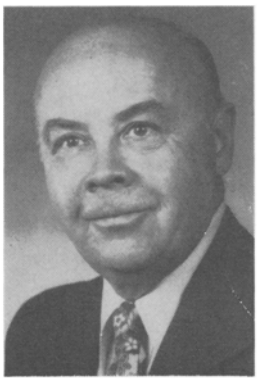

Increasing the Supply of Soybeans

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ABSTRACT

The increase in supply and use of soybeans during the past 40 years has been a dramatic change in world agriculture—the "Dark Green Evolution." The driving forces have been expanding population and income levels, increasing demand for protein and edible oils, pressures on other crop prices, and production and utilization research. The large growth of supply has been in temperate areas of North and South America, where increases will continue but at much slower rates than in the past. Production will increase in tropical and subtropical areas and soybeans will truly become a worldwide commercial crop. The rate of increase in supply will depend largely on the magnitude and effectiveness of research, education and developmental programs designed to exploit the full potential of the soybean to upgrade diets and alleviate the growing world malnutrition problem.

In 1975, a widely experienced internationalist wrote "the modern soybean sparked an authentic Green Revolution that preceded by 40 years the invention of the term. This revolution is still in process and may even be gaining in momentum" (1). I prefer to refer to the change in supply of soybeans as the "Dark Green Evolution" because the soybean plant is dark green in color and the forces behind the changes are more evolutionary than revolutionary in nature. But irrespective of the words used to describe the changes, they have been no less than spectacular.

World production of soybeans increased sevenfold from 1939 to 1979, doubling during the first half of this period and tripling during the second half (Table I). The native country of the soybean, China, produced three-fourths of the crop in 1939, but, with no discernable trend in production over the years, China's share of world production has declined to the 10% range. The United States was the dominant country in growth of soybean supplies until the 1960s, when Brazil became an important producer. It was 1967 before Brazil produced as much as 2% of world supplies and 1969 before more than one million tons were produced. During the past 6 years, Brazil has produced 13-16% of world supplies.

Countries other than the United States, Brazil and China have produced 5-7% of the world supplies of soybean during most of the past 40 years, but this proportion is now increasing with expanded production in Argentina and on a more limited scale in several other countries, including Mexico and Paraguay (Table II).

There was little change in world soybean yields during the 1940s and 1950s, although the influence of improved varieties and better cultural practices was being felt in the U.S. This was a period during which the U.S. area in soybeans expanded fivefold, and to less favorable land and other production conditions. The results of research and better farm management practices are reflected in the steadily increasing yields over the most recent 20 years. This period can be characterized as one of rapidly expanding area and steadily increasing yields. U.S. technology and farmer experience provided the foundation for the soybean industries of temperate South America.

In considering the future of soybean supplies, it is useful to look at the forces behind the rapidly expanding supplies and use. First, there has been an increasing demand not only for vegetable oils but also for protein to balance the livestock rations that supply poultry and animal products in the relatively high-income countries. Second, soybeans

TABLE I

World Soybean Production and Yield and Selected Country Production, Selected Years, 1939-1979 (in thousand metric tons)

	World	United States	China	Brazil	Other countries	World yield (kg/ha)
1939	13,167	2,453	9,495	–	1,219	1,064
1944	13,773	5,213	7,630	–	930	1,050
1949	14,169	6,374	6,673	25	1,097	1,100
1954	19,914	9,296	8,709	117	1,798	1,150
1959	25,845	14,511	9,525	147	1,662	1,212
1964	28,188	19,103	6,940	305	1,840	1,177
1969	40,516	30,839	6,200	1,057	2,420	1,425
1974	54,365	33,062	9,500	7,876	3,927	1,387
1979	94,375	61,715	8,300	15,200	9,160	1,857

Sources: Agricultural Statistics, U.S. Department of Agriculture, several issues; and Foreign Agriculture Circular, Foreign Agriculture Service, U.S. Department of Agriculture, several issues.

TABLE II

Soybean Area and Production, Mexico and South America, Selected Years[a]

Country	1961-1965		1969-1970		1974-1975		1978-1979		1979-1980[b]	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Mexico	17	30	170	300	255	420	170	334	N.A.[c]	701
Argentina	11	11	26	27	356	485	1,600	3,700	1,750	3,300
Bolivia	–	–	1	1	9	12	14	22	N.A.	N.A.
Chile	–	–	–	–	1	2	1	1	N.A.	N.A.
Colombia	23	35	58	95	57	114	71	42	N.A.	N.A.
Ecuador	–	–	1	1	7	7	22	42	N.A.	N.A.
Paraguay	6	10	28	52	151	220	300	375	475	750
Peru	1	1	–	–	3	8	3	6	N.A.	N.A.
Uruguay	1	1	1	1	14	15	50	60	35	50

[a]Except Brazil; area in hectares and production in thousand metric tons.

[b]Preliminary data.

[c]Data not available.

Source: U.S. Department of Agriculture, Foreign Agriculture Circular, several issues.

have become an alternative to crops of lower demand and less profitability to farmers. For example, in the U.S. soybeans have displaced large areas of corn, oats, cotton, and hay and some wheat in selected areas. Fewer draft animals reduced the demand for oats, and synthetic fibers reduced the demand for cotton fiber. From 1940 to 1980 there was a decrease of 29 million hectares of oats, corn, cotton and hay. Soybeans were substituted on most of this land, creating a 25 million hectare increase in soybean acreage. Third, government actions have been an important element in encouraging production in those countries that have made rapid increases in supply. In the U.S., crop area diversion programs for crops such as corn, cotton, and wheat, with few, if any, restrictions on soybean plantings have made soybeans an attractive alternative. Soybeans have been relatively free of price and income supports and restrictions, and, during some years, purchases of soybean oil have had a price stabilizing effect. In Brazil, the government has provided incentives to farmers through partial subsidization of the costs of inputs, loan programs, and price assurances. Fourth, research and extension education programs have been catalytic factors in making soybeans a stable and high-yielding crop over a constantly expanding range of conditions. Without these programs, soybeans would not have become competitive with other crops. Similarly, research has made soy products more efficient in livestock feeding, in use as a low-cost vegetable protein, and as a widely accepted source of oil for margarine and vegetable shortenings.

But what about the future of supplies? It will be shaped by the same general forces that have been operating over the past 40 years: demand for the crop to make diets nutritious, interesting and economical; the appeal of the crop to farmers in comparison to and in combination with other crops; government incentives to improve food supplies and to take advantage of the special qualities of the soybean as a diet improver; and research and education programs designed to fully exploit the potential of the crop as a high-quality food source.

The needs and demands for more and better food will be the overriding force that shapes the future. At current growth rates, world population will double in about 40 years. The importance of the very high population growth rates of Latin America must be underscored. The combination of high birth rates and low death rates, resulting in a natural increase of 2.8% per year, will lead to a doubling of population in about 25 years. In addition to gross population numbers, there will be the effect of people with increasing incomes choosing to use a portion of their income to increase food consumption and quality of their diet. The soybean has proved itself in both animal-based and vegetable-based protein diets; therefore, I foresee strong pressures to expand soybean supplies from the demand side of the economist's equation.

With these tremendous pressures of demand, where will the increases in soybean supplies come from? Will the temperate areas of North and South America continue to dominate the supply picture? The United States will increase production of soybeans; however, most U.S. expansion will come through a gradual increase in yields resulting from a steady flow of research results and improved management of the crop on farms. The results of research are unpredictable but insofar as I am aware, no major research breakthroughs are foreseen. With some 300 scientists working on the crop, there will be a steady flow of incremental yield improvements. There is still a wide gap between average yields and those gotten from experimental fields and by the best farmers. Improving farm management will narrow this gap.

A rapid increase in supplies resulting from more U.S. land being planted with soybeans is not a possibility for the future. Land earlier diverted from the major food and feed crops has now been brought back into production. There is increasing concern over the effects of intensive row cropping on soil erosion. High-yielding corn and cotton are strong competitors for the farmer's land and labor; wheat has an advantage in areas of marginal rainfall for soybeans. I expect soybeans to continue to make modest inroads on less profitable crops such as oats, but there have already been drastic reductions in such crops.

There will be increases in supplies from temperate South America but the expansion of area will be at a slower rate than in the past. Technological adaptation and farmer education programs will be required to move the crop to new land. In general, costs of inputs will increase as production areas expand to points farther from supplies. The cost of subsidizing expansion will place ever heavier burdens on government budgets. Yields will increase and approximate U.S. yield levels.

The future of soybeans in the Peoples Republic of China is a big question. With modernization of agriculture now a high priority, I expect China to increase yields and production substantially; however, all of the increase in production, and more too, will be required for the huge Chinese population.

Temperate area countries will continue to be the big suppliers for commercial export markets; however, these countries do not have the capacity to meet the burgeoning

needs for protein and vegetable oil of the middle and lower income countries with rapidly expanding populations.

The soybean will become an important crop in many more countries over the next two decades. Its reputation as the outstanding producer of protein per hectare in temperate zones will be extended to tropical and subtropical areas as well.

The potential for production of soybeans under tropical and subtropical conditions is indicated by Hinson and Hartwig, 2 well-known and highly respected U.S. Department of Agriculture (USDA) soybean breeders: "We have observed soybean research and production in several countries. Our observations indicate that the soybean can produce well in many areas that now produce few or no soybeans. In some areas, varieties developed for other locations may be well adapted. In other areas, plant breeders must develop varieties with specific adaptation to the environment, or the management system, before large-scale production is feasible. Also, farmers in new production areas should develop management skills that will result in efficient, economical production. We believe soybean production will be feasible in many other areas of the world, particularly tropical and subtropical areas, when varieties adapted to a wider range of conditions are developed and managerial skills are improved" (2).

The results of the International Soybean Program (INTSOY)-sponsored International Soybean Variety Experimental (ISVEX), initiated in 1973, confirm the judgments made by Hinson and Hartwig. It was concluded from data from 101 sites that "yields from 1,900-2,800 kg/ha of good quality soybean grain were obtained consistently with better-adapted cultivars in tropical and subtropical environments" (3).

W.H. Judy, who is in charge of ISVEX, has drawn the following conclusions from five years of experimental data:

> Interpretation of data from these variety trials over the past five years has led to a number of very interesting conclusions. We have found that the so-called temperate varieties developed in the United States are adapted over a much wider range of environmental conditions than we had thought possible. For example, the variety Davis which is a Group IV and some others have consistently been the highest yielding variety among environmental zones in the 0-30° latitude range. While cooperators have been encouraged to substitute local entries in the trial, the yield of the local entries has exceeded that of the supplied entries only about one time in twenty. This suggests that the varieties included in the ISVEX trials are better adapted than most locally developed varieties but it also hints at an untapped potential among varieties developed by other plant breeders. For this reason INTSOY instituted another variety trial in 1978 to evaluate germplasm contributed by plant breeders. Sixteen scientists from 12 countries contributed 48 outstanding varieties for the first trial.
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> One important result of this variety development program is that breeders and agronomists in many different countries have access to high-yielding widely adapted varieties for their own soybean production programs. There are a number of examples where cooperators have selected varieties, increased the seed and introduced these improved types to farmers with very significant success" (4).

Farmer experience, as well as experimental data, indicate that the crop can be grown over a wide range of conditions, tropical and subtropical as well as temperate. The United States, Brazil and China are the "big three," but many other countries have significant production: the Soviet Union and Bulgaria, Romania and Yugoslavia in Eastern Europe; Indonesia, Japan, Korea, Thailand and India in Asia; and Egypt in North Africa. In Latin America, Mexico, Argentina, Paraguay, Colombia, Uruguay and Ecuador have industries that are established and destined to grow.

The countries that will increase soybean production most rapidly are those that make the commitment to improve the food supplies and the quality of diets of their peoples. With the increases in population and nearly universal interest of people in improving their diets, there will be strong political and economic pressures tending to force more governments and their institutions to adopt policies and implement programs that will bring forth food supplies more rapidly that in the recent past. Paramount among these policies will be those that provide price and income incentives to producers as well as provision for input supplies. But improvements in the entire system of marketing and food distribution will also be required.

Research and education programs are the key to capitalizing on the full potential of the soybean. The soybean is often referred to as the "miracle" crop. Recent history provides us with the lesson that it is the combination of the basic qualities of the soybean and the minds of men and women working in production and utilization research laboratories and on experimental fields, and in farmer and consumer education programs that has produced miracles. Continuing basic research is needed, but large increases in supplies of soybeans can be realized from applied and adaptive research and technology designed to adapt soybeans to the wide range of conditions on farmers' fields. Cooperation among countries is needed, but each country must make its adaptations and conduct its own farmer education programs. It is equally important that processing and utilization research be conducted to adapt processes and food combinations to the needs of people with widely varying but often nutritionally inadequate diets.

The sponsoring and participating organizations are to be commended for organizing this World Conference on Soya Processing and Utilization, which is oriented to the needs of nations that could improve the nutritional quality of foods in their diets through a sustained growth in the use of soya. Current needs are great and the high population growth rates unmistakenly foretell needs of such magnitude that they are difficult to comprehend. There is a tremendous challenge before us to combine our best organizational and individual talents, and exploit the full potential of the soybean, with other food sources, to fulfill even more the needs of people with widely differing cultural backgrounds and economic circumstances.

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