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Federal Public Land Laws and Policies Relating to Intensive Agriculture, Volume V. Working Paper: Their Potential Contribution to Food and Fiber Needs, 1980 and 2000

Economics Department

Bill Folkerts

Federal Public Land Laws and Policies Relating to Intensive Agriculture

VOLUME V

WORKING PAPER

Federal Public Lands: Their Potential Contribution to Food and Fiber Needs, 1980 and 2000

Prepared for the

Public Land Law Review Commission

Washington, D. C.

By

The Economics Department

Agricultural Experiment Station

South Dakota State University

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See last page for titles of other volumes in this report

FEDERAL PUBLIC LANDS: THEIR POTENTIAL CONTRIBUTION TO FOOD AND FIBER NEEDS

Russell L. Berry

I. INTRODUCTION

It is common knowledge that the world's population is increasing at an unprecedented pace. Food supply has become a major world problem particularly in the underdeveloped countries and is also a matter of concern in the developed countries where population is increasing at a slower rate and agricultural productivity is high. In view of these trends and the expected demand for food, what is the potential contribution of the federal public lands to future food and fiber needs?

Total non-federal, non-urban cropland of varying quality totals 638 million acres in the 50 States. About 336 million acres are now in use, and 80 million additional acres could be returned to use in a short time. Urbanization is using approximately 200,000 acres of cropland per year.[1] Federal public lands comprise 371 million acres in 17 Western States. However only 3.3 million acres are classed as presently arable for either dry or irrigated farming. Another 35 million acres are considered irrigable, but water is not now either legally or physically available for them.

The purpose of this report is to assess the potential role of federal public lands in satisfying future food and fiber needs by reviewing (1) the projected trends in population, (2) the projected food and fiber needs, (3) the acres of cropland that will be required to produce the food and fiber needed, and (4) the potential contribution

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[1] Food & Fiber for the Future, report of the National Advisory Commission on Food and Fiber (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 243-245.

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of the federal public lands to these needs. This analysis assumes that the maximum public benefit will be achieved if food and fiber needs are met at least cost.

II. FUTURE POPULATION PROJECTIONS AND FOOD AND FIBER NEEDS, 1980 AND 2000

Other things being equal, the demand for food varies directly with the number of people. If world population doubles by 2000, food requirements will also double--especially in those areas of the world where food is barely sufficient to maintain life. With rising incomes the resulting increase in demand for food will probably mean that world supplies will need to increase by two and a half to three times. Hence any study of the future demand for food must begin with a study of population prospects or trends.

World Population and Food and Fiber Needs

If present trends continue, world population is expected to double by the year 2000. In 1965 it was estimated to be 3.3 billion, and the medium projection for the year 2000 is 6.0 billion (Table 1). The most rapid increases are taking place in Asia, Africa, and Latin America, areas of the world least able to bring their burgeoning population into balance with their food supplies. Asia had 1.8 billion people in 1965--56 percent of the total world population. If current trends continue, even the medium projections indicate increases of 30 percent by 1980 and 80 percent by 2000. African population is expected to increase 60 percent by 1980 and 150 percent by 2000, and in Latin America anticipated increases are 50 percent by 1980 and 150 percent by 2000. In contrast, population increases in Europe will probably be only about 10 percent by 1980 and 20 percent by 2000.

The rapid population increases expected in Asia, Africa, and Latin America are largely due to health and sanitation improvements which have reduced infant mortality and increased longevity. These desirable measures introduced by the United Nations, national governments, and private organizations have had the ironic effect of preventing death by disease but increasing the likelihood of malnutrition and death by starvation. It is now being recognized that malnutrition, particularly during infancy, may have most serious effects on mental as well as on physical ability.

Table 1.--Major world area population estimates for 1965 and medium projections for 1980 and 2000

Area	Estimate mid-1965	Medium projections 1980	Medium projections 2000	Increase over 1965 1980	Increase over 1965 2000
	- - - - - Millions	- - - - -		- - - Percent	- - -
Africa	311	449	768	63	147
Asia (total)	(1,842)	(2,404)	(3,307)	(30)	(80)
East Asia	867	1,038	1,284	20	48
South Asia	975	1,366	2,023	40	107
Europe	443	479	527	8	19
Latin America	248	374	624	51	152
North America	215	262	354	22	65
Oceania	17	23	32	35	39
U.S.S.R.	234	278	353	19	51
World total	3,308	4,269	5,965	29	80

Source: <u>Population Bulletin</u> (October 1965), p. 96.

The National Advisory Committee on Food and Fiber notes that the developing regions not only have two-thirds of the world population but that their populations are growing at almost twice the rate of developed countries with adequate diets. Furthermore, the Committee declares "if current trends in population, food demand and production continue, by 1980, the food deficit of the developing regions could be too large for the physical and financial capabilities of the developing regions to overcome it."[2]

In this dismal situation, food aid programs may be only a short-run palliative. Unless these programs are used with care, they can ruin market prices for native farmers and thereby discourage increased production. Food aid can also mask the need for population control and food production in the underdeveloped countries. But even effective efforts to control population and produce food may be too late to forestall severe pressure on supplies, and food aid will still be needed in increasing amounts to prevent famines such as recently ocurred in India as a result of drought. But in the long run these countries must produce most of their own food or purchase it on world markets. (Trends in world food production per capita are shown in Figure 1.)

In some cases food aid can be used in underdeveloped countries to good advantage as incentive payments for labor in the construction of farm-to-market roads and other similar projects that will help the people become more self-sufficient. In general, aid should be centered on providing and developing teaching, training, research, and demonstration institutions. New capital for agriculture should also be emphasized. Seeds, fertilizers, insecticides, hand tools, and machinery are examples of pressing needs. In the short run, capital may have to come from foreign sources, but as soon as possible it should be provided by the peoples themselves with the aid and assistance of their governments.[3]

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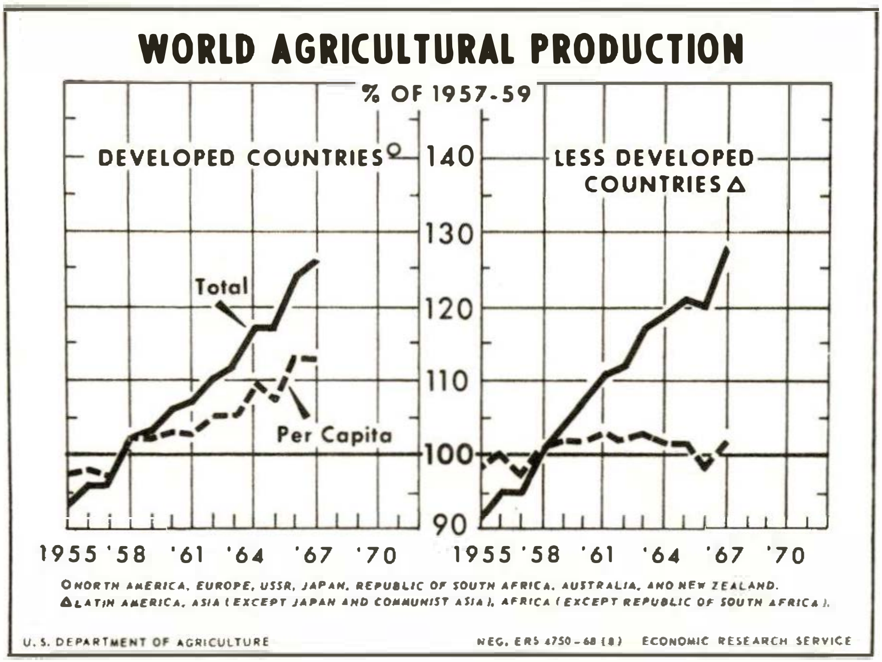
[2] Food & Fiber for the Future, National Advisory Commission on Food and Fiber, p. 306.

[3] Rutillis H. Allen, "The Role of Agriculture in World Economic Development," Agriculture and Foreign Economic Development, Technical Papers, Vol. VII, National Advisory Commission on Food and Fiber (1967), pp. 1-33.


WORLD AGRICULTURAL PRODUCTION
% OF 1957-59
DEVELOPED COUNTRIES○
LESS DEVELOPED COUNTRIES△
Total
Per Capita
140
130
120
110
100
90
1955 '58 '61 '64 '67 '70
1955 '58 '61 '64 '67 '70
○NORTH AMERICA, EUROPE, USSR, JAPAN, REPUBLIC OF SOUTH AFRICA, AUSTRALIA, AND NEW ZEALAND.
△LATIN AMERICA, ASIA (EXCEPT JAPAN AND COMMUNIST ASIA), AFRICA (EXCEPT REPUBLIC OF SOUTH AFRICA).
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 4750-68 (8)
ECONOMIC RESEARCH SERVICE

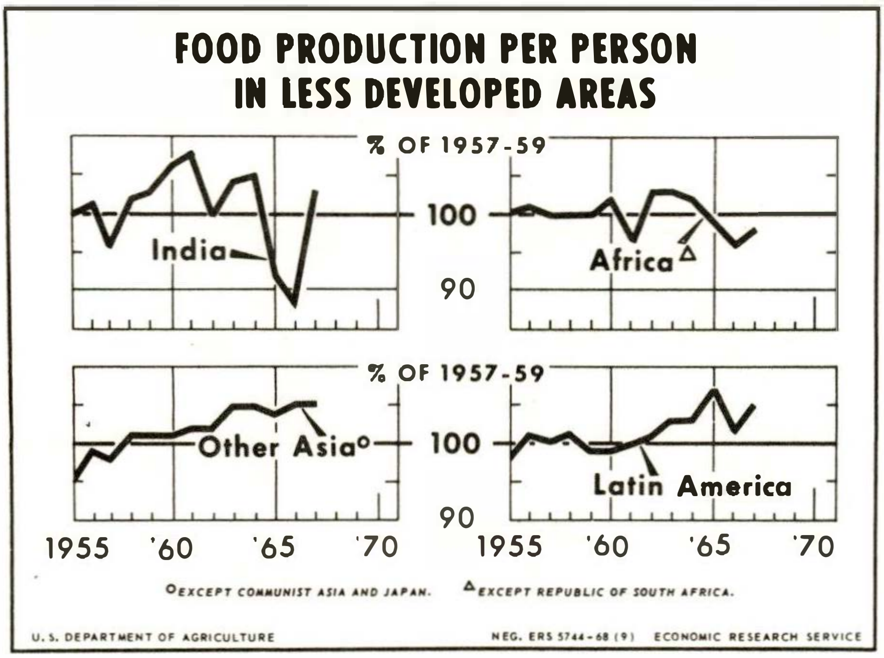

FOOD PRODUCTION PER PERSON IN LESS DEVELOPED AREAS
% OF 1957-59
India
Africa△
100
90
% OF 1957-59
Other Asia○
Latin America
100
90
1955 '60 '65 '70
1955 '60 '65 '70
○EXCEPT COMMUNIST ASIA AND JAPAN.
△EXCEPT REPUBLIC OF SOUTH AFRICA.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 5744-68 (9)
ECONOMIC RESEARCH SERVICE

Figure 1

New Low Cost Foods

Crop yields in other countries will continue to increase rapidly, although at a slower pace than population, if present trends continue.

Arthur and others have called attention to new low-cost foods that may be developed to help feed the world's growing population.[4] They point out that one of the serious food shortages is protein. At present, about 50 million metric tons of fish are harvested yearly, but it is estimated that this harvest could be increased to 250 million metric tons if more efficient methods were used and fish now unmarketable are utilized.

Synthetic milk and meats from soybean, peanut, sunflower, and safflower proteins may greatly improve efficiency in production of needed proteins. Feeding these products to livestock in order to produce milk and meat is relatively inefficient.

A fish protein concentrate (FPC) that is virtually odorless and tasteless may be an inexpensive way of providing needed proteins when added to conventional foods such as stews, soups, tortillas, and bread.

A new rice variety (IRI-8) could double the world's rice production in the next 10 years. By the year 2000, production may have increased many times.

A new field corn (Opaque 2) is capable of producing most of the amino acids that the body needs. General use of such a corn might greatly reduce malnutrition in Latin America where corn is a staple food.

Lysine, an amino acid derived from fermented molasses, is a promising new food supplement that can be added to conventional foods to provide proteins almost equal to those in milk and meat.

Yeasts, used during World War II in Germany, are also a promising source of protein although somewhat deficient in amino acids. Other micro-organisms can also be used such as *fungi imperfecti* which synthesize proteins from products like blackstrap molasses, sweet potatoes, and corn starch.

Algae farming is an especially promising source of foods and feeds for the future. Algae are most efficient converters of solar energy into foods and produce yields 20 to 40 times greater than most

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[4] H. B. Arthur, R. A. Goldberg and K. M. Bird, *The United States Food and Fiber System in a Changing World Environment*, Technical Papers, Vol. IV, National Advisory Commission on Food and Fiber, p. 58.

farm crops. They are high in protein, but not so high as meat and fish; they are also fairly high in vitamins. Production costs are estimated to be $40 to $100 per ton of 50 percent protein food, a cost that compares favorably with soybean proteins.

There are a number of other possibilities for developing foods for the future. Arthur and others suggest that in the years ahead food may come from such strange sources as petroleum, methane gas, and chemical synthesis.[5] Their estimates of the probability of commercial success by 1980 of the products discussed above are as follows:

Product	Percentage
Lysine to supplement grains	95
IRI-8 rice	95
Opaque 2 corn	90
Fish protein concentrates	95
Protein foods from soybeans, peanuts, etc.	80
Soybean milk	60
Fungi proteins	20
Protein foods from petroleum	3
Protein foods from sea water	5
Protein foods from sewerage wastes	7
Protein foods from industrial wastes	5
Plankton, chemical synthesis and synthetic energy compounds	½

Perhaps by the year 2000 other possibilities will have been developed to meet food and fiber needs beyond that date.

Foreign Demand for U.S. Food and Fiber

Despite the rapidly growing populations in the developing countries, the strongest export markets for U.S. food and fiber are still found in the developed countries (Figure 2). In 1968, Japan was our best commercial market for agricultural exports. Canada, the Netherlands, the United Kingdom, West Germany, and Italy followed in that order. India took $500 million worth of farm products, but these were all under U.S. government programs. Pakistan and South Vietnam also received considerable government-sponsored farm exports.

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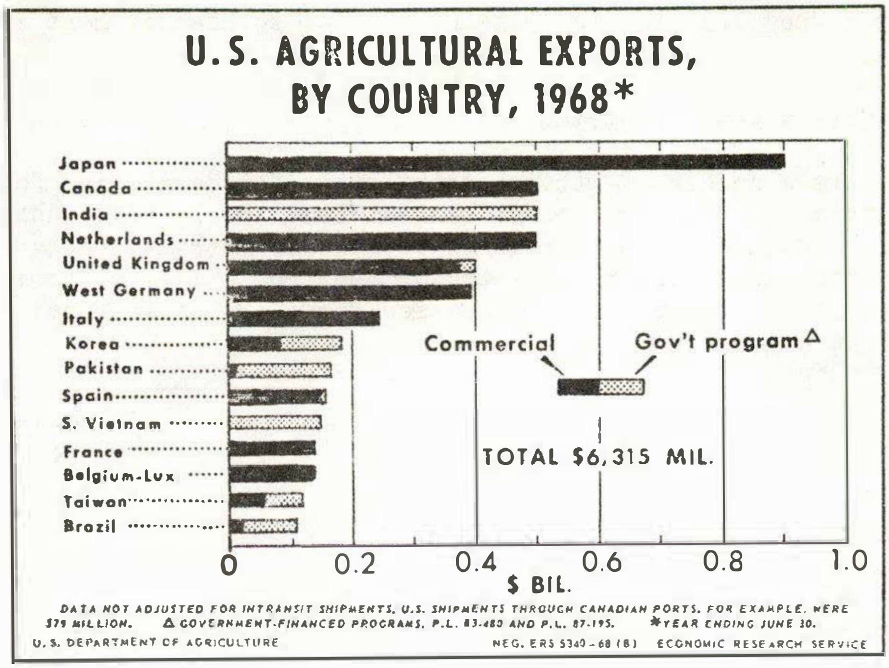
[5] Ibid., pp. 58-59.


U.S. AGRICULTURAL EXPORTS,
BY COUNTRY, 1968*
Japan
Canada
India
Netherlands
United Kingdom
West Germany
Italy
Korea
Pakistan
Spain
S. Vietnam
France
Belgium-Lux
Taiwan
Brazil
Commercial
Gov't program △
TOTAL $6,315 MIL.
0
0.2
0.4
0.6
0.8
1.0
$ BIL.
DATA NOT ADJUSTED FOR INTRANSIT SHIPMENTS. U.S. SHIPMENTS THROUGH CANADIAN PORTS, FOR EXAMPLE, WERE $79 MILLION. △ GOVERNMENT-FINANCED PROGRAMS, P.L. 83-480 AND P.L. 87-195. *YEAR ENDING JUNE 30.
U. S. DEPARTMENT OF AGRICULTURE
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ECONOMIC RESEARCH SERVICE

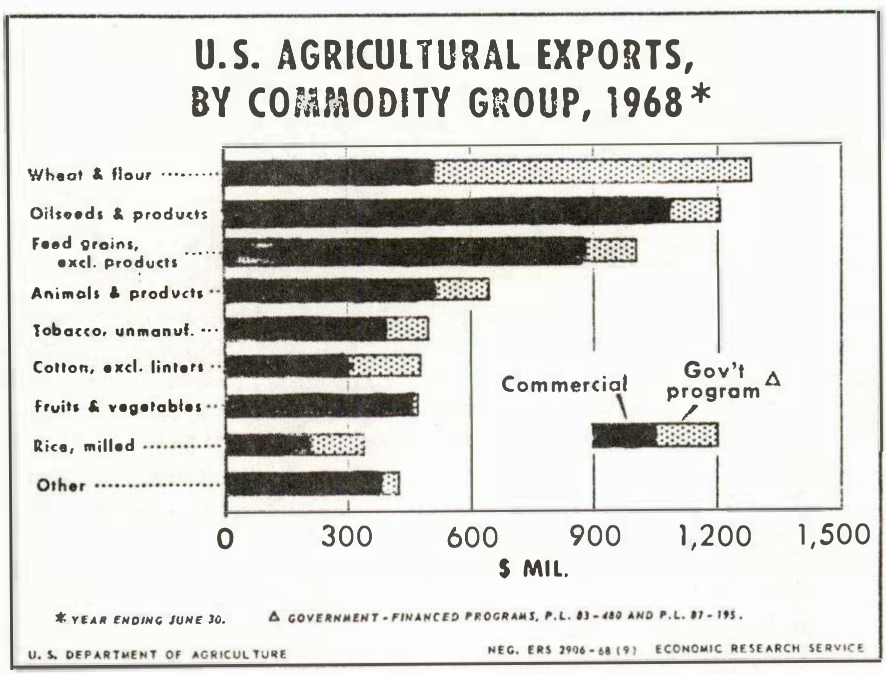

U.S. AGRICULTURAL EXPORTS,
BY COMMODITY GROUP, 1968*
Wheat & flour
Oilseeds & products
Feed grains, excl. products
Animals & products
Tobacco, unmanuf.
Cotton, excl. linters
Fruits & vegetables
Rice, milled
Other
Commercial
Gov't program △
0
300
600
900
1,200
1,500
$ MIL.
*YEAR ENDING JUNE 30.
△ GOVERNMENT-FINANCED PROGRAMS, P.L. 83-480 AND P.L. 87-195.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 2906-68 (9)
ECONOMIC RESEARCH SERVICE

Figure 2

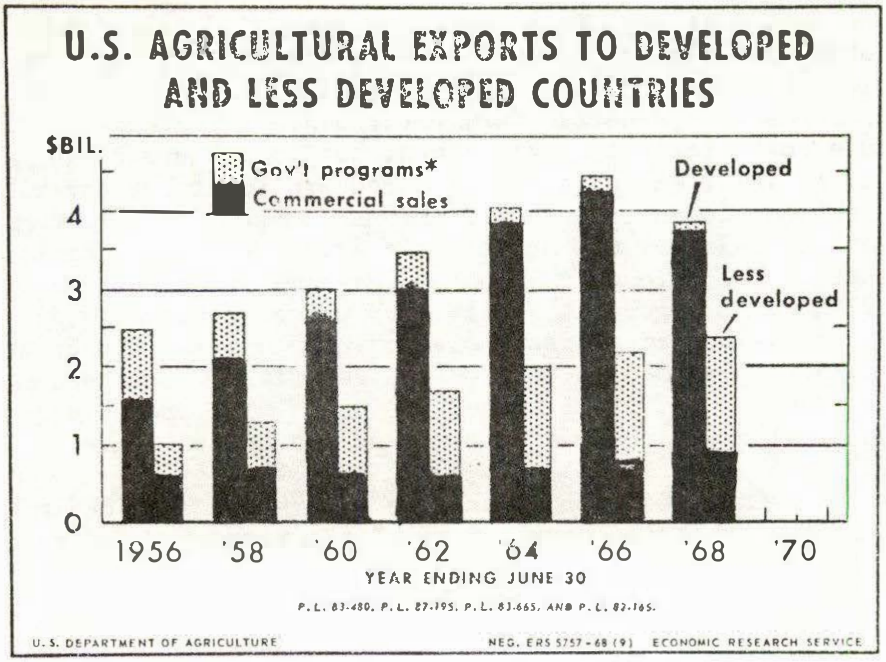
In the United States, total cropland harvested fell from 324 million acres to about 300 million during the last decade. At the same time, croplands harvested for export increased from about 50 million to 75 million acres--50 percent. Farm exports are expected to remain strong and even increase in years ahead, but this increase is not expected to be great enough to warrant concern about our capacity to produce the foods demanded at home. Exports tend to be the surplus after domestic needs are met and to this extent are not competitive with local markets. The role of government programs in present major food exports is shown in Figure 3. While such programs probably will be continued, the vast food needs of developing countries can be transformed into effective demand only over a relatively long period. Their use of our farm products for the next 30 years will probably depend heavily on foreign aid policies pursued by the United States.

Thus the primary concern is whether future domestic demands for food and fiber warrant the development of the remaining federal public lands for dry or irrigated crop production at this time. Since population in underdeveloped countries threatens to outrun food supply, will population in the United States also outrun our capacity to produce?

Future U.S. Population and Food Needs

Despite the steady population increase in the United States there has been no food shortage in this country. Price-depressing surpluses of foods and fibers have led to farm programs that have idled over 60 million acres of cropland. Since 1950 total food consumption has increased more rapidly than population. (U.S. trends in population and food production are shown in Figure 4.)

But what of the future? Population projections for the United States are presented in Table 2. The medium-high projections are for a 25 percent increase by 1980 and a 75 percent increase by the year 2000. If these projections prove to be accurate, food and fiber needs will also increase 25 percent by 1980 and 75 percent by 2000. These needs can be met by a comparable increase in cropland, a comparable increase in yields, by imports, or by some combination of these methods.


U.S. AGRICULTURAL EXPORTS TO DEVELOPED AND LESS DEVELOPED COUNTRIES
$BIL.
Gov't programs*
Commercial sales
Developed
Less developed
4
3
2
1
0
1956
'58
'60
'62
'64
'66
'68
'70
YEAR ENDING JUNE 30
*P.L. 83-480, P.L. 87-195, P.L. 83-665, AND P.L. 82-165.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 5757-68 (9)
ECONOMIC RESEARCH SERVICE

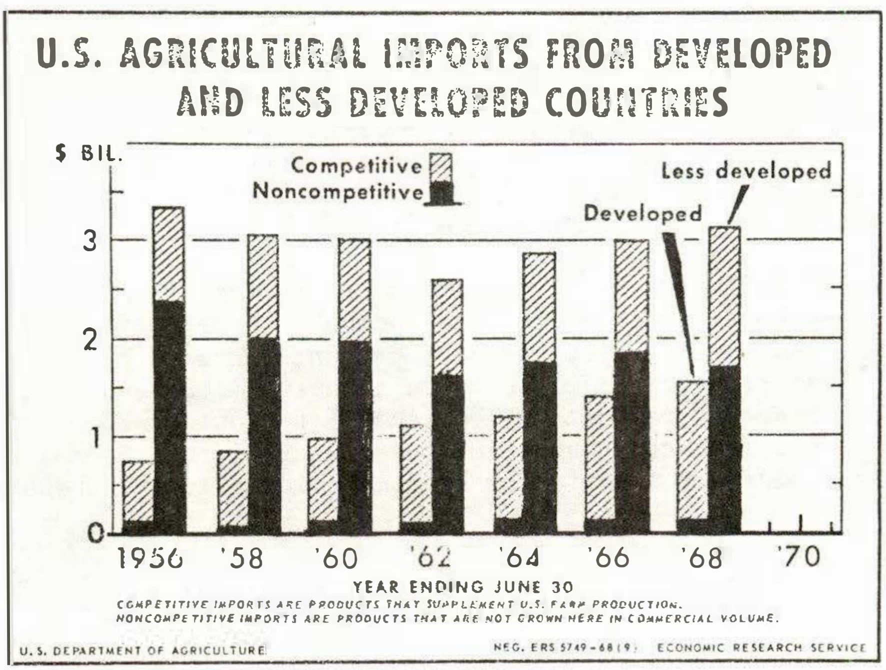

U.S. AGRICULTURAL IMPORTS FROM DEVELOPED AND LESS DEVELOPED COUNTRIES
$ BIL.
Competitive
Noncompetitive
Less developed
Developed
3
2
1
0
1956
'58
'60
'62
'64
'66
'68
'70
YEAR ENDING JUNE 30
COMPETITIVE IMPORTS ARE PRODUCTS THAT SUPPLEMENT U.S. FARM PRODUCTION.
NONCOMPETITIVE IMPORTS ARE PRODUCTS THAT ARE NOT GROWN HERE IN COMMERCIAL VOLUME.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 5749-68 (9)
ECONOMIC RESEARCH SERVICE

Figure 3

Table 2.--Estimated population of the United States for 1965 with projections for 1980 and 2000

Year and level	Population estimate (millions)	Increase over 1965 (percent)
1965 estimate	193.8	---
<u>1980 projections</u>		
Low	227.7	17
Medium-low	235.2	21
Medium-high	243.3	26
High	250.5	29
<u>2000 projections</u>		
Low	282.6	46
Medium-low	307.8	58
Medium-high	336.0	73
High	361.4	86

Sources: U.S. Department of Commerce, *Population Estimates*, Bureau of the Census, Series P-25, No. 375 (3 October 1967), p. 18; Series P-25 No. 381 (18 December 1967), pp. 76, 77, 94, 95.

III. PRIVATE CROPLANDS: CAN THEY MEET FOOD AND FIBER NEEDS OF 1980?

Whether or not the maximum benefit of the general public will be served by disposal of arable federal public land for crop production depends in large part upon the production potentials of privately owned lands that are available for food and fiber production. This part of the report will review:

(a) the trends in population growth, food consumption and production,

(b) the recent study made for the National Advisory Commission on Food and Fiber concerning the ability of U.S. agriculture to meet food and fiber needs of 1980, and

(c) the prospects for meeting the food and fiber needs of the year 2000.

U.S. Population Growth and Farm Production Trends

Since 1950 the population of the United States has increased by 32 percent, but farm output has increased by 42 percent (Figure 5). Perhaps the most significant point is that this remarkable increase in production was achieved by a 52 percent increase in crop yields and a 34 percent increase in livestock production with 10 percent less cropland (Table 3). The achievement is all the more remarkable since between 1955 and 1967, acreage devoted to export crops increased from 47 million to 71 million, or 50 percent.

The 42 percent increase in farm production has not only fed the sharp increase in population but fed it well. Since 1950 there has been a 4.5 percent increase in per capita food consumption. There has also been a sharp increase in per capita use of beef and veal and a decline in cereal and bakery products (Figures 6 and 7). The result is a diet that requires considerably more farm production either by increasing acres or yields. Despite a 32 percent population growth, better diets, and a 50 percent increase in acreage of crops exported, the nation has been able to meet the food needs that have arisen since 1950. But reassuring as this performance has been, there are new challenges to food production. By 1980 the population may rise to the high estimate of 243 million people-- 25 percent above the 1965 level.

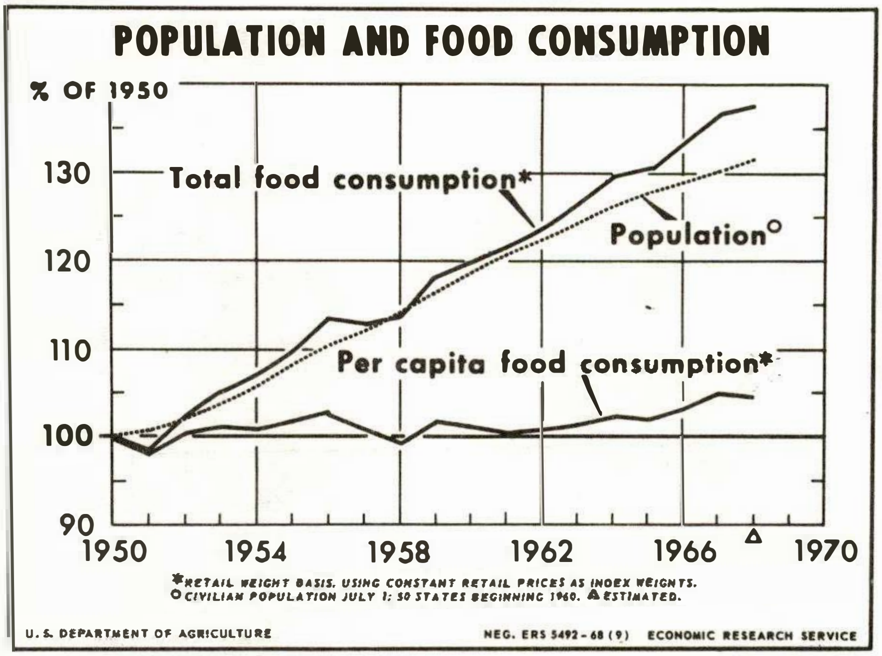


Figure 4

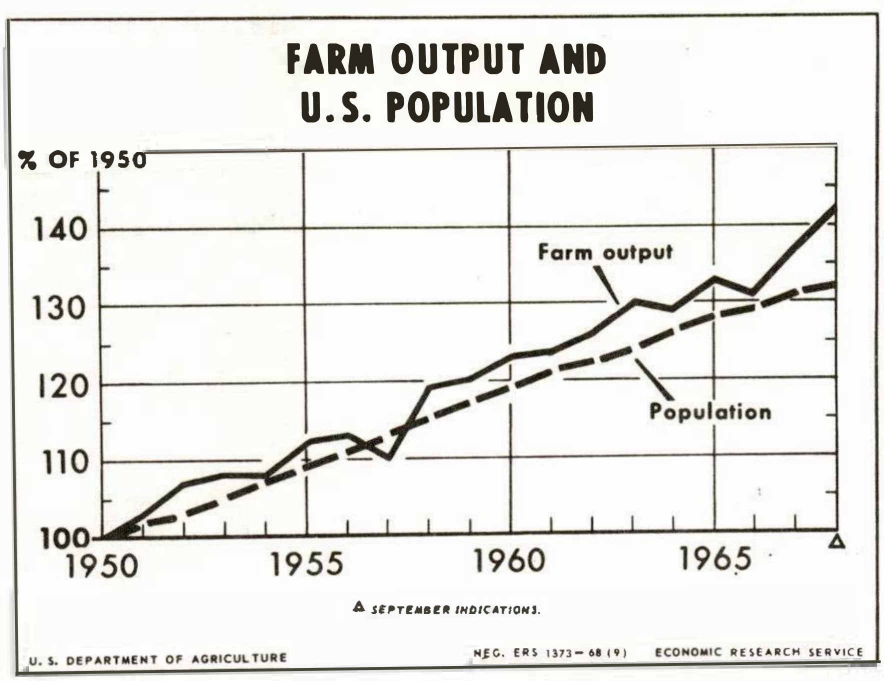


Figure 5

Table 3.--Trends in population and crop and livestock production, United States, 1950-1968

	1950	1955	1960	1965	1968
	- - - - - - - -	- Index	numbers -	- - - -	- - -
U.S. population	100	109	119	128	132
Farm output	100	112	123	133	142
Livestock production	100	112	116	126	134
Crop production	100	108	121	129	137
Crop production per acre	100	108	130	145	152
Cropland used for crops	100	100	93	89	90

Source: U.S. Department of Agriculture Handbook of Agriculture Charts 1968, p. 10.

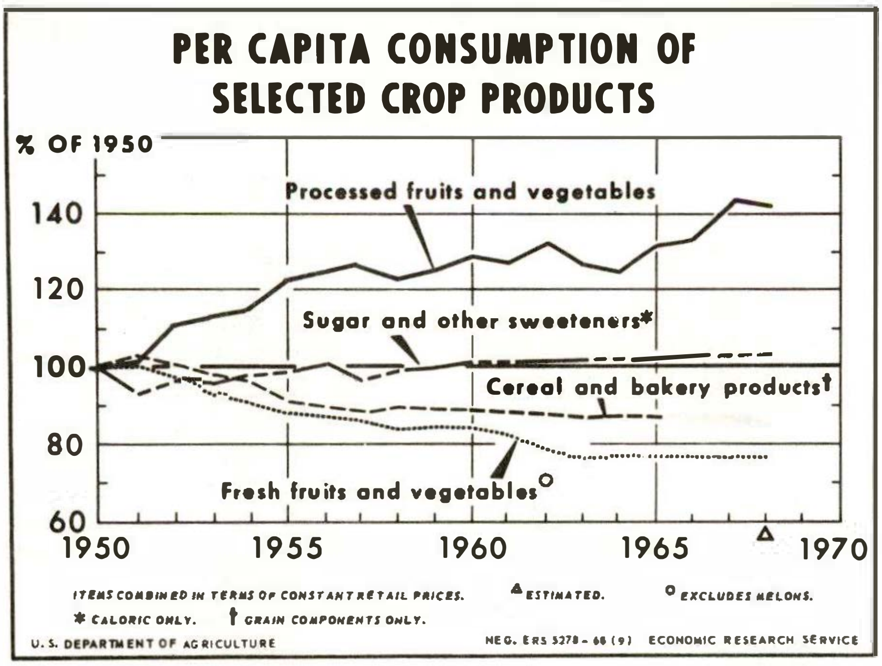


Figure 6

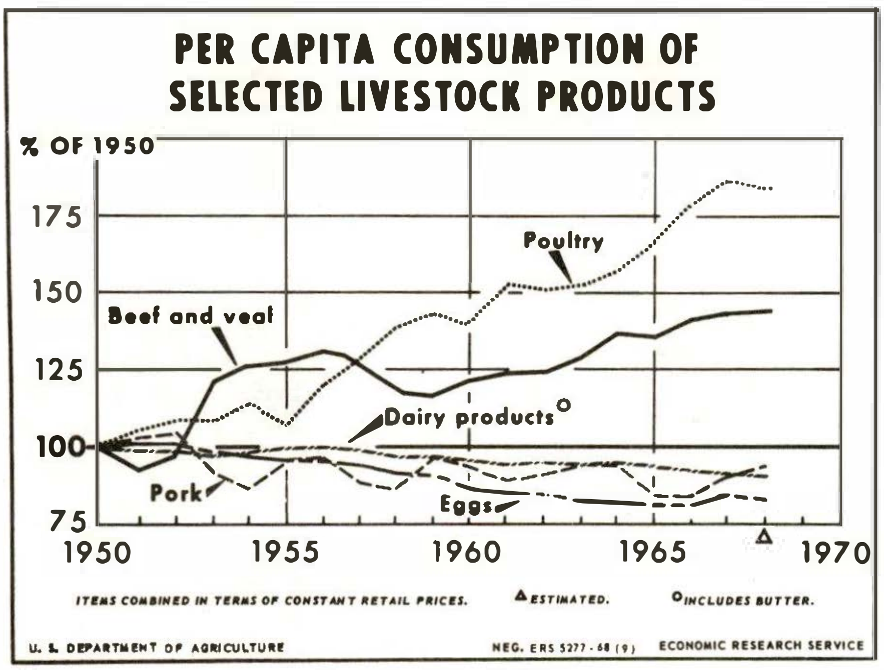


Figure 7

Given expected trends in crop yields and per capita consumption, would this increase in population, plus increased foreign demand, exhaust the supply of idle cropland by 1980?

U.S. Agriculture and Food Needs, 1980

Whether or not agriculture in the United States can meet the food and fiber demands of the population of 243 million expected by 1980 has been recently studied by Heady and Mayer for the National Advisory Commission on Food and Fiber.[6] Their work, reviewed here in detail, should be of much help to the Public Land Law Review Commission as it seeks to determine what should be done with federal lands suited to crop production. The study could not have been made without a powerful tool, a multi-regional linear program, which Heady and Mayer used for the 144 producing and 31 demand regions involved. The authors studied four alternative "free market" farm programs (models) and found that an excess of 47 to 78 million acres existed under the first three plans so that only "a policy of exporting all quantities of major crops above domestic needs which the agricultural sector is able to produce" would exhaust the nation's excess capacity of 56 million acres of idle land by 1980. Heady and Mayer concluded that "given any policy other than all-out production, it is evident from the models analyzed that the agricultural economy will continue to have surplus capacity for the forseeable future."[7]

The authors note that "unless society changes its views on what constitutes equitable returns to landowners, it is probable that programs for removing land from production will continue." Therefore, they analyzed models of three "controlled market" farm programs that involve restrictions on crop production. Their analysis revealed excess capacity with 45 to 71 million acres of idle land.

Consumption Rates and Total Demand

Obviously the number of acres of land that were found to be idle depends not only upon the population expected (243.4 million) but also upon per capita consumption, feeds required to produce livestock products consumed, expected level of exports, and finally, expected crop yields.

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[6] Earl O. Heady and Leo V. Mayer, Food Needs and U.S. Agriculture in 1980, Technical Papers, Vol. I, National Advisory Commission on Food and Fiber, p. 63.

[7] Ibid., p. 70.

Per capita food consumption is an important factor affecting the needs for foods and fibers in 1980 and hence the amount of idle acres. Since the consumption estimates used by Heady and Mayer in Table 4 are considerably higher than dressed or refined product rates would be, it appears that their rates are for live weight and unmilled grains.

Efficiency in converting rough feeds into human foods is also an important factor affecting the amount of land needed in the future. The Heady and Mayer estimates of feeds and oilmeal required to produce 1,000 pounds of livestock products are shown in Table 5. These human consumption and livestock feeding rates were then used to project the total demand for the four major crops--wheat, feed grains, soybeans and cotton--to 1980 under four levels of export. These figures are shown in Table 6.

To translate the human and livestock consumption rates into acres of cropland, the expected yields of these crops must be estimated. The Heady--Mayer estimates for 1980 are presented and compared with historical trends of these crops in Table 7. Yields for the various States are shown in Table 8.

The maximum cropland available for these seven major crops--wheat, corn, oats, barley, sorghum, and cotton--was assumed to be equal to the maximum acreages which have been harvested in past years. For example, in 1965 the harvested and idled acres of these seven crops was 252 million. Although 56 million acres were idle, they could easily be brought back into production if needed.

Lands devoted to tame hay were not included in the study. Other minor crops and fruits and vegetables were also omitted. In 1967, a total of 6.6 million acres of vegetables, fruits and nuts was harvested. Therefore, if demand warranted, their acreages could be doubled or tripled without greatly affecting the acreages of the seven major crops studied.

Costs of production and transportation for the various crops were also projected to 1980 for the study. These included machinery, power, seed, chemicals, fertilizers, labor, and similar costs. Land and management costs were omitted since they would claim the net returns after other costs had been paid.

Cropland Used and Idle Land in 1980

Using these basic rates Heady and Mayer determined the amount of cropland that would be needed under the four free market and three controlled market situations previously mentioned. The results are summarized in Table 9.

Table 4.--Estimated per capita consumption for 1964 with projection used in study of food and fiber needs for 1980

Commodity consumed	Per capita consumption 1964	1980	Increase 1950-1964	1964-1980
	- - - - Pounds	- - - -	- - Percent	- -
Livestock products				
Beef and Veal	183.8	203.5	47	11
Pork	107.5	97.0	1	-10
Lamb and Mutton	8.6	7.2	5	-16
Broilers	31.2	50.2	11	61
Turkeys	7.2	11.8	16	64
Dairy products	628.0	570.0	-5	-9
Eggs(number)	314.0	290.0	-7	-8
Grain products				
Wheat	160.0	142.8	-2	-11
Corn	53.0	51.1	1	-4
Oats	7.8	8.0	3	3
Barley	1.4	1.1	0	-22
Fiber products				
Cotton	22.1	21.6	-30	-2

Sources: Heady and Mayer, Food Needs and U.S. Agriculture in 1980, Table 3 (per capita consumption only) -- these estimates are for undressed and unrefined products of farm. Statistical Abstracts of the United States 1967, p. 88 (1950 and 1964 statistics).

Table 5.--Estimated feed grains and oilmeal required to produce 1,000 pounds of animal product, 1964 and 1980

Livestock fed	Feed Grains		Oilmeals	
	1964	1980	1964	1980
	- - - - - - - - - - Pounds	- - - - - - - - - -		
Beef and veal	1302	1417	244	315
Pork	4666	4764	264	312
Lamb and mutton	966	973	658	571
Dairy cattle (milk)	322	317	52	64
Turkeys	2626	2451	(a)	(a)
Hens and pullets (eggs)	297	234	(a)	(a)
Broilers	1752	1482	(a)	(a)

Source: Heady and Mayer, Food Needs, Table 4.

[a]Not estimated by class.

Table 6.--Domestic use and export of four major crops for 1965 and projected levels for 1980

Plan	Wheat bushels	Feed grains tons	Oilmeals tons	Cotton bales
	- - - - - - - -	- - - - Millions	- - - - - - - -	- - - -
Actual level, 1965				
Domestic	587	130	17	9
Export	867	29	11	4
Projected use, 1980				
Domestic	720	154	20	10
Export levels				
Actual level, 1965	867	29	11	4
Trend level, 1950-1965	1302	40	24	6
Dumping level	2157	70	37	7
Commercial level	560	36	17	5

Source: Heady and Mayer, Food Needs, Table 6. Figures rounded.

Table 7.--Crop yields for 1948 and 1965 with projections used in study of food and fiber needs for 1980

Crops Studied	Yields per acre 1950	1965	1980	Percentage increase 1950 1965	1965 1980
Wheat, bu.	16.5	27.2	32.3	65	19
Soybeans, bu.	21.7	24.6	29.3	13	19
Corn, bu.	38.2	73.1	99.4	91	36
Oats, bu.	34.8	50.2	59.1	44	18
Barley, bu.	27.2	43.5	48.6	60	12
Sorghum, bu.	23.4	50.0	61.8	114	24
Cotton, lbs.	26.9	53.2	75.4	98	42

Sources: <u>Agricultural Statistics 1965</u>; Heady and Mayer, <u>Food Needs</u>, Table 2.

Table 8.--Yields of major field crops, actual 1965 and projected 1980

Area	Bushels per acre												Cotton (Pounds per acre)	
	Wheat		Soybeans		Corn		Oats		Barley		Grain sorghum			
	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980	1965	1980
United States	27.2	32.3	24.6	29.3	73.1	99.4	50.2	59.1	43.5	48.6	50.0	61.8	532	754
New York	36.0	43.6	15.0	19.2	57.0	73.4	55.0	73.0	40.0	47.5	—	—	—	—
New Jersey	35.0	41.7	23.5	28.9	68.0	90.8	37.0	44.9	48.0	59.7	—	—	—	—
Pennsylvania	34.0	39.9	24.0	26.5	65.0	79.4	46.0	60.7	48.0	48.8	—	—	—	—
Ohio	32.0	40.2	24.5	30.5	75.0	95.2	56.0	79.4	42.0	41.1	—	—	—	—
Indiana	34.0	48.5	28.0	35.4	94.0	116.1	52.0	69.6	38.0	50.2	70.0	87.1	—	—
Illinois	35.5	49.0	29.0	34.0	92.0	115.2	57.0	69.7	39.0	38.9	64.0	75.1	—	—
Michigan	33.0	45.6	22.0	28.8	62.0	87.9	49.0	65.6	39.0	51.1	—	—	—	—
Wisconsin	32.4	45.3	18.5	19.8	76.0	95.0	61.0	77.4	50.0	55.3	—	—	—	—
Minnesota	27.8	31.6	18.5	26.6	61.0	80.3	55.0	64.0	44.0	45.2	—	—	—	—
Iowa	19.0	30.2	25.5	34.3	82.0	109.2	54.0	63.3	44.0	53.3	67.0	83.2	—	—
Missouri	27.5	43.7	26.0	30.8	72.0	87.0	36.0	48.7	32.0	41.6	57.0	70.3	575	793
North Dakota	26.5	25.7	18.0	17.9	37.0	45.6	52.0	60.7	41.0	46.3	—	—	—	—
South Dakota	18.0	19.5	17.0	20.5	39.0	48.0	48.0	48.5	38.0	40.9	30.0	53.2	—	—
Nebraska	20.0	29.3	24.0	34.3	67.0	89.9	40.0	45.4	30.0	34.8	54.5	78.5	—	—
Kansas	24.0	30.0	20.0	23.3	59.0	76.4	32.0	40.8	26.5	35.9	45.0	53.4	—	—
Delaware	36.0	40.0	25.0	29.6	75.0	86.4	38.5	28.6	43.0	58.1	—	—	—	—
Maryland	33.0	36.5	27.0	32.3	74.0	84.0	46.5	57.1	43.0	51.8	—	—	—	—
Virginia	30.0	36.2	20.5	25.0	68.0	71.9	43.0	40.7	43.0	58.7	42.0	47.6	298	367
West Virginia	29.0	34.7	—	—	50.0	57.5	39.0	52.2	41.0	46.9	—	—	—	—
North Carolina	29.0	36.5	24.5	34.2	70.0	90.5	43.0	44.8	38.0	49.1	48.0	31.4	286	423
South Carolina	27.0	34.2	22.5	30.1	56.0	73.1	38.0	45.6	35.0	47.9	30.0	36.8	480	527
Georgia	29.0	39.0	20.5	26.5	51.0	71.0	41.0	56.8	31.0	49.3	34.0	37.3	460	629
Florida	—	—	26.0	28.2	44.0	64.4	38.0	54.0	—	—	—	—	313	489
Kentucky	32.0	40.3	24.0	31.2	69.0	89.8	37.0	52.0	34.0	44.2	40.0	54.9	—	—
Tennessee	28.0	35.7	23.5	31.3	52.0	68.6	39.0	48.6	28.0	39.0	41.0	52.4	634	836
Alabama	26.0	35.1	23.0	34.0	44.0	58.9	34.0	46.0	—	—	26.0	33.7	490	632
Mississippi	28.0	30.1	22.5	28.3	40.0	55.3	40.0	54.0	—	—	35.0	45.2	691	930
Arkansas	26.0	44.1	21.5	26.3	37.0	49.1	50.0	68.9	30.0	39.9	35.0	39.9	611	817
Louisiana	21.0	35.5	21.5	31.2	35.0	48.0	27.0	41.5	—	—	35.0	40.0	553	775
Oklahoma	28.0	29.8	15.5	24.4	34.0	47.6	34.0	40.2	31.0	36.1	37.0	41.2	300	448
Texas	22.5	24.6	28.0	32.4	33.0	45.1	25.0	31.0	19.0	28.9	52.0	62.1	408	583
Montana	25.6	25.9	—	—	60.0	100.3	44.0	44.9	39.0	35.7	—	—	—	—
Idaho	44.9	47.9	—	—	78.0	112.7	57.0	68.2	52.0	53.0	—	—	—	—
Wyoming	12.8	21.8	—	—	55.0	112.0	39.0	43.5	43.0	47.0	—	—	—	—
Colorado	15.7	18.6	—	—	70.0	111.3	38.0	49.0	39.5	43.8	35.5	39.1	—	—
New Mexico	24.5	27.0	—	—	55.0	84.5	37.0	61.0	46.0	73.6	65.0	76.7	699	960
Arizona	46.0	61.6	—	—	27.0	39.9	42.0	55.4	73.0	94.3	70.0	89.9	1,066	1,330
Utah	32.3	27.4	—	—	71.0	97.4	55.0	59.4	60.0	61.9	—	—	—	—
Washington	40.0	46.4	—	—	75.0	129.0	54.0	55.1	49.0	56.1	—	—	—	—
Oregon	37.4	43.9	—	—	74.0	111.9	50.0	69.9	46.0	49.0	—	—	—	—
California	26.5	34.2	—	—	84.0	129.3	44.0	53.7	51.0	72.0	73.0	97.9	1,126	1,314

Source: Heady and Mayer, Food Needs, Table 2.

Table 9.--Major crops and idle land, United States, 1965 with projections for 1980 under seven market situations

Market plan	Wheat	Feed grains	Soybeans	Cotton	Idle land
	- - - - - - - - - - - - -	Millions of acres	- - - - - - - - - - -		
Present Plan, 1965	49.3	99.0	34.6	13.6	56.0
"Free markets," 1980					
A Cotton acreage controls; exports at 1965 level	59.7	73.9	29.3	10.0	78.4
B Cotton acreage controls; exports at 1950-65 trend	69.4	81.0	42.5	11.3	47.0
C No controls; exports at 1950-65 trend	70.0	81.2	42.6	9.3	48.0
D No controls; export dumping	88.7	94.4	58.6	9.7	0.0
Controlled markets, 1980					
E Feed-grain program exports at 1950-65 trend	62.5	89.2	43.1	11.0	45.6
F Acreage quotas; exports at 1950-65 trend	63.2	96.4	42.2	11.5	38.0
G Acreage quotas; commercial exports only	42.2	93.7	33.8	10.3	71.3

Source: Heady and Mayer, Tables 7, 11, 15, 19, 23, 27, and 31. Assumes 251.2 million acres are used for these crops. Feed grains include corn, oats, barley, and sorghum. Hay and minor crops omitted.

The four free market farm programs were analyzed to provide a benchmark for the three controlled market situations that Heady and Mayer believed most likely to prevail in the future. The free market plans result in greatly expanded wheat and soybean production as compared with 1965. Feed grains production would fall by about 20 million acres unless all surpluses are dumped on the world market.

Cotton acreage quotas are assumed to be in use with Plans A and B, but the least amount of cotton is produced with no controls, as shown for Plan C and D (Table 9). This indicates that cotton cannot compete with wheat, feed grains, and soybeans in some areas and raises questions about the need for cotton acreage controls.

Idle land will increase under Plan A from 56 to 78 million acres, a 40 percent increase, unless exports exceed 1965 levels. But even when exports are projected with 1950-65 trends in Plans B and C, only eight to nine million of the 56 million acres of idle land are needed for food and fiber production.

Controlled markets achieved by feed grain programs or acreage quotas would result in the production of somewhat less wheat than under free market conditions but in more feed grains produced (compare B and C with E and F).

In any event, only Plan D which calls for greatly expanded exports in 1980 would generate enough demand to utilize the excess capacity of U.S. agriculture as represented by 56 million acres of idle land in 1965. But Plan D is undoubtedly the most unrealistic of the seven plans. Wheat would have to sell for $4.40 per bushel to attract all the idle land into production (Table 10). Under the assumptions made in this study concerning consumption, yields, and exports, it seems probable that 40 to 60 million acres of idle cropland will still be available in 1980 to help meet the food and fiber needs between 1980 and 2000.

The probable location of these idle lands under two free market plans and two controlled market plans is shown in Figure 8. Under the free market plan, lands would be idled because they are not productive enough to pay the costs involved. In contrast, government programs tend to idle land more uniformly over the country regardless of its profitability.

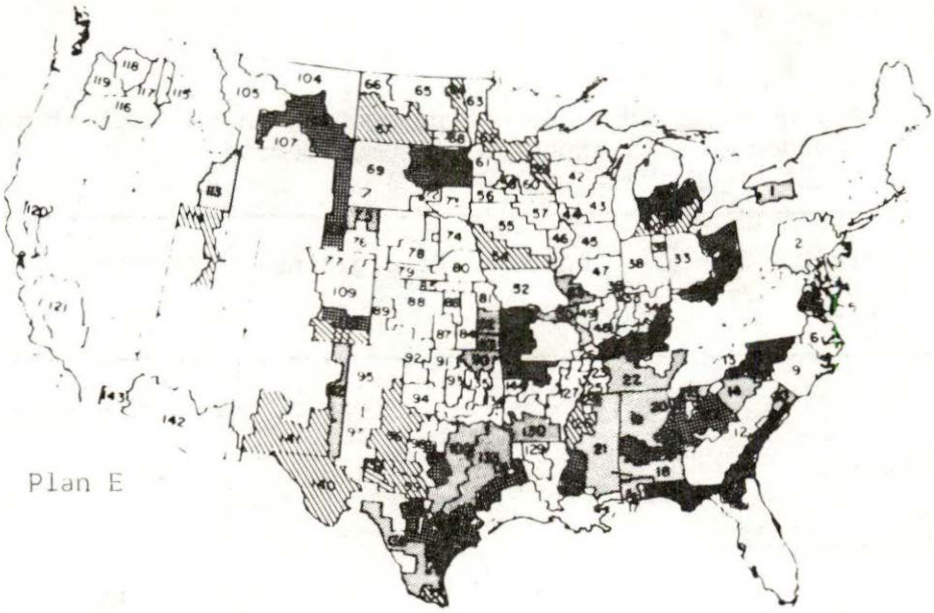
Free Markets versus Controlled Markets

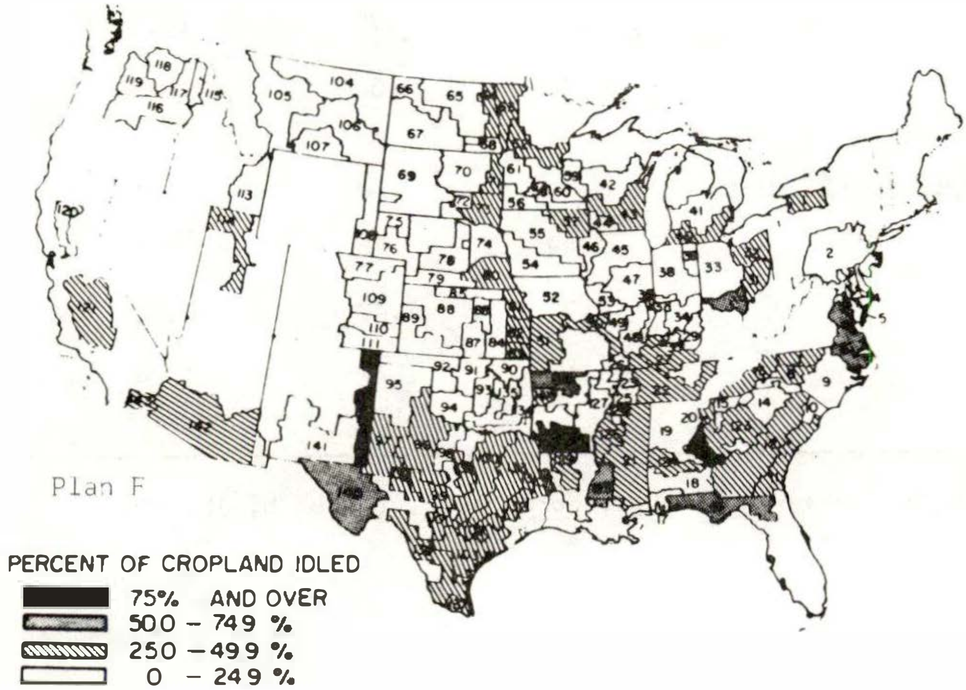
Will increased demands make possible a reliance on free markets to provide farmers and landowners with satisfactory prices in the future? Or will the federal government still find price support programs irresistible in 1980?

Table 10.--Prices required to secure production in the highest cost area needed to meet expected consumer demand in 1980

Market plan	Wheat bu.	Feed grains bu.	Soybeans bu.	Cotton lb.
	- - - - - -	Dollars per unit	- - - - - - -	
1965 (actual)	1.34	1.10	2.49	.28
"Free Market" plans				
A	1.11	.69	1.13	.26
B	1.27	.76	1.25	.27
C	1.27	.75	1.23	.17
D	4.40	2.53	6.19	.24
Controlled market plans				
E	1.49	.78	1.28	.31
F	1.92	1.48	1.19	.44
G	1.17	1.41	1.04	.41

Source: Heady and Mayer, Food Needs, Tables 8, 12, 16, 20, 24, 28, and 32.

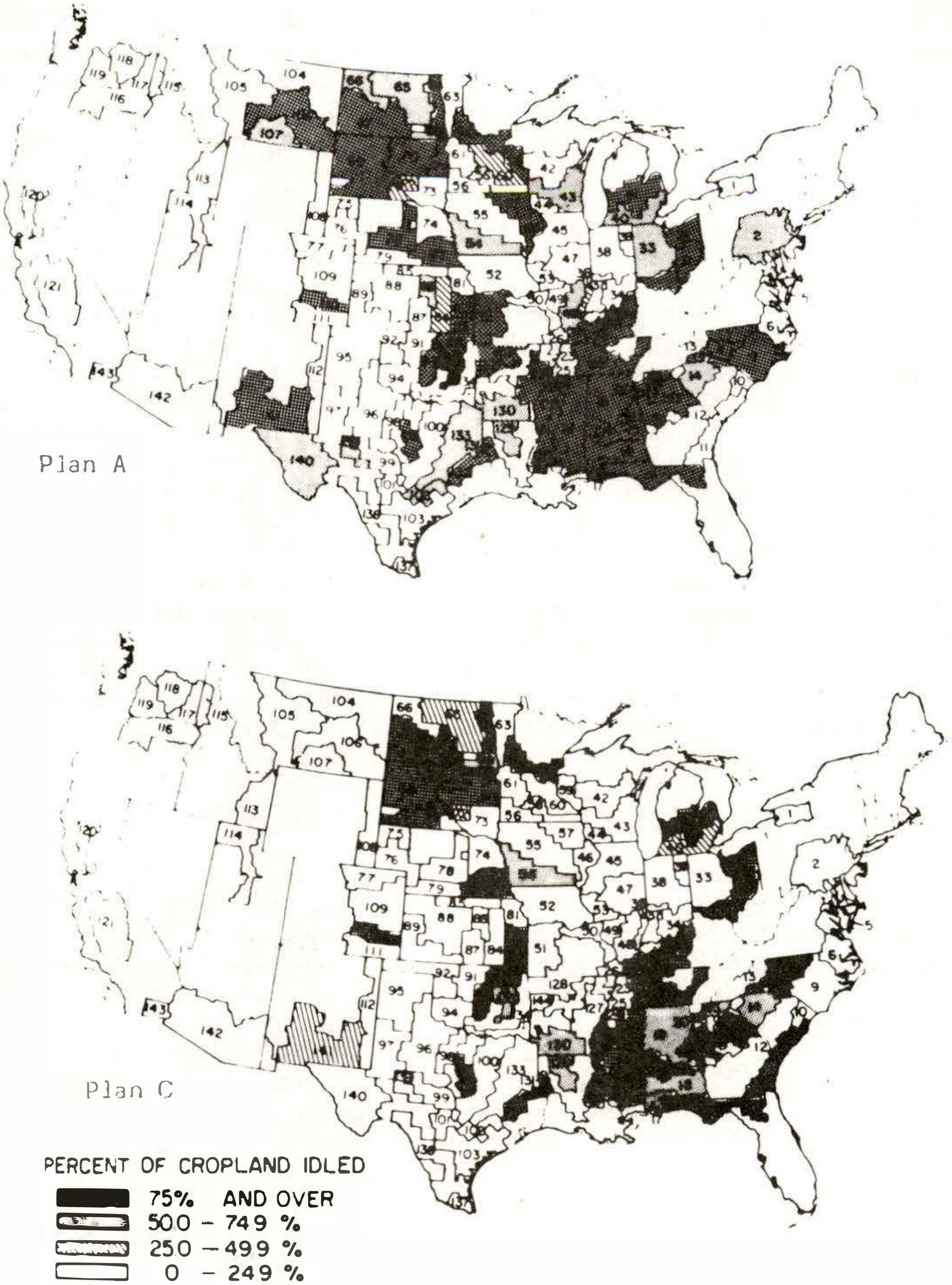




Plan E A feed grain program with trend level exports in 1980.

Plan F An acreage quota program with trend level exports in 1980.

Figure 8.--Location of idled cropland under four farm plans, 1980, continued.



Plan A A free market model 1965 level exports in 1980.

Plan C A free market without cotton quotas and with trend level exports in 1980.

Figure 8.--Location of idled cropland under four farm plans, 1980 (Source: Heady and Mayer, Food Needs)

The Heady-Mayer study shows that none of the three possible free market farm plans (A,B,C) would result in major crop prices as high as those of 1965 (Table 10). Hence, strong resistance to these alternatives can be expected. On the basis of price alone, Plan F with acreage quotas is the most attractive of the six practical plans considered.

Some idea of the subsidy involved can be obtained by comparing the free market prices (Plans A,B,C) with the controlled market prices (Plans E,F,G) in Table 10. The difference in these prices constitutes a tax on the consumers of farm products. The main justification of such a tax is that it prevents hardships to the owners and renters of farm land. Yet, even the lower prices of free market plans A,B,C would be offset by increased yields and lower costs. The result, as the Heady-Mayer study shows, would be an increase in net income or economic rent as shown in Table 11. These increased returns would tend to be bid up into higher land prices. For example, under Plan B in the Northeast, the net increase in annual rent of $10.21, if capitalized at 5 percent, would result in an increase in land values of $204 ($10.21 ÷ .05 = $204). In the mountain region, $11.85 would capitalize at $237 an acre and in the Pacific, $34.02 at $684. The increase in land values under the feed grain or acreage quotas of Plans F and G would be much higher. However, some of the returns might also be retained by farmers as a higher income for their management. In either case this study indicates that a decision to adopt a free market system would not result in farm incomes lower than present incomes. It would result in higher incomes but not so high as those provided by acreage quotas of Plans F and G.

<u>Consuming Regions and Location of Production</u>

Where should wheat, feed grains, soybeans and cotton be produced in the United States? To help answer this question Heady and Mayer combined the 48 States into 31 consuming regions. Some small States in the East and South were combined as were Idaho and Montana, Nevada and Utah, and Arizona and New Mexico in the West. The demand for wheat, feed grains, soybeans and cotton was then determined for each of these regions. Next, the least cost per bushel or pound was calculated for each of the 31 consumption regions. This cost included both variable production transportation costs as well as the higher land rent that might result from increased demand for cropland limited by nature or artifically by acreage quotas.

The resulting costs per bushel for wheat and feed grains are presented in Table 12 as prices that would have to be paid to meet expected consumer demand under the seven farm plans. Wheat prices show that demand relative to supply is the greatest in the northeastern and Pacific regions where the population will continue to be large and the supply of land suited for low cost wheat production will continue to

Table 11.--Estimated increase in economic rent under seven farm programs by regions, United States, 1980

Farm programs	A	B	C	D	E	F	G
United States			Dollars per acre				
Northeast	6.29	10.21	10.13	63.05	12.04	28.32	19.93
Lake States	3.19	5.16	5.00	59.42	5.52	24.52	20.02
Corn Belt	3.77	8.01	7.69	83.43	9.76	33.83	28.08
Northern Plains	2.51	4.31	3.94	46.52	7.33	22.22	11.83
Appalachian	2.31	5.84	2.93	59.71	8.41	28.62	23.75
Southeast	.08	.18	.18	51.77	.28	17.43	13.97
Delta States	1.31	4.55	2.70	57.78	6.88	25.77	20.34
Southern Plains	22.08	27.07	17.06	49.65	28.75	43.41	35.98
Mountain	7.28	11.85	11.25	68.26	8.93	23.98	12.17
Pacific	24.61	34.02	29.58	68.26	30.85	57.63	38.61

Source: Heady and Mayer, Food Needs, Tables 8, 12, 16, 20, 24, 28 and 32.

Table 12.--Wheat and feed grain prices required to secure production on the highest cost land needed to meet expected consumer demand in each region, present plan, 1965, and seven projected plans, 1980

Farm market plans	1965	A	B	C	D	E	F	G
	Wheat: dollars per bushel							
United States	1.34	1.11	1.27	1.27	4.40	1.49	1.92	1.17
Northeast	1.35	1.35	1.46	1.45	4.44	1.71	2.13	1.47
Lake States	1.43	.97	1.05	1.04	3.89	1.38	1.81	1.16
Corn Belt	1.35	.97	1.08	1.08	4.18	1.35	1.77	1.06
Northern Plains	1.36	.67	.78	.76	3.93	1.06	1.49	.74
Appalachian	1.38	1.32	1.46	1.45	4.46	1.73	2.16	1.45
Southeast	1.42	1.40	1.48	1.48	4.35	1.83	2.26	1.61
Delta States	1.29	1.37	1.49	1.47	4.54	1.79	2.22	1.45
Southern Plains	1.34	1.20	1.38	1.34	4.55	1.66	2.08	1.30
Mountain	1.26	1.04	1.16	1.15	4.18	1.15	1.57	.91
Pacific	1.34	1.13	1.34	1.32	4.39	1.16	1.59	1.00

Farm market plans	1965	A	B	C	D	E	F	G
	Feed grains: dollars per bushel							
United States	1.10	0.69	0.76	0.75	2.53	0.78	1.48	1.41
Northeast	1.30	.86	.90	.90	2.63	.95	1.63	1.57
Lake States	1.01	.57	.61	.61	2.42	.63	1.39	1.33
Corn Belt	1.08	.47	.52	.52	2.23	.54	1.22	1.16
Northern Plains	1.13	.55	.60	.59	2.40	.62	1.29	1.15
Appalachian	1.24	.83	.89	.89	2.61	.94	1.60	1.55
Southeast	1.24	.91	.93	.93	2.70	.95	1.70	1.65
Delta States	1.27	.86	.94	.94	2.65	.95	1.66	1.60
Southern Plains	1.25	.61	.66	.86	2.59	.67	1.34	1.24
Mountain	1.23	.83	.93	.91	2.81	1.08	1.77	1.61
Pacific	1.44	1.06	1.16	1.14	2.90	1.17	1.86	1.72

Source: Heady and Mayer, Food Needs, Tables 8, 12, 16, 20, 24, 28, and 32.

be scarce. Under all seven plans wheat can be most cheaply produced or provided in the Northern Great Plains and feed grains in the Corn Belt. The comparative advantage of these regions is most apparent under free market conditions. (Plans A, B, and C). Under the feed grains and acreage quota programs these differences are reduced (Plans E, F, and G).

The differences in prices actually paid to farmers in 1965 are also quite small because a national support price is set for each product supported and then State support prices are set on the basis of transportation costs to the nearest major market. Because the large differences in costs of production are ignored, there are only small price differences among the regions.

Conclusions

Up to 1980, Heady and Mayer conclude that for all models studied "except the maximum production model which was aimed at determining potential levels of crop output, there remained excess land resources after the level of demand was satisfied. In the past several years, this excess productive capacity has been controlled by retiring a substantial acreage of cropland from production. However, under these circumstances, society not only loses production gain from these acres, but also bears the expense of holding the land in idleness."[8]

After exploring the use of idle cropland for pasture in case of greatly increased per capita beef consumption by 1980, the authors conclude there would probably still be idle cropland in most regions amounting to a national total of from 37 to 39 million acres.

Can this situation be expected to hold to the year 2000? The next section will assess America's century-end food and fiber needs.

Can U.S. Agriculture Meet Food and Fiber Needs of Year 2000?

In the United States, there are 2,271 million acres of land. When the 369 million acres in Alaska and Hawaii are omitted, there remain 1,902 million acres in the contiguous 48 States of which 407 million acres are federal lands and 1,496 million acres are non-federal (mostly private) lands.[9]

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[8] Ibid., p. 89.

[9] U.S. Department of the Interior, Public Land Statistics, (Bureau of Land Management, 1967), Table 7.

According to a National Inventory of Soil and Water Conservation Needs made by the Soil Conservation Service, in 1958 there were 638 million acres of land suited to regular or annual cultivation, but only 373 million acres were actually in cropland. The balance consisted of 113 million acres in pasture and range, 125 million acres of forest and woodland, and 26 million acres of other land (Table 13). If all these 638 million acres were brought into production, the present 300 million acres of harvested cropland would be increased by 112 percent. This would be ample to meet the estimated medium high population increase of 75 percent by 2000 even if yields on the new lands were considerably less than present national averages. In addition, there are another 169 million acres that could be used for intermittent or occasional crop production. Thus a total of 807 million acres is considered suitable for regular or intermittent cultivation.

In view of the abundant supply of non-federal cropland, should the arable federal lands be disposed of for crop production? Under a free market for cropland the development of new land would tend to hold down farm produce prices and land values. But developing new lands when production controls are in use is difficult to justify since the two policies are generally contradictory. Yet it can be argued that developing new cropland in the Pacific region might be justifiable to help lower food costs there and thus restrain land prices. Perhaps the same end could be achieved more effectively, however, by simply adjusting or removing production controls for that region. Generally the maximum benefit to the general public is achieved when food and fiber are produced at least cost to meet the demands of the various regions. They will tend to be produced at least cost if acreage, production quotas or other barriers do not interfere and if production in high-cost areas is not encouraged by no-cost land (homesteads) and heavily subsidized irrigation development. Some of the comparative costs of developing new lands for crop production will be reviewed later in this report, but first the amount of federal lands suited for crop production will be examined.

The evidence indicates that the present large supply of land suitable for production--when combined with increasing yields and new food sources--will be able to meet food and fiber needs for the future. This was also the conclusion of the National Advisory Commission on Food and Fiber when it declared "the United States has no shortage of the natural resources needed to produce food and fiber. This does not mean that some regional shortages may not occur, but with intelligent use and flexibility in regional production patterns, there is no forseeable shortage."[10]

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[10] Food & Fiber for the Future, National Advisory Commission on Food and Fiber, p. 243.

Table 13.--Non-federal, non-urban lands suitable for crop production in the 50 States, 1958

Present use	Lands suitable for crop production[a]		
	Regular use	Intermittent use	Total
	- - - - - - - - - 1,000 acres - - - - - - - - -		
Cropland	373,328	48,993	422,321
Pasture and range	113,393	53,938	167,330
Forest and woodland	124,909	58,413	183,322
Other uses	26,380	7,838	34,218
Total	638,009	169,181	807,190

Source: United States Department of Agriculture, National Inventory of Soil and Water Conservation Needs, Soil Conservation Service, 1958, as published in Food & Fiber for the Future, p. 245.

IV. FEDERAL ARABLE LANDS: ARE THEY NEEDED FOR CROP PRODUCTION?

Amount of Arable Federal Lands

There are 371 million acres of federal public lands in the 17 Western States under administrative control of seven major federal agencies (Table 14). Much of this land is reserved for forests, and still more is used for grazing sheep and cattle. Some lands are parks and wildlife preserves, and others are utilized for defense activities. Much is mountainous and desert, presently unused by man to any extent.

This analysis is based only upon public lands that are arable--deemed suitable for intensive agriculture or crop production by federal agencies that now have administrative control. Estimates secured in a companion study (Volume IV) indicate that only 2.0 million of the 371 million acres of federal lands are suited for dryland crop production and that water is presently physically and legally available for only 1.3 million acres suited for irrigated crop production (Table 15). There are another 35 million acres that could be irrigated if water were available, but the prospect of these lands being brought into production by the year 2000 are so remote that they are not included in this analysis.

Lack of water seriously limits the amount of irrigation possible in the West. As urban population and industry increase they will outbid agriculture for available water supplies. It has been estimated that water for irrigated crop production is worth only ten cents per 1,000 gallons while in industries requiring water for processing, its value may exceed $5.00 per 1,000 gallons.[11] In addition, irrigation is a consumptive use of water. Very little of it returns to streams where it can be re-used. In contrast, most urban and industrial use is not consumptive. The water is returned to streams where it is available for re-use or waste dilution.

The pressure on water supplies in western water resource regions is indicated by the fact that 20 percent of the maximum sustainable flow is consumed as compared with only 1 percent in the eastern regions. Not only is there about one-third as much water in the West as in the East, but much more of it is used for crops. Of 64 million acre-feet consumed in the West, 60 million, or nearly 94 percent, were used up by irrigation.

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[11] C. P. Barnes, "Land Resource Potentials of the United States and World Regions," in Modern Land Policy, Land Economics Institute, University of Illinois (Urbana: University of Illinois Press, 1960), p. 80.

Table 14.--Federal public lands estimated suitable for dryland or irrigated crop production in 17 Western States, 1968, by agency

Agency	Federal lands held--total[a]	Federal lands--arable[b]		
		Dryland	Irrig.[c]	Irrig.[d]
	- - - - - - - - - - - 1,000 acres - - - - - - -			
Bureau of Land Management	174,949	569	516	28,450
Forest Service	143,789	842	101	933
Bureau of Reclamation	9,012	23	424	371
National Park Service	12,854	21	5	696
Bureau of Sports, Fisheries and Wildlife	6,463	83	114	58
Department of Defense	17,351	344	151	4,550
Corps of Engineers	3,671	113	1	11
Agency not determined	3,211	0	0	0
Total acres	371,300	1,996	1,313	35,086
National Grasslands[e]	1,161	510	115	536

[a] Public Land Statistics 1967, Tables 7 and 9.

[b] As reported by agencies. See Vol. IV of this report.

[c] Deemed irrigable with water physically and legally available.

[d] Deemed irrigable but water not now physically or legally available.

[e] National Grasslands/Land Utilization (LU) lands are administered by the Bureau of Land Management and the Forest Service. These acres are included in their figures.

Table 15.--Estimated acres of land suitable for farming as reported by seven federal agencies in 17 Western States, 1968

State	Federal land owned[a]	Federal land reported[b]	Dryland	Irrigable (water available)	Irrigable (water not available)
	- - Millions of acres - - -		- - - - - Thousands of acres - - - - - - - - -		
Arizona	32.4	33.0	0	11	7,145
California	44.4	44.7	172	137	6,129
Colorado	24.0	23.0	103	88	298
Idaho	34.0	31.6	85	314	2,623
Kansas	.6	.6	99	43	0
Montana	27.6	26.9	279	6	13
Nebraska	.7	.6	10	5	26
Nevada	61.0	60.6	4	7	9,916
New Mexico	26.7	26.1	0	11	2,922
North Dakota	2.1	2.2	262	4	4
Oklahoma	1.4	1.2	44	3	45
Oregon	32.2	29.6	67	72	625
South Dakota	3.4	3.3	237	46	97
Texas	3.0	2.3	149	6	190
Utah	35.2	35.2	1	14	2,557
Washington	12.6	13.8	15	158	42
Wyoming	30.0	30.7	469	387	2,437
Totals	371.3	365.4	1,996	1,313	35,068

[a]From Public Land Statistics 1967, Table 7.

[b]Reported by seven federal agencies surveyed in 1968. See Vol. IV of this report.

While it may be physically possible to bring water to the West from the Columbia River or even the Yukon, the costs are prohibitive for agriculture and are likely to remain so for the forseeable future. When crops produced per 1,000 gallons are worth only a few cents, the water charge must be extremely low to make irrigated crop production profitable. Desalination of sea water may eventually ease the pressures on river and ground water in urban communities, but at present there seems little or no prospect that sea water can be utilized for irrigation.

Available Arable Federal Lands

It is assumed that arable lands held by the Forest Service, Department of Defense, National Parks, and Bureau of Sport Fisheries and Wildlife have high economic, political or social uses and will not be available for intensive crop production. Therefore this study is further limited to those lands that are under the control of the Bureau of Land Management, the Bureau of Reclamation, and the U.S. Army Corps of Engineers. These are believed to be the federal lands most likely to be brought into crop production in the next 30 years. They total only 705,000 acres suited for dryland crop production and 941,000 acres suited for irrigation for which water is presently available (Table 16). Most of the dryland acres are in Wyoming, Montana, North Dakota, and South Dakota. None of the other 13 States has over 200,000 acres and nine States have fewer than 100,000 acres. The average for each of the 17 States is only slightly more than 100,000 acres. Irrigable land with water available amounts to 387,000 acres in Wyoming and 314,000 acres in Idaho. Washington has the next largest amount with 158,000 acres, and California has 137,000 acres. None of the other States has as much as 100,000 acres, and 10 States have less than 50,000 acres each.

These lands, if used for crop production, would increase dryland harvested cropland in the 17 Western States by less than 1 percent and irrigated harvested cropland by only 3 percent (Table 17). In only five States would the dryland be increased by more than 1 percent, and in only six States would irrigated land be increased by more than 1 percent. Wyoming would have by far the largest increase, 34 percent in dryland and 35 percent in irrigated acreage. Idaho would have a 5 percent increase in dryland with a 14 percent increase in irrigated land, and Washington and Colorado would have 11 and 3 percent increases in irrigated land, respectively.

The number of new farms that might be created from these federal lands is quite small. If $5,000 were considered an adequate annual return to the farmer for his labor and management, then 1,200 acres of dryland crops or 300 acres of irrigated crops would be needed in

Table 16.--Federal public lands suited for crop production held by three federal agencies in 17 Western States, 1968

	Bureau of Reclamation		Bureau of Land Mg't		Corps of Engrs.		Total	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	- - - - - - - - - - - - - - - - - - - 1,000 acres	- -						
Arizona	0	6	0	0	0	0	0	6
California	4	20	0	0	0	0	4	20
Colorado	2	13	101	72	0	0	103	86
Idaho	0	146	83	160	0	0	83	306
Kansas	2	0	0	0	24	0	26	0
Montana	12	5	88	0	5	0	105	5
Nebraska	1	1	0	0	0	0	1	1
Nevada	0	2	0	0	0	0	0	2
New Mexico	0	0	0	0	0	0	0	0
North Dakota	0	0	4	0	18	0	22	0
Oklahoma	0	0	1	0	1	0	3	0
Oregon	1	23	59	0	0	0	60	23
South Dakota	0	0	30	0	1	0	31	0
Texas	0	0	0	0	61	0	61	0
Utah	0	1	0	0	0	0	0	1
Washington	1	103	0	0	2	1	3	104
Wyoming	0	102	203	284	0	0	203	387
Totals	23	423	569	516	113	1	705	941

Source: Estimates provided by these three agencies, 1968. See Vol. IV of this report.

Table 17.--Private cropland harvested and arable federal lands held by Bureau of Land Management, Bureau of Reclamation and Corps of Engineers in 17 Western States

State	Private cropland harvested[a]			Federal arable public lands[b]			
	Total	Dryland	Irrigated	Dryland	Irrigated[c]	Dryland increase	Irrigated increase
	- - - - - - - - - - - - 1,000 acres			- - - - - - - - - - - - -		- - -Percent - - - -	
Arizona	1,025	20	1,005	0.0	6.0	0	*
California	7,846	1,409	6,437	4.1	20.3	*	*
Colorado	4,726	2,682	2,044	103.4	85.9	4	3
Idaho	3,935	1,696	2,239	83.0	306.3	5	14
Kansas	18,160	17,312	848	26.2	0.0	*	0
Montana	7,813	6,433	1,380	104.9	5.2	2	*
Nebraska	15,229	13,167	2,062	0.7	1.0	*	*
Nevada	507	4	503	0.0	2.5	0	1
New Mexico	906	218	688	0.0	0.0	0	0
North Dakota	17,695	17,646	49	22.3	0.0	*	0
Oklahoma	8,344	8,084	260	2.5	0.0	*	0
Oregon	3,050	1,964	1,086	59.6	22.5	3	2
South Dakota	14,445	13,310	1,135	31.0	0.0	*	0
Texas	19,408	13,509	5,899	61.0	0.0	*	0
Utah	1,039	270	769	0.0	1.1	0	*
Washington	4,423	3,514	909	3.3	103.8	*	11
Wyoming	1,702	598	1,104	203.1	386.6	34	35
Total	130,243	101,836	28,444	705.2	941.2	1	3

[a] 1964 U.S. Census of Agriculture, Vol. 2, Chap. 3, pp. 248-49. [b] From Table 18 or Volume IV of this report. [c] Water available. * Less than 0.5 percent.

most areas of the West. Thus the 705,000 acres deemed suitable for dryland farming would create fewer than 600 new dryland farms, and the 941,000 acres suited for irrigation would create perhaps another 3,100 irrigated farms in the 17 Western States.

Even these estimates may be high. Much of this land is in small tracts scattered along streams that are often in mountainous areas difficult to reach and far from public services considered essential for modern living. It seems probable that they would eventually be used by ranchers for hay and winter feeds or to enlarge other farms that are too small to provide a satisfactory living.

Probable Contribution of Federal Public Lands to Food and Fiber Needs

The contribution of arable federal lands to future food and fiber needs depends not only upon their acreage but also upon potential crops and their yields. This analysis assumes that dryland crops grown and the acres of each crop will be approximately the same as planted acres of the major crops in the 11 Western States. These States were used because the eastern portions of the Great Plains are not typical of the areas where most of the federal arable lands are located. It is also assumed that irrigated crops grown and the acres of these crops would closely approximate the pattern of irrigated crops in the 17 Western States as shown in Figure 9. Most of this irrigated cropland is in areas like those of the arable federal lands suited for irrigation. Finally, it is assumed that the yields of these crops will approximate average yields in the nation.

With these assumptions Table 18 was prepared. It indicates that arable federal lands would increase the nation's 300 million acres of harvested cropland only slightly more than 0.5 percent (rounded to 1 percent). The increases by crops are also shown. Only barley and sugar beets would increase by more than 1 percent under these assumptions. Since any rise in yields by 1980 or 2000 would probably affect the new lands as much as the old, the percentage contribution of new lands to food and fiber needs would not change.

The probable effect of arable federal lands on crops produced in each of the 11 Western States with such lands are shown in Appendix A Tables 1-11. These tables are included to illustrate the small acreage changes that would occur if these lands were developed. They are not predictions of crops that might be grown.

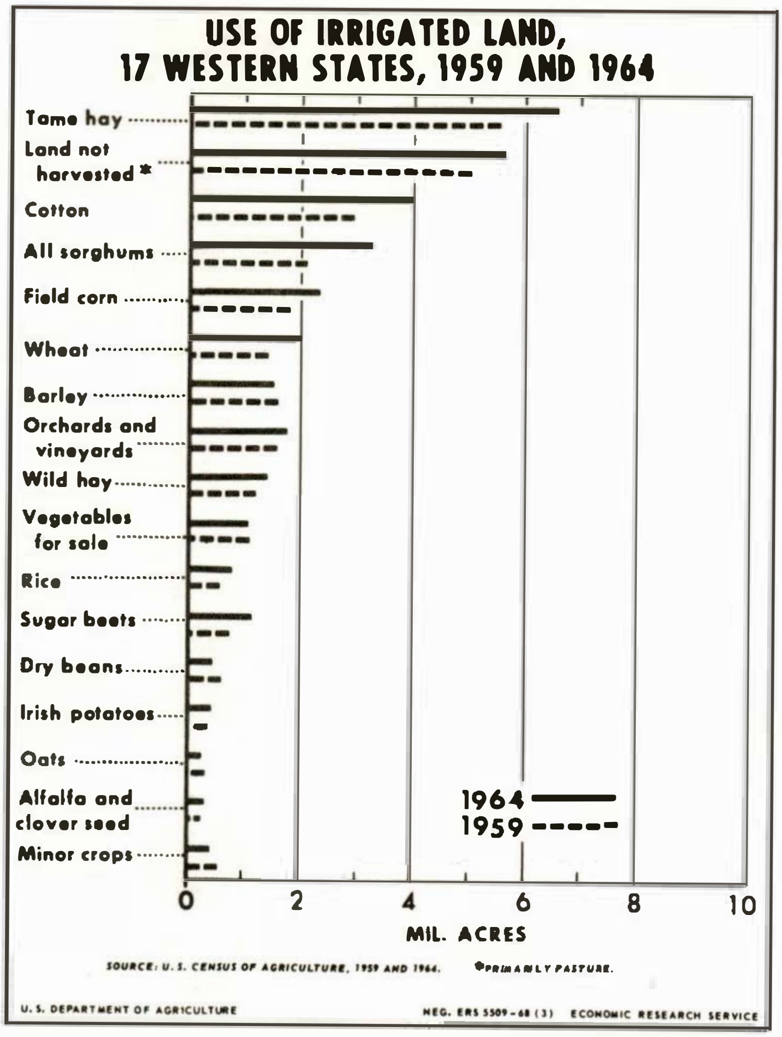
USE OF IRRIGATED LAND,
17 WESTERN STATES, 1959 AND 1964
Tame hay
Land not harvested *
Cotton
All sorghums
Field corn
Wheat
Barley
Orchards and vineyards
Wild hay
Vegetables for sale
Rice
Sugar beets
Dry beans
Irish potatoes
Oats
Alfalfa and clover seed
Minor crops
1964
1959
0
2
4
6
8
10
MIL. ACRES
SOURCE: U.S. CENSUS OF AGRICULTURE, 1959 AND 1964.
*PRIMARILY PASTURE.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 5509-68 (3)
ECONOMIC RESEARCH SERVICE

Figure 9

Table 18.--Estimated effect of federal public lands suitable for crop production on total acres of cropland, by crop

Crops	Harvested cropland[a]	Estimated use of arable public lands			
		Dryland	Irrigated	Total	Increase
	- - - - - - - - - - 1,000 acres			- - - - - -	percent
Total	300,446	705	941	1,646	1
Corn, grain	60,557	14	65	79	*
Wheat, all	58,771	197	56	253	*
Oats	16,017	21	19	40	*
Soybeans (beans)	39,767	0	0	0	0
Barley	9,177	99	47	146	2
Minor grains	5,000	0	19	19	1
Sorghums	16,000	127	94	221	1
Cotton	13,400	0	112	112	1
Hay, all	66,800	225	404	629	1
Beans, dry	1,428	0	19	19	*
Potatoes	1,358	0	19	19	1
Sugar beets	1,228	0	38	38	3
Vegetables, fresh	1,638	0	18	18	1
Vegetables, other	1,675	0	20	20	1
All other	12,630	1	11	12	*

[a]1967 data for the 48 contiguous States from Crop Production, 1968 Annual Summary by States, U.S. Department of Agriculture (Statistical Reporting Service, 19 December 1968), p. 3.

[b]Total arable federal lands divided by harvested cropland, 48 States.

* Less than 0.5 percent.

V. SOME COSTS OF DEVELOPING LANDS FOR DRY AND IRRIGATED CROP PRODUCTION

The National Advisory Commission on Food and Fiber has declared that "reclamation and land development projects paid for by public investment have significantly increased farm production in the past three decades, during which agriculture was plagued with overproduction and surpluses. Clearly it is unsound policy to invest public funds in new farm capacity at a time when the overriding problem is too much capacity." Therefore "*the Commission recommends that public funds for agricultural reclamation, irrigation, drainage and development projects should be justified on the basis of whether they represent the cheapest means of getting additional farm production--if needed.*"[12]

In deciding whether public funds would be the cheapest way to get additional production, the Advisory Commission declared that "all land should be considered as a possibility for expanding output and the cost of transforming the land should be weighed against the cost of putting idle acres back into use." At the present time, over 60 million acres of cropland are idle (Table 19). Since the Heady-Mayer study indicates that 35 million acres or more will still be idle in 1980 despite a 26 percent increase in population and a sharp increase in consumption rates, it appears that the excess capacity problem is certain to persist well beyond that date.

The fact that the government is currently paying farmers, either directly or indirectly, to keep these 60 million acres idle makes it quite clear that returning them to production would result in substantial savings of public funds--a sharp contrast to transforming land through federal irrigation projects whose costs often exceed $1,000 an acre. In 1959 the Bureau of Reclamation estimated the average cost of developing 9.5 million acres of new irrigated land (or its equivalent in old cropland) at $921 an acre (Table 20). In the south Pacific region the estimate was $2,780 an acre, and for the other regions it ranged from $600 to $1,400.

The Bureau of Reclamation also estimated non-federal costs of developing 2.7 million acres of irrigated land in the Western States (Table 20). The average was estimated to be $313 an acre with a range from $140 to $659.

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[12] *Food & Fiber for the Future*, National Advisory Commission on Food and Fiber (italics in original), p. 21.

Table 19.--Land diverted from crop production by government production or conservation programs, 1956-1966

Year	Acreage Reserve	Conservation Reserve	Feed Grain	Wheat	Cotton	Cropland Conversion	Cropland Adjustments	Total†
			(million acres)					
1956	12.2	1.4	...	...	..	..	..	13.6
1957	21.4	6.4	...	...	..	..	..	27.8
1958	17.2	9.9	...	...	..	..	..	27.1
1959	...	22.5	...	...	..	..	..	22.5
1960	...	28.7	...	...	..	..	..	28.7
1961	...	28.5	25.2	...	..	..	..	53.7
1962	...	25.8	28.2	10.7	..	..	..	64.7
1963	...	24.3	24.5	7.2	..	0.1	..	56.1
1964	...	17.4	32.4	5.1	0.5‡	0.1	..	55.5
1965	...	14.0	34.8	7.2	1.0‡	0.4	..	57.4
1966§	...	13.3	32.0	8.2	4.7	0.4	2.0	60.6

* Source: USDA.
† Total diverted including acreage devoted to substitute crops.
‡ Not required to be put to conserving uses.
§ Except for conservation reserve, represents enrolled acreage Agr. Stab. and Conserv. Ser., USDA, *Agricultural Statistics 1966*, GPO, p. 541.

Source: Food Goals, Future Structural Changes, and Agricultural Policy: A National Basebook (Ames: Iowa State University Press, 1969), p. 307.

Table 20.--Irrigation development costs per equivalent acre as estimated by Bureau of Reclamation, 1959

Water resource region	New land equivalent[a]		Cost equivalent new land	
	Federal	Non-federal	Federal	Non-federal
	- - - 1,000 acres - - -		- - Dollars per acre - -	
Upper Rio Grande and Pecos	165	- - -	$ 750	$ - - -
Upper Missouri	2,740	603	1,160	200
Upper Arkansas and Red	174	731	1,167	207
Lower Arkansas Red-White	52	- - -	566	- - -
Western Gulf	796	88	730	659
Colorado	1,200	69	1,374	140
Great Basin	260	299	906	251
Pacific Northwest	2,650	802	646	484
Central Pacific	1,445	84	681	384
South Pacific	18	24	2,780	425
TOTALS	9,500	2,700	$ 921	$ 313

Source: U.S., Congress, Senate, Select Committee on National Water Resources, _Future Needs for Reclamation in the Western States: Water Resources Activities in the United States_, 86th Congress, 2nd Session, 1960, Committee Print 14, Table 11, p. 19.

[a]Includes not only new, previously uncultivated irrigated lands but also allows for any previously cultivated lands scheduled to receive some water.

The initial stage of the Oahe Unit of the Missouri Basin Project has just been authorized. The initial stage calls for the irrigation of 190,000 acres of land with total allocated costs of $25.8 million or $1,083 an acre. By charging some of these costs to main-stem storage and power the cost is reduced to $881 an acre. Of this amount the landowner is expected to pay only 15 percent and Missouri River Basin power revenues, 84 percent. Thus this project involves a subsidy of $740 to $910 an acre, the amount depending on cost allocation.[13]

While the necessity of subsidizing 84 percent of the cost of irrigation development clearly indicates that such development is not economic, the Bureau of Reclamation was still able to show direct benefits of $1.60 for each $1.00 spent. The Bureau explains as follows: "Direct irrigation benefits result from the increase in net farm income with the application of water. These benefits include increases in family living and in accumulation of equity in the farm investment."[14] Quite obviously such benefits involve double counting of net income--once when it is received and again when it is spent to improve family living or pay off debts. These and other weaknesses of the benefit-cost analyses of the Bureau of Reclamation have been pointed out by several economists including Douglas and Renshaw.[15] (Renshaw's article cited below is reproduced in Appendix B.)

Fortunately there are 113 million acres of pasture and range, 125 million acres of forest and woodland, and 26 million acres of other land that can be used for regular or annual crop production (Table 13). Moreover, there are another 169 million acres that can be used from time to time, and much of this acreage is in more humid areas of the United States where irrigation is not necessary.

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[13] U. S., Congress, House, Oahe Unit, Missouri River Basin Project, South Dakota: Report on the Initial Stage of the Oahe Unit . . ., 90th Congress, 1st Session, 1967, House Document 163, Table 2, pp. 46-50.

[14] Ibid., p. 41.

[15] Edward F. Renshaw, "Appraisal of Federal Investment in Water Resources" in Modern Land Policy, Papers of the Land Economics Institute, University of Illinois (Urbana: University of Illinois Press, 1960), Paper 17; and Paul H. Douglas, Why the Upper Colorado River Project is Against the Public Interest, Remarks in U.S. Senate, 18 April 1955 (Washington, D.C.: U.S. Government Printing Office, 1955).

How does the cost of clearing and draining land compare with the Bureau of Reclamation's 1959 estimates of irrigation costs? A general survey of land clearing and draining costs was made by Wooten and Purcell in 1949.[16] They found that there were many millions of acres of land that could be developed for farming by clearing and draining and cited the following costs per acre:

Kind of work	Cost in dollars per acre
1. South	
Draining undeveloped land in drainage districts	\$ 5 - \$ 30
Clearing costs (stumps remain)	\$25
Clearing costs (stumps removed)	\$50 - \$ 75
2. Northeast	
Brush cleared for seeded pasture	\$50 - \$110
Brush cleared for cultivated crops	\$95 - \$160
Light brush cleared from abandoned fields	\$15 - \$ 30
Clearing of brush and stone	\$50 - \$100
Clearing for drainage	\$30 - \$125
3. Southeast	
Custom clearing, group basis	\$36 - \$ 50
Clearing small trees and brush	\$25
Clearing, stumping and draining	\$60 - \$ 75
Clearing or drainage	\$40 - \$ 55

[16] H. H. Wooten and Margaret R. Purcell, Farm Land Development: Present and Future by Clearing, Drainage and Irrigation, U.S. Department of Agriculture Circular 825 (1949).

	Cost in dollars per acre
4. Mississippi River Delta	
Clearing land	$30 - $100
Buying and clearing land	$65
Cost of land and clearing	$60 - $100
5. Northwest	
Easy clearing	$18 - $ 39
Medium clearing	$57
Difficult clearing	$80
Clearing heavy timber and stumps	up to $200

No doubt some of these lands have been brought into production during the past 20 years. It also seems likely that those most cheaply cleared or drained may have been the first developed. Hence, future costs will be higher not only because of inflation but also because lands remaining will be more difficult and more expensive to clear and drain. Even so, the figures suggest that millions of acres of uncleared and undrained lands could be brought under cultivation for well under $200 an acre.

Whether or not it is economical to clear and drain these lands is certainly another question. The fact that over 60 million acres of croplands have been retired from production under various governmental programs indicates that such development even at these low costs would not result in "maximum benefit for the general public" at this time. However, by the year 2000 these lands may be needed. If so, demands for food will tend to result in higher farm prices and provide incentive for developing them.

VI. SUMMARY AND CONCLUSIONS

Can U.S. agriculture meet the food and fiber needs of 1980 and 2000? What contribution can arable federal lands make that is consistent with "maximum benefit to the general public"? The purpose of this paper was to help answer these questions by a review and analysis of the situation which appears to be as follows:

1. While world population is expected to double by the year 2000 and thus create unprecedented demands for food, demands in the under-developed countries must be met, except in time of drought or diaster, by local production.

2. The U.S. contribution to food and fiber needs of other countries will be maximized by providing fetilizers, insecticides and other chemicals, seeds, tools and technical help rather than food.

3. The demand for U.S. agricultural production will continue to be largely limited to the needs of the domestic population and the developed countries that find it profitable to import our foods, feeds, and fibers.

4. The U.S. population is expected to increase about 25 percent by 1980 and 75 percent by 2000.

5. A study made for the National Advisory Commission on Food and Fiber by Professors Earl Heady and Leo Mayer of Iowa State University indicates that, despite expected rises in population and foreign demand, the increase in yields and efficiency will be so great that no more than 20 million of the 60 million acres of idle cropland will be called back into production by 1980.

6. A survey by the Soil Conservation Service indicates that out of the 638 million acres of land suited for regular crop production in the United States in 1958, 373 million acres were in cropland. Currently only 300 million acres of cropland are being harvested, and 60 million acres have been retired from production by government programs.

7. Even if there were little or no increase in yields and technology, U.S. food and fiber needs of the year 2000 could be easily met by increasing crop acreage from 300 million to 600 million.

8. Of the 371 million acres of federal public lands, only 3.3 million acres are deemed arable or suitable for crop production by the seven federal agencies that now administer these lands; only 705,000 acres suited for dryland crop production and 941,000 acres suited for irrigation are likely to be available. These are lands held by the Bureau of Land Management, Bureau of Reclamation and the Corps of Engineers. The contribution of these 1.6 million acres of federal lands to food and fiber production needs would be very small indeed.

9. The Bureau of Reclamation estimated the cost of future federal irrigation projects at $921 an acre and non-federal projects at $313 an acre. Both these costs far exceed clearing and draining costs for millions of acres of land in humid areas of the United States. The latter would seldom exceed $200 an acre.

10. The evidence indicates that U.S. agriculture can easily meet food and fiber needs for both 1980 and 2000 without the use of the 1.6 million acres of federal lands considered suitable and available for crop production.

APPENDIX A

Table A 1.-- Arizona: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	800,000	100	6,000
Corn, all	32,000	4	240
Oats	*	*	*
Barley	187,000	23	1,380
Sorghum, all	254,000	32	1,920
Wheat, all	55,000	7	420
Rye	*	*	*
Rice	*	*	*
Cotton	248,000	31	1,860
Potatoes	11,000	1	60
Beans Dry	*	*	*
Peas	*	*	*
Sugar Beets	13,000	2	120

* Less than .05 percent

Table A 2.--California: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	4,647,000	100	24,400
Corn, all	326,000	7	1,708
Oats	393,000	8	1,952
Barley	1,618,000	35	8,540
Sorghum, all	451,000	10	2,440
Wheat, all	383,000	8	1,952
Rye	*	*	*
Rice	362,000	8	1,952
Cotton	595,000	13	3,172
Potatoes	110,000	2	488
Beans Dry	189,000	4	976
Peas	*	*	*
Sugar Beets	220,000	5	1,220

* Less than .05 percent

Table A 3.--Colorado: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	5,332,000	100	189,300
Corn, all	501,000	9	17,037
Oats	114,000	2	3,786
Barley	279,000	5	9,465
Sorghum, all	659,000	12	22,716
Wheat, all	3,349,000	63	119,259
Rye	63,000	1	1,893
Rice	*	*	*
Cotton	*	*	*
Potatoes	47,000	1	1,893
Beans Dry	184,000	4	7,572
Peas	*	*	*
Sugar Beets	136,000	3	5,679

* Less than .05 percent

Table A 4.--Idaho: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	2,770,000	100	389,300
Corn, all	82,000	3	11,679
Oats	73,000	2	7,786
Barley	542,000	20	77,860
Sorghum, all	*	*	*
Wheat, all	1,398,000	50	194,650
Rye	16,000	1	3,893
Rice	*	*	*
Cotton	*	*	*
Potatoes	307,000	11	42,823
Beans Dry	92,000	3	11,679
Peas	102,000	4	15,572
Sugar Beets	158,000	6	23,358

* Less than .05 percent

Table A 5.--Montana: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	6,546,000	100	110,100
Corn, all	70,000	1	1,101
Oats	244,000	4	4,404
Barley	1,319,000	20	22,020
Sorghum, all	*	*	*
Wheat, all	4,825,000	74	81,474
Rye	12,000	*	*
Rice	*	*	*
Cotton	*	*	*
Potatoes	8,000	*	*
Beans Dry	8,000	*	*
Peas	*	*	*
Sugar Beets	60,000	1	1,101

* Less than .05 percent

Table A 6.--Nevada: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	55,000	100	2,500
Corn, all	6,000	11	275
Oats	10,000	18	450
Barley	19,000	35	875
Sorghum, all	*	*	*
Wheat, all	19,000	35	875
Rye	*	*	*
Rice	*	*	*
Cotton	*	*	*
Potatoes	1,000	1	25
Beans Dry	*	*	*
Peas	*	*	*
Sugar Beets	*	*	*

* Less than .05 percent

Table A 7.--New Mexico: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	1,011,000	100	0
Corn, all	45,000	5	0
Oats	*	*	0
Barley	30,000	3	0
Sorghum, all	424,000	42	0
Wheat, all	372,000	37	0
Rye	*	*	0
Rice	*	*	0
Cotton	132,000	13	0
Potatoes	3,000	*	0
Beans Dry	5,000	*	0
Peas	**	*	0
Sugar Beets	*	*	0

* Less than .05 percent

Table A 8.--Oregon: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	1,744,000	100	82,100
Corn, all	36,000	2	1,642
Oats	155,000	9	7,389
Barley	298,000	17	13,957
Sorghum, all	*	*	*
Wheat, all	1,080,000	62	50,902
Rye	95,000	5	4,105
Rice	*	*	*
Cotton	*	*	*
Potatoes	50,000	3	2,463
Beans Dry	*	*	*
Peas	10,000	1	821
Sugar Beets	20,000	1	821

* Less than .05 percent

Table A 9.--Utah: Estimated probable use of federal public lands suited for crop production in the Western States

State	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	537,000	100	1,100
Corn, all	46,000	9	99
Oats	30,000	5	55
Barley	130,000	24	264
Sorghum, all	*	*	*
Wheat, all	288,000	54	594
Rye	*	*	*
Rice	*	*	*
Cotton	*	*	*
Potatoes	8,000	1	11
Beans Dry	9,000	2	22
Peas	*	*	*
Sugar Beets	26,000	5	55

* Less than .05 percent

Table A 10.--Washington: Estimated probable use of federal public lands suited for crop production in the Western States

States	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	3,648,000	100	107,100
Corn, all	54,000	1	1,071
Oats	61,000	2	2,142
Barley	235,000	6	6,426
Sorghum, all	*	*	*
Wheat, all	3,002,000	82	87,822
Rye	52,000	1	1,071
Rice	*	*	*
Cotton	*	*	*
Potatoes	64,000	2	2,142
Beans Dry	9,000	*	*
Peas	121,000	3	3,213
Sugar Beets	50,000	1	1,071

* Less than .05 percent

Table A 11.--Wyoming: Estimated probable use of federal public lands suited for crop production in the Western States

States	Planted cropland non-federal lands		Arable federal land
	Acres	Percent	Acres
Total	758,000	100	589,700
Corn, all	56,000	7	41,279
Oats	118,000	16	94,352
Barley	111,000	15	88,455
Sorghum, all	*	*	*
Wheat, all	351,000	46	271,262
Rye	27,000	4	23,588
Rice	*	*	*
Cotton	*	*	*
Potatoes	3,000	*	*
Beans Dry	38,000	5	29,485
Peas	*	*	*
Sugar Beets	54,000	7	41,279

* Less than .05 percent

APPENDIX B

Appraisal of Federal Investment in Water Resources

EDWARD F. RENSHAW *

Over the decades since 1900, appropriations by the federal government for the development of water resources have increased substantially. As of 1954, appropriations from 1900 to 1954 were estimated to have amounted to 14.3 billion dollars. Expenditures by the major project-building agencies for the fiscal year, 1958, are expected to be in excess of 850 million dollars, a moderate increase over 1957, and an increase of over 150 million dollars compared with 1956. Given the magnitude of federal expenditures, the general tightness of the budgetary situation, and the necessity of making dramatic changes in appropriations in order to maintain our national defense, to prepare ourselves for the age of missiles and space exploration, and to lay the foundation for an era of unparalleled scientific and technical competition on an international level, scrutiny of expenditure policies in the area of water resource development is entirely apropos. Do expenditures in this area, by the federal government, represent the best use to which a limited amount of funds can be put? Can the transfer of resources from the private sector of our economy to the public sector be truly justified in the sense that benefits exceed costs? These are but a few of the difficult questions that must be asked as Congress reviews the demands which have been placed on the budget and attempts to ration funds among competing proposals.

The need for an economic appraisal of federal investment in water resource development programs rests essentially on the extent to which these

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investments are subsidized by the general taxpayer as opposed to comparable investments made elsewhere in our economy. The extent of the subsidy ranges from about 40 per cent, in the case of public power, to nearly 100 per cent, in the case of navigation, flood control, and basin-wide irrigation. Since the benefits that accrue from public investment are more localized than the tax base that supports expenditures, the direct return from a particular project need not be as great as could be obtained by investing the same funds elsewhere in the economy in order to make a public project appear justified from a purely local point of view. On the basis of logic alone, one would anticipate that local groups would bring pressure to bear upon Congress and the agencies involved in water resource development to construct local projects which would not be in the best interest of the nation as a whole.

An attempt has been made by the author to subject contemporary federal investment to a test that was largely independent of the elaborate procedures used by the various agencies to justify project construction.[1] Attention was focused on four major aspects of water resource development: reclamation, navigation, flood control, and power. The results of the overall analysis of these aspects of resource development suggested that a large part of contemporary investment cannot truly be justified in terms of expected benefits exceeding the opportunity cost of development. The need for a fundamental reappraisal of financial responsibility on the part of the federal government in this area was emphasized.

In this paper, an attempt is made to extend the analysis in two ways. First, an endeavor is made to establish a theoretical framework from which one can view contemporary benefit-cost analysis within an economic context. Second, an attempt is made to analyze the bias inherent in the estimating procedures of one specific water resource agency, the Bureau of Reclamation, and thus demonstrate the way in which submarginal projects are "justified" to be in the public interest. The latter analysis is meant to be illustrative of biased estimating procedures rather than a specific criticism of the Bureau, since the various agencies are equally guilty with respect to the practice of presenting biased estimates to justify project construction.

ECONOMIC AND THEORETICAL FRAMEWORK FOR BENEFIT-COST ANALYSIS

In recent years increasing attention has been paid to the way in which the various federal agencies allocate resources for public improvements. The rather large body of independent procedures established by law and administrative edict to aid in the selection of investment alternatives has been subjected to searching criticism both within and outside the government.

It has been suggested that the evaluations (commonly referred to as benefit-cost analyses) of water resource projects, by all agencies, "be put

[1] Edward F. Renshaw, *Toward Responsible Government* (Chicago: Idyia Press, 1957).

on a uniform basis, requiring balanced consideration of all benefits and costs which can reasonably be measured in dollars, as well as consideration of other values not readily expressed in monetary terms." [2] In light of this suggestion, the Federal Inter-Agency River Basin Committee is currently revising *Proposed Practices for Economic Analysis of River Basin Projects*, referred to hereafter as the *Green Book*.

A purpose of this paper is to establish a correspondence between "proposed practices" and established economic theory. Attention is focused on the object of benefit-cost analysis or benefit measurement and on the budgeting of project resources and costs.

To make the notions underlying contemporary benefit-cost analysis completely general and to make them correspond to established economic theory, benefit-cost analysis is assumed to have the objective of maximization of the "social welfare" over time.[3] The welfare to be maximized corresponds to increments in consumer and producer surplus[4] unobtainable without public action.

From an allocative point of view the surplus is regarded as a return to public action. The returns are generally distributed in three directions: (1) to political factors of production either in the form of compensations directly associated with the office itself or compensations derived indirectly from those who benefit from public action; (2) to nonpolitical factors of production with inelastic supply schedules which have their prices bid higher than would have been the case without public action; and (3) to consumers in the form of lower prices paid for goods consumed than would otherwise prevail.

In order to arrive at a net surplus (benefit) for any specific project, one must deduct from gross surplus the value of the alternative product that

[2] Presidential Advisory Committee on Water Resources Policy, *Water Resources Policy* (Washington: GPO, 1956), p. 12.

[3] If the benefit-cost ratio is used as a maximizing tool, alternative assumptions as to what is being maximized can lead to a marked instability in the computed ratio, depending on the extent to which associated costs are netted out of gross benefits before the ratio is computed. Since benefit-cost ratios are also subject to relevant variation due to differences in product demand, underlying production functions, and factor supply prices, this author is inclined to reject their use as an indicator of either project priority or social goodness. The correct criterion for choosing among projects, assuming all resources have been properly valued or costed, is to select those projects with the largest surplus of benefits over costs. An advantage of this criterion is that it will lead to consistent results in many cases even though the object of maximization is assumed to be different; i.e., it makes no difference whether the object of maximization is the return to water as a scarce resource put to its highest alternative uses, the return to all resources used by the project, the social return associated with investing capital on public account, or what I choose to call, in this paper, the "social welfare."

If public capital is rationed such that not all mutually exclusive projects with benefit-cost ratios in excess of unity can be undertaken, it may be necessary to substitute into the fixed budget various alternatives until one is convinced that the aggregate return to the entire budget is maximized.

[4] For a discussion of consumer and producer surplus, see Alfred Marshall, *Principles of Economics*, 8th ed. (New York: Macmillan Company, 1952), p. 811.

could have been produced if resources had not been diverted to the production of project output.

Benefit Measurement

Any attempt to measure the social surplus or benefits resulting from a project [5] contains an assumption that for every good or service produced there exists both a *demand* relationship and a *supply* relationship which are independent of each other and independent of the acceptance or rejection of project alternatives.

The demand for the output of a proposed project is an excess demand derived by subtracting the supply schedule that would exist without the project from aggregate demands. The social surplus or benefit has been defined as the maximum amount consumers would be willing to pay for alternative outputs given the all-or-none proposition of consuming each output separately or of forgoing consumption of project output entirely.

If the criterion for benefit estimation is a willingness to pay either individually or collectively for benefits received, then the notion of a benefit corresponding to social surplus by definition contains every conceivable benefit associated with project output. Additional benefits should not be claimed unless there is associated with the output under consideration a joint product with a positive excess demand which would be forgone without public investment.[6]

The only kind of excess demand curve from which it makes sense to estimate the benefits from project investment, is an excess demand computed from demand and supply schedules that would exist in the absence of government intervention on behalf of pricing policies. Obviously if production is being restrained in order to maintain a higher market price than would otherwise prevail, it would be inappropriate to value public output at the supported price, since any surplus associated with a price reduction to the free market equilibrium level could be obtained without cost by merely removing the restraint on production. The reverse argument holds for prices that are being held below free market equilibrium levels since consumers value incremental output at a much higher price than they are permitted to pay.

[5] Unless the income-generating effects of a project are large in relation to total income and/or the income elasticity of demand for project output high, a partial equilibrium analysis of aggregate demand will yield an estimate of the social surplus sufficiently close to the general equilibrium case that income-generating effects of the project can be ignored. From the standpoint of the nation as a whole, the income-generating effects of any one water resource project are bound to be so small as to only imperceptibly influence aggregate demand.

[6] If the notion of secondary or indirect benefits, which has recently crept into the project analysis of the Bureau of Reclamation, makes sense, it must refer either to consumer surplus stemming from lower product prices, to producer surplus stemming from higher factor prices than would otherwise exist, or to the production of joint products in excess demand. From the point of view of the analysis in this paper, all of these benefits are primary and should be regarded as such in project analysis.

The same line of reasoning holds with respect to marginal taxes. If marginal taxes on output or on some necessary factor of production such as capital are not to be treated as costs, then the only relevant excess project demand would be a curve computed from demand and supply schedules existing in the absence of federal excise taxes.

Neither the social surplus lost because of the tax nor the value of the excise tax should be counted as net project benefits since such benefits could be obtained by altering the tax structure, without the aid of project investment.

Estimating Project Demand

Excess (project) demand is defined by the prices prevailing when alternative quantities of project output are added to the amounts others supply. If the maximum price consumers are willing to pay for any amount of project output is the price prevailing in the market without the project, then the prevailing market price imposes an upper limit on the true project demand function.

If project output is so small as to only imperceptibly affect market price, we can assume a perfectly elastic demand for project output. An exact measure of the social benefit from public output is obtained by multiplying expected output by the expected market price at which the project output is sold. This procedure for estimating benefits corresponds, in general, to actual practices of the various agencies, where goods and services produced have market values.

If the project output is so large as to perceptibly affect the market price, an allowance must be made for the fact that consumers place a smaller value on successive units of output. Assuming that the excess demand for project output is linear, an exact measure of the social benefits, corresponding to the area under the demand curve, is obtained by averaging the market prices that would prevail both with and without the project and by multiplying this average price by the expected output. This procedure for estimating benefits corresponds to what is recommended in the *Green Book.*[7]

The analysis of benefits stemming from products for which there exists no perfect substitute in the market poses difficulties.[8] Conceptually the procedure for estimating benefits is the same. The problem of course is that

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[7] In general, the various agencies make no allowances for a fall in prices resulting from large project outputs. This is true even with respect to inland waterway investment where a large part of the benefits from navigation are assumed to accrue from traffic which does not flow because of prohibitive freight rates. The proposed Hell's Canyon dam represents an excellent example of a case where the benefits from a large increment in power were analyzed without taking into account the possibility of a downward sloping demand.

The Missouri River Basin Project represents a case in which a 75 per cent increase in sugar beet production was postulated without taking into account either demand effects or artificial restraints imposed upon supply to maintain sugar prices.

[8] Such benefits are often discussed in the literature as intangibles and as extra market values.

market data cannot be used in estimating the excess project demand unless one is prepared to assume that the true parameters governing aggregate demand bear close relationship to parameter estimates for close substitutes.[9]

Some hope exists for being able to estimate the aggregate demand for certain nonmarketable outputs[10] in terms of marginal output expenditures by local and state governments. Assuming that demand is stable geographically and that the cost of producing public output varies from one area to another, crosssectional data on public expenditures can be used to identify the social demand. The idea underlying an aggregate demand function of this type is that the social demand for public output is expressed by the willingness of governments to appropriate funds for alternative quantities of output received. Given an estimate of the aggregate demand for nonmarketable output, an excess project demand can be obtained by subtracting from this estimate the supply that would be produced by government without the project.

In those few instances in which licenses to exploit public goods and services are sold, as is the case with respect to fish and wildlife, there is some hope of being able to estimate aggregate demand directly from cross-sectional data on license fees. Where there exists no market price for the asset produced or saved by the project, as is the case with respect to human capital, a benefit might be estimated by capitalizing expected net income streams.

The task of assigning dollar values to nonmarketable outputs may not be as hopeless as many in the field of resource analysis would have us believe. In fact the theoretical and empirical difficulties associated with identifying the social demand for public goods and services may be no greater than the problems encountered in an attempt to identify the demand parameters for marketable outputs.

When a good is entirely a public good and the parameters governing social demand are unknown, the rational approach to resource allocation is to maximize per capita output (consistent with some rule or restraint specifying an equitable distribution) for a given appropriation. This approach would be equivalent to minimizing the per unit cost of producing public output.

Given a behavioral rule which specifies that the costs of producing any quantity of public output must be minimized, it is immediately apparent that the marginal cost of producing a comparable public good by the cheapest alternative means imposes an upper limit to the excess demand for project output. To fully define the excess demand function for the nonmarketable output of a given project, it would be necessary to know, in addi-

[9] An expedient way of estimating nonmarket values associated with project investment is to estimate an excess demand for the closest marketable substitute and assume this estimate will approximate the true excess demand.

[10] One of the chief problems associated with estimating the social demand for intangibles is developing suitable measures for quantifying output and/or consumption.

tion to the alternative cost of producing project output, the aggregate amount government is willing to appropriate for production of the good in question and the rules to insure that the good in question is equitably distributed.

Viewed from a slightly different perspective, excess demand for a nonmarketable output is a schedule of average prices paid for alternative project outputs by an agency endowed with the responsibility of purchasing and distributing at minimum cost the entire public output.

Although the idea of alternative cost pricing is used extensively by the various agencies in measuring benefits, little attention is paid to the fact that distributional considerations and the aggregate willingness of government to appropriate funds for nonmarketable output is expected to eventually create inelasticity in the excess (project) demand for such output.

Assigning Market Values to Output

Placing a value on public output has as its objective a narrowing of the alternatives that must be considered in order to insure a social maximum. By assigning a market value to the resources used to produce project output and by agreeing to accept only those projects where benefits equal or exceed costs, one excludes from further choice analysis the market alternatives which would yield benefit-cost ratios of unity. The market values assigned to project resources can be presumed to reflect the value of the alternative product forgone by society in the market as a result of the project.

Public investment in the market must always be considered a relevant choice alternative if project resources are assigned social costs which are less than their market value in producing comparable product. A given project would not be socially justified unless it were expected to yield a greater surplus of benefits over costs than could be obtained by diverting its resources into the market.

The idea of costing resources, so as to narrow the range of alternatives that must be considered in order to achieve a social maximum can be extended to social as well as to market alternatives. With respect to irrigation, for instance, the use of water as an agent of dilution in pollution control has a certain opportunity return.[11] The pollution control alternative can be excluded in a choice sense from further analysis by costing the opportunity return forgone as a result of using the water for irrigation.

If opportunity returns forgone as a result of a project are left out of the benefit-cost ratio this implies that the optimum cut-off point [12] for rationing

[11] See Edward F. Renshaw, "Value of an Acre-Foot of Water," *Journal of American Water Works Association* (March, 1958), pp. 303-309.

[12] According to the March, 1957, issue of *The Farm Real Estate Market*, the net return expected from rented agricultural land is six per cent. The Bureau of Reclamation uses a two and one-half per cent interest rate to convert benefits and costs to average annual equivalents. The present value of $0.035 per year (the difference in discount rates) for 50 years, discounted at two and one-half per cent is $0.99. By merely investing a dollar in fully developed land, the Bureau could expect a 99-cent surplus of benefits over the

resources within and between projects is in excess of unity. In view of the fact that a benefit-cost ratio in excess of unity implies to many that a project ought to be undertaken, a case can be made for including in project analysis all opportunity costs associated with the construction of a given project.[13] Benefit-cost ratios that ignore opportunities forgone can be grossly misleading. From an efficiency standpoint such ratios lead to a misallocation of resources vis-a-vis the public and private sectors, if not to real wealth losses.

Currently the most flagrant example of undervaluing the resources used to produce project output, is in the use of discount rates approaching the yield on long-term government bonds.[14] The government borrowing rate is irrelevant in converting resource flows to equivalent average annual flows, since the risk to the holders of government securities is not at all comparable to the risk associated with public investment in water resource projects.

The current justification for the use of the government borrowing rate is that it reflects a pure rate of return to capital. Since there may be a positive liquidity yield associated with the holding of government securities and additional tax advantages occurring to holders of state and municipal bonds, it can hardly be argued that government rates reflect a pure return. Pure rates of return to capital, if in fact rates exist,[15] would probably be higher.

Unless risks and uncertainties associated with the construction and development of water resource projects on public account are commensurably different from risks associated with private development, there would seem to be little point in differentiating between a return component and a risk component in the discount rate used to convert costs and benefits to comparable average annual equivalents. If risk is to be treated explicitly in terms of specific allowances for contingencies, conservative benefit estimates, and fixed terminal dates, such allowances should be collapsed into an average rate to be directly compared with risk premiums associated with the production of comparable products in the market. Otherwise the public has little assurance that adequate allowances have been made in the project analysis to provide for the real risks and uncertainties inherent in resource development.

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assumed social cost of obtaining a dollar to be invested in a far more risky venture, the production of new land. If capital is to be rationed in terms of its opportunity cost, only those reclamation projects expected to yield a benefit-cost ratio of 1.99 to 1.00 should be built.

[13] One effect of a costing practice of this type would be to eliminate from further choice consideration all mutually exclusive alternatives that would yield less than a maximum surplus of benefits over costs.

[14] See Arnold C. Harberger, "The Interest Rate in Cost-Benefit Analysis," *Federal Expenditure Policy for Economic Growth and Stability* (Washington: GPO, November 5, 1957).

[15] A more appealing "rate of return to capital" could be obtained by taking a weighted average rate of return on the capitalized value of all producer wealth stocks.

Measurement of Costs

In general, the measurement of resource costs used by a project is similar to the measurement of benefits. If resources used by a project are only a small proportion of total resources available for project use, we assume perfectly elastic factor supply curves. Prevailing factor prices will reflect the exact value of the alternatives forgone as a result of the project. If some of the resources used by the project have inelastic supply curves, a linear approximation of their social cost can be obtained by averaging the resource prices expected to prevail with and without the project. As before, the cost of nonmarketable values and opportunities forgone as a result of a project is the net social surplus (benefit) forgone.

A few words should be said with respect to social costs of water resource investments generally overlooked. First both the direct and indirect costs are associated with obtaining federal money. The direct costs consist of scarce resources used up in the process of collecting taxes and/or borrowing funds. The indirect costs consist of certain consumer and producer surpluses forgone as a result of the imperfect way in which the government obtains its funds.[16] Although costs of obtaining federal funds may be only a small percentage of total project costs, these costs should also be considered in project analysis.

A second category of costs generally not considered to be project costs consists of administrative costs borne by the various agencies responsible for resource development and by the legislative branch of government. These costs typically represent a sizable proportion of the total costs associated with resource development programs. That portion of total administrative costs marginal to each project should be included in project justification.

The fixed administrative costs of any agency can be justified only if they are less than surplus of aggregate benefits over costs for the agency's total program. If the fixed costs of administering an agency are high in relation to its total expenditures, there should exist, in addition to benefit-cost analysis for individual projects, an over-all benefit-cost analysis that would ascertain the justification of the entire agency program in terms of whether the aggregate benefits produced exceed all costs incurred by the program.

An aggregate appraisal of the net social benefits stemming from any agency's program should concern itself not only with an *ex anti* benefit-cost analysis, but with an *ex post* analysis of the effectiveness of past investments. On both efficiency and distributional grounds, it would seem that far too little attention has been paid to the value of developing a framework for making *ex post* benefit-cost analyses.

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[16] Prof. Arnold Harberger at the University of Chicago has estimated, using a formula developed by Hotelling, that the welfare loss associated with the federal excise tax ranges from one to 25 per cent of the tax revenue collected; the median percentage being five per cent of the tax take.

BIAS IN ESTIMATING PROCEDURES

In the second part of *Toward Responsible Government,* an attempt was made to analyze, in as rigorous a manner as possible, one major aspect of water resource development; namely, reclamation. On the basis of survey and other information, the benefits and costs associated with individual projects were scrutinized, and the results of an appraisal of 43 existing irrigation projects were presented. Only about a fourth of these projects now appear to have been justified on the basis of realized benefits exceeding costs. If average benefits on various existing projects in 1956 are compared with expected cost allocations associated with proposed irrigation investment in the Missouri and Colorado River basins, only one of the 30 units and divisions proposed for these two projects can reasonably be expected to have a net benefit-cost ratio in excess of unity; the majority of the proposed units have net benefit-cost ratios substantially less than 0.5. The conclusion is inescapable that contemporary federal investment in both the Missouri and Colorado River basins cannot be justified on the basis of expected increases in land and water values exceeding costs. This being the case, the question arises as to precisely how such projects are made to appear justified. The answer to this question will be made clear in the following analysis of proposed irrigation in the Goshen Park Unit of the North Platte River basin. The potential Goshen Park Unit is located near Torrington, Wyoming, in east central Goshen County, Wyoming, and northwestern Scotts Bluff County, Nebraska. It would irrigate approximately 62,560 acres of undeveloped class two land lying on the south side of the North Platte River above the Fort Laramie Canal. Goshen Park is the largest of eight units currently being appraised by the Bureau of Reclamation in the North Platte River basin. The procedures used by the Bureau to estimate benefits and costs are standard and representative of current appraisal techniques. The estimated cost per acre ($563.00) of constructing the Goshen Park Unit is not high in relation to recent cost allocations per acre for such projects as the Missouri and Colorado River projects. Similar results would follow if the analysis contained in this paper were made in relation to other reclamation projects.[17]

The first indication that the Bureau's estimate of irrigation benefits on the proposed Goshen Park Unit represents a gross benefit is the assumption (first line, Table 1, column 2) that the 291 families not now engaged in irrigated farming can achieve an alternative income of only $1,000.[18] This assumption is unrealistic, depicting gross imperfections in the factor market for labor. Assuming that alternative income streams of $2,560 exist outside

[17] The basic data on the Goshen Park Unit is taken directly from U.S. Department of the Interior, *North Platte River Basin Report*, Denver, Colorado: Preliminary and unpublished report, Bureau of Reclamation, Region 7, July, 1953.

[18] Includes the value of home-grown products consumed by the family, the value of the farm dwelling, and other consumer investments, and a cash allowance for family living expenditures.

Table 1

DIRECT FARM BENEFITS, GOSHEN PARK UNIT, MISSOURI BASIN PROJECT

ITEM	DEVELOPMENT WITH PROJECT (1)	DEVELOPMENT WITHOUT PROJECT (2)	DIFFERENCE (3)	FACTOR (4)	BENEFIT (5)
Improved family living	$ 990,720[a]	$ 560,760[b]	$ 453,960	100%	$ 453,960
Increased cash farm income	715,563	0	715,563	100%	715,563
Accumulation of equity	12,067,047	2,508,480	9,558,567	1%	95,586
Total direct farm benefits					1,265,109
Development period factor (88.5%) multiplied by direct farm benefits equals total annual net direct irrigation benefits					1,119,621
Present value of total annual net direct irrigation benefits (discounted at 2.5% for 150 years)					43,666,061
Present value per acre					698
Construction costs per acre[c]					563
Benefit-cost ratio ($698 ÷ $563) = 1.24					

[a] $2,560 family living allowance for 387 farm families.
[b] Represents dryland conditions without irrigation where 96 families achieve a living allowance of $2,560, and 291 achieve an alternative income of $1,000.
[c] Derived by dividing the 1952 reconnaissance estimate of construction costs on the Goshen Park Unit ($35,204,000) by the proposed acreage (62,560).
Source: The basic data on the Goshen Park Unit is taken directly from U.S. Department of the Interior, *North Platte River Basin Report*, Denver, Colorado: Preliminary and unpublished report, Bureau of Reclamation, Region 7, July, 1953.

the area (and they surely do), families could move and be equally as well off as they would be if the government invested capital in irrigation and they remained locally employed. National income cannot be expected to increase as a result of labor being employed on irrigated farms unless it earns a greater return than would be attained if it were employed elsewhere in the economy.

If families can, in fact, achieve an alternative income stream outside irrigated agriculture of $2,560, this benefit attributed by the Bureau to irrigation would be zero; and the Bureau's estimate of net direct benefits should be reduced by 36 per cent. A deduction in direct benefits of 36 per cent would lower the Goshen Park benefit-cost ratio from 1.24 to 0.79.

As far as the Bureau is concerned, increased farm income (Table 1, second line) refers to an item in the budget study termed payment capacity. Payment capacity (see Table 2) certainly is not a net benefit attributable entirely to the project's construction costs; part of a farmer's payment capacity must be used to cover annual operation and maintenance charges. Amortization capacity would be a much better measure of the theoretical increase in cash farm income due to project construction. In fact, it is on the basis of expected amortization capacity that the Bureau negotiates its repayment contracts with the irrigation districts. Deduction of operation and maintenance charges from increased cash farm income would reduce

Table 2

SUMMARY OF INCOME AND EXPENSES, REPRESENTATIVE 160-ACRE FARM, GOSHEN PARK UNIT OF THE MISSOURI BASIN PROJECT

	PER FARM
Receipts	$12,655.00
Farm privileges	811.00
Total	$13,536.00
Farm expenses	9,127.00
Net farm income	$ 4,409.00
Family living allowance	2,560.00
Payment capacity	$ 1,849.00
	PER ACRE
Payment capacity	11.56
Less operation and maintenance charge	4.25
Amortization capacity	$ 7.31
Amortization capacity, less 11.5% development factor	$ 6.47

the Bureau's estimate of direct benefits by another 21 per cent, leaving 43 per cent, and would further reduce the resulting benefit-cost ratio from 0.79 to 0.53.

It is difficult to imagine how the Bureau can rationalize that one per cent of expected equity accumulation (which includes the farm investment in land, feed, buildings, machinery, and livestock) represents a direct benefit from irrigation. The fact that people save part of their incomes (forgoing current consumption) and invest it either directly or indirectly in irrigation enterprises rather than something else does not, in itself, imply a net benefit from irrigation. For a net benefit to accrue, the return on capital invested in irrigation must be higher than the return on the same capital invested elsewhere in the economy. (This would include the possible return to lending the same funds to nonirrigation farmers and letting them make investments.) An analysis of the assumptions underlying the farm budget appraisal of expected returns under irrigation does not indicate a greater return on capital invested in irrigation on the proposed Goshen Park Unit than might currently be earned on funds invested in other equally risky business investments. The budget study assumes a modest five per cent return on invested farm capital.[19] This can be contrasted to an average return of six per cent ex-

[19] An additional bias in the direction of an overestimation of the true benefit from irrigation is introduced by virtue of the fact that the budget study estimate of the value of farm investment under irrigation is extremely low. The value of the land before irriga-

pected to accrue from all rented agricultural land in the United States in 1956.[20]

In terms of the Bureau's own analysis, it seems fair to assume that the expected return on equity accumulation will not be greater than the return on the same funds invested elsewhere. One, therefore, should not attribute any return on farm equity to the construction of the irrigation project. Deletion of one per cent equity accumulation decreases the Bureau's estimate of direct benefits an additional eight per cent, leaving a final net direct benefit amounting to 35 per cent of the Bureau's original estimate of direct benefits. With this adjustment, the resulting benefit-cost ratio is reduced from 0.53 to 0.43. All three adjustments combined have reduced the benefit-cost ratio from 1.24 to 0.43. The only benefit remaining, which can reasonably be expected to be a net benefit attributable to the act of public investment in irrigation, is amortization capacity. It has already been pointed out that this is precisely the benefit estimate upon which repayment contracts are negotiated.

As was argued earlier in this paper, a benefit-cost ratio of 0.43 is still too high, owing to the fact that a 2.5 per cent discount rate is used to make benefits and costs comparable. If amortization capacity is discounted by a 4.5 per cent rate, which was the average rate on farm mortgage loans in 1950, the resulting benefit-cost ratio is further reduced to 0.25. This ratio is slightly in excess of an alternative benefit-cost ratio calculated on the basis of a functional relationship existing in 1950 between land and water value per acre on 30 Bureau of Reclamation projects and the acreage percentage devoted to various crops.[21] One is led to conclude that budget-study estimates of irrigation benefits might not be so "bad" from the standpoint of determining an optimum resource allocation if care were taken to use an appropriate discount rate and if the procedure used to determine repayment capacity also determined project justification.

By way of summary, the Bureau's procedure for estimating direct farm benefits leads to a gross benefit estimate; i.e., it includes certain items which should be offset by other expenses incurred by the farm enterprise. It follows that the Bureau's benefit estimate could not be collected from irrigation farmers in the form of water repayment contracts without coercion. By including in direct benefits from irrigation a sufficient proportion of increased gross farm receipts, nearly all direct benefit-cost ratios could be made to exceed unity and appear to be economically justified in the sense that estimated benefits equal or exceed estimated costs.

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tion, for instance, is assumed to be the long-time average value of nonirrigated land which is considerably less than what the land could be purchased for in the market today.

[20] USDA, *The Farm Real Estate Market* (November, 1956), p. 16.

[21] For more detailed analysis of this functional relationship see Chapter XIII of *Toward Responsible Government.*

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