Lawrence Livermore Laboratory

MASTER

FOOD SURVEY

PART A: U.S. AGRICULTURE IN THE U.S. BALANCE OF TRADE

PART B: THE WORLD FOOD-POPULATION PROBLEM

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PREFACE

Part A of this paper examines U.S. agriculture with respect to its current and future role in the U.S. trade balance. Part B is a brief look at the world food-population problem.

As we investigate the role of R&D in solutions to the energy problem it is appropriate to examine alternatives. One alternative is to simply import oil and pay for it with agricultural exports, security being achieved through diversification of sources of imports. This study examines and identifies the major food issues. We attempt to demonstrate that U.S. agricultural exports will probably continue to be a strong positive element in the trade balance for at least the next decade. However, while world-wide demand for food will grow, so will the competition for U.S. agricultural exports. The uncertainties are of significant magnitude that to count on this strategy for the long term seems unwise. The treatment of the subject has not been exhaustive, but we hope it has been in sufficient depth to highlight the important issues.

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PART A

U.S. AGRICULTURE IN THE U.S. BALANCE OF TRADE

An assessment of the future prospects for the U.S. merchandise trade balance would, of course, have to consider all categories of imports and exports. Nonetheless, certain items do have a key role. Oil is certainly in this category among U.S. imports and agriculture occupies an analogous role among the exports.

The basis of U.S. agriculture exports is the abundance of high quality farm land in the U.S. and the high productivity of U.S. farmers. This combination has led to world leadership for the U.S. in agricultural exports.

AGRICULTURAL EXPORTS HAVE A KEY ROLE IN THE
U.S. POSITIVE BALANCE-OF-TRADE. CONTINUED
STRONG GROWTH IN AGRICULTURAL EXPORTS
THROUGH 1985 APPEARS PROBABLE.

Agriculture is a strong positive element in the U.S. balance of trade. This chart shows the value of exports and imports of certain items in the merchandise balance of trade in the year 1974. There were about \$22 billion of agricultural exports which will be detailed in the succeeding charts. There were about \$10 billion of agricultural imports - meat and products, coffee, sugar, and molasses are all large import items. There were about \$24 billion of oil imports. Raw material on the chart excludes oil. Thus, if oil is lumped with raw material, the U.S. is a large importer of raw material. However, excluding oil, the U.S. is a net exporter. Coal is the largest item in U.S. exports of raw material. The raw material imports are largely metal ores. The production materials include chemicals, textiles, iron, steel, and non-ferrous metals. The United States is a large net exporter of stationary machinery. The largest item in this category is electrical and electronic equipment. Other large items are construction, excavation, and mining machinery, and metal working equipment. In transportation equipment the United States exports large numbers of automobiles and aircraft and imports large numbers of automobiles. If automobiles alone were considered, the U.S. would be a net importer. The aircraft sales make the U.S. a net exporter of transportation equipment.

We'll next look at the agricultural exports in some detail.

AGRICULTURE IS A STRONG POSITIVE ELEMENT IN THE US BALANCE-OF-TRADE

Soybeans, feed grains, and wheat dominate exports. In fiscal '75, soybeans, feed grain, and wheat flour each ran about \$5 billion. The value of soybean is about twice that of wheat or corn. Thus, the volume of soybean is about half. Feed grain is about 80% corn, 15% sorghum, and the other 5% oats and barley. Some items that are large but not included on the chart are about \$1 billion of rice, \$3/4 billion of agricultural equipment and \$1/2 billion of fertilizer.

Next we'll consider where the exports went.

SOYBEANS, FEED GRAINS, AND WHEAT DOMINATE EXPORTS

USDA

Most top importers are developed countries with insufficient agricultural land. This chart shows both the imports from the United States and the harvested area per capita in cereal grain in the year 1973. Japan, the Netherlands, West Germany, Korea, Egypt, and a few other countries just do not have enough land to feed their people at their current diet. Thus, these countries are large importers and will presumably continue to be importers on into the future. The imports shown for the Netherlands probably reflects the importance of the port of Rotterdam through which some of the commodities are trans-shipped to other Bene-lux countries whose situation is much the same as the Netherlands in terms of low amount of agricultural land.

The population of Canada is only 10% that of the U.S. Although their land per capita (0.88 HA/cap) is almost three times that of the U.S. (0.31 HA/cap), their total agricultural land is only about 1/3 of the U.S.

Some important producers that are not shown on this chart are India, China, and the Soviet Union. India and China have about .18 and .15 hectares per capita, not as much as the United States, but large as compared to European countries and Japan. The Soviet Union has almost half a hectare per capita. This reflects the low yields from wheat as compared to corn which is the principle U.S. crop and the fact that they are mainly a wheat producer.

It is of interest to consider whether the importers could reduce their dependence by farming the land they have more intensively.

MOST TOP IMPORTERS ARE DEVELOPED COUNTRIES WITH INSUFFICIENT AGRICULTURAL LAND.

\$ Billion, FY 75

USDA/FAO

Top importers farm more intensively than the United States. It's unlikely that European countries and Japan could reduce their need for imports by farming still more intensively; they're already near saturation in the amount of fertilizer they are applying. What the chart shows is the equivalent nitrogen, phosphate and potash applied per hectare of crop planned. The result is large crop yields, as shown in the next chart.

TOP IMPORTERS FARM MORE INTENSIVELY THAN THE U.S.

The gains from intensive fertilizer application have already been realized. Intensive farming will not meet the needs of importers. This illustrates the same point as the fertilizer usage chart; the crop yields in Europe and Japan are already at a level where further large gains are unlikely.

THE GAINS FROM INTENSIVE FERTILIZER APPLICATION HAVE ALREADY BEEN REALIZED

Metric tons per Hectare (1973)

Wheat		Rice		Corn	
Netherlands	5.3	Japan	6.0	Austria	6.6
Belgium	5.0	Italy	5.1	USA	5.7
France	4.5	Egypt	5.1	Italy	5.6
Germany Fed	4.4	USA	4.8	France	5.5
Denmark	4.4	Korea	4.8	Germany Fed	5.4
UK	4.4	Peru	4.2	Canada	5.3
Sweden	4.1	Korea DPR	3.9	Czechoslovakia	4.3
Germany DR	4.1	USSR	3.8	Bulgaria	4.2
Japan	2.7	Colombia	3.8	Hungary	4.1
USA	2.1	Iran	3.3	Japan	2.7

Besides Europe and Japan, the USSR will probably continue buying U.S. grain. The agricultural areas in the USSR lie so far north that the growing season is short and seasonal variations produce large fluctuations in agricultural output. The chart shows how far north most of the Soviet Union is - but even this juxtaposition tends to understate the Russian problem. While there appears to be ample farm land around 50° north latitude (equivalent to the Canadian wheat belt) these areas are dry. Consequently, their crop land is even further north.

A second geographical factor that produces weather variations is isolation from the world's oceans. The agricultural lands are so far from the oceans that the moderation of the oceans on weather is not effective. When it's cold, it's very cold. When it's wet, it's very wet and when it's dry, it's very dry.

The Soviet Union has contracted to buy from the United States between 6 million and 8 million tons of grain a year for the next 5 years.

This series of charts has attempted to demonstrate that the main importers of U.S. agriculture have little choice but to be importers. Next we'll look at what other options they might have rather than importing from the United States. Could they import from some other supplier or could they go to unconventional agriculture?

THE SOVIETS WILL PROBABLY BE BIG BUYERS OF U.S.
GRAIN FOR A LONG TIME TO COME, BECAUSE OF
THEIR UNFAVORABLE CLIMATE.

Chart from National Observer

The North American dominance in grain exports is illustrated on this chart. It is probably more realistic to worry about the U.S. ability to meet the growing demand than to worry about competition. Still, on the next chart we will consider one particular area of competition.

From Newsweek

Brazilian soybean production will probably remain below that of the U.S.A. This chart shows production records and estimates for the future from U.S.D.A. publications. It appears unlikely that Brazil will displace the U.S. as the major soybean exporter for a decade or so at any rate.

The next chart considers unconventional agriculture.

BRAZILIAN SOYBEAN PRODUCTION WILL PROBABLY REMAIN BELOW U.S.A.

Single cell protein production could, in principle, compete with soybean exports. This chart lists the production that is expected to be on line by the year 1980. However, notice that the largest plant is only 200,000 tons per year as compared with many millions of tons of soybean that move in foreign trade. Thus, it will be some time, if ever, before single cell protein will take a major share of the soybean market.

SINGLE-CELL PROTEIN COULD COMPETE WITH SOYBEANS.

Plants planned to be on-line by 1980 include:

	<u>Organism</u>	<u>Substrate</u>	<u>Estimated 1975-80 Capacity Tons/year</u>
<u>Czechoslovakia</u>			
Slovnaft Kojetin	Yeast	Ethanol	60,000
Slovnaft Kojetin	Yeast	N-paraffins	100,000
<u>Finland</u>			
United Paper Mills	Fungi	Sulphite liquor	10,000
<u>France</u>			
British Petroleum, Lavera	Yeast	Gasoil	100,000
Group Francais des Proteines	Yeast	N-paraffins	40,000
<u>West Germany</u>			
Biological Carbon Research	Algae	Carbon dioxide	pilot
<u>Italy</u>			
Italproteine, Sardinia	Yeast	N-paraffins	100,000
Liquichimica, Calabria	Yeast	N-paraffins	200,000
<u>Mexico</u>			
Sosa Texcoco	Algae	Carbon dioxide	pilot
<u>Romania</u>			
Roniprot	Yeast	N-paraffins	60,000
<u>Republic of China</u>	Yeast	N-paraffins	1,000

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	<u>Organism</u>	<u>Substrate</u>	<u>Estimated 1975-80 Capacity Tons/year</u>
<u>Switzerland</u>			
Nestle	Bacteria	Ethanol	1,000
<u>Taiwan</u>			
Chinese Petroleum	Yeast	N-paraffins	100,000
<u>United Kingdom</u>			
British Petroleum	Yeast	N-paraffins	100,000
ICI	Bacteria	Methanol	100,000
Shell Chemical	Bacteria	Methane	1,000
RHM Foods	Fungi	Carbohydrates	10,000
Tate and Lyle	Fungi	Carbohydrates	4,000
<u>USSR</u>	Yeast	N-paraffins	200,000
<u>United States</u>			
Amoco Foods Co.	Yeast	Ethanol	5,000
LSU/Bechtel	Bacteria	Cellulose	10,000
U.S. Army	Bacteria	Cellulose	10,000
<u>Japan</u>			
Mitsubishi Gas	Yeast	Methanol	100,000
Sumimoto	Bacteria	Methanol	100,000
Kyowa Hakko	Yeast	N-paraffins	100,000

Source: Paper by Jeremy Wells at American Chemical Society Meeting, April 1975.

The major importers are developed countries. Their meat consumption is noticeably below the U.S.; European consumption per capita is about half that of the U.S., and Japanese consumption only 20% that of the U.S. They are on a curve of rising meat consumption which means an increased need for agricultural products. Their prospects are not good for large increases in their own production because of their limited land and the fact they are already farming very intensively. It appears that major competition to U.S. agriculture in terms of an alternate source of supply is not going to develop soon. This combination of factors probably means that U.S. agricultural exports will rise. A U.S.D.A. projection, which is shown on the chart, has soybean exports doubling and corn exports increasing by 50% while wheat exports increase slightly in the next 10 years.

USDA PROJECTIONS SHOW STRONG INCREASES IN EXPORTS

All of the foregoing might be taken to indicate that food exports can pay for oil imports. However, the analysis is incomplete. For example: How can Europe and Japan pay their bills for both agriculture and oil? What competition will develop in the trade of non-agricultural items? There could certainly be increased competition for stationary machinery. How will the United States respond to food shortages in less developed countries? Adjustments of monetary exchange rates may be at least a partial answer to the first two questions.

Not to answer the last question, but to develop some relevant background, part B speaks to the problem of the less developed countries.

THERE ARE PROBLEMS WITH THE IDEA THAT FOOD CAN
PAY FOR OIL.

HOW CAN EUROPE AND JAPAN PAY THEIR BILLS
FOR BOTH AGRICULTURE AND OIL?

WHAT COMPETITION WILL DEVELOP IN THE TRADE
OF NCN-AGRICULTURAL ITEMS?

HOW WILL THE U.S. RESPOND TO FOOD SHORTAGES
IN LESS DEVELOPED COUNTRIES?

U.S. AGRICULTURAL EXPORTS WILL INCREASE THROUGH 1985.
BEYOND THAT TIME SATURATION OF DEMAND FROM TRADITIONAL
IMPORTERS COUPLED WITH COMPETITION FROM ALTERNATE
SUPPLIERS MAY CUT THE GROWTH OF EXPORTS.

NON-AGRICULTURAL ITEMS IN THE BALANCE OF TRADE WILL
FACE INCREASED COMPETITION.

A LONG TERM POLICY OF IMPORTING OIL MAY THUS LEAD TO
GROWING TRADE DEFICITS.

PART B
THE WORLD FOOD-POPULATION PROBLEM

Food production per capita in the less developed countries is about 1/3 that in the developed countries. This chart shows that the total cereal production in 1973 was about 700 million metric tons in both the developed countries and the less developed countries. But the population in the less developed countries is about three times that of the developed countries. Therefore, the LDC's production in calories per day per capita is only about 1/3 that in the developed countries. Clearly, people in the developed countries don't eat 7500 calories per day, but only about 3,000. The large difference between production and consumption is because most of the grain production of the developed countries is fed to animals (livestock - beef, hogs, chickens). The number of calories that people obtain from consuming meat is much less than the number of calories consumed by the animals.

This chart shows a very large gap between the two groups. What's happening to the gap?

FOOD PRODUCTION PER CAPITA IN THE LESS DEVELOPED COUNTRIES
IS ABOUT 1/3 THAT IN THE DEVELOPED COUNTRIES.

FAO

For the world as a whole, food production is increasing faster than population. This chart shows the percent increase per year in population and in food production in the developed countries, communist Asia, which is China (the largest of the less developed countries), and the other less developed countries excluding communist Asia. In the developed countries food production is increasing noticeably faster than population. Therefore, food production per capita is increasing. This also appears to be true in China. In the other less developed countries, i.e., Asia, Africa, and Latin America, despite isolated areas of progress, the difference between the population increase and the food production increase is not significant. The statistics aren't really good enough to know whether food production or population is increasing faster. Even if the bars as shown are exactly right, the rate of increase of per capita food production is too small to make a difference in anybody's lifetime.

The situation is that large numbers of people are malnourished in these countries. The next chart illustrates this point.

FOOD PRODUCTION IS INCREASING FASTER THAN POPULATION

In the less developed countries large numbers of children are malnourished. In some 25 surveys including about 2000,000 children, measurements were made of body weight versus height. On this basis, degree of protein-calorie malnutrition was assessed. In non-communist Asia about 30% of the children were malnourished according to this criteria. The number shown on the chart is the median value found in the various surveys.

Can anything be done about this problem?

IN THE LESS DEVELOPED COUNTRIES, LARGE NUMBERS OF CHILDREN ARE MALNOURISHED.

Bengoa in Man, Food, and Nutrition. Chemical Rubber Company

The next chart shows the yield metric tons per hectare of rice versus the area harvested. This is taken from the FAO Production Yearbook and is an envelope of histograms for all of the countries reporting. Of course, rice is the biggest crop in China and India. The chart shows that doubling or tripling production is, in some sense, technically feasible, in that Japan has achieved a yield of 6 metric tons per hectare with intensive agriculture. That is with large amounts of fertilizer applied. The U.S. level is the same as Korea, about 4.8 metric tons per hectare. Of course in practice, China and India and the other less developed countries are not going to increase their yield dramatically soon. Writers on the subject of agriculture in the less developed countries are almost unanimous that the central problem is institutional. That is, the potential is there but is not being realized.

It is of interest to look at success stories - - look at places where high yields have been produced and see what some of the ingredients of the success have been.

A LARGE INCREASE IN RICE PRODUCTION IS TECHNICALLY FEASIBLE.

The Punjab is an outstanding example. The Punjab produces 25% of India's grain requirements from only 2.6% of India's cropped area. The green revolution in the Punjab includes the elements shown on the chart. Literacy is very important. There has to be price policies to provide a guaranteed incentive for the farmer. Credit has to be available at reasonable interest rates so that the farmer can purchase fertilizer and other inputs. Local plant breeding and research has to be carried out. There has to be fertilizer available and electricity for irrigation pumps. Marketing and roads are, of course, essential.

THE PUNJAB PRODUCES 25% OF INDIA'S GRAIN REQUIREMENTS FROM
ONLY 2.6% OF INDIA'S CROPPED AREA. THE GREEN REVOLUTION
IN THE PUNJAB INCLUDES:

LITERACY PROGRAMS

FARM PRICE POLICIES

LAND REFORM - CREDIT

LOCAL R&D

FERTILIZER - ELECTRICITY

MARKETING - ROADS

RANDHAWA

In the area of technology, fertilizer has a somewhat unique role. How to produce fertilizer and apply fertilizer is completely known and just doing it could result in a major increase in food production. One possibility to get some of the benefit from fertilizer without the expense is to develop crops that biologically fix nitrogen. This could be a development of major importance. But, of course, only cutting the population growth offers real hope for the future.

A MAJOR INCREASE IN FOOD PRODUCTION IN THE LESS
DEVELOPED COUNTRIES CAN BE OBTAINED FROM INCREASED
FERTILIZER USE.

DEVELOPMENT OF CROPS THAT BIOLOGICALLY FIX NITROGEN
COULD BE OF GREAT IMPORTANCE.

CUTTING THE POPULATION GROWTH IS ESSENTIAL

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