VII World Soybean Research Conference &
IV International Soybean Processing and Utilization Conference

February 29 to March 5, 2004
Foz do Iguassu, Brazil

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Processed soybeans are the largest source of protein feed and vegetable oil in the world. (L.F. Flora, 1993)

Table 1 Global soybean area and production in 2002

Region/country	Area X 10^3 ha	Production x 10^3 t	Yield kg ha^{-1}	% of world production
Africa	1 090	989	907	0.50
Europe	969	1 824	1 882	1.00
Asia	17 124	23 720	1 385	13.00
South America	30 021	76 689	2 554	42.62
North America	30 245	76 761	2 538	42.67
World	**79 410**	**179 917**	**2 265**	**100.00**
South Africa	124	202	1 630	0.11
Nigeria	624	437	700	0.24
China	9 420	16 900	1 794	9.40
Argentina	11 405	30 000	2 630	16.60
Brazil	16 345	41 903	2 568	23.30
USA	29 202	74 290	2 544	41.00

FAO STAT (November 2003)

Table 2. Soybean export as % of world exports

Country	Grain	Oil	Flour
Argentina	14	41	36.5
Brazil	33	20	26
USA	43	10	14

Current status of the soybean production and utilization in Argentina

R.L. Rossi

Argentina is the biggest exporter of soybean meal and soybean oil. In 2003 soybean accounted for 49% of the total value of agricultural production and 73% of agricultural exports and about one third of total Argentinean exports (R. Munoz). Planting area has more than doubled from 1995/6 (5.9 M ha) to 2002/3 (12.4 M ha, 50% of the total cultivated area). Over the same period average yields have increased from 2.00 t/ha to 2.75 t/ha. Soybean has become the "first choice crop" since 1995.

The rapid increase in soybean production has been accompanied by an increase in the planting of Roundup Ready (RR), glyphosate resistant GM varieties and the adoption of no-till farming practices. Transgenic soybeans comprised nearly 100% of the varieties grown by Argentine farmers in 2003. There is also a trend is towards shorter season varieties (mostly group3 & 4). More than 85% of soybean is planted according to the no till system. No till accounts for nearly 100% of new soybean areas. Gross margins calculated for soybean production has shown the NT-RR system to be more profitable than the conventional system (R. Munoz).

More than 50% of soybeans are grown as a monoculture and 25% as a double crop with wheat.

The practice of planting early maturing varieties early have expanded as a new crop management strategy to avoid summer drought stress, minimize late soybean diseases and reduce soybean pest incidence in the central provinces.(J. Aragon)

The black market accounts for almost 50% of the soybean seed supply. This has adversely affected the seed companies. Private companies are responsible for more than 95% of the certified seed.

Current status of soybean production and utilization in Brazil

A. Dall'Agnol

Soybean remained a marginal crop in Brazil until 1960. A rapid increase in soybean production occurring in the 1970's, lead to soybean establishing itself as the lead crop of Brazilian agriculture. This increase was sustained in the 1980's and 1990's due mainly to the cropping of the savannas (Cerrado) of central Brazil. Soybean production

in the Cerrado region increased from 2% in 1970 to 60% in 2003. Planting area has increased from 8.5 million ha in 1977 to 16.3 million ha in 2002/3. Average yield has also increased from 1977 (1.77 t/ha) to 2003 (2.57 t/ha).

Total exports of soybeans represented 77% of the soybean produced in Brazil in 2003. Soybean is responsible for 12% of total Brazilian income from exports. Brazil has far more potential than any other country to increase soybean production. Less than 10% of the Cerrado is under cultivation with annual crops and there is at least 50 million ha suitable for soybean production.

No till production of soybeans accounts for 70% of the cropping area, with 30% under continuous no-tillage.

Current status of the soybean industry in the North American Region
H. Kauffman

Soybeans have grown from a minor forage crop from the 1940's to the second biggest row crop, the second biggest cash crop, and the biggest export crop for the United States (U.S.). Soybean production in North America and South America is similar (over 76 million MT). The U.S. is the largest producer of soybean (74 million MT), 41% of the total world production (FAOSTAT).

Soybeans yields have increased from 1.5 t/ha in 1950 to 2.5 t/ha in the early 2000's (40% increase). This upward trend in yield seems to have slowed during the past decade. Maize yields have however continued to increase during the same time period. (E.D. Nafziger)

RR soybean varieties were introduced in 1996 and rapidly accounted for more than 80% of the seed market in 2003. Cultivar trials conducted in 2002 in Illinois show equal average yields for RR varieties and conventional varieties.

No-till production of soybeans accounts for approximately 35% of the cropping area. Most tillage studies show very little effect of tillage on soybean yield.

Soybeans are mainly grown in rotation with maize. In the major cropping area of the U.S., the US Corn Belt, the two-year maize-soybean rotation is the predominant cropping system.

In the Midwest the most commonly used row spacing has been reduced from 76 cm in the 1970's to 38 cm in the 2000's. Less than 20% of soybeans are planted in rows more than 50 cm apart. Increasing seeding rates from 200 000 to over 300 000 increases yields only for very early or late planted soybean (E.D. Nafziger)

Recent research has shown little or no effect of nitrogen or foliar micronutrient supplements on soybean yield in the US.

No tillage challenges and solutions for soybeans in Australia

J.D. Sykes *et al*

Australian soybean production peaked at 130 000 kt in 1988-89. Soybeans have never become a dominant crop within a farming system like wheat in dry land areas, cotton or rice in irrigated areas or sugar cane in coastal areas. However in the last ten years interest in growing soybeans has moved away from a competitive main crop to a complimentary rotation crop.

Disease control

The topic of soybean rust (*Phakopsora pachyrhizi*) was the most predominant. Numerous poster presentations from Brazil and Argentina focused on the evaluation of fungicides for the control of rust in soybeans. In Argentina many alternative hosts for soybean rust were confirmed. Examples of these hosts are Cajan (*Cajanus cajan*), Kudzu (*Pueraria lobata*), Mucuna, Dolichos, Lablab, Crotalaria, *Vigna unguiculata* and *Lupinus hirsutus.*

Asian rust was first detected in the America Continent on March 2001 in Paraguay. Since then it has spread to all of Paraguay and Bolivia, most parts of Brazil and parts of Argentina. Total grain losses due to rust in Brazil for the 2002/03 season where estimated to be 3.44 million tons or US$759 million. The two major problems in controlling this disease in Brazil are identified as continuous cropping of soybeans and inability of many farmers and advisors in identifying the early stages of rust infection. Elimination of host plants and volunteers as well as the timely use of fungicides are the recommended rust control strategies. (J.T. Yorinori)

Soybean rust was first identified in Argentina during the 2001/02 growing season. Disease management relies on the use of fungicides such as Mancozeb, the Triazoles and Strobilurins. (A. Ivancovich)

The number and severity of soybean diseases in Argentina have increased steadily, particularly since the early 1990s. Severe epidemics have occurred within the last 8 years (Sclerotinia stem rot in 1995/96 and 1997/98, stem canker in 1996/97 and 1997/98, frogeye leaf spot in 1999/2000, and charcoal rot in 200/01 and 2002/03). The following practices are seen to be the major causes of these epidemics, lack of crop rotation, increase in area under no-till, nation wide trend of use of own, often diseased, farmer produced seed. The use of fungicides to control of these diseases has increased steadily in the past 5 years. (L.P. Ploper)

Pest control

Soybeans in the subtropical regions of Argentina suffer greater pest damage. Control measures are moving away from total reliance on synthetic pyrethroids to the use of Integrated Pest Management (IPM) strategies that include the use of biological control agents and adoption of early planting with early maturing varieties. (J. Aragon)

The first activities related to soybean IPM in Brazil began during the 1974-95 season. Prior to the implementation of the soybean IPM program, insect pests were controlled exclusively by chemical insecticides, often on a preventative or calendar basis. On average five insecticide applications were performed during each cropping season. As a result of a successful IPM campaign the number of applications was reduced to less than two per season. Use of early maturing cultivars to escape stinkbug damage is preferred by growers in southern Brazil. (C.B. Hoffmann-Campo *et al*)

Recently the bean leaf beetle has increased in the northern states and the soybean aphid, *Aphis glycines,* has become a major soybean pest in the USA. Slugs are also a major pest of soybeans in no-till lands. (R.B. Hammond)

More than three decades of breeding to develop high-yielding insect-resistant soybean lines have met with limited success. Although three insect resistant cultivars have been released in the USA, none of them yield as well as the most productive non-resistant cultivars. Many cultivars with nematode resistance and high yield have however been successfully released. (H.R. Boerma)

Weed control

Trials carried out in Brazil have shown that post-emergence herbicide applications can be halved when row spacings are reduced from 60cm to 20 or 40cm (A.M. Brighenti *et al*). In other trials in Brazil the use of narrow rows and residue cover (black oat) decreased weeds and increased yields (G. Theisen & C. Steckling).

Soybean nutrition

Many studies have shown stratification of essential nutrients such as phosphorus (P) in soils under no-tillage management. Studies in the US have indicated no affects of P stratification on P uptake and grain yield of soybeans. (J.H. Grove & M. Uranga)

Studies conducted in Argentina showed high soil P levels increased the capability of soybean plants to tolerate drought through improved water use efficiency and penetration of roots into deeper soil layers (R.H. Brevedan *et al*).

The seed treatment of soybeans with the biostimulant Stimulate in Brazil increased seed numbers and grain yield by 24% and 37% respectively (P.R.C. Castro & E.L.Vieira).

Crop rotations and double cropping

Studies on the allelopathic effect of crop residues on soybeans was conducted in India (D. Patel *et al*). Greatest inhibition of plant growth of soybeans was measured

sunflower, safflower and soybean residues. Better germination and yield of soybeans was recorded with the incorporation of maize, sorghum and wheat residues.

Row spacing and plant density effects

Decreasing row spacing and increasing plant densities are an effective way to increase yields for late planted soybeans (SS. Baioni *et al*, R.M.J. Melchiori *et al*). In Brazil surveyed farms gave an average plant density of 300 000. Trials conducted in Brazil showed that some cultivars yielded best at 300 000 and others at 400 000 (V. Spader *et al*).

The science behind soyafoods

M. Messina

Abstract
Soyafoods and soyabean constituents, especially isoflavones, are being investigated in laboratories throughout the world. Soyafoods are hypothesized to reduce the risk of several chronic diseases including breast and prostrate cancer, osteoporosis, and coronary heart disease (CHD). The estrogen-like effects of isoflavones have caused many health professionals to view soyafoods and isoflavones as alternatives to conventional hormone replacement therapy (HRT), however, there are also non-hormonal mechanisms by which isoflavones can exert physiological effects in vivo.
Sales of soyafoods have tripled within the last ten years and are expected to increase at least 10% per year for the foreseeable future. In recognition of the high quality of soya protein in 2000 the U.S. Department of Agriculture (USDA) issued a ruling allowing soy protein to replace 100% of the animal protein in the National School Lunch Program.

Soyafoods can also be good sources of both essential fatty acids, linoleic acid and linolenic acid. The latter is an omega-3 fatty acid with possible coronary benefits. In 1998, in a comprehensive review of chemo preventative agents the Chemoprevention Branch of the National Cancer Institute (NCI) in conjunction with researchers from the University of Illinois at Chicago concluded that of the 25 agents tested, genistein, the main isoflavone in soyabeans, was of four agents considered to possess superior chemo preventative properties.

Vegetable soybean production for human consumption

In some Asian countries vegetable soybean is consumed as a snack, by boiling the pods in salty water. Japan, China, Korea and Taiwan have historically been the major producers and consumers of vegetable soybean (S. Shanmugasundaram & M.R. Yan). The most prominent institution researching and promoting vegetable soybeans is the Asian Vegetable Research Development Center (AVRDC) in Taiwan. Embrapa in Brazil have identified suitable cultivars for vegetable soybeans. Interest in vegetable

soybean in South America is due to the niche market created by the consumption of vegetable soybean by the Asian populations in this continent. Brazil has also seen an increase in organic vegetable soybean production. (N.A. Vello *et al*).

Perspectives on the impact of biotechnology on soybean production and utilization

R. F. Wilson

The rate by which GE crops have been adopted worldwide is an impressive story, growing at a linear rate of about 24 million acres planted in GE crops per year. Only 6 years after the introduction of RR soybeans in commercial agriculture, 16 countries now report total GE crop production on about 145 million acres (58 M ha), or approximately 22% of the cultivated global land mass. On a cumulative basis from 1996 to 2003, empirical estimates indicate that GE soybeans accounted for about 48% of the soybean products consumed in the U.S.

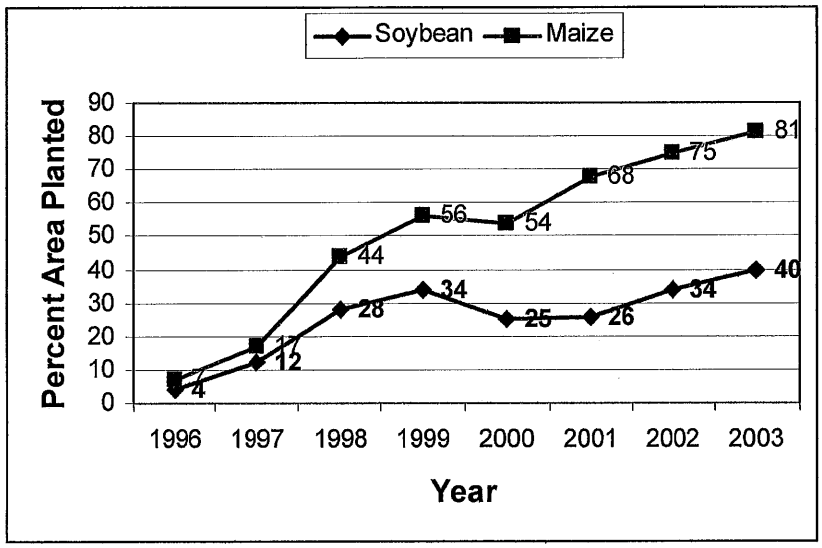

Figure 1. Adoption of Genetically Engineered soybean and Corn in the United States

The Codex Alimentarius Commission, the UN foods standard agency, supports strong regulations for GE foods. These standards provide guidance for determining if GE food contains new toxins or allergens, is altered nutritionally, or exhibits unexpected effects. They also establish a baseline that GE products should be 'as safe as their conventional counterparts'; and endorse the use of 'product tracing' as a tool of risk management.

Three federal agencies share distinct responsibilities in regulation of biotechnology products in the U.S. the USDA-APHIS (Animal & Plant Health Inspection Service) administers permits to conduct field and greenhouse research with GE plants, and the transportation and commercialization of GE products. The Environmental Protection Agency (EPA) administers permits for biotechnology derived chemicals and makes decisions on toxicity to other organisms and the environmental fate of the GE agent. The Federal Drug & Food Administration (FDA) evaluates safety assessments for potential toxins or novel allergens before companies may market GE foods, FDA also is responsible for regulation of GE product labeling, which now is voluntary in the U.S.

Regulatory laws recently passed by the European Union Parliament reinforce constraints on soybean imports posed by the EU's 5-year moratorium on GE crops. Under this legislation, all products from sources with 0.9% or more GE material must be labeled. In addition, exporters of GE products (except for cheese and wine) will be liable for documenting the origin and composition of agricultural commodities at each step of the production cycle.

The cost of attaining regulatory approval, under any system, may become a deciding factor that mediates the rate of advancement in agricultural biotechnological science. The trend towards higher costs of regulatory approval probably will restrict the commercial application of GE research on soybeans.

Researchers from Argentina demonstrated that the early generation GM soya cultivars did not yield as well as the conventional cultivars, but by the 2000/2001 season GM cultivars were comparable to the conventional cultivars.(D.J.Santos *et al.*)

Trials carried out by Embrapa in Brazil showed very low frequencies of cross-pollination from transgenic to non-transgenic soybeans. At a distance of 1m the frequency of cross-pollination was 0.485% and at 2m it was only 0.099%. (S. Abud *et al.*)

Soybean breeding

In Argentina almost 100% of soybean cultivars come from the private sector. Breeding programs have concentrated on adaptation to environment and increase in yield. Release of cultivars with disease tolerance has enabled the management of diseases such as soybean stem canker, Frogeye, Soybean Cyst (SCN) and Root Knot Nematode. Current breeding programs are focused on tolerance to salty soils, cold and drought. Very little attention has been paid to increasing the nutritive quality of soybean in Argentina. The major impact has been the release of cultivars tolerant to glyphosate. (J. Ferrarotti)

Soybean breeding in Brazil has been based on public research, such as Embrapa Soybean which had a 60% market share in 2002/03. Current breeding programs focus

on tolerance to the major nematode species, especially SCN, tolerance to soybean rust and tolerance to glyphosate. (J.F.F. Toledo *et al*)

In Australia the soybean breeding program has concentrated on different traits for the different regions. Weathering tolerance has been identified in cultivars for the humid coastal environments. More drought tolerant lines have been developed for the drier region of inland NSW. (A.T. Jams & I.A. Rose)

After working for many years on drought tolerance the USDA-ARS program has made substantial progress, although no variety has been released to date which combines high yield potential with a high level of drought tolerance.(J.H. Orf *et al*)

The genetic improvement of soybeans is moving from conventional to molecular based plant breeding techniques. It is argued that marker-assisted selection will supplement but not replace conventional breeding methods. (J.H. Orf)

Global environmental benefits of soil carbon management: soybean concerns
D. C. Reicosky

Agricultural carbon (C) sequestration may be one of the most cost-effective ways to slow the processes of global warming. Numerous environmental benefits may result from agricultural activities that sequester soil C and contribute to environmental security. Practices that sequester soil C help reduce soil erosion and improve water quality and are consistent with more sustainable and less chemically dependent agriculture. Increasing soil C storage can increase infiltration, increase fertility and nutrient cycling, decrease wind and water erosion, minimize compaction, enhance water quality, decrease C emissions, impede pesticide movement and generally enhance environmental quality.

Conservation agriculture and zero tillage have been shown to limit and reverse the trend of intensive tillage causing soil degradation and erosion through loss of soil C.

Soybean processing and products research: progress contributed by the USDA
L. F. Flora

Early USDA contributions included improving the quality of soybean oil for food use and developing soyoil epoxide plasticizers and dimmer resins. More recently, Agricultural Research Service (ARS) researchers have developed printing inks, lubricants, composites, nutraceuticals, personal care products, glue, adsorbents, more stable and lower cost soy diesel, methods for improved oil stability without hydrogenation, and alternatives to hexane extraction of soybeans. Future efforts by ARS researchers, combined with collaborations with public and private sector interests, promise additional market opportunities for soybeans.

Food uses of soybean oil

Studies on the formulation of margarines/spreads from hi-stearic acid soybean oils have shown that products formulated from them have suitable physical and sensory properties, thus providing an outlet for these crops estimated to have a market value in excess of $ 130 000 000.

Edible oil research on effects of fatty acid composition on oil quality has lead to recommendations to plant breeders for new cultivars of soybeans. These oils that have improved stability to oxidation without hydrogenation include low linolenic acid soybean, high oleic soybean and the more recent mid-oleic soybean which has an ideal composition for frying.

Industrial uses of soybean oil

Epoxidized vegetable oils (largely epoxidized soybean oil) account for about 15% of the current domestic plasticizer market. A recent discovery of a cheaper and more effective source of enzyme to epoxidize vegetable oils, will create a bigger market share for soyoil in plastic compounds.

New biodegradable lubricants and hydraulic fluids made from soybean oil which have the industrial quality and performance characteristics of current petroleum based lubricants and hydraulic fluids have been developed and used commercially.

A new "all natural" sunscreen active ingredient, SoyScreen has been patented for use as a UVA and UVB protection agent from the sun.

The first patent for production of biodiesel came from Brazil in 1980. However, biodiesel has only recently (2000-3) moved to the initial stages of commercialization. Brazil has proposed to substitute all diesel fuel with a blend of 5% biodiesel and 95% petroleum diesel blend by 2005. The main source of biodiesel will be soybeans. (P.A.Z. Suarez, 1993)

Biodiesel was introduced in Europe in the early 1990's. Since then a rapid expansion ahs created a large production base of over 2 million MT capacity. Biodiesel production in Europe has been based on the use of rapeseed. The recent approval of a European Biodiesel standard broadens the road to introduction of other vegetable oils such as soyoil in blends for the biodiesel market. (I. Debruyne & J.L. Pinheiro).

Soybean oil is the major feedstock for the production of biodiesel in the United States. New research enabling the production of biodiesel from soy soapstock as opposed to biodiesel produced from soy oil can reduce production costs by 25%. Soapstock is a byproduct of the edible oil refining process. (M.J. Haas et al, 1993)