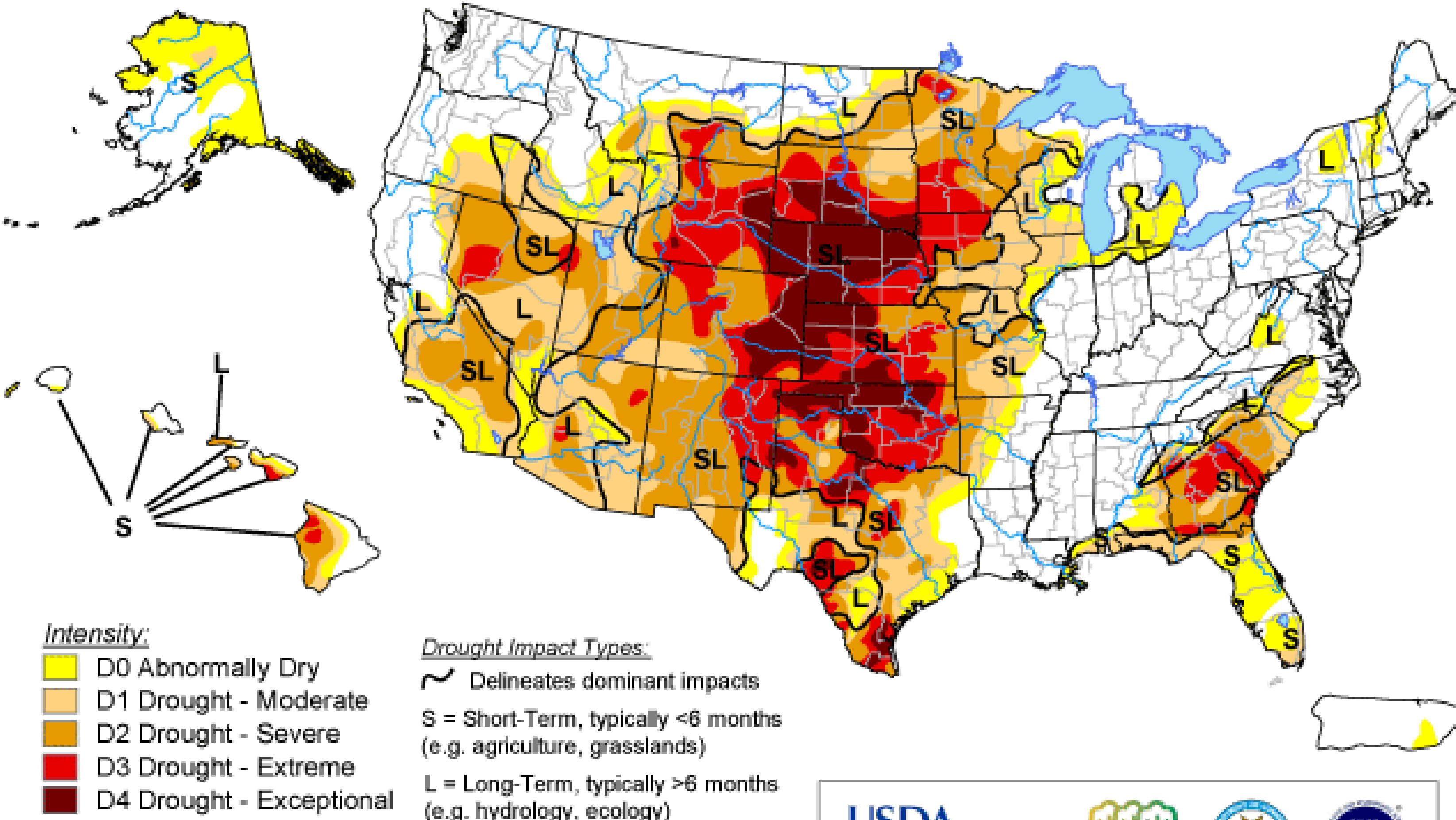

PDO index
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year


Atlantic Multidecadal Oscillation (°C)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year

Texas, Black Sunday, April 14, 1935

U.S. Drought Monitor

February 12, 2013
Valid 7 a.m. EST



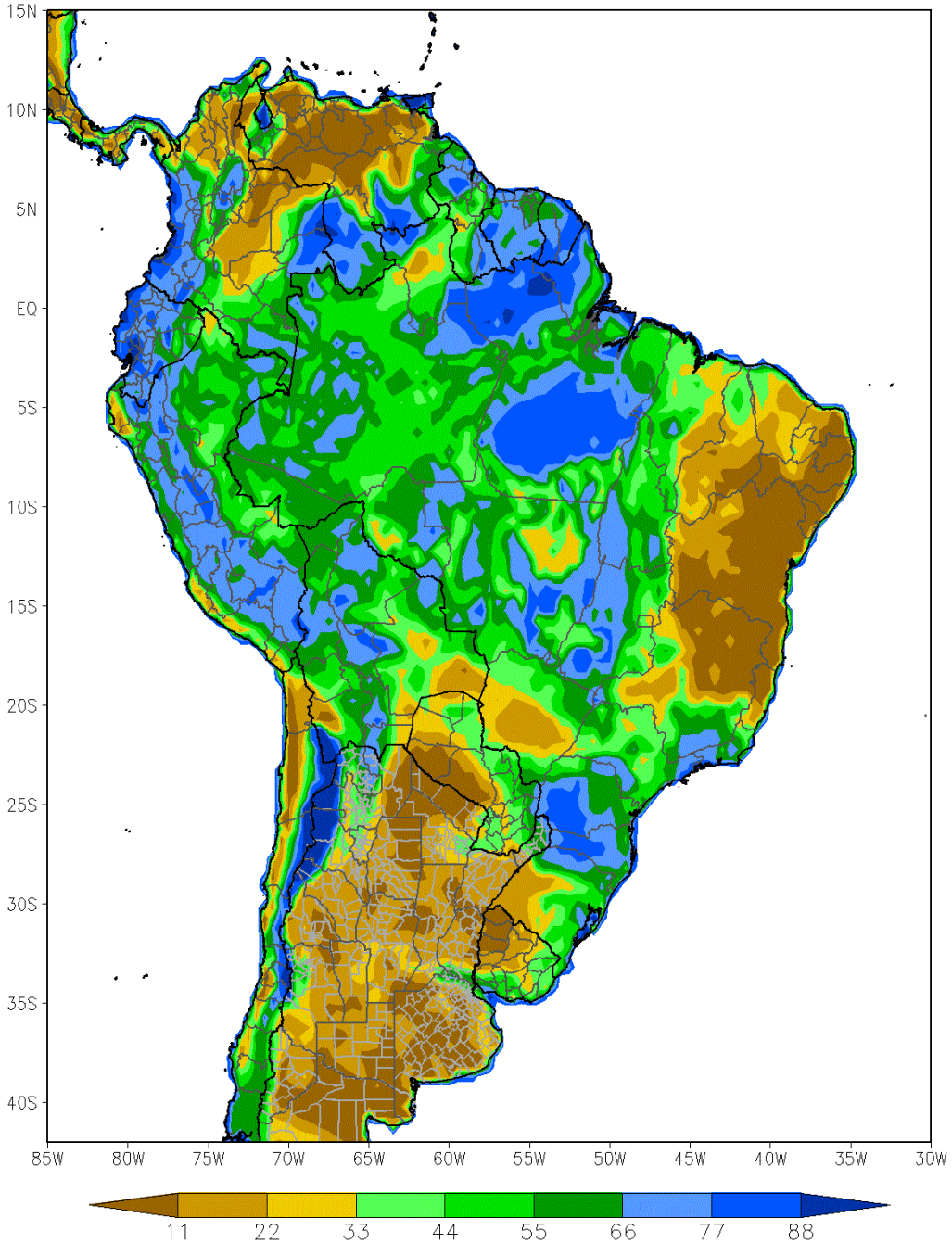
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, February 14, 2013

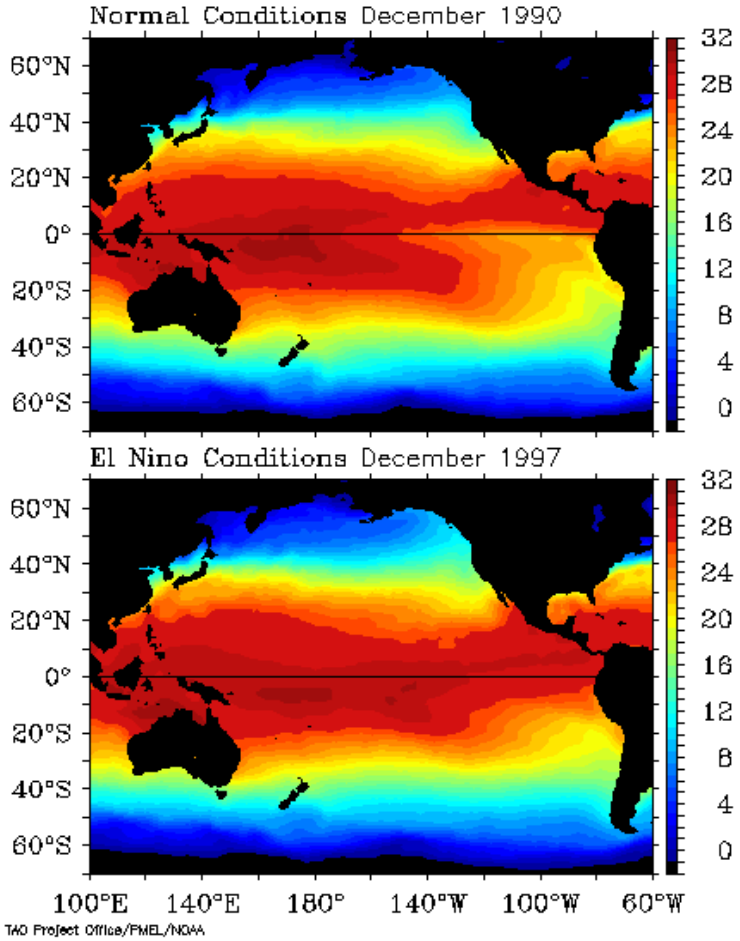
Author: Michael Brewer/L. Love-Brotak, NOAA/NESDIS/NCDC

SOIL WATER CONTENT (%)
February 11–18 2013

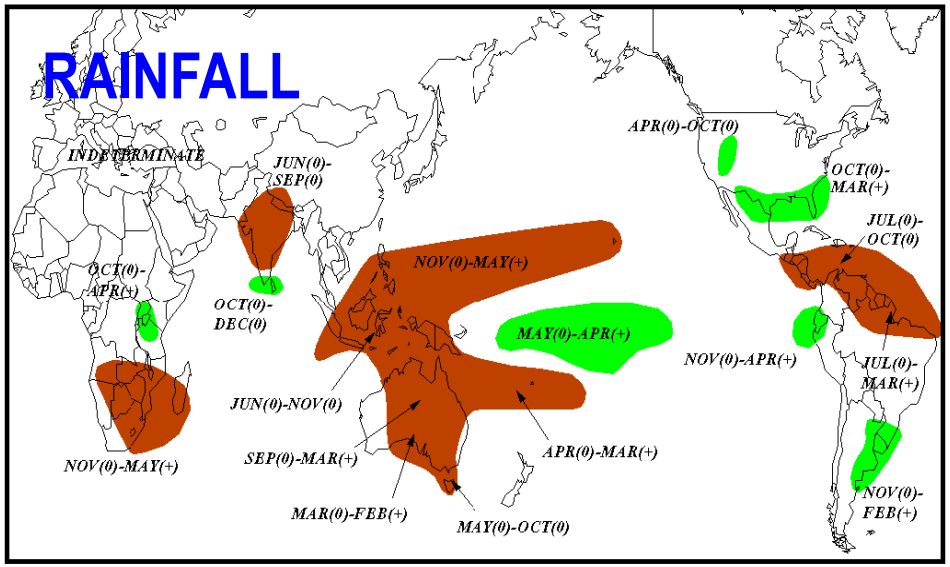


“EL NIÑO”

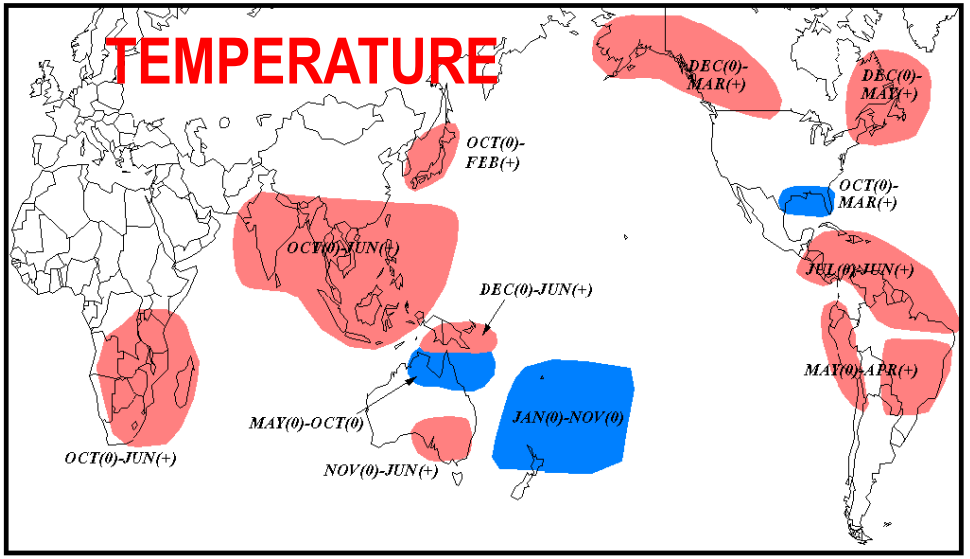
NORMAL



“El NIÑO”



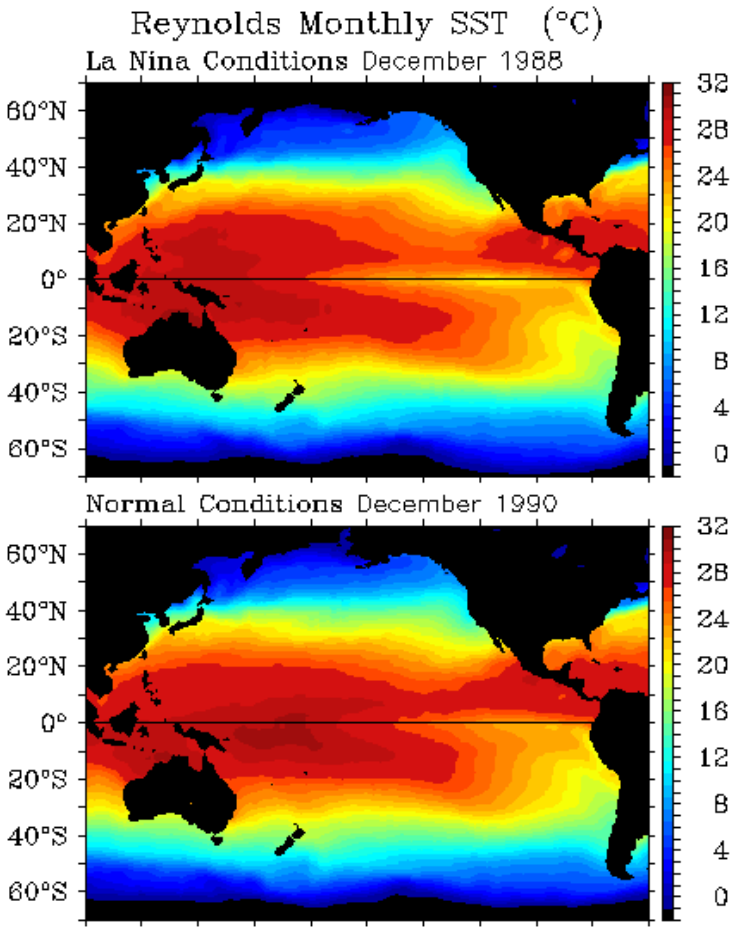
Prepared by the Joint Agricultural Weather Facility
Source: Ropelewski and Halpert, 1987. Monthly Weather Review, (115) p. 1606-1626.



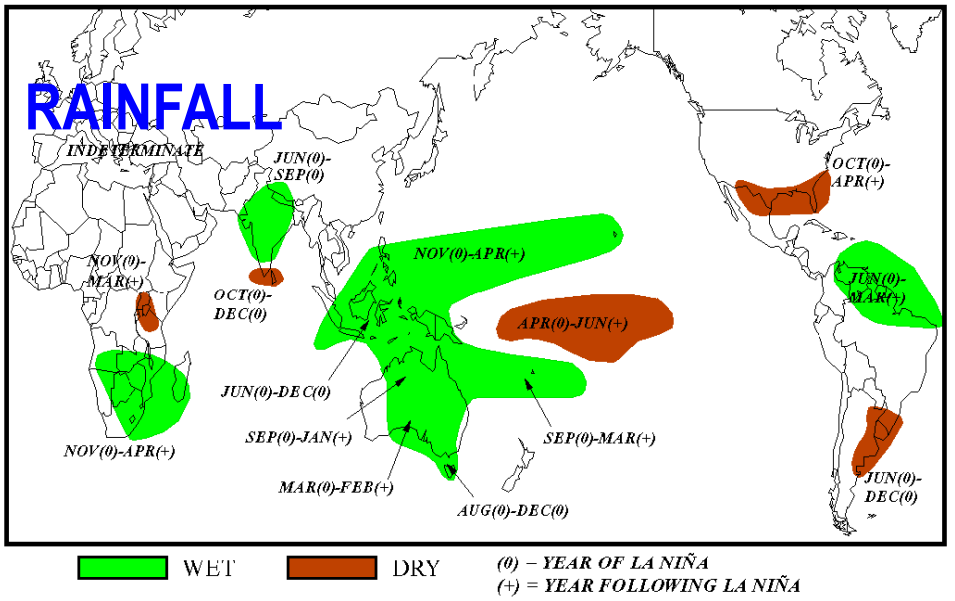
Prepared by the Joint Agricultural Weather Facility
Source: Halpert and Ropelewski, 1992. Journal of Climate, (5) p. 577-593.

EFECTOS DE “LA NIÑA”

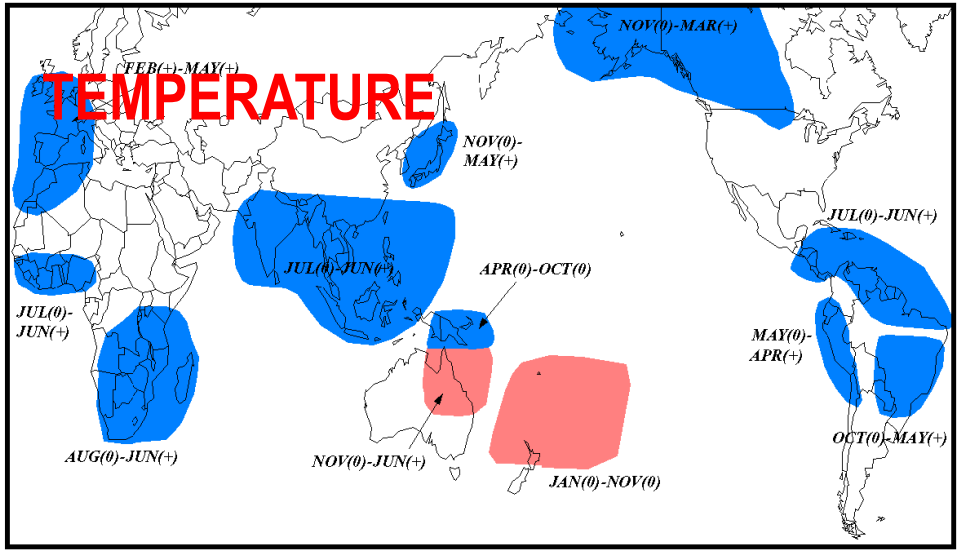
“LA NIÑA”



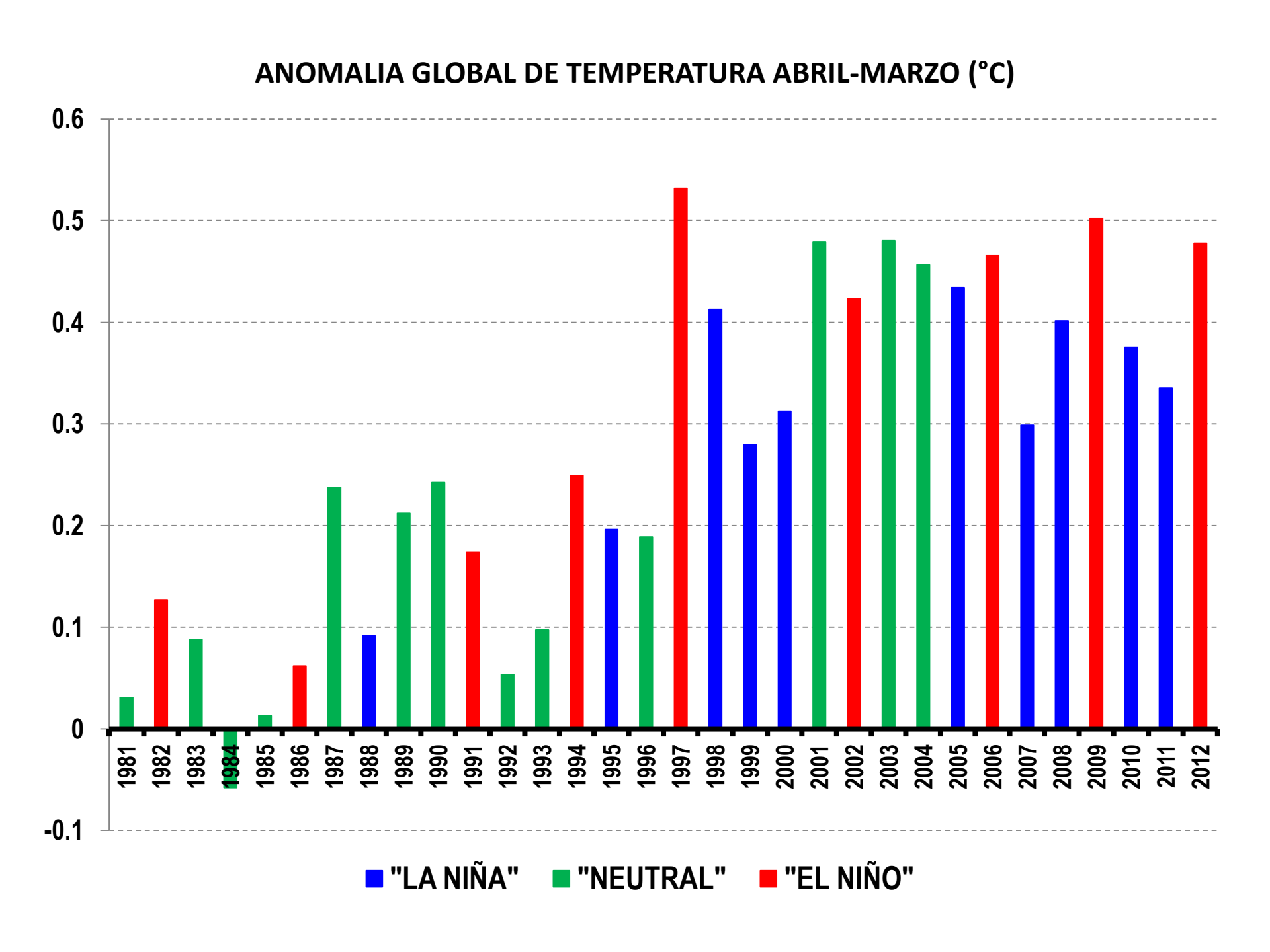
NORMAL

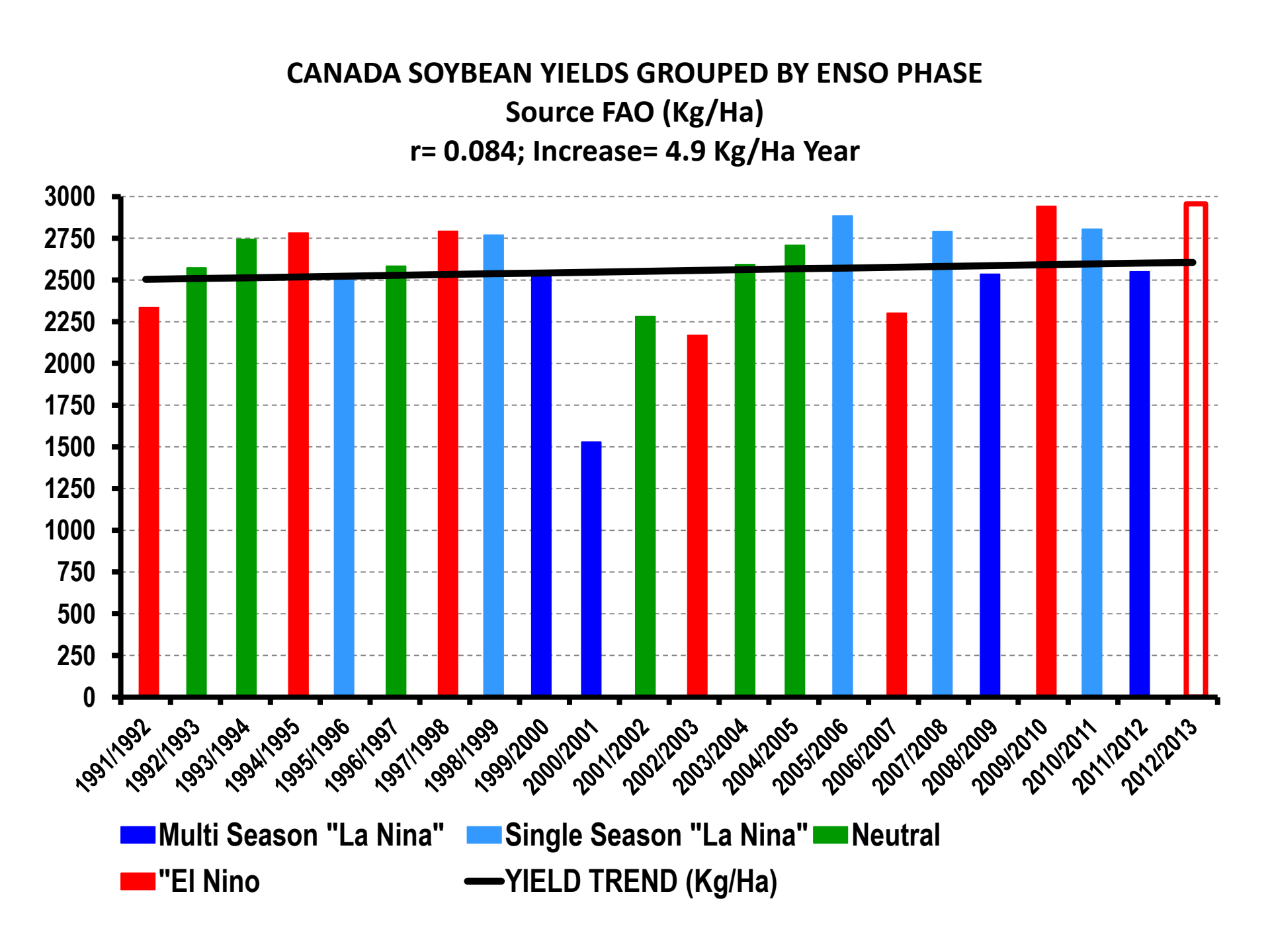


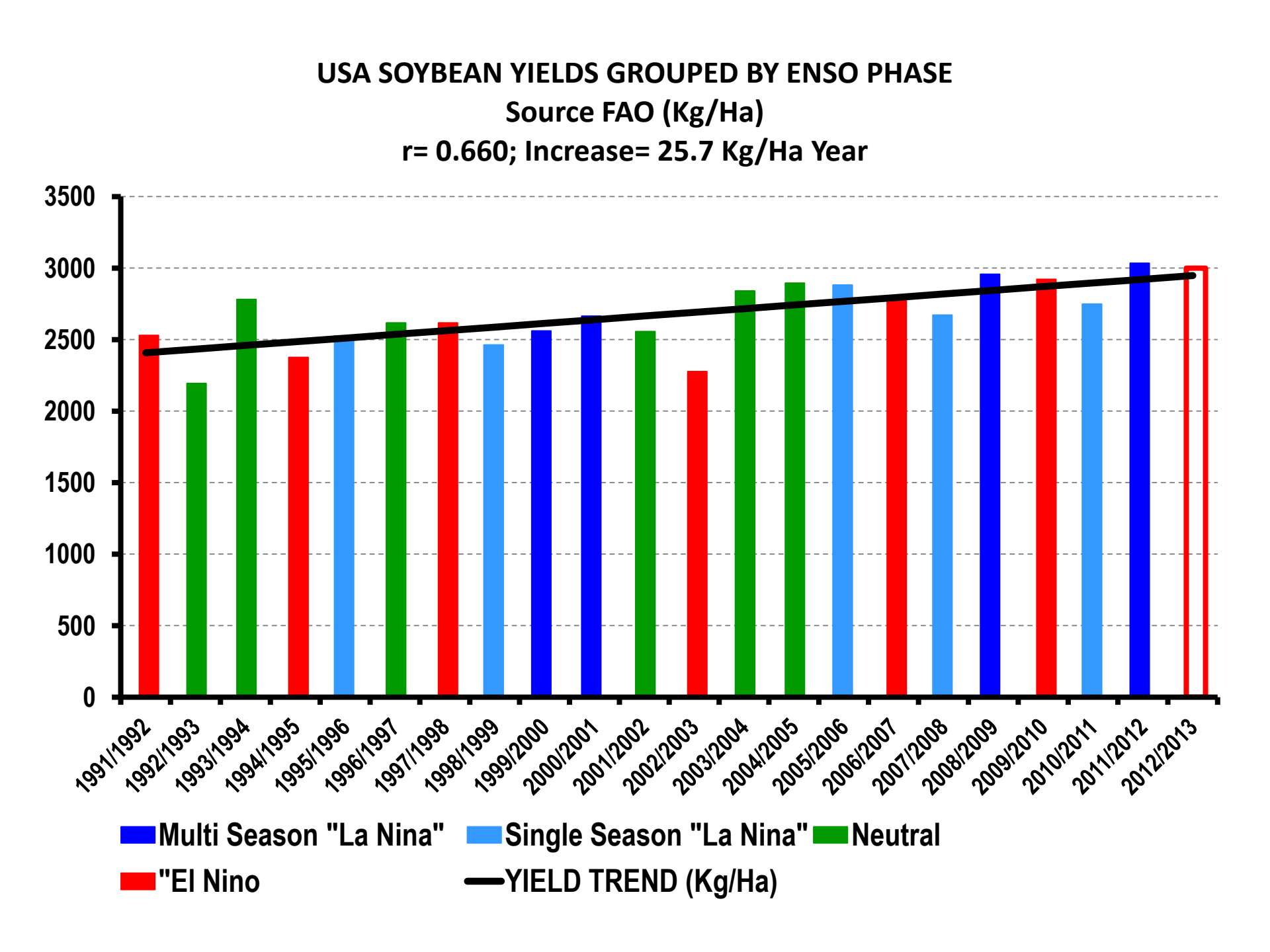
Prepared by the Joint Agricultural Weather Facility
Source: Ropelewski and Halpert, 1989. Journal of Climate, (2) p. 268-284.

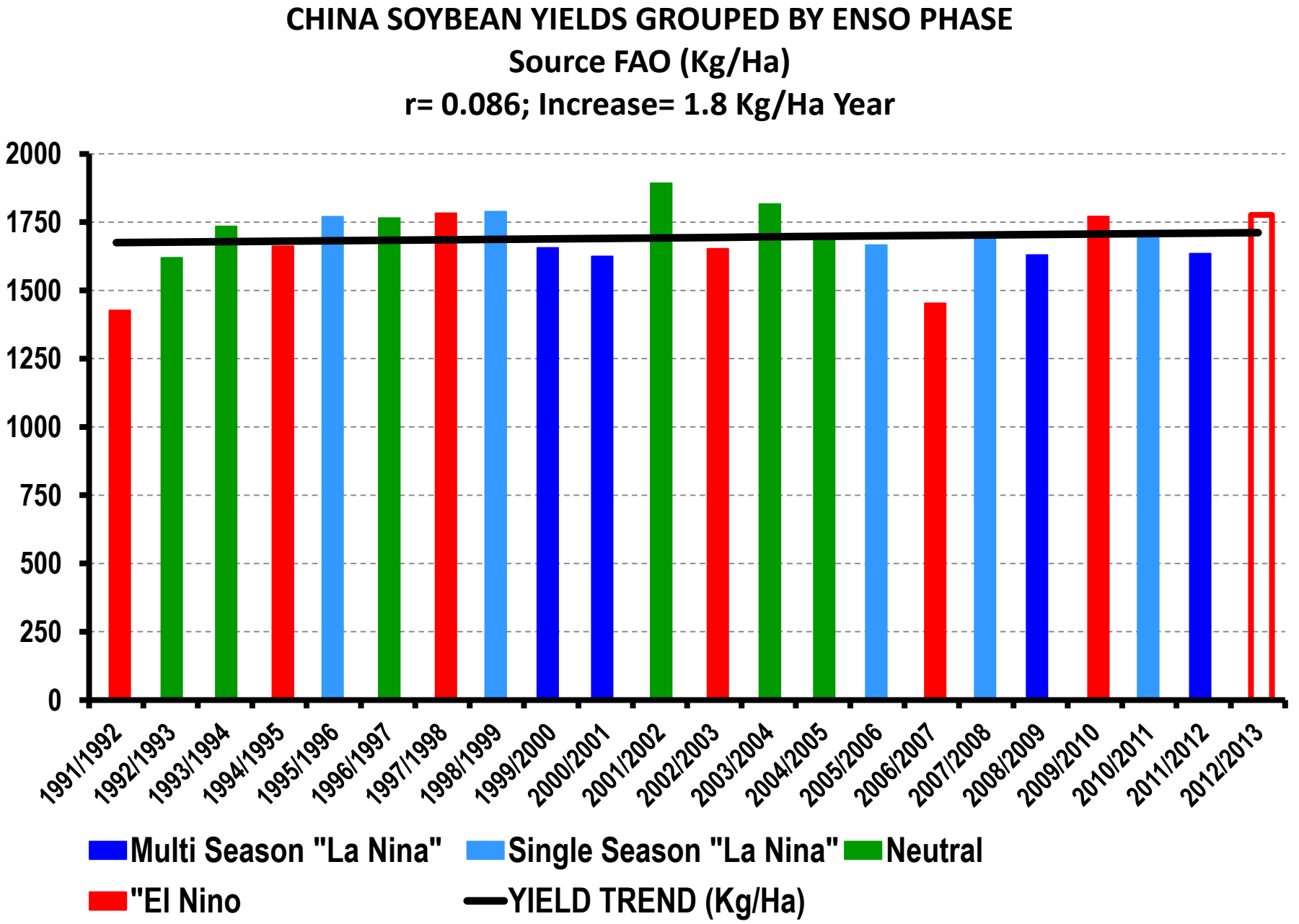


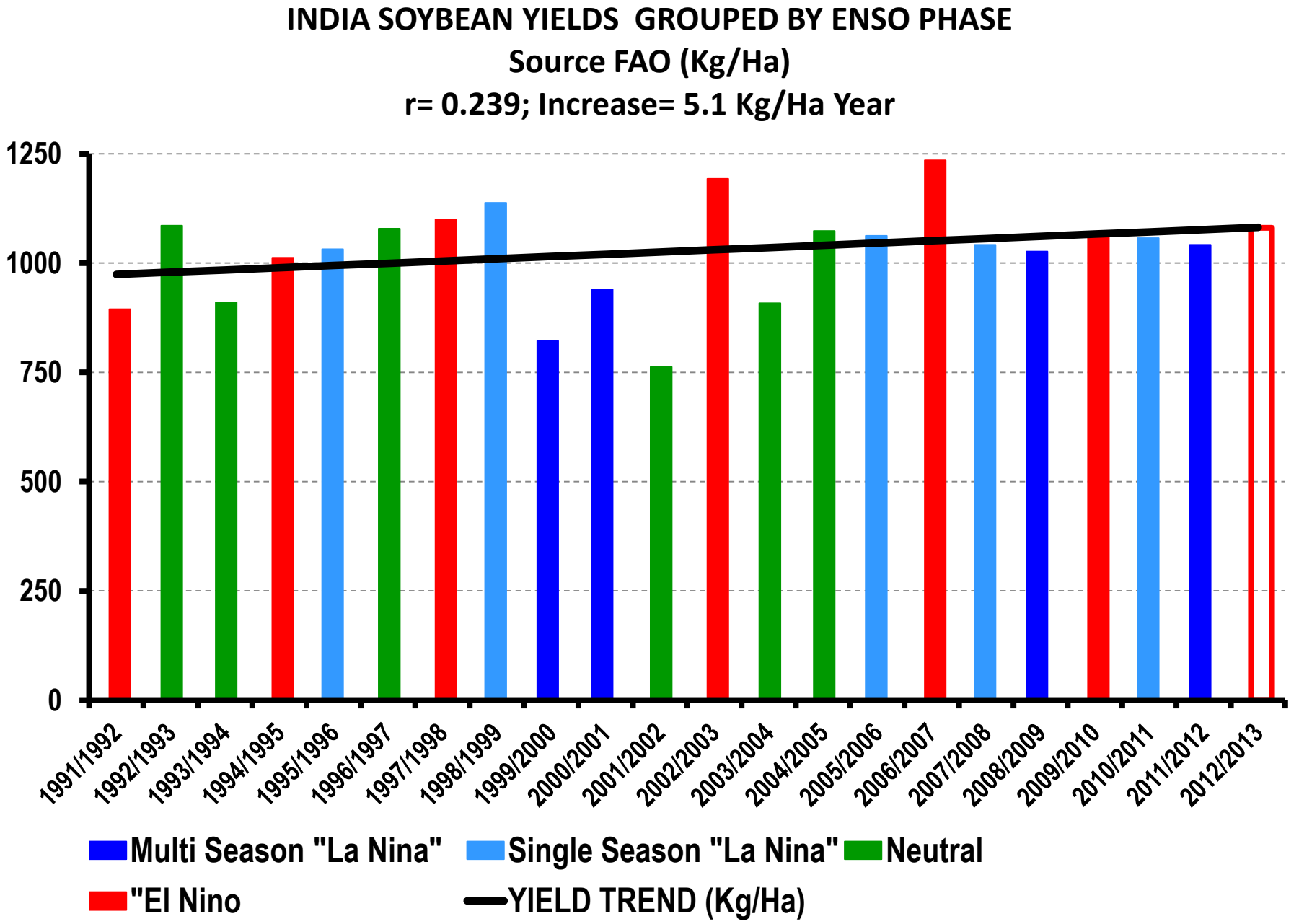
Prepared by the Joint Agricultural Weather Facility
Source: Halpert and Ropelewski, 1992. Journal of Climate, (5) p. 577-593.

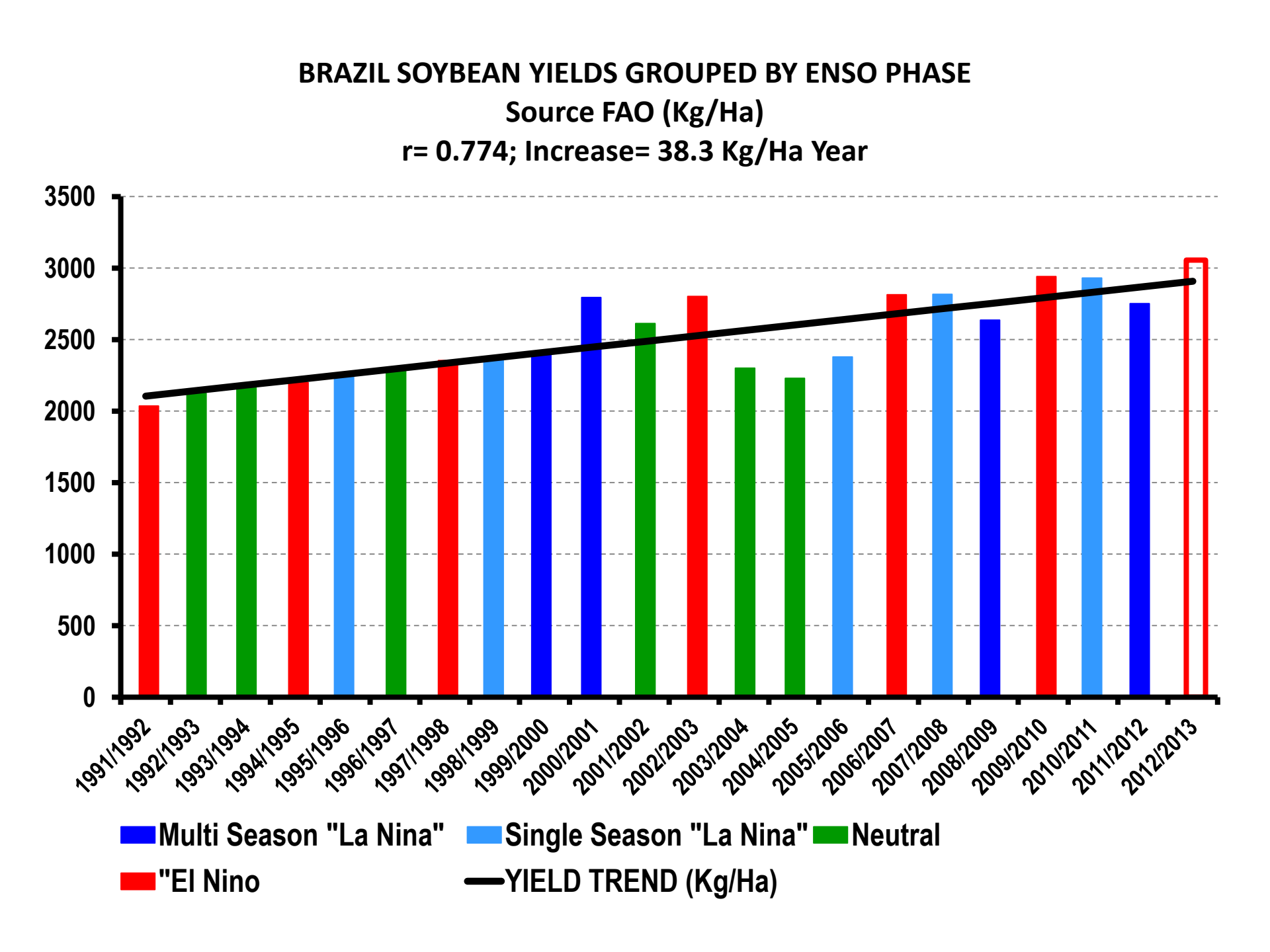

ANOMALIA GLOBAL DE TEMPERATURA ABRIL-MARZO (°C)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
"LA NIÑA"
"NEUTRAL"
"EL NIÑO"

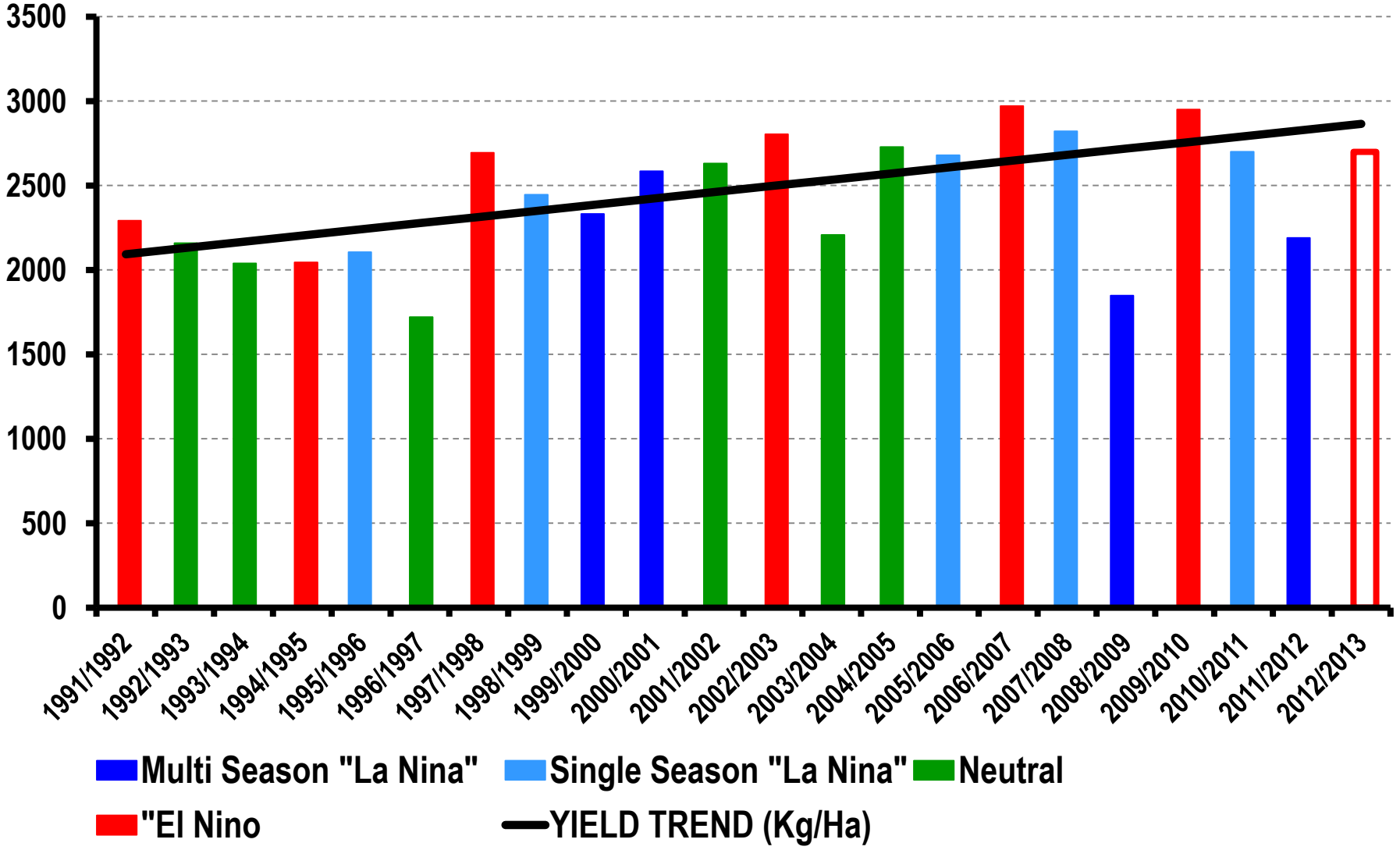

CANADA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.084; Increase= 4.9 Kg/Ha Year
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

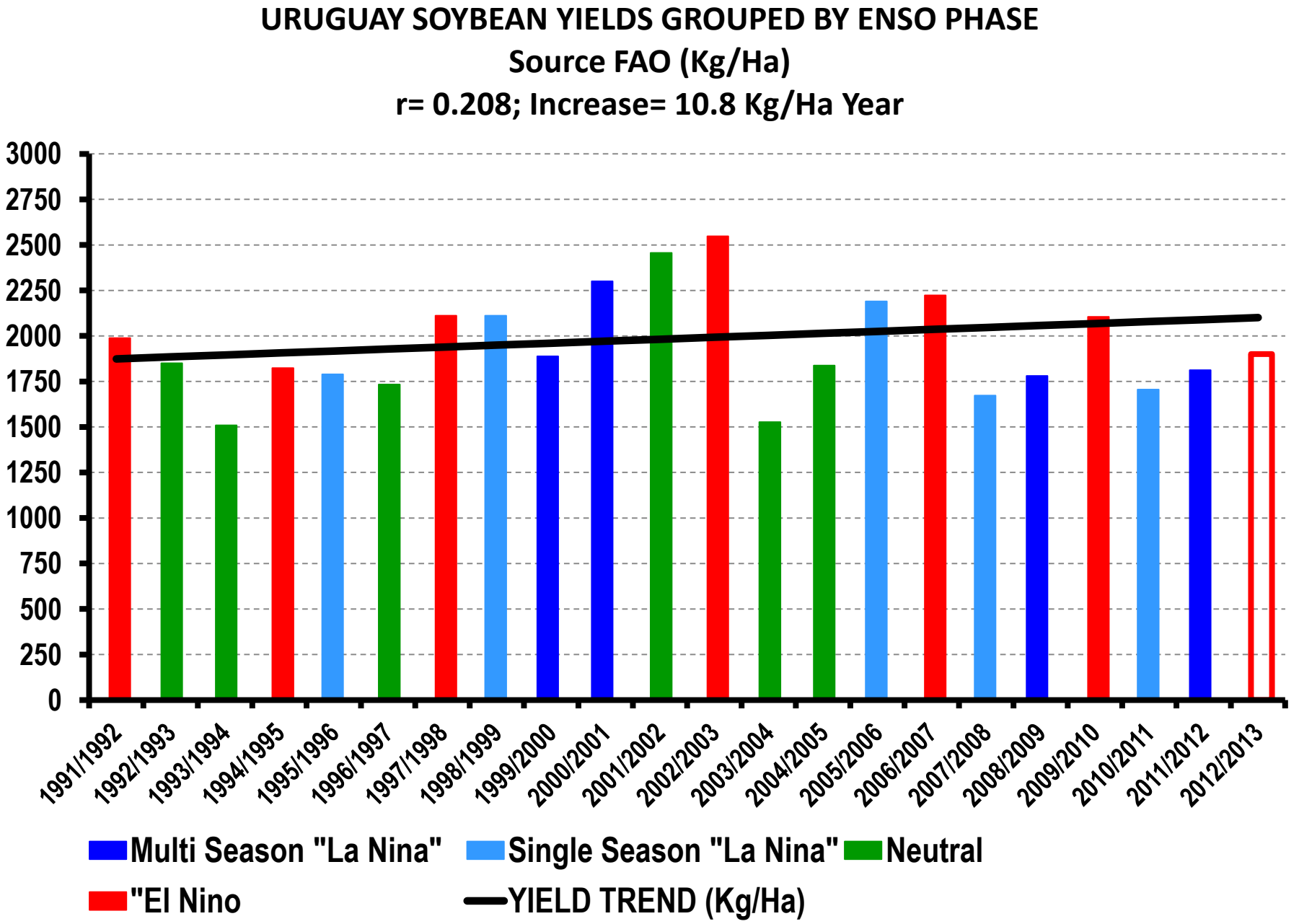

USA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.660; Increase= 25.7 Kg/Ha Year
3500
3000
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

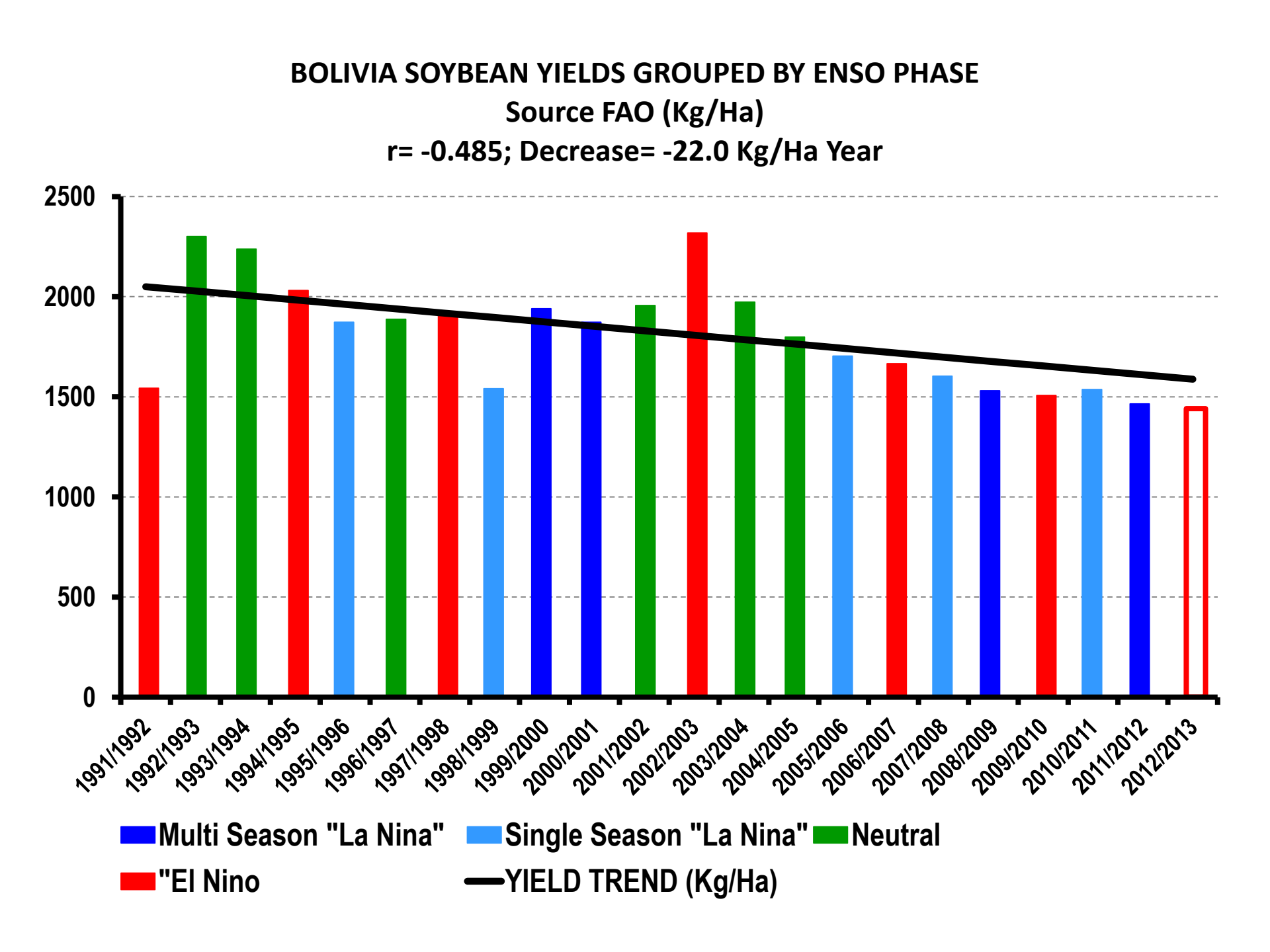

CHINA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.086; Increase= 1.8 Kg/Ha Year
2000
1750
1500
1250
1000
750
500
250
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

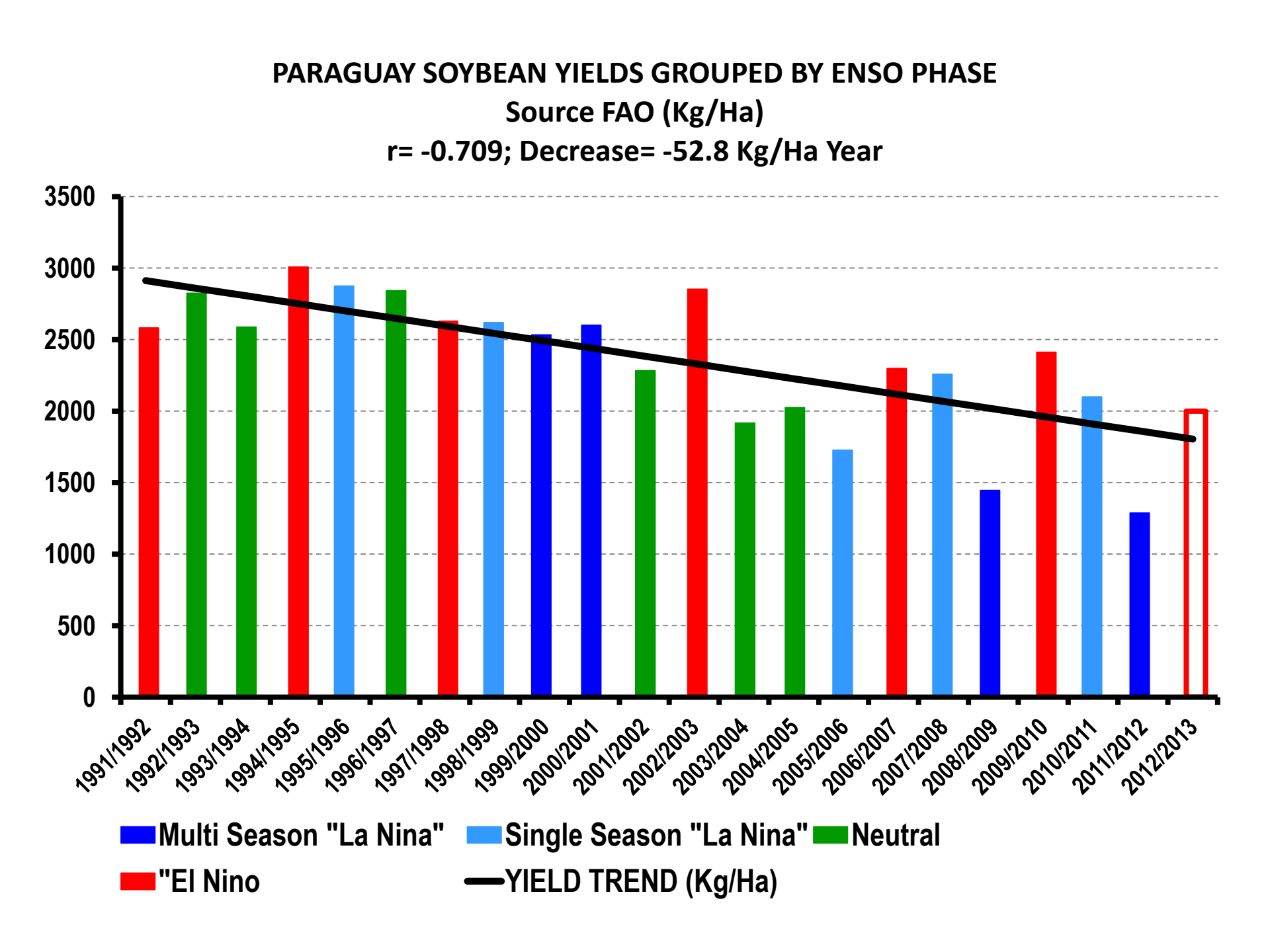

INDIA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.239; Increase= 5.1 Kg/Ha Year
1250
1000
750
500
250
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

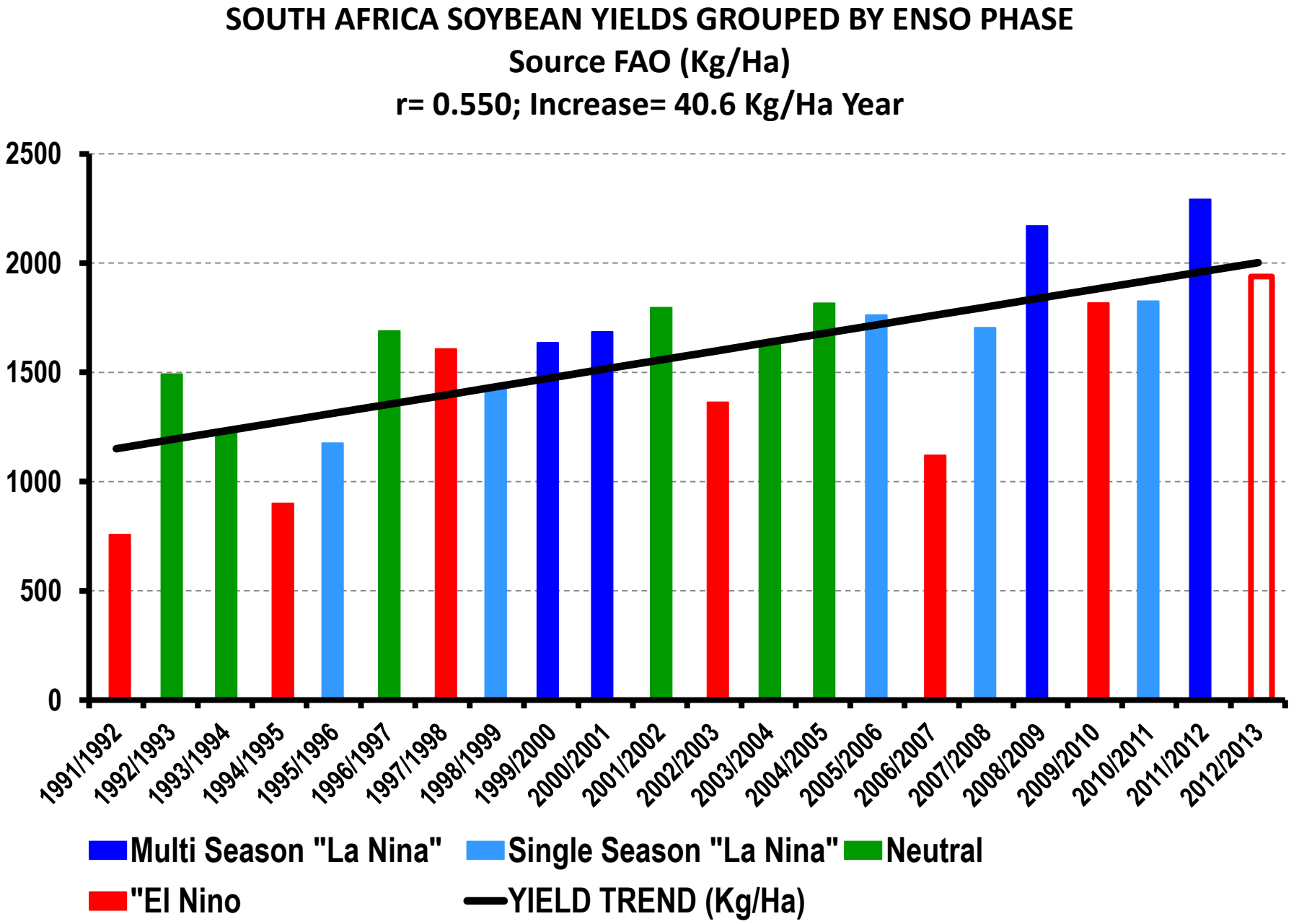

BRAZIL SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.774; Increase= 38.3 Kg/Ha Year
3500
3000
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

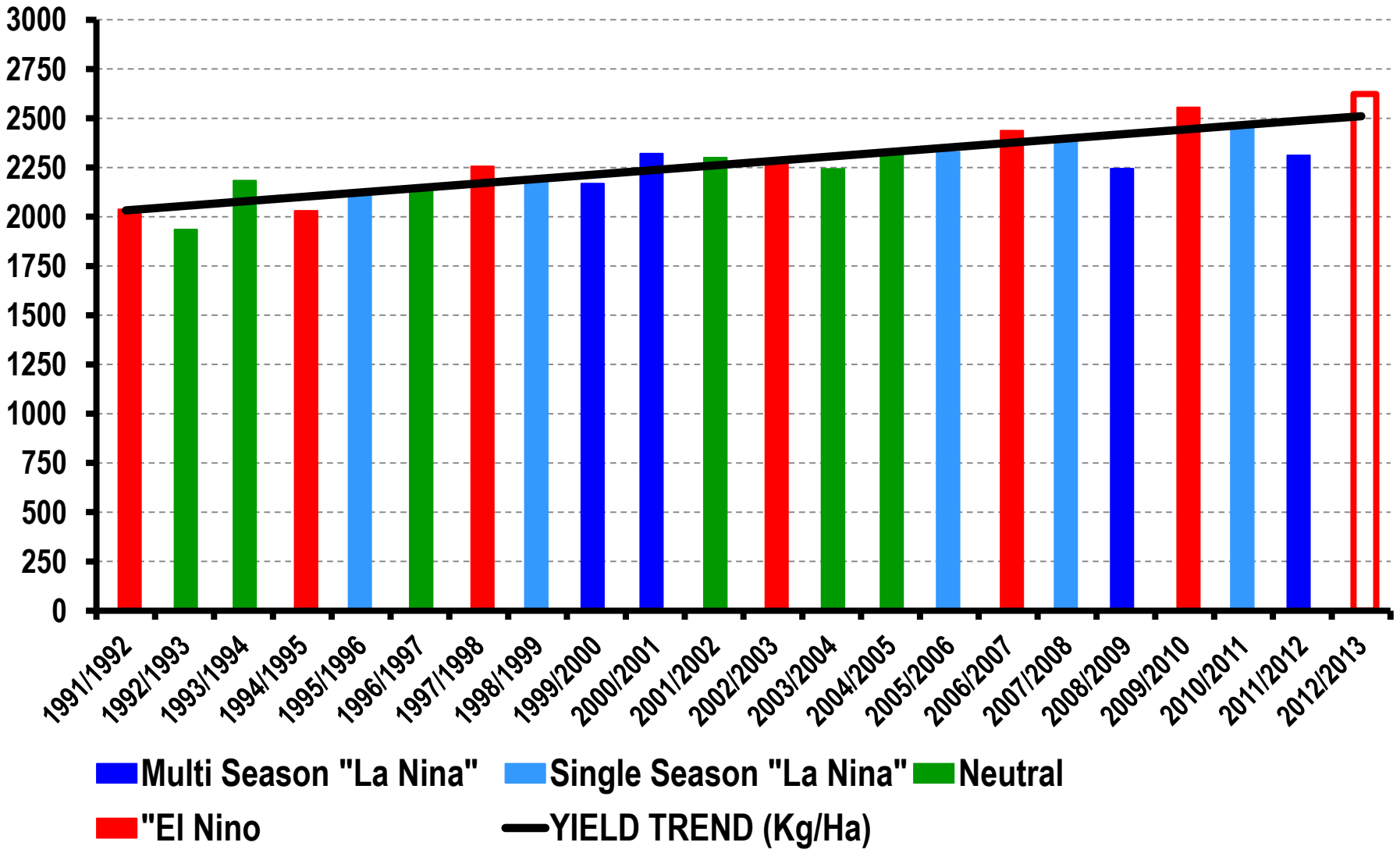

ARGENTINA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO/BCBA (Kg/Ha)
r= 0.550 ; Increment= 36.7 Kg/Ha Year
3500
3000
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

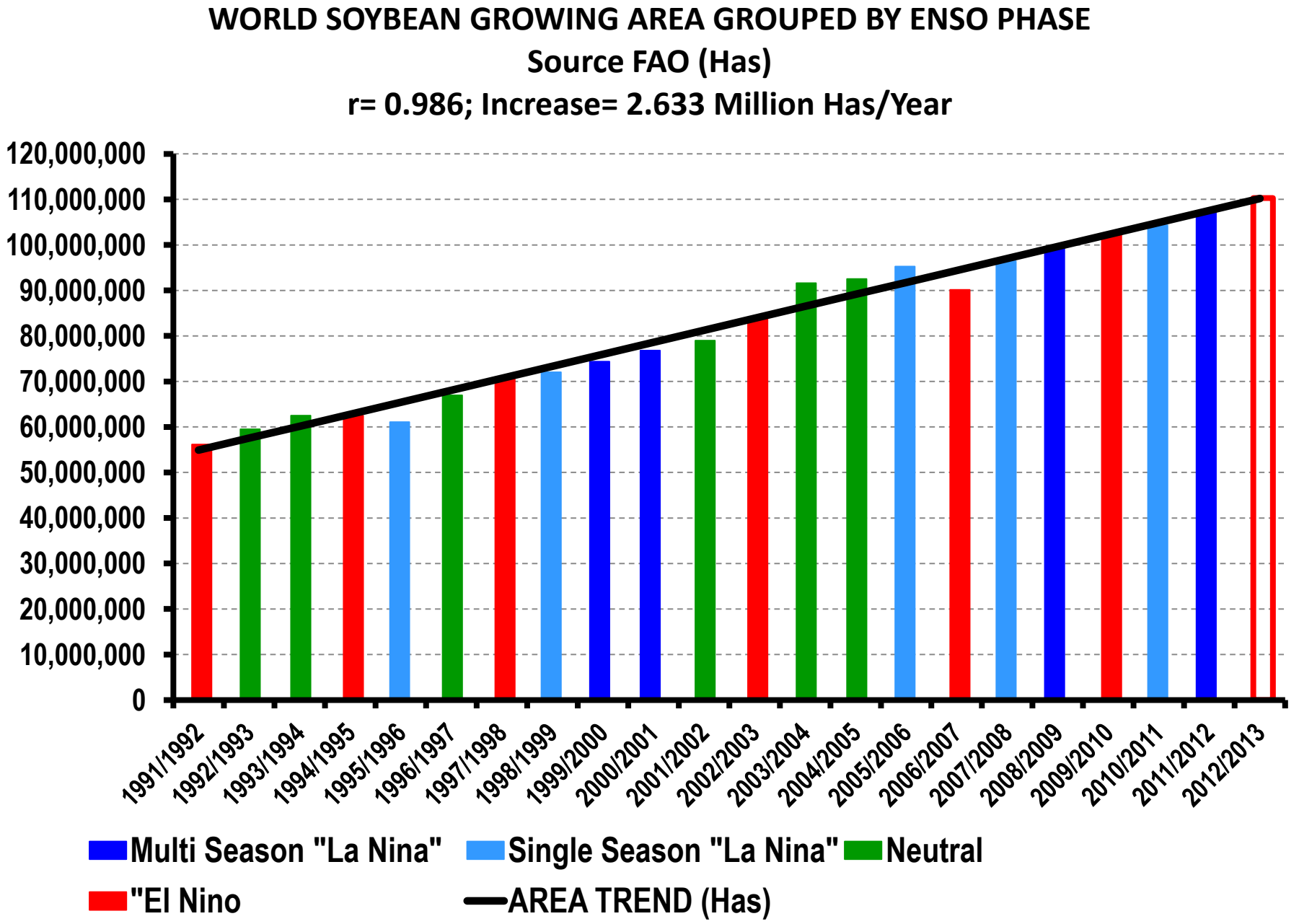

URUGUAY SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.208; Increase= 10.8 Kg/Ha Year
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)

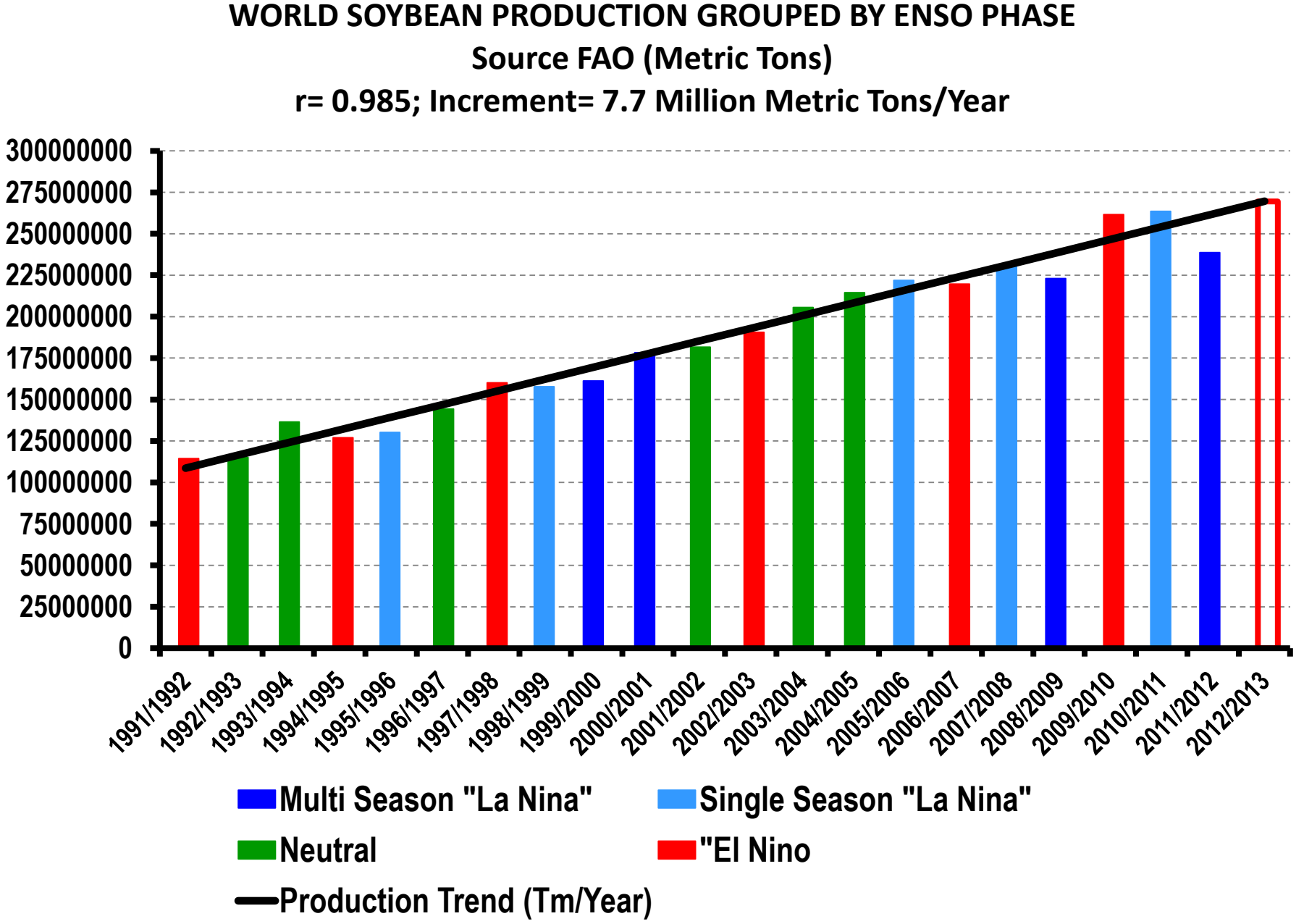

BOLIVIA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= -0.485; Decrease= -22.0 Kg/Ha Year
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)


PARAGUAY SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= -0.709; Decrease= -52.8 Kg/Ha Year
3500
3000
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)


SOUTH AFRICA SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.550; Increase= 40.6 Kg/Ha Year
2500
2000
1500
1000
500
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)


WORLD SOYBEAN YIELDS GROUPED BY ENSO PHASE
Source FAO (Kg/Ha)
r= 0.864; Increase= 22.8 Kg/Ha Year
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
YIELD TREND (Kg/Ha)


WORLD SOYBEAN GROWING AREA GROUPED BY ENSO PHASE
Source FAO (Has)
r= 0.986; Increase= 2.633 Million Has/Year
120,000,000
110,000,000
100,000,000
90,000,000
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
AREA TREND (Has)


WORLD SOYBEAN PRODUCTION GROUPED BY ENSO PHASE
Source FAO (Metric Tons)
r= 0.985; Increment= 7.7 Million Metric Tons/Year
300000000
275000000
250000000
225000000
200000000
175000000
150000000
125000000
100000000
75000000
50000000
25000000
0
1991/1992
1992/1993
1993/1994
1994/1995
1995/1996
1996/1997
1997/1998
1998/1999
1999/2000
2000/2001
2001/2002
2002/2003
2003/2004
2004/2005
2005/2006
2006/2007
2007/2008
2008/2009
2009/2010
2010/2011
2011/2012
2012/2013
Multi Season "La Nina"
Single Season "La Nina"
Neutral
"El Nino
Production Trend (Tm/Year)

THANK YOU FOR YOUR ATTENTION

edmasi@fibertel.com.ar