

World Soybean Production: Area Harvested, Yield, and Long-Term Projections

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Abstract

Soybeans serve as one of the most valuable crops in the world, not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and recently as a biodiesel feedstock. The world soybean production quantity increased by 4.8% annually from 1960s and reached 217.6 million tons in 2005-07. World production of soybeans is predicted to increase by 2.1% annually to 359.7 million tons by 2030, using an exponential smoothing model with a damped trend. Finally, various scenarios and their implications are discussed for increasing supply.

Key words

Soybean, production, long-term projection, exponential smoothing with damped trend

Introduction

Soybeans are one of the most valuable crops in the world¹ not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and recently as a biodiesel feedstock. As the soybean demand increases, the supply is challenged, the stocks reduce, and the market prices rise. In order to meet the demand, there are two alternatives: increase planted hectares or increase yield (tons/ha)². This paper examines the long range forecasts of future production.

Objectives and Procedures

This paper has three objectives: 1) to examine the contribution of increased land use as a component of overall production; 2) to analyze the contribution of yield to overall production across large and small, but promising, producing countries; and 3) to estimate the long range production quantities of soybeans at the country and international levels. The estimation results are used for the discussion of land requirements and necessary yield improvements in the projection period.

We use time series of soybean production quantity, yield, and area harvested of 7 top producing countries (USA, Brazil, Argentina, China, India, Paraguay, and Canada)³ and 6 continents

¹ According to National Aeronautics and Space Administration (NASA), soybeans are chosen as one of the primary crops to be grown on the lunar or planetary surface in their research projects. Other candidates include wheat, rice, peanuts, dried beans, white potato, and sweet potatoes. Some fresh fruits and vegetables such as tomatoes, lettuce, spinach, bell pepper, onions, carrots, radish, and strawberries are also considered. Regarding soybeans, some processes like oil expression and tofu production will be tested on the lunar surface in 2024 or later.

² Reducing losses also increases the available supply, but would have minor impact on the overall supply-demand balance.

³ These 7 countries cover more than 95% of the world soybean production quantities in 2005-07.

(Africa, Asia, Europe, North America & Caribbean, South America, and Oceania) from 1961 to 2007⁴. Ukraine and Russian Federation are combined and also picked up for the discussion of yield and land use in the estimation period. With 'Rest-Of' terms⁵, the world total production quantities are calculated in the model. In order to estimate production quantity through 2030, exponential smoothing with a damped trend⁶ is employed as a univariate time series model. The estimation results by country and by continent are shown, and the long-term soybean supply market is examined.

Increasing harvested land historically has been the most expedient manner to increase crop output. World-wide soybean harvested acres increased over 60% while yield increased less than 30% since 1990. Going forward available farmland will be limited by decreasing quantities of land not already in production, increased farmland loss for urbanization, heightened sensitivities about agricultural uses of land, and weak property rights in regions such as Africa that constrains the employment of modern agricultural methods (Goldsmith, 2008b). Soybean production therefore will require research and development to increase yields in order to meet future demand and compensate for declining stocks of available land. Combinations of growth rates of area harvested and yield are simulated to meet the world soybean supply-demand. Based on the simulations, we discuss some concerns such as arable land limitation and the environment, technological progress and R&D investments, and intellectual property and trade policy issues.

⁴ Data are provided from FAOSTAT.

⁵ Rest of Asia, Rest of North America and Caribbean, Rest of South America, and Rest of Europe.

⁶ Developed by Gardner and McKenzie (1985).

Soybean Production: 1961-2007⁷

Over the 2005-07 period on average 217.6 million tons of soybeans were annually produced in the world (Table 2). By continent, South America produced 101.8 million tons (46.8% of the world total), Northern America & Caribbean produced 83.9 million tons (38.6%) and Asia produced 27.4 million tons (12.6%) (Table 3). By country, the top producer in the world was USA., who produced 37.0% (80.6 million tons) out of the world total soybeans, and the second largest producer was Brazil, who produced 53.9 million tons of soybeans (24.8%). Argentina was the third producer and produced 41.4 million tons (19.0%). Including China (15.8 million tons, 7.3%) and India (8.9 million tons, 4.1%), these top five countries produced more than 90 percent (92.2%) of the world total soybeans. Adding Paraguay (3.9 million tons, 1.8%) and Canada (3.1 million tons, 1.4%), the top 7 countries shared more than 95 percent (95.4%) of total world soybean production quantity.

In 1961-63, the world total soybean production quantity was 27.4 million tons. At that time, 68.5% out of the world total was produced in the Northern America & Caribbean and 28.3% was in Asia. South America shared only 1.3%. By country, the USA was already the top soybean grower and produced two third of the world total production quantity (67.8%, 18.6 million tons). The second largest producer was China and it produced 6.6 million tons (24.1%). The former USSR was the third producer (0.4 million tons, 1.5%). The fourth and fifth soybean growers were Indonesia (0.39 million tons, 1.4%) and Japan (0.35 million tons, 1.3%) respectively, and Brazil was the sixth producer (0.31 million tons, 1.1%) at that time.

⁷ As of December 2008, soybean production quantity, area harvested, and yield data are available during the period by FAOSTAT. The covered period 1961-2007 is divided into 3 terms: 1961-63 to 1981-83, 1981-83 to 1995-97, and 1995-97 to 2005-07. For example, the 3-year average of 1961, 1962 and 1963 is denoted by 1961-63.

During the period of 1961-2007, the production quantity rose approximately 800% from 27.4 million tons to 217.6 million tons. However, most of the production was due to increased harvested land as yield only doubled from 1.14 tons/ha (1961-63 world average) to 2.31 tons/ha (2005-07) (Table 8). The world soybean area harvested approximately quadrupled from 24.0 million ha in 1961-63 to 94.1 million ha in 2005-07 (Table 6). Though every continent except Oceania increased its area harvested during the period, major production areas shifted from North America and Asia to South and North Americas in terms of shares of production quantity and acreage harvested.

Disaggregation into Yield and Area Harvested

From soybean production quantity, P (metric tons), and its area harvested, A (ha), the yield, Y (tons/ha), is calculated as P divided by A and replaced with Y as follows (Rosegrant et al, 2001 and 2002; FAPRI, 2008):

$$P = (P/A) \times A = Y \times A$$

Taking each growth rate, production growth rate (\dot{P}) is disaggregated into yield growth rate (\dot{Y}) and area harvested growth rate (\dot{A}) to obtain

$$\dot{P} = \dot{Y} + \dot{A}$$

For the world soybean production's 44 years of growth, 1961-63 through 2005-07,

$$\dot{P} = \left(\frac{217597616}{27403342} \right)^{\left(\frac{1}{44} \right)} - 1 = 4.8\% \quad (\text{annual average growth}). \quad \dot{A} = 3.2\% \quad \text{and} \quad \dot{Y} = 1.6\%.$$

From 1961-63 through 1981-83 world soybean production quantity increased from 27.4 million tons in 1961-63 to 86.7 million tons in 1981-83 by 5.93% annually on average (Figure 1 and Table 4).

Out of the annual average growth 5.93%, 3.80% came from area harvested growth and 2.05%

came from yield growth (Tables 7 and 9). During the term, the world soybean area harvested increased from 24.0 million ha in 1961-63 to 50.6 million ha in 1981-83 (Table 6) and the world average yield increased from 1.141 tons/ha to 1.712 tons/ha (Table 8). The 3.80% annual growth of world area harvested was due to the rapid expansion in the USA (11.2 million ha to 26.7 million ha) and in Brazil (0.3 million ha to 8.3 million ha) and their contributions were 2.2 % points and 1.6 % points respectively (Table 7). At the same time, however, China's area harvested declined from 9.7 to 8.0 million ha and pushed down the world annual growth rate of soybean area harvested by 0.28 % points.

During the second term (1981-83 through 1995-97), the world soybean production quantity increased by 2.94% annually on average and reached 133.9 million tons in 1995-97. Production quantity growth slowed from 5.93% to 2.94% annually. The slowing of soybean production resulted from decreased harvested growth that declined from 3.80% to 1.52%, lower yield growth (2.05% to 1.39%). Though the world soybean area harvested increased to 63.5 million ha in 1995-97, the USA's area harvested decreased from 26.7 million ha in 1981-83 to 26.2 million ha in 1995-97 and pushed down the world area harvested annual growth by 0.07 % points. While the USA harvested area was shrinking, India (0.7 to 5.4 million ha), Argentina (2.1 to 6.1 million ha) and Brazil (8.2 to 11.2 million ha) all expanded, and contributed 0.73, 0.51, and 0.34 % points respectively to the world's 1.52% annual growth of area harvested. The world average yield increased to 2.11 tons/ha in 1995-97. The USA (2.51 tons/ha), Canada (2.63 tons/ha), and Paraguay (2.90 tons/ha) showed higher yields while China (1.73 tons/ha), India (1.04 tons/ha), and Ukraine & Russian Federation (0.68 tons/ha) were below the world average yield.

During the third term (1995-97 through 2005-07), soybean production increased 4.98% per year and world production reached 217.6 million tons (2005-07). The rapid annual average growth was due to significant expansion of 4.0% per year of harvested acres (63.5 to 94.1 million ha). Brazil (11.2 to 21.9 million ha) and Argentina (6.1 to 15.1 million ha) accounted for two thirds of the growth annual increasing harvested acreage by 1.4 and 1.2 % points respectively (Table 7). The world average annual growth rate of yield though slowed to 0.93% (Table 9). Yield in Ukraine & Russia increased rapidly by 5.27% annually and reached 1.128 tons/ha in 2005-07 and Africa's yield also rose by 3.26 % annually and reached 1.156 tons/ha. Now there is no area where the soybean production yield is below 1.00 tons/ha from the viewpoint of average yield by continent (Table 8). Argentina has the highest yield 2.75 tons/ha (2005-07). Average yield in South America reached 2.52 tons/ha and is fast approaching average yields in the United States (2.698 tons/ha) and Canada (2.661 tons/ha).

Method

The soybean production quantities by continent or major countries are estimated as univariate time series (Equation 1). Out of Box-Jenkins or ARIMA type univariate time series model employs exponential smoothing with a damped trend (See Gardner and McKenzie, 1985; Hamilton, 1994; Mills, 1990). Introducing a damped trend into exponential smoothing makes sense as growth rates in yield and expansion of harvested land begin to plateau. Both linear and damped trends are estimated for comparison purposes.

Following Gardner and McKenzie (1985) and Gardner (1985), the general damped-trend linear exponential smoothing model is as follows⁸:

$$P_t = \mu_t + \beta_t t + \epsilon_t \quad (1)$$

where P_t is production at time t , μ_t is the mean or level of production at time t , β_t is parameter at t , t is the time trend or year, and ϵ_t is error term at t .

The smoothing equations are:

$$\text{Level: } L_t = \alpha P_t + (1 - \alpha)(L_{t-1} + \phi T_{t-1}), \text{ and}$$

$$\text{Trend: } T_t = \gamma(L_t - L_{t-1}) + (1 - \gamma)\phi T_{t-1}$$

where L_t = smoothed level at t of the series, computed after P_t is observed,

α = smoothing parameter for the level of the series,

ϕ = trend modification or damping parameter,

T_t = smoothed trend at the end of period t , and

γ = smoothing parameter for trend.

The error-correction form of the smoothing equations is:

$$L_t = L_{t-1} + \phi T_{t-1} + \alpha e_t, \text{ and}$$

$$T_t = \phi T_{t-1} + \alpha \gamma e_t$$

where $e_t = P_t - \hat{P}_t(1)$ is a one-period-ahead forecast error.

The forecast for k period(s) ahead from origin t is:

⁸ In the end, this paper estimated soybean production quantities first then examined three scenarios of yield and area harvested growths. When using Box-Jenkins methodology to forecast a constructed variable, in our case $P = A \times Y$, it is not clear whether it is better to forecast A and Y separately to produce the forecast, or to forecast P directly (Kennedy, 2003). There is no conclusive evidence at all as to the choice between the direct forecast of aggregated variables (production quantity, P) and the indirect forecasts as the sum of forecasts of the components (area harvested, A , and yield, Y), whereas indirect forecasts tend to outperform direct forecasts (Kang, 1986). From the viewpoint of methodology analysis, comparisons between alternative approaches/models are called for.

$$\hat{P}_t(k) = L_t + \sum_{i=1}^k \phi^i T_t .$$

If $0 < \phi < 1$, the trend is damped and the forecasts approach an asymptote given by the horizontal linear line or plateau: $L_t + T_t \phi(1 - \phi)$. The equivalent process is ARIMA (1, 1, 2)⁹ which can be written as:

$$(1 - \phi B)(1 - B)P_t = (1 - \theta_1 B - \theta_2 B^2)\epsilon_t ,$$

where $\theta_1 = 1 + \phi - \alpha - \alpha\gamma\phi$, and

$$\theta_2 = (\alpha - 1)\phi .$$

If $\phi = 1$, the model is equivalent to the standard version of Holt (1960) model and the trend is linear. The equivalent process is ARIMA (0, 2, 2):

$$(1 - B)^2 P_t = (1 - \theta_3 B - \theta_4 B^2)\epsilon_t$$

where $\theta_3 = 2 - \alpha - \alpha\gamma$, and

$$\theta_4 = \alpha - 1 .$$

Estimation Results

The world soybean production quantity is projected at 278.5 million metric tons in 2015 and 359.7 million metric tons in 2030 in the damped trend case (Table 2). The annual growth rates are 2.78% from 2005-07 to 2015 (Term 4) and then 1.72% through 2030 (Term 5 in Table 4). The estimated quantity level in 2030 is approximately 1.7 times greater than that in 2005-07. For comparison or reference, in the case of linear trend, the quantity level was projected as 289.8 million tons in 2015 and 411.7 million tons in 2030. The annual growth rates are 3.23% in Term 4 and then 2.37% in Term 5. The differences of the 2030 estimated quantities between in the

⁹ In the general ARIMA (1, 1, 2), $-1 < \phi < 1$.

damped and linear trend cases are 52.0 million tons and the linear trend case is 1.14 times greater than the damped trend case. As a moderate projection, we use the damped trend case for following discussion and examination.¹⁰

By continent, South America increases its production quantity over the projection period and reaches 214.9 million tons in 2030 (Table 2), producing approximately 60% of world's soybeans (Figure 3 and Table 3). Argentine's production quantity rises rapidly by 5.64% annually in Term 4 and 2.81% annually in Term 5, when it reaches 102.9 million tons in 2030 (Tables 2 and 4). At that time, Argentina is projected to become the top soybean grower, producing 28.6% of the world's output (Table 3). Brazil keeps the position as the second largest soybean producer in the world and produces 100.7 million metric tons (28.0%) of soybeans in 2030. On the other hand, the United States becomes the third largest producer (96.6 million tons) and its share declines to 26.9%. Including Canada, the production share in the Northern America and Caribbean is projected as 28.0% in 2030. Though China and India continue to increase their production quantities by 18.3 and 14.7 million tons respectively in 2030, the Asia's share gradually declines to 11.3% in 2015 and 10.2% in 2030. These top 5 countries will still produce more than 90 percent of the world soybean supply. Ukraine and Russia show the highest annual average growth rate (5.8% in Term 4 and 3.1% in Term 5) then the share rises above 1.0% in 2030.

Scenarios

Arable land for soybeans is limited and a yield plateau appears to exist at 3.00 tons per hectare for many countries. Specht et al. (1999) discuss the biological limit to soybean yield

¹⁰ The annual average growth rates of world soybean production quantity for the period 2005-07 to 2030 are 2.69% by the linear trend case and 2.12% by the damped trend case.

improvement in the USA and the 4.00 tons per ha milestone could be achieved between in 2029 (earlier case) and in 2064 (later case). Recent research in Illinois, USA, has shown little yield growth over since 2000 (Goldsmith, 2008a). On the 2005-07 year average, the USA soybean yield was 2.70 tons/ha (16.9% greater than the world average yield). Land pressure and public debates over land use will continue to limit the expansion of agricultural production. Competition from other crops too may limit the rate of soybean expansion.

Three future scenarios are discussed set and the yield and area harvested are calculated.

- Scenario 1: Yield Annual Growth keeps the same rate (0.93% per year) of Term 3 (1995-97 to 2005-07).
- Scenario 2: Global Annual Yield Level reaches 3.000 tons/ha in 2030.
- Scenario 3: Annual Yield Growth slows to 0.85% annually.

Scenario 1: Yield Annual Growth keeps the same rate (0.93%) of Term 3 (1995-97 to 2005-07)

As a benchmark scenario, yield reaches 2.89 tons/ha in 2030 when the annual growth rate of the world average yield remains 0.93% during the estimation period. If yield growth were to remain constant at .93% per year, area harvested has to grow faster by 1.2% annually and total land under cultivation for soybeans reaches 124.8 million ha to meet expected demand. Such land expansion is 1.33 times greater than 94.1 million ha in 2005-07 (Figure 4 and Table 10).

Scenario 2: Yield Level reaches 3.00 tons/ha in 2030

Specht et al. (1999) state that the United States soybean yield could reach 4.00 tons/ha by 2029 as earlier case. Genetic and agronomic R&D investments in the leading soybean production areas and the implementation of technology transfer policies to low-yield areas might easily raise production in the western hemisphere to 3.00 tons per hectare by 2030. Currently (2005-07)

North America and the Caribbean average 2.70 metric tons per hectare and South America averages 2.52 tons/ha. To reach the 3.00 tons/ha target, the average yield growth needs to increase from its base level of .93% to 1.1%. Even under this positive yield growth scenario the area harvested would still need to add over 25 million hectares and would reach 120 million hectares in 2030.

Scenario 3: Annual yield growth slows to 0.85%

Weak intellectual property rights limit private incentives to invest in soybean research (Goldsmith, 2006). As well increasing demand for liquid biofuels makes maize investment increasingly attractive. Soybean yield growth may decline with reduced soybean research and farmer investment in soybean production. Greater land expansion, though unlikely, would be needed to meet demand. Declining availability of land, higher productivity from competing crops, and greater sensitivity to maintain native biomes will limit the rate of soybean area expansion. To meet production forecasts world soybean hectares would need to increase over 30 million hectares to 127 million, if yield growth fell to .85% per year. At that level, the world average yield is 2.83 tons/ha, the lowest in these scenarios.

Concluding Remarks

This paper projected soybean production quantities by major counties and by continent, using an exponential smoothing with a damped trend. The world soybean production quantity was forecasted at 359.7 million metric tons in 2030. If 3.00 tons/ha in 2030 is set as the yield target, the average yield needs to increase by 1.1% per year and the area harvested will expand to 120 million ha in 2030 (Scenario 2). On the other hand, if the yield growth slows from the recent

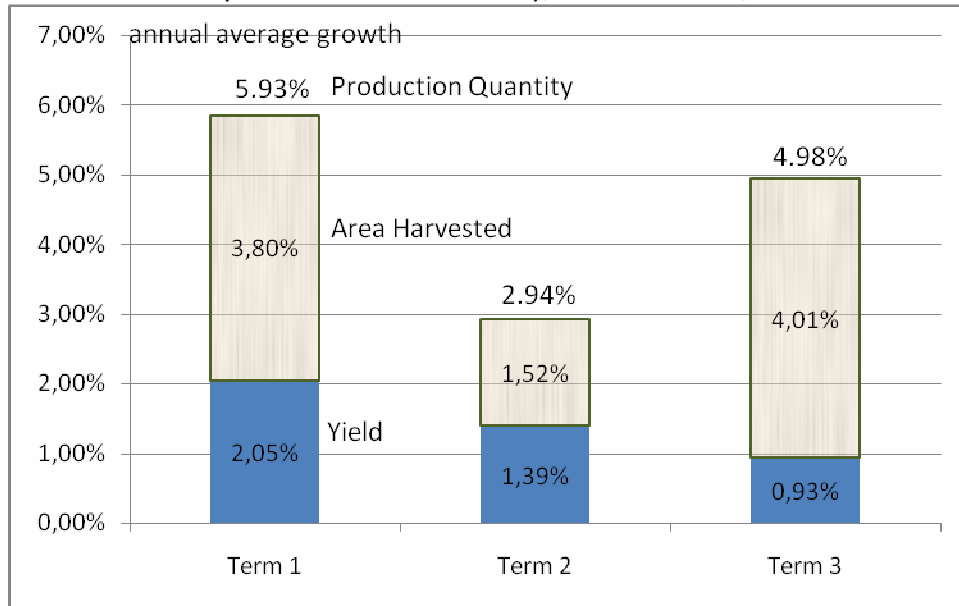
pace of 0.93% to 0.85 % per year (Scenario 3), more than 127 million ha of soybean will be needed in 2030 to meet world demand.

Arable land on the globe is limited and the competition from other crops restricts the soybean area expansion. The expansion of farmland will continue to be constrained as the international community values environmental stewardship and biome preservation. Therefore, yield improvement appears to be essential for the industry to meet growing demand. Raising yield might take either or both of two directions: i) substantial R&D investments in genetics and agronomics to (or beyond) the biological limit in advanced soybean producing areas, or ii) technological transfers to low-yield areas. Soybean processing firms, livestock managers, and policymakers, as well as producers, therefore need to relook at the important role of agricultural research investment and associated intellectual property issues to assure adequate supply in the future.

References

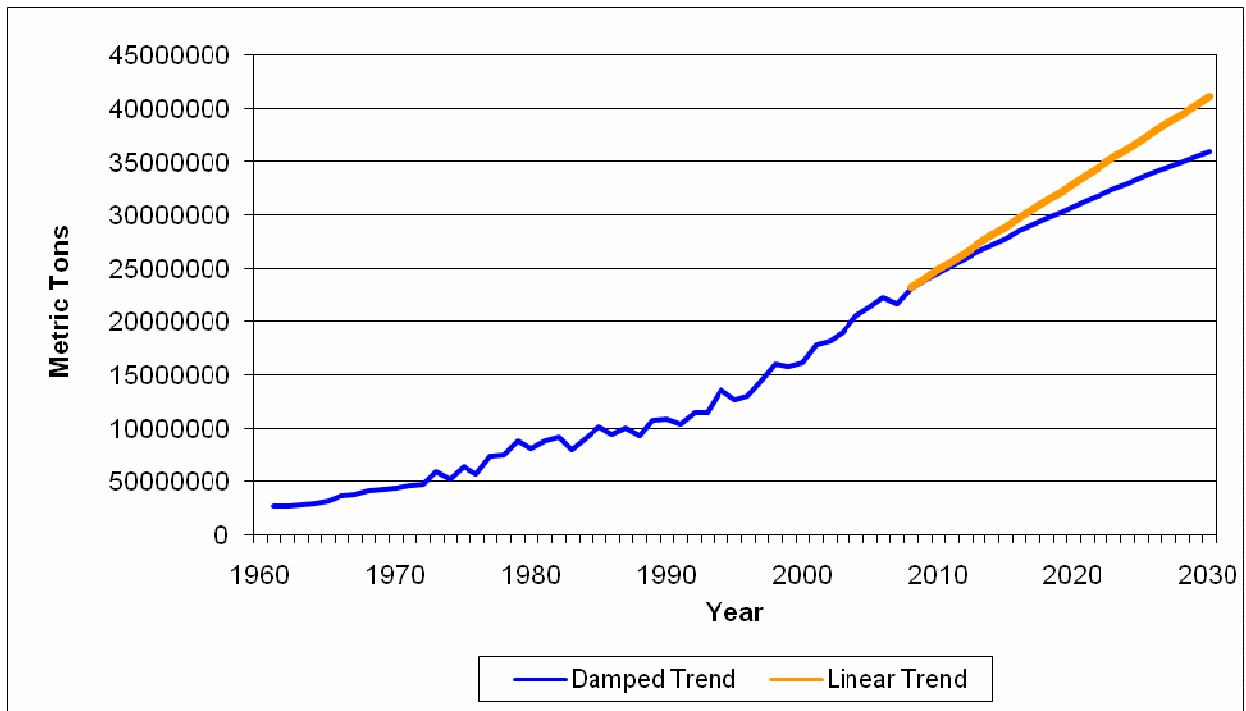
- Food and Agricultural Policy Research Institute (FAPRI). 2008. USA and World Agricultural Outlook. FAPRI Staff Report 08-FSR 1. FAPRI, Iowa State University and University of Missouri-Columbia, Ames, Iowa, U.S.A.
- Food and Agriculture Organization (FAO) of the United Nations. FAOSTAT. www.faostat.org.
- Gardner, E. S. Jr. 1985. Exponential Smoothing: The State of the Art. *Journal of Forecasting*. 4: 1-28.
- Gardner, E. S. Jr. and McKenzie, E. D. 1985. Forecasting Trends in Time Series. *Management Science*. 31 (10): 1237-1246.
- Goldsmith, P. 2008a. Executive Director's Message. *NSRL Bulletin*. 15 (1): 7.
- Goldsmith, P. 2008b. Economics of Soybean Production, Marketing and Utilization. In Johnson, L. A., White, P. J. and R. Galloway. Eds. *Soybeans: Chemistry, Production, Processing, and Utilization*. American Oil Chemists Society (AOCS) Press, Champaign, IL. Pp.117-150.
- Goldsmith, P., Ramos, G. and C. Steiger. 2006. Intellectual Property Piracy in a North-South Context: Empirical Evidence. *Agricultural Economics*. 35: 335-349.
- Hamilton, J. D. 1994. *Time Series Analysis*. Princeton University Press.
- Holt, C. et al. 1960. *Planning, Production, Innovation, and Work Force*. Prentice-Hall.
- Kang, H. 1986. Univariate ARIMA Forecasts of Defined Variables. *Journal of Business & Economic Statistics*. 4 (1): 81-86.
- Kennedy, P. 2003. *A Guide to Econometrics, 5th ed.* MIT Press.
- Mills, T. C. 1990. *Time Series Techniques for Economics*. Cambridge University Press.
- Rosegrant, M. W., Meijer, S. and S. A. Cline. 2002. *International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description*. International Food Policy Research Institute.
- Rosegrant, M. W., Paisner M. S., Meijer, S. and J. Witcover. 2001. *Global Food Projections To 2020: Emerging Trends and Alternative Futures*. International Food Policy Research Institute.
- Specht, J. E., Hume, D. J. and S. V. Kumudini. 1999. Soybean Yield Potential – A Genetic and Physiological Perspective. *Crop Sci*. 39: 1560-1570.

Figure 1. Annual Average Growth Rates for
World Soybean Production Quantity, Area Harvested, and Yield



Note. Term 1: 1961-63 to 1981-83, Term 2: 1981-83 to 1995-97, Term 3: 1995-97 to 2005-07.
Source: FAOSTAT.

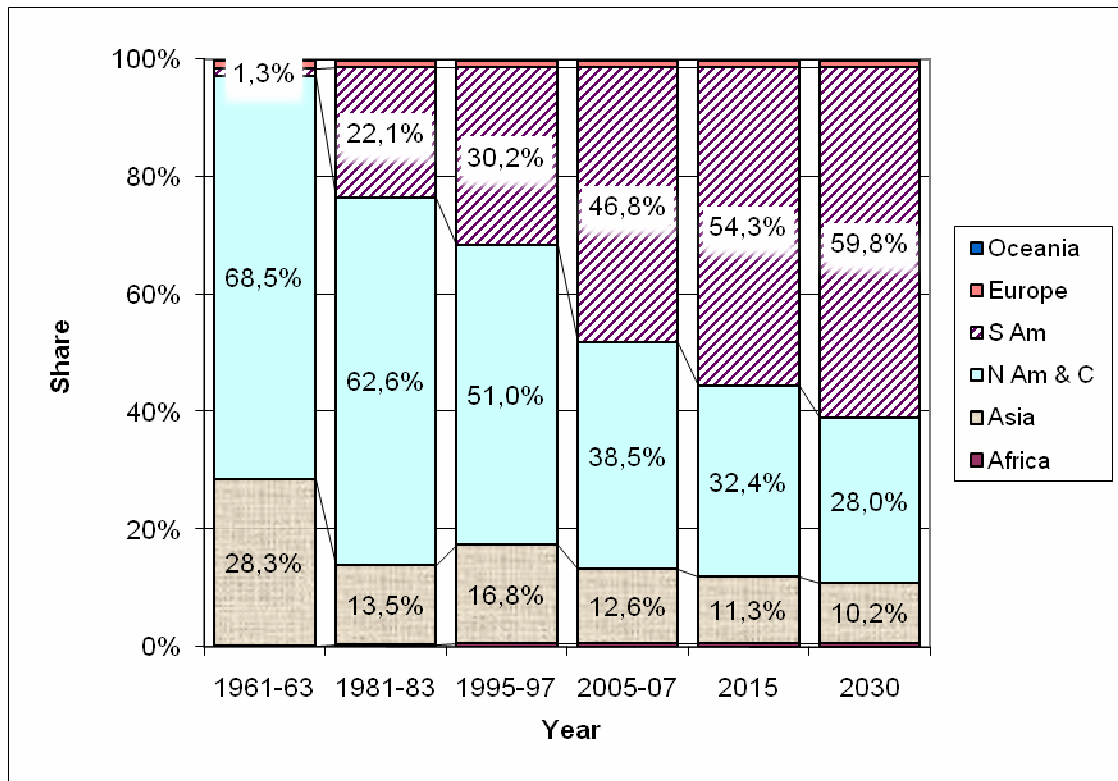
Figure 2. World Soybean Production Quantity



Note. Projections start from Year 2008.

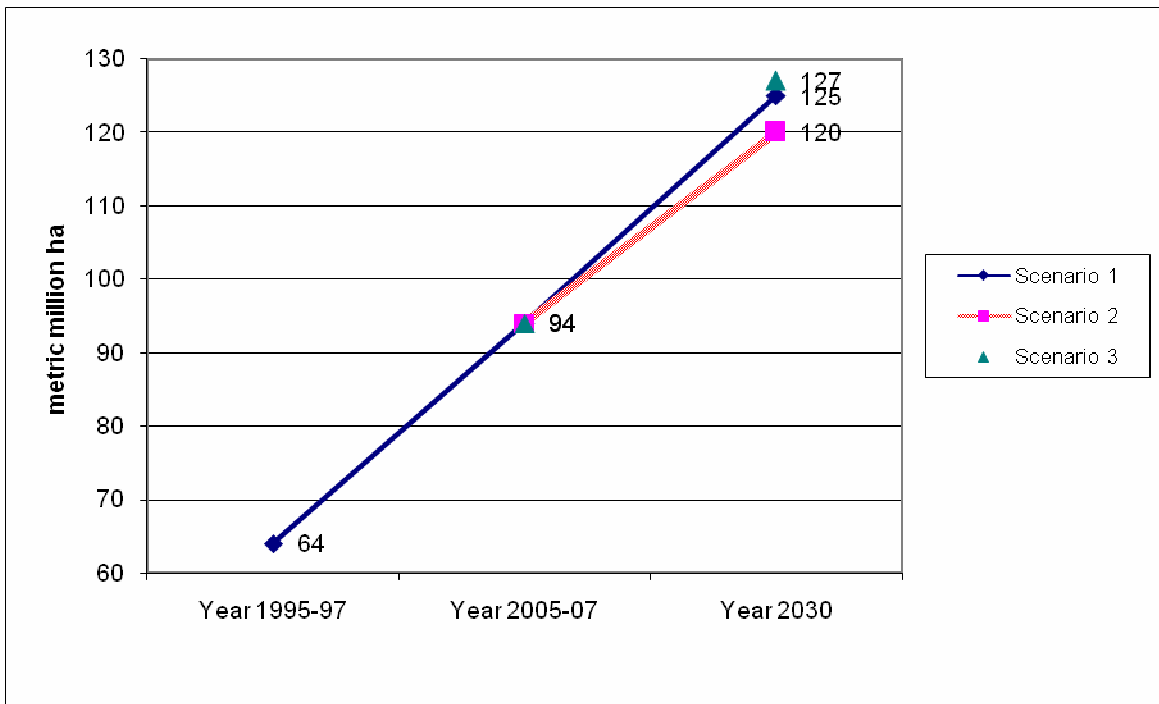
Source: FAOSTAT and Author's Estimation.

Figure 3. Shifts of Soybean Production Quantity Share by Continent



Note. Years 2015 and 2030 are projections.
Source: FAOSTAT and Author's Estimation.

Figure 4. Scenarios for Soybean Area Harvested to 2030



Notes:

Scenario 1: Yield Annual Growth 0.93%, 2.9 tons/ha in 2030.

Scenario 2: Yield Annual Growth 1.09%, 3.0 tons/ha in 2030.

Scenario 3: Yield Annual Growth 0.85%, 2.8 tons/ha in 2030.

Source: FAOSTAT and Author's Estimation.

Table 1. Top 7 Countries of Soybeans Production in Years 1961-63, 1981-83, and 1995-97

| Year 1961-63 | | | Year 1981-83 | | | Year 1995-97 | | |
|--------------|------------|--------|--------------|------------|--------|--------------|-------------|--------|
| country | tons | share | country | tons | share | country | tons | share |
| USA | 18,569,669 | 67.8% | USA | 52,855,168 | 61.0% | USA | 65,711,000 | 49.1% |
| China | 6,596,519 | 24.1% | Brazil | 14,141,920 | 16.3% | Brazil | 25,076,453 | 18.7% |
| USSR | 421,333 | 1.5% | China | 9,383,839 | 10.8% | China | 13,827,103 | 10.3% |
| Indonesia | 391,100 | 1.4% | Argentina | 3,973,333 | 4.6% | Argentina | 11,862,030 | 8.9% |
| Japan | 349,600 | 1.3% | Paraguay | 789,178 | 0.9% | India | 5,653,033 | 4.2% |
| Brazil | 313,193 | 1.1% | Canada | 729,933 | 0.8% | Paraguay | 2,425,635 | 1.8% |
| N Korea | 175,000 | 0.6% | Mexico | 681,263 | 0.8% | Canada | 2,400,233 | 1.8% |
| ROW | 586,928 | 2.1% | ROW | 4,149,960 | 4.8% | ROW | 6,918,366 | 5.2% |
| World+ | 27,403,342 | 100.0% | World+ | 86,704,595 | 100.0% | World+ | 133,873,854 | 100.0% |
| Africa + | 81,222 | 0.3% | Africa + | 376,481 | 0.4% | Africa + | 729,724 | 0.5% |
| N Am+ | 18,779,373 | 68.5% | N Am+ | 54,272,203 | 62.6% | N Am+ | 68,332,223 | 51.0% |
| S Am+ | 354,849 | 1.3% | S Am+ | 19,140,449 | 22.1% | S Am+ | 40,456,153 | 30.2% |
| Asia + | 7,751,006 | 28.3% | Asia + | 11,667,718 | 13.5% | Asia + | 22,466,785 | 16.8% |
| Europe + | 436,539 | 1.6% | Europe + | 1,179,701 | 1.4% | Europe + | 1,840,351 | 1.4% |
| Oceania+ | 353 | 0.0% | Oceania+ | 68,042 | 0.1% | Oceania+ | 48,618 | 0.0% |

Note. 'ROW' denotes Rest of World and '+' total.

Source: FAOSTAT.

Table 2. World Soybean Production (metric tons)

| continent/country | 3-Year Average | | | | Linear Trend Case | | Damped Trend Case | |
|---------------------|----------------|------------|-------------|-------------|-------------------|-------------|-------------------|-------------|
| | 1961-63 | 1981-83 | 1995-97 | 2005-07 | 2015 | 2030 | 2015 | 2030 |
| World + | 27,403,342 | 86,704,595 | 133,873,854 | 217,597,616 | 289,755,239 | 411,698,024 | 278,472,217 | 359,693,531 |
| Africa + | 81,222 | 376,481 | 729,724 | 1,374,931 | 1,983,524 | 2,920,217 | 1,902,488 | 2,527,195 |
| Asia + | 7,751,006 | 11,667,718 | 22,466,785 | 27,357,042 | 32,551,478 | 41,288,560 | 31,426,774 | 36,776,406 |
| -- China | 6,596,519 | 9,383,839 | 13,827,103 | 15,816,867 | 17,320,768 | 20,014,183 | 16,817,443 | 18,259,570 |
| -- India | 6,000 | 485,767 | 5,653,033 | 8,854,500 | 12,021,573 | 17,122,342 | 11,454,609 | 14,692,857 |
| -- Rest of Asia | 1,148,488 | 1,798,112 | 2,986,649 | 2,685,675 | 3,209,137 | 4,152,036 | 3,154,722 | 3,823,979 |
| N Am & C + | 18,779,373 | 54,272,203 | 68,332,223 | 83,877,488 | 93,064,475 | 110,584,352 | 90,308,207 | 100,693,740 |
| -- USA | 18,569,669 | 52,855,168 | 65,711,000 | 80,581,667 | 89,311,947 | 105,714,724 | 86,796,166 | 96,565,209 |
| -- Canada | 165,465 | 729,933 | 2,400,233 | 3,135,500 | 3,592,208 | 4,709,308 | 3,428,514 | 4,082,223 |
| -- Rest of N Am & C | 44,239 | 687,102 | 220,989 | 160,320 | 160,320 | 160,320 | 83,527 | 46,307 |
| South America + | 354,849 | 19,140,449 | 40,456,153 | 101,789,883 | 158,393,170 | 251,587,026 | 151,173,016 | 214,943,163 |
| -- Brazil | 313,193 | 14,141,920 | 25,076,453 | 53,948,004 | 78,121,705 | 117,103,644 | 74,675,554 | 100,679,264 |
| -- Argentina | 10,366 | 3,973,333 | 11,862,030 | 41,422,367 | 70,978,772 | 120,613,154 | 67,869,814 | 102,924,789 |
| -- Paraguay | 4,422 | 789,178 | 2,425,635 | 3,896,000 | 4,894,840 | 6,448,612 | 4,440,854 | 5,056,276 |
| -- Rest of S Am | 26,868 | 236,018 | 1,092,035 | 2,523,512 | 4,397,853 | 7,421,616 | 4,186,795 | 6,282,833 |
| Europe + | 436,539 | 1,179,701 | 1,840,351 | 3,152,710 | 3,717,028 | 5,272,307 | 3,632,735 | 4,744,033 |
| -- Ukraine + Russia | n/a | n/a | 302,640 | 1,495,117 | 2,631,476 | 4,688,843 | 2,486,103 | 3,906,364 |
| -- Rest of Europe | n/a | n/a | 1,537,711 | 1,657,593 | 1,085,552 | 583,463 | 1,146,632 | 837,669 |
| Oceania + | 353 | 68,042 | 48,618 | 45,563 | 45,563 | 45,563 | 28,996 | 8,993 |

Source: FAOSTAT and Author's Estimation.

Table 3. World Soybean Production: Quantity Share

| continent/country | 3-Year Average | | | | Linear Trend Case | | Damped Trend Case | |
|---------------------|----------------|---------|---------|---------|-------------------|---------|-------------------|---------|
| | 1961-63 | 1981-83 | 1995-97 | 2005-07 | 2015 | 2030 | 2015 | 2030 |
| World + | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |
| Africa + | 0.30% | 0.43% | 0.55% | 0.63% | 0.68% | 0.71% | 0.68% | 0.70% |
| Asia + | 28.28% | 13.46% | 16.78% | 12.57% | 11.23% | 10.03% | 11.29% | 10.22% |
| -- China | 24.07% | 10.82% | 10.33% | 7.27% | 5.98% | 4.86% | 6.04% | 5.08% |
| -- India | 0.02% | 0.56% | 4.22% | 4.07% | 4.15% | 4.16% | 4.11% | 4.08% |
| -- Rest of Asia | 4.19% | 2.07% | 2.23% | 1.23% | 1.11% | 1.01% | 1.13% | 1.06% |
| N Am & C + | 68.53% | 62.59% | 51.04% | 38.55% | 32.12% | 26.86% | 32.43% | 27.99% |
| -- USA | 67.76% | 60.96% | 49.08% | 37.03% | 30.82% | 25.68% | 31.17% | 26.85% |
| -- Canada | 0.60% | 0.84% | 1.79% | 1.44% | 1.24% | 1.14% | 1.23% | 1.13% |
| -- Rest of N Am & C | 0.16% | 0.79% | 0.17% | 0.07% | 0.06% | 0.04% | 0.03% | 0.01% |
| South America + | 1.29% | 22.08% | 30.22% | 46.78% | 54.66% | 61.11% | 54.29% | 59.76% |
| -- Brazil | 1.14% | 16.31% | 18.73% | 24.79% | 26.96% | 28.44% | 26.82% | 27.99% |
| -- Argentina | 0.04% | 4.58% | 8.86% | 19.04% | 24.50% | 29.30% | 24.37% | 28.61% |
| -- Paraguay | 0.02% | 0.91% | 1.81% | 1.79% | 1.69% | 1.57% | 1.59% | 1.41% |
| -- Rest of S Am | 0.10% | 0.27% | 0.82% | 1.16% | 1.52% | 1.80% | 1.50% | 1.75% |
| Europe + | 1.59% | 1.36% | 1.37% | 1.45% | 1.28% | 1.28% | 1.30% | 1.32% |
| -- Ukraine + Russia | n/a | n/a | 0.23% | 0.69% | 0.91% | 1.14% | 0.89% | 1.09% |
| -- Rest of Europe | n/a | n/a | 1.15% | 0.76% | 0.37% | 0.14% | 0.41% | 0.23% |
| Oceania + | 0.00% | 0.08% | 0.04% | 0.02% | 0.02% | 0.01% | 0.01% | 0.00% |

Source: FAOSTAT and Author's Estimation.

Table 4. World Soybean Production: Quantity Annual Average Growth

| continent/country | Term 1 | Term 2 | Term 3 | Linear Trend Case | | Damped Trend Case | |
|---------------------|--------|--------|--------|-------------------|--------|-------------------|--------|
| | | | | Term 4 | Term 5 | Term 4 | Term 5 |
| World + | 5.93% | 2.94% | 4.98% | 3.23% | 2.37% | 2.78% | 1.72% |
| Africa + | 7.97% | 4.51% | 6.54% | 4.16% | 2.61% | 3.67% | 1.91% |
| Asia + | 2.07% | 4.46% | 1.99% | 1.95% | 1.60% | 1.55% | 1.05% |
| -- China | 1.78% | 2.62% | 1.35% | 1.01% | 0.97% | 0.68% | 0.55% |
| -- India | 24.57% | 17.78% | 4.59% | 3.46% | 2.39% | 2.90% | 1.67% |
| -- Rest of Asia | 2.27% | 3.44% | -1.06% | 2.00% | 1.73% | 1.80% | 1.29% |
| N Am & C + | 5.45% | 1.55% | 2.07% | 1.16% | 1.16% | 0.82% | 0.73% |
| -- USA | 5.37% | 1.46% | 2.06% | 1.15% | 1.13% | 0.83% | 0.71% |
| -- Canada | 7.70% | 8.26% | 2.71% | 1.52% | 1.82% | 1.00% | 1.17% |
| -- Rest of N Am & C | 14.70% | -7.28% | -3.16% | 0.00% | 0.00% | -6.99% | -3.86% |
| South America + | 22.07% | 5.12% | 9.67% | 5.04% | 3.13% | 4.49% | 2.37% |
| -- Brazil | 20.99% | 3.89% | 7.96% | 4.20% | 2.74% | 3.68% | 2.01% |
| -- Argentina | 34.64% | 7.56% | 13.32% | 6.17% | 3.60% | 5.64% | 2.81% |
| -- Paraguay | 29.59% | 7.77% | 4.85% | 2.57% | 1.85% | 1.47% | 0.87% |
| -- Rest of S Am | 11.48% | 10.75% | 8.74% | 6.37% | 3.55% | 5.79% | 2.74% |
| Europe + | 5.10% | 3.01% | 5.53% | 1.85% | 2.36% | 1.59% | 1.80% |
| -- Ukraine + Russia | n/a | n/a | 17.32% | 6.48% | 3.93% | 5.81% | 3.06% |
| -- Rest of Europe | n/a | n/a | 0.75% | -4.59% | -4.05% | -4.01% | -2.07% |
| Oceania + | 30.09% | -2.22% | -0.65% | 0.00% | 0.00% | -4.90% | -7.51% |

Note. Term 1: 1961-63 to 1981-83, Term 2: 1981-83 to 1995-97, Term 3: 1995-97 to 2005-07, Term 4: 2005-07 to 2015, Term 5: 2015-30.

Source: FAOSATAT and Author's Estimation.

Table 5. World Soybean Production: Quantity Growth Contribution (% points)

| continent/country | Linear Trend Case | | | | | Damped Trend Case | |
|---------------------|-------------------|--------|--------|--------|--------|-------------------|--------|
| | Term 1 | Term 2 | Term 3 | Term 4 | Term 5 | Term 4 | Term 5 |
| World + | 5.93% | 2.94% | 4.98% | 3.23% | 2.37% | 2.78% | 1.72% |
| Africa + | 0.03% | 0.02% | 0.04% | 0.03% | 0.02% | 0.02% | 0.01% |
| Asia + | 0.43% | 0.68% | 0.29% | 0.23% | 0.17% | 0.19% | 0.11% |
| -- China | 0.31% | 0.28% | 0.12% | 0.07% | 0.05% | 0.05% | 0.03% |
| -- India | 0.07% | 0.43% | 0.19% | 0.14% | 0.10% | 0.12% | 0.07% |
| -- Rest of Asia | 0.07% | 0.07% | -0.02% | 0.02% | 0.02% | 0.02% | 0.01% |
| N Am & C + | 3.57% | 0.88% | 0.93% | 0.41% | 0.34% | 0.29% | 0.22% |
| -- USA | 3.46% | 0.80% | 0.89% | 0.39% | 0.32% | 0.28% | 0.21% |
| -- Canada | 0.06% | 0.11% | 0.04% | 0.02% | 0.02% | 0.01% | 0.01% |
| -- Rest of N Am & C | 0.07% | -0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| South America + | 2.58% | 1.34% | 3.72% | 2.55% | 1.81% | 2.27% | 1.35% |
| -- Brazil | 1.83% | 0.68% | 1.73% | 1.09% | 0.76% | 0.95% | 0.55% |
| -- Argentina | 0.80% | 0.51% | 1.86% | 1.34% | 0.97% | 1.22% | 0.75% |
| -- Paraguay | 0.14% | 0.11% | 0.09% | 0.04% | 0.03% | 0.02% | 0.01% |
| -- Rest of S Am | 0.02% | 0.06% | 0.09% | 0.09% | 0.06% | 0.08% | 0.04% |
| Europe + | 0.08% | 0.04% | 0.08% | 0.03% | 0.03% | 0.02% | 0.02% |
| -- Ukraine + Russia | n/a | n/a | 0.08% | 0.05% | 0.04% | 0.05% | 0.03% |
| -- Rest of Europe | n/a | n/a | 0.01% | -0.03% | -0.01% | -0.02% | -0.01% |
| Oceania + | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Note. Term 1: 1961-63 to 1981-83, Term 2: 1981-83 to 1995-97, Term 3: 1995-97 to 2005-07, Term 4: 2005-07 to 2015, Term 5: 2015-30.

Source: FAOSATAT and Author's Estimation.

Table 6. World Soybean Production: Area Harvested (1)

| | continent/country | 1961-63 | 1981-83 | 1995-97 | 2005-07 |
|---------|---------------------|------------|------------|------------|------------|
| Hectare | World + | 24,013,348 | 50,638,358 | 63,517,042 | 94,086,520 |
| | Africa + | 209,020 | 454,158 | 870,044 | 1,189,550 |
| | Asia + | 11,307,945 | 10,392,098 | 15,772,470 | 19,294,066 |
| | -- China | 9,744,814 | 8,002,762 | 7,984,867 | 9,197,965 |
| | -- India | 13,333 | 693,667 | 5,419,400 | 8,197,167 |
| | -- Rest of Asia | 1,549,797 | 1,695,670 | 2,368,203 | 1,898,935 |
| | N Am & C + | 11,337,396 | 27,442,440 | 27,216,784 | 31,126,633 |
| | -- USA | 11,226,667 | 26,726,405 | 26,169,667 | 29,862,550 |
| | -- Canada | 89,164 | 335,733 | 913,267 | 1,178,467 |
| | -- Rest of N Am & C | 21,565 | 380,301 | 133,851 | 85,616 |
| | South America + | 329,633 | 10,955,015 | 18,642,499 | 40,455,435 |
| | -- Brazil | 298,118 | 8,280,519 | 11,151,000 | 21,877,955 |
| | -- Argentina | 9,977 | 2,048,767 | 6,080,452 | 15,078,129 |
| | -- Paraguay | 2,533 | 491,700 | 836,053 | 2,156,667 |
| | -- Rest of S Am | 19,004 | 134,029 | 574,994 | 1,342,684 |
| | Europe + | 828,808 | 1,351,751 | 988,382 | 1,999,307 |
| | -- Ukraine + Russia | n/a | n/a | 448,370 | 1,325,323 |
| | -- Rest of Europe | n/a | n/a | 540,012 | 673,983 |
| | Oceania + | 546 | 42,895 | 26,863 | 21,528 |
| Share | World + | 100.00% | 100.00% | 100.00% | 100.00% |
| | Africa + | 0.87% | 0.90% | 1.37% | 1.26% |
| | Asia + | 47.09% | 20.52% | 24.83% | 20.51% |
| | -- China | 40.58% | 15.80% | 12.57% | 9.78% |
| | -- India | 0.06% | 1.37% | 8.53% | 8.71% |
| | -- Rest of Asia | 6.45% | 3.35% | 3.73% | 2.02% |
| | N Am & C + | 47.21% | 54.19% | 42.85% | 33.08% |
| | -- USA | 46.75% | 52.78% | 41.20% | 31.74% |
| | -- Canada | 0.37% | 0.66% | 1.44% | 1.25% |
| | -- Rest of N Am & C | 0.09% | 0.75% | 0.21% | 0.09% |
| | South America + | 1.37% | 21.63% | 29.35% | 43.00% |
| | -- Brazil | 1.24% | 16.35% | 17.56% | 23.25% |
| | -- Argentina | 0.04% | 4.05% | 9.57% | 16.03% |
| | -- Paraguay | 0.01% | 0.97% | 1.32% | 2.29% |
| | -- Rest of S Am | 0.08% | 0.26% | 0.91% | 1.43% |
| | Europe + | 3.45% | 2.67% | 1.56% | 2.12% |
| | -- Ukraine + Russia | n/a | n/a | 0.71% | 1.41% |
| | -- Rest of Europe | n/a | n/a | 0.85% | 0.72% |
| | Oceania + | 0.00% | 0.08% | 0.04% | 0.02% |

Source: FAOSTAT.

Table 7. World Soybean Production: Area Harvested (2)

| | continent/country | Term 1 | Term 2 | Term 3 |
|-----------------------|-----------------------------------|---------|--------|--------|
| Annual Average Growth | World + | 3.80% | 1.52% | 4.01% |
| | Africa + | 3.96% | 4.43% | 3.18% |
| | Asia + | -0.42% | 2.82% | 2.04% |
| | -- China | -0.98% | -0.01% | 1.42% |
| | -- India | 21.85% | 14.69% | 4.22% |
| | -- Rest of Asia | 0.45% | 2.25% | -2.18% |
| | N Am & C + | 4.52% | -0.06% | 1.35% |
| | -- USA | 4.43% | -0.14% | 1.33% |
| | -- Canada | 6.85% | 6.90% | 2.58% |
| | -- Rest of N Am & C | 15.43% | -6.72% | -4.37% |
| | South America + | 19.15% | 3.61% | 8.06% |
| | -- Brazil | 18.08% | 2.00% | 6.97% |
| | -- Argentina | 30.50% | 7.52% | 9.51% |
| | -- Paraguay | 30.14% | 3.60% | 9.94% |
| | -- Rest of S Am | 10.26% | 10.20% | 8.85% |
| | Europe + | 2.48% | -2.07% | 7.30% |
| | -- Ukraine + Russia | n/a | n/a | 11.45% |
| | -- Rest of Europe | n/a | n/a | 2.24% |
| | Oceania + | 24.38% | -3.07% | -2.19% |
| | Growth Contribution (% points) | World + | 3.80% | 1.52% |
| Africa + | | 0.03% | 0.05% | 0.04% |
| Asia + | | -0.14% | 0.64% | 0.46% |
| -- China | | -0.28% | 0.00% | 0.16% |
| -- India | | 0.16% | 0.73% | 0.36% |
| -- Rest of Asia | | 0.02% | 0.08% | -0.06% |
| N Am & C + | | 2.29% | -0.03% | 0.51% |
| -- USA | | 2.21% | -0.07% | 0.48% |
| -- Canada | | 0.04% | 0.07% | 0.03% |
| -- Rest of N Am & C | | 0.06% | -0.03% | -0.01% |
| South America + | | 2.20% | 0.92% | 2.91% |
| -- Brazil | | 1.59% | 0.34% | 1.42% |
| -- Argentina | | 0.62% | 0.51% | 1.22% |
| -- Paraguay | | 0.15% | 0.04% | 0.18% |
| -- Rest of S Am | | 0.02% | 0.06% | 0.10% |
| Europe + | | 0.08% | -0.04% | 0.13% |
| -- Ukraine + Russia | | n/a | n/a | 0.12% |
| -- Rest of Europe | | n/a | n/a | 0.02% |
| Oceania + | | 0.01% | 0.00% | 0.00% |

Source: FAOSTAT.

Table 8. World Soybean Production: Yield (tons/ha)

| continent/country | 3-Year Average | | | |
|---------------------|----------------|---------|---------|---------|
| | 1961-63 | 1981-83 | 1995-97 | 2005-07 |
| World + | 1.141 | 1.712 | 2.108 | 2.313 |
| Africa + | 0.389 | 0.829 | 0.839 | 1.156 |
| Asia + | 0.685 | 1.123 | 1.424 | 1.418 |
| -- China | 0.677 | 1.173 | 1.732 | 1.720 |
| -- India | 0.450 | 0.700 | 1.043 | 1.080 |
| -- Rest of Asia | 0.741 | 1.060 | 1.261 | 1.414 |
| N Am & C + | 1.656 | 1.978 | 2.511 | 2.695 |
| -- USA | 1.654 | 1.978 | 2.511 | 2.698 |
| -- Canada | 1.856 | 2.174 | 2.628 | 2.661 |
| -- Rest of N Am & C | 2.051 | 1.807 | 1.651 | 1.873 |
| South America + | 1.076 | 1.747 | 2.170 | 2.516 |
| -- Brazil | 1.051 | 1.708 | 2.249 | 2.466 |
| -- Argentina | 1.039 | 1.939 | 1.951 | 2.747 |
| -- Paraguay | 1.746 | 1.605 | 2.901 | 1.806 |
| -- Rest of S Am | 1.414 | 1.761 | 1.899 | 1.879 |
| Europe + | 0.527 | 0.873 | 1.862 | 1.577 |
| -- Ukraine + Russia | n/a | n/a | 0.675 | 1.128 |
| -- Rest of Europe | n/a | n/a | 2.848 | 2.459 |
| Oceania + | 0.647 | 1.586 | 1.810 | 2.116 |

Source: FAOSTAT.

Table 9. World Soybean Production: Yield Annual Average Growth

| continent/country | Term 1 | Term 2 | Term 3 |
|---------------------|--------|--------|--------|
| World + | 2.05% | 1.39% | 0.93% |
| Africa + | 3.86% | 0.08% | 3.26% |
| Asia + | 2.50% | 1.60% | -0.05% |
| -- China | 2.79% | 2.63% | -0.07% |
| -- India | 2.24% | 2.69% | 0.35% |
| -- Rest of Asia | 1.81% | 1.16% | 1.15% |
| N Am & C + | 0.89% | 1.60% | 0.71% |
| -- USA | 0.90% | 1.60% | 0.72% |
| -- Canada | 0.79% | 1.27% | 0.12% |
| -- Rest of N Am & C | -0.63% | -0.60% | 1.27% |
| South America + | 2.45% | 1.46% | 1.49% |
| -- Brazil | 2.46% | 1.85% | 0.93% |
| -- Argentina | 3.17% | 0.04% | 3.48% |
| -- Paraguay | -0.42% | 4.03% | -4.63% |
| -- Rest of S Am | 1.10% | 0.51% | -0.10% |
| Europe + | 2.56% | 5.18% | -1.65% |
| -- Ukraine + Russia | n/a | n/a | 5.27% |
| -- Rest of Europe | n/a | n/a | -1.45% |
| Oceania + | 4.59% | 0.88% | 1.58% |

Note. Term 1: 1961-63 to 1981-83, Term 2: 1981-83 to 1995-97, Term 3: 1995-97 to 2005-07.
Source: FAOSTAT.

Table 10. Scenarios for World Soybean Area Harvested and Yield to 2030

| World Total/Average | | Year 2005-07 | Annual Growth | Year 2030 | |
|-----------------------------------|---------------------|--------------|---------------|-------------|------|
| | | a | | b | b/a |
| Production Quantity (metric tons) | | 217,597,616 | 2.12% | 359,693,531 | 1.65 |
| Scenario 1 | Area Harvested (ha) | 94,086,520 | 1.18% | 124,784,797 | 1.33 |
| | Yield (tons/ha) | 2.313 | 0.93% | 2.890 | 1.25 |
| Scenario 2 | Area Harvested (ha) | 94,086,520 | 1.03% | 120,213,463 | 1.28 |
| | Yield (tons/ha) | 2.313 | 1.09% | 3.000 | 1.30 |
| Scenario 3 | Area Harvested (ha) | 94,086,520 | 1.27% | 127,257,326 | 1.35 |
| | Yield (tons/ha) | 2.313 | 0.85% | 2.834 | 1.23 |

Notes:

Scenario 1: Yield Annual Growth keeps the same rate (0.93%) of Term 3 (1995-97 to 2005-07).

Scenario 2: Yield Level reaches 3.000 tons/ha in 2030.

Scenario 3: Yield Annual Growth slows to 0.85% annually.

Source: FAOSTAT and Author's Estimation.

Appendix. Exponential Smoothing Estimation Procedure and Parameters

The estimation was preceded as follows:

- i.) As a default, set $\phi = 1$ (liner trend) and the level and trend parameters were chosen to minimize the mean square error (MSE).
- ii.) For damped trend, set $\phi = 0.98$ and the level and trend parameters were chosen to minimize the MSE.

Table 11. Parameters for Exponential Smoothing

| Continent/Country | Linear Trend ($\phi = 1.00$) | | Damped Trend ($\phi = 0.98$) | |
|---------------------|--------------------------------|-------|--------------------------------|-------|
| | Level | Trend | Level | Trend |
| Africa + | 0.90 | 0.10 | 0.90 | 0.10 |
| -- China | 0.60 | 0.05 | 0.60 | 0.05 |
| -- India | 0.70 | 0.05 | 0.70 | 0.05 |
| -- Rest of Asia | 0.70 | 0.30 | 0.70 | 0.30 |
| -- USA | 0.40 | 0.05 | 0.40 | 0.05 |
| -- Canada | 0.70 | 0.05 | 0.70 | 0.05 |
| -- Rest of N Am & C | 0.40 | 0.05 | 0.40 | 0.05 |
| -- Brazil | 0.70 | 0.10 | 0.70 | 0.10 |
| -- Argentina | 0.50 | 0.20 | 0.50 | 0.25 |
| -- Paraguay | 0.40 | 0.10 | 0.40 | 0.15 |
| -- Rest of S Am | 0.70 | 0.15 | 0.70 | 0.15 |
| -- Ukraine + Russia | 0.90 | 0.30 | 0.90 | 0.30 |
| -- Rest of Europe | 0.90 | 0.05 | 0.90 | 0.05 |
| Oceania + | 0.50 | 0.05 | 0.50 | 0.05 |

- iii.) Other continents and the world total were calculated for each trend model as follows:

Asia+ = China + India + Rest of Asia,

N Am & C+ = USA + Canada + Rest of N Am & C,

S Am+ = Brazil + Argentina + Paraguay + Rest of S Am,

Europe+ = Ukraine & Russia + Rest of Europe, and

World+ = (Africa+) + (Asia+) + (N Am & C+) + (S Am+) + (Europe+) (Oceania+).

Masuda, T. and P.D. Goldsmith. "World Soybean Production: Area Harvested, Yield, and Long-Term Projections."
Under Review. *The International Food and Agribusiness Management Review*. December, 2008.