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GRAIN EXPORT POSSIBILITIES AS A FUNCTION OF DOMESTIC HUMAN AND ANIMAL NUTRITION

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Paper presented, AAEA annual meetings, Pennsylvania State Univ., Aug. 1976.

ABSTRACT

The study indicates the possibilities which exist for the alleviation of the world food shortage through changes in human diets and animal production patterns. Using a linear-programming model, it is found that exports of wheat feed grains and soybeans can be more than doubled relative the 1971-73 average quantities exported.

GRAIN EXPORT POSSIBILITIES AS A FUNCTION OF DOMESTIC HUMAN AND ANIMAL NUTRITION[1]

Introduction

Recently many developing countries have been unable to obtain sufficient food through either production or imports. This "food crisis" has two basic causes: (a) crop shortfalls in some major producing countries, and consequently, (b) market pressures that caused market prices to go out of reach of some developing countries, which usually do not have sufficient funds (foreign exchange) to compete in the world market (Heady, 1975). Also implicit in the latter cause is the uneven distribution of income among developing countries as well as within developing countries. Therefore when countries and individuals alike are outbid, malnutrition on a large scale such as is presently the case, will be the immediate result.

To solve the food-scarcity problem attention must be focused on agricultural practices and food production and export capacity throughout the world. Though there are many means by which world food supplies could be increased and spread more evenly or equitably among consumers, this study will examine some changes in the role of livestock (Riemann) and the diet pattern of the consumer (Higgins) in the United States and their effect on the quantity of grain available for export.

The changes discussed in this report are not aimed at elimination of livestock products from the diet of U.S. consumers. High quality amino-acids, such as provided by ruminants are of major importance in human nutrition (Kendrick and Peterson). Also ruminants play a crucial

role in transforming forages into human food in the form of animal proteins (Heady et al. 1975).

However, the feasibility of substitution of animal proteins for soy proteins is considered. Although the use of soybeans in the human diet is still very small, (only 3 percent of total soybean production) it seems to have great potential (Horan).

The Study

Because of the recent world wide concern regarding available food supplies, this study was initiated to investigate possible adjustments which U.S. consumers and farmers could make to provide larger grain exports to the world. Of course, the changes proposed here cannot alone eradicate hunger from the world. However, other research has indicated that actions in the United States make considerable impact on world food supplies. In the long run, however, the deficit developing countries themselves must become more self-sufficient through more effective policies relating to agricultural production, economic growth and reduced birth rates (Butz).

Alternative Futures Analyzed

There are various means in which the United States can increase its exports. In this paper, four alternatives are analyzed as means of increasing U.S. food exports to consumers of the world. The first emphasizes wheat exports by allowing increased production potential for the year 1980 to be used for wheat only. There are indications "that most of

the developing countries will tend to import more wheat rather than feed grains because of limited foreign exchange and because their people cannot afford to consume large quantities of livestock products" (Gasser). Under the second alternative the trend level consumption of feed grains by fed beef to 1980 is reduced by 25 percent. Corn and sorghum silage are used to replace feed grains in the cattle's ration. The third alternative supposes that American consumers substitute vegetable protein for 25 percent of their projected animal protein intake.[2] The fourth alternative supposes that consumers reduce their animal protein intake by 25 percent, but do not allow for substitution from other sources.

The results of these four alternatives (B through E) are analyzed and compared with the base situation, Alternative A, representing trend production and consumption patterns to 1980. The parameters of the linear programming model used for the analysis are all projected to 1980, and the results are understood to be for that year of reference.

The Model

The four alternatives previously described are analyzed by means of an interregional linear programming model. The model consists of 307 equations and 2214 real variables; it contains the 48 contiguous states and incorporates the wheat, soybeans, cotton, corn and sorghum silage and feed grain (corn, barley, oats and grain sorghum) sectors endogenously. Livestock and other crops are included on an exogenous basis. The model includes an interregional comparative advantage production sector as well as a transportation submodel.

A land base of 250 million acres is available to the commodities internal to the programming model (U.S. Dept. of Commerce, 1971). The nation is divided into 150 rural areas with land restraints for each in the production sector. The consumption sector is specified by 31 demand regions. Demand restraints are defined for each major commodity in the latter regions. Demands specified for the endogenous crops embrace the total usage of these commodities as domestic food, livestock feed, seed, industrial uses and exports-both in raw and processed form. A complete description of the model may be found in (Heady, et al., 1975).

To emphasize the export potential of American agriculture for food and feed grains, cotton exports are held constant at 4.2 million bales per annum for the five alternatives. Although this study emphasizes maximum production and exports, we would not expect farmers to "go all out" in production if adequate markets were lacking and farmers could not get a normal return on their resources. The model therefore assumes a long-run equilibrium in the sense that each unit of resource used in agriculture receives its market rate of return.

Consumption of Livestock

Although the specific goal of this analysis is maximization of exports, estimates of the domestic demands for the endogenous crop commodities also are required. Actually these demands form a major input for this study. As suggested earlier, diet patterns of the American consumer is the variable forced to change in alternatives D and E. The linear programming model specifies that domestic demands have to be satisfied before any grain is available for export. Since livestock

feed is a large component of domestic demand for feed grains and soybeans and because per capita meat consumption is a major variable of interest in this study, the demand estimates for meat adopted for this analysis are presented here.

The basic demand equations used for livestock products are those of Waugh. These equations relate the per capita consumption of meat products to per capita income and the price of meat products. Projected per capita income for 1980 was derived from B.E.A. data (U.S. Dept. of Commerce, 1968). The livestock prices used in this report and their resulting consumption estimates are presented in Table 1. These livestock prices are estimated to be consistent with the feedstuff prices that result in the programming model under full capacity production.

Under alternative A, the consumption of beef in 1980 is estimated to increase from recent levels by 14 percent to 131.4 pounds. Pork is projected to decrease 8 percent, or 5.3 pounds, to 61.4 pounds. Consumption of broiler and turkey meats is not estimated to change significantly over this period. Lamb consumption is projected to decline by less than 1.0 pound.

Under alternatives D and E, these same projections are made for per capita consumption in 1980. Once the estimates have been derived, however, they are further transformed. In alternative D the American consumer cuts back his animal protein intake by 25 percent but substitutes soy protein for the meat reduction. This means that the projected levels (Table 1) are reduced by 25 percent for all meats. Thus, in alternative D, soy and meat proteins are substituted on a one-for-one

basis. In alternative E, however, the consumer's demand for meat is reduced by 25 percent without replacement by soy protein. In alternatives B and C consumption estimates do not change from those of alternative A.

Estimated Export Potentials

Results of the model solutions provide an indication of maximum export possibilities for the United States under an optimal allocation of resources and production under the land and domestic demand restraints outlined earlier. Potential exports for each commodity are presented in Table 2. To further illustrate these results, estimates for each commodity are graphed in Figure 1, using feed units as a common denominator for wheat, feed grain and soybeans.

Comparing alternative A with the 1971-73 average level of exports, the rather significant increase in export possibilities for each commodity can be explained as follows: (a) Land is included in production for our estimates, while a large acreage was idle under government supply-control in 1971-73. (b) Yields for the endogenous crops are projected to increase as a result of improved technology by 1980. (c) All crops are allocated among the 150 regions according to their comparative advantage in production of each crop.

The "wheat" alternative, B, has 2.7 billion bushels of wheat available for export. (Export of feed grain and soybeans are held at the 1971-73 average level.) This change in the composition of grain exports implies a tremendous increase in the amount of directly consumable food available, 950 million bushels of additional wheat over alternative A.

If the trend toward more feeding of silage to fed beef is assumed to accelerate by a modest 25 percent, however, an even larger quantity of grain would become available for export. Under alternative C, 5.6 million more tons of grain expressed in feed units are available than estimated for alternative A.

With a modest substitution of soy protein for meat, thus keeping total protein constant, alternative D exports increase by 108 percent over the 1971-73 actual level and 17 percent over alternative A. Exports of wheat would now be 2 billion bushels; feed grain and soybean exports would be 66 million tons and 936 million bushels, respectively.

Even greater exports are possible if consumers do not substitute soy protein for the 25 percent reduction in meat consumption, alternative E. Exports could increase by 5.7 million tons of feed units over alternative D. Under alternative E, exports increase 21 percent over alternative A and 115 percent over the actual 1971-73 level. Under alternative E, wheat exports are 2.1 billion bushels, feed grains 68 million tons and soybeans 968 million bushels. The proportion of grains in export under alternatives A, and C through E is forced to remain constant at the 1971-73 mix.

Conclusion

To estimate possibilities of U.S. exports to a hungry world, this study examines four rather modest shifts in U.S. exports and consumption patterns: (a) allowing greater production potential for 1980 to be used for wheat only (alternative B); (b) substituting corn and sorghum silage for 25 percent of the feed grain fed to fed beef;

(c) substituting vegetable protein for 25 percent of the projected animal protein intake of American consumers (alternative C); and (d) reducing the animal protein intake of the American consumer by 25 percent (alternative D).

Under the first shift (alternative B), exports of wheat increase 175 percent over 1971-73 average levels. Wheat exports total 2.7 billion bushels. The second method (alternative C) releases an additional 69 million bushels of wheat, 2.2 million tons of feed grains and 31 million bushels of soybeans for export. Under the third shift (alternative D), exports of the three commodities together increase 108 percent over average 1971-73 levels and 17 percent over alternative A. Exports are 2.0 billion bushels of wheat, 66 million tons of feed grains and 936 million bushels of soybeans. The highest levels of exports are realized with the fourth shift (alternative E). Wheat exports are 2.1 billion bushels; feed grains are 68 million tons; and soybeans are 968 million bushels. Total exports are 21 percent greater than those in alternative A.

Some implications of this research are: American capacity to increase production and exports is quite large, even without implementing any of the policy alternatives, as in alternative A. Additionally, shifts in the form of American grain exports and changes in American diet patterns could provide sharply increased amounts of grain for export. A major complementary issue not addressed here is what market or policy situation would have to be developed before the changes discussed would result. Also the changes discussed, could have adverse

effects on some of the nation's rural communities as well as the livestock industry.

Another major policy issue to be addressed before shifts of the type analyzed are made involves the U.S. farmer's need for strong market institutions and demand levels to insure that the resources used in "full capacity" production will earn a fair return. A policy of "all-out production" without means of price guarantees or assurance of foreign demand would cause great uncertainty of over-production such as that which prevailed in the decades of the 1950s and 1960s.

The alternatives in this study were used to evaluate possibilities posed by U.S. and other leaders and the 1974 World Food Conference. The analysis of such alternatives does not necessarily represent a recommendation of such policies. It does serve to indicate relationships that are important factors if and when a world food policy is developed.

Footnotes

1. Journal Paper No. J-8353 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 2103.

2. In this study the substitution is based solely on soy-protein.

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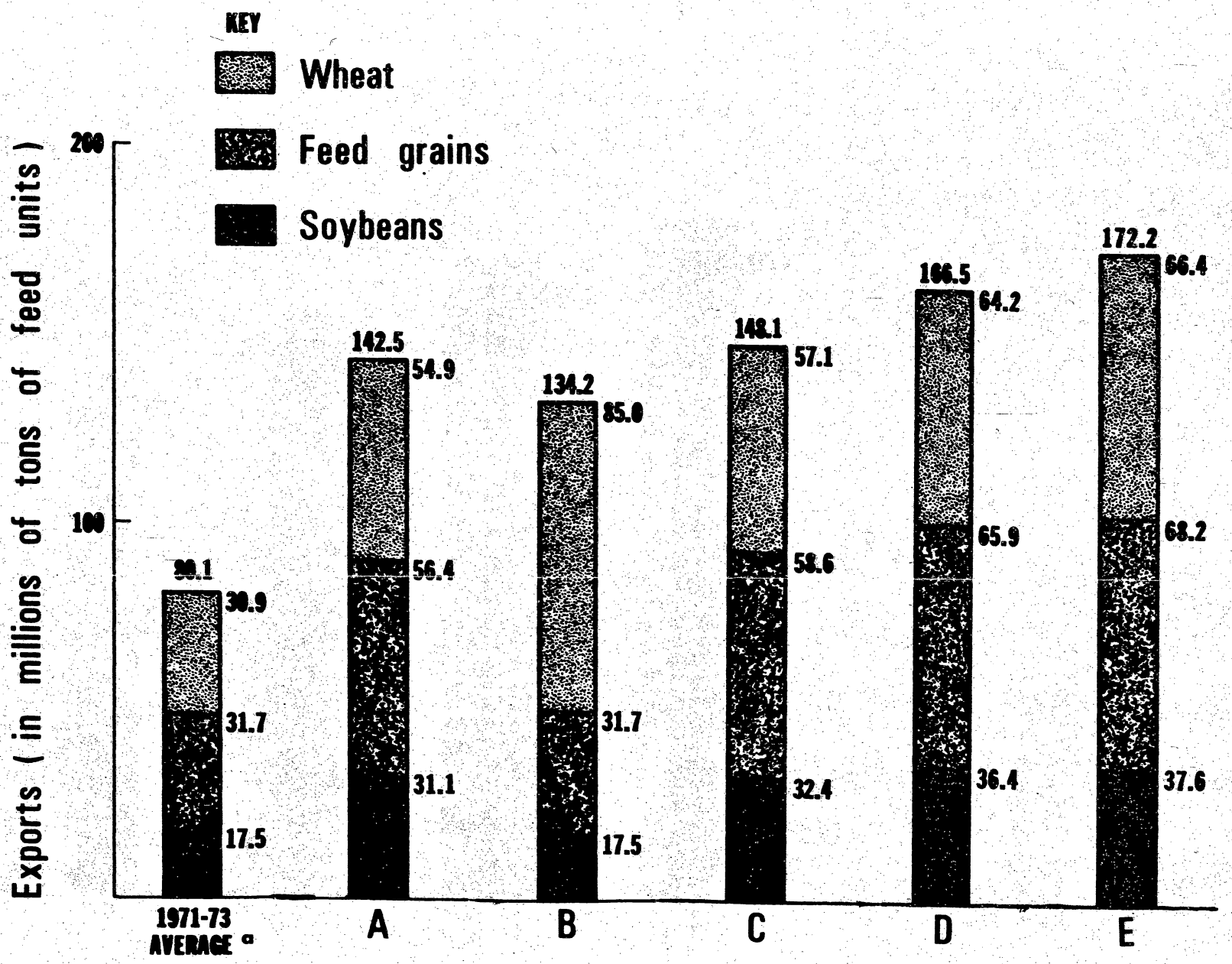

Figure 1. Estimates of wheat, feed grain, and soybean exports for each model alternative (in millions of tons of feed units).

[a]Source: (U.S. Dept. of Agr., 1974).

Table 1. Per capita consumption for selected years and prices received at farm level as used in this study.

Livestock class	Per Capita Consumption 1969-72 average[b]	1974[b]	1980	Price at farm level[a]
			(lbs.)	(¢/lb.)
Beef	115.4	109.6	131.4	48.0
Pork	66.7	61.6	61.4	37.0
Broilers	38.9	41.5	40.5	24.0
Lamb	3.2	2.7	2.7	41.0
Turkeys	9.1	8.7	9.2	22.4

[a]Prices are expressed in 1972 dollars with no adjustments for inflation to 1980.

[b]Source: (U.S. Dept. of Agr., 1973).

Table 2. Estimated exports for each model alternative with 1971-73 average exports for comparison.

	Actual 1971-73[a]	Model alternatives				
		A	B	C	D	E
Wheat	979.8	1,744.1	2,698.4	1,812.6	2,038.0	2,106.6
Feed grains (million tons)	31.7	56.4	31.7	58.6	65.9	68.2
Soybeans (million bu.)	450.2	801.3	450.2	832.9	936.4	967.9
Cotton (million bales)	4.2	4.2	4.2	4.2	4.2	4.2

[a]Source: (U.S. Dept. of Agr., 1974)