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9. ABSTRACT
The use of land and related natural resources in the United States is influenced by an increasingly interrelated complex of turbulent forces. Recent months and years have yielded abundant evidence for us to study, analyze and act upon. Food and fiber, the major agricultural products of land, traditionally abundant and cheap as monuments to our technological and managerial prowess coupled with natural endowments of soils and climate, have suddenly become scarce and high priced. Furthermore, recent gyrations in prices and availabilities have been characterized by surprises and turbulence that send shock waves through both producing and consuming sectors of food and fiber. In an effort to understand current and prospective needs for land to meet food and fiber demands, this paper is addressed to the following objectives. First, the authors strive to put the current food and fiber demand and supply situation into perspective in terms of the recent past and the probable future. Second, they outline current and prospective land use and production possibilities over the near term, into the mid 1980's, and over a longer term, to the turn of the century, the year 2000. Third, they suggest certain policies and structural changes relating to the conjoint interrelationships between the land needs for food and fiber demands and the uses of the nation's lands.

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# U. S. LAND NEEDS FOR FOOD AND FIBER DEMANDS WITH INHERENT POLICY IMPLICATIONS[1/]

by Earl O. Heady and John F. Timmons[2/]

The use of land and related natural resources in the United States is influenced by an increasingly interrelated complex of turbulent forces. Recent months and years have yielded abundant evidence for us to study, analyze and act upon. Food and fiber, the major agricultural products of land, traditionally abundant and cheap as monuments to our technological and managerial prowess coupled with natural endowments of soils and climate, have suddenly become scarce and high priced. Furthermore, recent gyrations in prices and availabilities have been characterized by surprises and turbulence that send shock waves through both producing and consuming sectors of food and fiber.

Interrelated forces affecting present and future land use, both man made and nature made, are intertwined in forming responsive and deliberate policy actions. For example, drouths in Russia, South Africa and Australia deplete our wheat and food grain stocks, send our prices skyrocketing and bring millions of acres of land into use. Currency devaluations and efforts to ease balance of payments deficits through export of agricultural products bring repercussions on our use of land. Anchoveta shortages off the coasts of Peru and Chile coupled with decreased availability and increased price of petroleum throughout the world have brought shortages and sharp price increases in soybeans and cotton as protein,

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oil and fiber replacements. Thus, price and shortage of one product affect production and price of other products. This means that land uses become altered through principles of substitution and competition. For example, high wheat prices induce increased wheat production on extensive as well as intensive margins of cultivation. Expansion of production on extensive margins push plantings of wheat into marginal and fragile lands as well as into corn, bean, cotton and feed grains lands. Most land uses are interlinked and shift back and forth in response to changes in product prices and factor costs emanating from foreign and domestic demands and changing technologies.

Serious questions arise concerning the impacts of these exogenous forces upon land and related natural resources. Our policies and management of land resources must not remain passive to consequences of these impacts. A more active role must be generated through land use policy and planning to cope with these kinds of questions. For example, will the extension of wheat production into fragile lands set the stage for a new dust bowl? How will uses of land emanating from balance of payments transactions involving agricultural products interfere with urban and recreational uses of land including the quality of water, air and landscape within the natural environment? How may these deletorious impacts be mitigated? What are the trade offs between numerous and often conflicting land uses?

The ever-normal granary idea of H. A. Wallace, initiated in the 1930's to provide prudent reserves of food stock, became a dumping ground for agricultural surpluses in the 1950's and 1960's. Now the bins are empty and are disappearing from the rural landscape. Surpluses which were rediculed during the fifties and sixties have been replaced by scarcities which are feared. Part of our anticipated production of food crops is being committed for sale even before

their harvest. Wheat stocks have become so low that Russia has kindly offered to resell to the U. S. some of the same wheat sold to Russia a year earlier but the resale would carry a threefold price increase. Land prices tied to current product prices are soaring and tied to higher incomes that may well not continue. Additional questions arise. Are current demands, prices and shortages temporary or are they a continuing phenomenon of the future? Is the agricultural sector facing the bust phase of a boom and bust cycle? Is there any need for further governmental intervention in the management of production and stocks of agricultural products or will the market system provide the answers? Lessons gained from recent supply squeezes and price gyrations appear obvious but it is not obvious that the U. S. Department of Agriculture comprehends these lessons.

In the meantime, land use policy and planning legislation languish in federal and state legislatures while federal executives and legislators turn attention to crises and crunches.[1/] All the while, residential and industrial uses of land sprawl into open lands in chaotic fashion. And crops are expanding into timber and pasture lands subjecting these lands to wind and water erosion hazards with adverse effects on water and air quality.

In an effort to understand current and prospective needs for land to meet food and fiber demands, this paper is addressed to the following objectives. First, we strive to put the current food and fiber demand and supply situation into perspective in terms of the recent past and the probable future. Second, we outline current and prospective land use and production possibilities over the near term, into the mid 1980's, and over a longer term, to the turn of the

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1/ For example, Senate Bills 632 and 992 introduced in the first session of the 92nd Congress and kept alive in the current session providing for establishment of a national land policy are dying for lack of congressional and executive attention.

century, the year 2000. Third, we suggest certain policies and structural changes relating to the conjoint interrelationships between the land needs for food and fiber demands and the uses of the nation's lands.

## The Current Food and Fiber Demand and Supply Situation in Perspective

In light of current tight world markets with large U. S. exports and high grain and fiber prices, some people claim that a new era in food and fiber demand is already before us--that the recent experience in farm exports, prices and income is here to stay. The basis for this proposition is on the demand side--that suddenly consumers have "discovered" food and have greater incomes world over. Consequently, as this reasoning continues, the world will continue to burden us for exports and intense competition with domestic consumers for food. What is reality? Has world demand for food suddenly, as a strike of lightning in the middle of night, been transformed to create an entirely new situation forever? Or is the situation only a temporary event--an illusion as experienced in 1950 with respect to the "5th plate" and again in 1966 with respect to the pending "world food famine?" Is Malthusian reasoning being vindicated?

Despite dire predictions of world food famine, scarcities and high prices, U. S. farmers during the 1950's and 1960's experienced depressed incomes and burdening surpluses because output flooded against limited demand. In 1960, embarrassing public stocks approximated annual production for several commodities. In 1966, detailed figures were amassed and a massive propaganda drive emphasized the severity of the onrushing world food shortage and the need for the U. S. to

"go all out" in meeting this "certain market" to prevent world starvation. Presidential programs were initiated and international organizations implemented special studies to cope with this pending situation. By 1968, U. S. farm commodity supplies again were a heavy burden against demand, farm prices and income were low and the Midwest farm region helped defeat Humphrey, a democrat associated with Freeman who relaxed controls in 1967 and let farm income "go to pot." Where do we stand now? Are we in another "5th plate" or "pending world food crisis" phase which may convert to domestic overproduction again?

Initially, it it important to stress that the U. S.'s current world food market simply could not be predicted two years back. Its causes rest on exogenous and stochastic events which are outside normal economic relationships. Main elements of our future demand-supply balances and food prices may similarly revolve around stochastic events and be the core of our food concern. We return to this proposition later. World food demand has always been in a gradual upward trend due to growth in population and per capita incomes. Total world food demand does not leap discretely from the trend line, linear or nonlinear, in a stair-step jump in the span of a year. Some people seriously propose this quantum leap--citing growth in income of Europeans, preference of world consumers for more meat and a greater population. These world variables are gradual and do not give rise to quantum jumps by years. Population increases by small inter-year degrees; as do income, preferences and purchases of meat as world economic development occurs. The demand facing one major food exporting nation such as the U. S. can take a "stair-step leap" because of stochastic and exogenous events relating to the supply side in other countries. But it does not necessarily happen the world over and may well not constitute a continuing and additional phenomenon.

Numerous variables in the current domestic food situation were unpredictable two years ago; some have prospects of permanence, and some are transitory. The more stochastic and transitory elements of the present food situation include the following factors. The small anchovy harvest off South America is a short-run phenomenon. The crop shortfall in East Europe, Asia and parts of Africa in 1972-73 falls in a similar category. These conditions of supply were transformed into a short-run demand leap for exporting countries such as the U. S. Long-run variables which are more gradual and do not generate food demand leaps even for U. S. exports include ongoing world trends in population, income and meat consumption. Some demand variables are unique to agricultural commodities of the U. S. Devaluation of the dollar twice over the last two years has lowered the real price of agricultural commodities from the U. S. in world markets. This is directly a demand expansion element unique to export commodities of the U. S., and countries with currencies meshed with the dollar. At the present, until other countries might retaliate with further devaluations, it is one of the elements in the outlook for U. S. agriculture.

World demand for food and feed grains in aggregate and in livestock production in particular did not suddenly jump vertically from the time trend in 1973. It did for the U. S., but only because the supply in the rest of the world and not the demand was perturbed in 1972-73. World food demand most likely will continue its smooth trend upward in correlation with population and per capita income. The extent to which the slope of this "smooth curve" accentuates will depend, aside from the real price of food, on national policies which affect birth rates, economic growth rates and income distribution. But it would never leap suddenly and remain upward, due to these variables, as is now proposed by many persons.

Inflation and currency devaluation constitute important factors in recent food and fiber demand increases. However, inflation of world farm commodity prices has generally been low compared with other commodities. For example, world mid-year prices between 1972 and 1973 revealed increases of 50 percent for food, 73 percent for metals and 93 percent for fibers. Against world commodity prices, and even in our own domestic experience, U. S. agricultural commodities have not experienced record real prices in the last few months. Actually, real farm commodity prices generally were as high or higher in terms of consumers' purchasing power during the 1940's and 1950's.

The rather abrupt devaluations of the last two years, augmented by more rapid inflation in other countries and a large supply of dollars afloat in world monetary markets, represents the major "step function" or discrete upward movement in world demand for U. S. farm commodities. It will remain nontransitory until further currency re-evaluations over the world reverse the relative value of convertible currencies. These re-evaluations are already under way. Estimates suggest that around 25 percent of the export demand jump over the last year and a half is due to this set of monetary forces. Hence, without a reversal or major realignment of market exchange rates for world currencies, this is the proportion of added demand (beyond trend) we might expect to stay with us.

We may well be in a new position with respect to world demand for U. S. farm commodities, but of somewhat different nature. This new situation would not give continuous stair-step increases in demand. Rather, it has prospects of being a yo-yo or "come again, gone again" change, in demand, for U. S. farm commodities. While there has long been periodic demand increments due to poor crops elsewhere in the world, changed conditions give more certain prospects to their future existence. These changed conditions would cause the effects

of sporadic ups and downs in world food production or supplies to fall on U. S. farmers as demand gyrations.

One foundation for volatile prospects is the growing inelasticity of world food demand. Demand becomes more inelastic as consumers' incomes increase, as clearly shown throughout the world during the past two decades. Other world processes and assessments add to this inelasticity. A case is the U.S.S.R. With only modest capacity to carry buffer stocks, in previous years of crop shortfalls Russia simply tightened its belt and ate less. The burden of production fluctuations fell on its own consumers. In Stalin's time, a drouth simply meant less cereals and more hunger for Russian families. By Khrushchev's time, people got about as much food but more in the form of cereals which previously went to livestock. In recent years, Soviet leaders have committed themselves to an upgrading of food consumption and livestock production and are reluctant to accommodate even drouth-generated shortages in policies of reduced consumption.

Perhaps the riots over food scarcities and prices in Poland in 1969 presented near-at-hand evidence that it could "even happen here." Public protests in the Ukraine over food availability, although of a more modest extent, suggested the same. Because of these "manifestations" of effective consumer demands, but perhaps more particularly because of growing per capita incomes and their associated demand pressures for livestock and similar food commodities, the U.S.S.R. seems to have fully committed itself to a more stable and larger supply of livestock products. Its five-year plan in process calls for vast increases in livestock products. To implement and maintain this growth with limited buffer stock capacity, the U.S.S.R. is likely to be in the world market periodically on a large scale in future domestic crop shortfalls.

Hence, its demand wouldn't jump "stair-step-wise" permanently but the short supply would translate into a "stochastic jump" in demand for grains of exporting nations such as the U. S. This commitment, to the extent it exists, causes food demand in the U.S.S.R. to be more inelastic and constant--thus transferring a stochastic increment of demand to food exporting nations. There is prospect also that developing nations whose historic experience has been that of famine and deaths in years of crop shortfalls also will reflect a less elastic demand in the future.

As few as two decades ago, administrators and public officials of developing countries had gone through sporadic drouth and hunger periods and merely looked upon them as "the way of nature and life." Their experience in planning and administration was meager and they lacked capacity and investment funds to store up for unfavorable yields. To the extent they averted disaster, the solution came from very large public stocks carried by the U. S. over this period--stocks which are now gone. With passage of time, new administrators and planners have emerged in developing countries. They are more educated, experienced and humanitarian. It is unlikely that they will consider starvation by masses in drouth years to be a necessary condition of either God or nature. Prospects are, they too will buy more heavily in poor crop years and the greater consistency of their domestic demand and limited buffer stock facilities also will add a greater stochastic increment to farm commodity demands of exporting nations. Finally, developed countries such as Western Europe, which import a large proportion of their food, are unlikely to "bear the brunt and do the best buckling" in years of poor crops when the U.S.S.R. and developing countries are temporarily in the world market to offset domestic crop shortfalls. Consumers nowhere like food shortages and inflated prices

and it is likely that their governments will help avoid them. The current intensive effort of the Japanese to assure themselves ample food supplies is an example.

Hence, because of these potential minimum restraints and greater demand inelasticities for food in several categories of countries, plus a general lack of grain storage capacity over the world, U. S. farmers and consumers likely are faced with export demands and prices which will bounce briskly upward in selected future years of world crop shortfalls--just as they did in 1972 and 1973. Then, once weather has recovered and other countries have replenished their stocks, our supply capacity will still be large enough to cause a sharp fall in U. S. farm commodity prices. Hence, American consumers (in food prices) and farmers (in income) are faced with whip-lash effects related to (a) weather, (b) inelastic food demands, (c) insufficient world grain storage capacity and (d) archaic and transitory policies.

Future instability of food prices and farm income is likely to be extreme for the U. S. due to these conditions plus our own large supply capacity. However, as mentioned previously, excess supply capacity of our agriculture may well tend to decrease by those ongoing and continuous increases in export demand due to currency devaluation, growth in both world population and per capita incomes and institutional arrangements of extended duration. But demand increases of the size we have witnessed during the past two years are stochastic in the above setting and under normal world weather and supply conditions and our producing capacity will be too large to maintain prices at or near recent levels. We are likely to go along at a reduced level under normal world weather--then suddenly be whip-lashed again under the conditions of drouth coupled with greater demand inelasticity in other countries. To avoid this

extreme instability, and even to forestall battles of consumers with farmers in years of stochastic demand and price increments, a major U. S. and world policy need for the future is a storage program to meet these new conditions.

## Land Use and Production Possibilities Into the 1980's

The United States has a land base of slightly less than 2.3 billion acres. Of this amount, 21 percent is in cropland, 27 percent in grassland pasture and rangeland, 32 percent in forests, 8 percent in special uses and 13 percent in other lands as rounded from Table 1. Proportions of the national land base in cropland, pasture and rangeland and forests have remained practically constant for more than two decades, although changes have occurred within regions.

Table 1. Uses of Land in the United States[1/]

| Uses of land | Millions of acres in each use | Percentage of land in each use |
|---|---|---|
| Cropland | 472 | 20.9 |
| Grassland pasture and range land | 604 | 26.7 |
| Forest land | 723 | 31.9 |
| Special uses of land[2/] | 178 | 7.8 |
| Other land[3/] | 287 | 12.7 |
| Total land | 2,264 | 100.0 |

1/ Based on 1969 U. S. Census data.

2/ Includes urban, highway, parks, wildlife, military and farmstead uses.

3/ Includes land in desert, swamps, rock and tundra conditions.

Under the special use category of Table 1, urban uses have doubled in area since 1950, but their present total area includes only one and one-half percent of the total land base. Highways and airport transportation uses absorb only one percent which includes the Interstate system of highways and the considerable expansion of airports.

Although cropland has remained practically constant for a quarter of a century, the land actually used for crops in 1972 declined 14 percent from the all-time high of 387 million acres in 1949. This decline of 53 million acres included land idled under federal land retirement programs in their effort to lessen surplus production of food and fiber.

Referring to the cropland segment of the national land base (Table 1) consisting of 472 million acres, we analyze possibilities of expanding cropland in Table 2. These cropland possibilities must necessarily come from other uses since the national land base remains constant. In exploring these possibilities, there appears to be an additional 264 million acres, representing a 56 percent expansion of current cropland, that could be converted to cropland. This expansion consists of Class I, II and III land not now in cropland but suitable for cultivation if improved and if managed properly to prevent erosion and deterioration. This potential cropland, as shown in Table 2, includes 124 million acres of forest land, 117 million acres of pasture and range land and 23 million acres of other land. These lands could be developed and converted to cropland within the next decade if needed.

Table 2. Current and Potential Cropland in United States.

| Current Cropland[1/] | | Potential Cropland Sources[2/] | | Current and Potential Cropland |
|---|---|---|---|---|
| Uses | Millions of acres | Uses | Millions of acres | Millions of acres |
| Cropland used for crops | 333 | Forest land | 124 | |
| Soil improvement and idle | 51 | Pasture and range land | 117 | |
| Cropland pasture | 88 | Other land | 23 | |
| Total | 472 | | 264 | 736 |

1/ Based upon 1969 U. S. Census.

2/ Based upon Conservation Needs Inventory. Soil Conservation Service. U. S. Department of Agriculture. 1967. Includes Class I, II and III land not now in cropland but suitable under certain management limitations for regular cultivation if improved. Excludes Alaska and Hawaii.

These potential croplands added to the present cropland base could be expected to add substantial increases in production as estimated by the U. S. Department of Agriculture under certain assumptions. Besides the development and management assumptions specified earlier, other assumptions include expectations and realization of (1) favorable product prices, (2) adequate available supplies of inputs at favorable prices, (3) normal climatic conditions, (4) unrestricted use of lands, and (5) increased use of technologies. These assumptions are important constraints in realizing potential increases in production for major food, fiber and feed crops.

Table 3 summarizes potential increases in production for five major crop categories by 1985. These increases are not predictions but they do appear possible in light of the stated assumptions.

Table 3. Actual and Potential Production for Five Major Crops.[1/]

| Years | Corn | | | Soybeans | | |
|---|---|---|---|---|---|---|
| | Acres millions | Yields bushels per acre | Production billions of bushels | Acres millions | Yields bushels per acre | Production billions of bushels |
| 1969-71 average | 58.7 | 82.2 | 4.8 | 42.1 | 27.4 | 1.2 |
| 1972 | 53.3 | 96.9 | 5.6 | 45.8 | 28.0 | 1.3 |
| 1973 | 61.5 | 93.8 | 5.8 | 56.2 | 28.5 | 1.6 |
| 1980 | 73.7 | 109.5 | 8.1 | 64.1 | 32.0 | 2.1 |
| 1985 | 75.5 | 120.0 | 9.9 | 65.7 | 34.5 | 2.3 |
| Percentage increase in potential production in 1985 over 1969-71 average | | | 53 | | | 52 |

[1/] Adapted from The Farm Index, Economic Research Service, U. S. Department of Agriculture, Vol. XII, No. 12, December, 1973.

Table 3. Actual and Potential Production for Five Major Crops.[1/]

| Years | Feed Grains | | | Wheat | | | Cotton | | |
|---|---|---|---|---|---|---|---|---|---|
| | Acres millions | Yields tons per acre | Production millions of tons | Acres millions | Yields bushels per acre | Production billions of bushels | Acres millions | Yields pounds per acre | Production millions of bales |
| 1969-71 average | 100.4 | 1.18 | 182 | 46.1 | 31.9 | 1.5 | 11.2 | 437 | 10.2 |
| 1972 | 94.1 | 2.13 | 200 | 47.3 | 32.7 | 1.5 | 13.2 | 507 | 13.7 |
| 1973 | 102.4 | 2.05 | 210 | 53.7 | 32.2 | 1.7 | 12.4 | 502 | 12.9 |
| 1980 | 114.7 | 2.47 | 283 | 62.3 | 34.5 | 2.2 | 14.1 | 510 | 15.0 |
| 1985 | 115.7 | 2.72 | 315 | 62.3 | 36.6 | 2.3 | 14.7 | 535 | 16.4 |
| Percentage increase in potential production in 1985 over 1969-71 average | | | 58 | | | 65 | | | 62 |

[1/] Adapted from The Farm Index, Economic Research Service, U. S. Department of Agriculture, Vol. XII, No. 12, December, 1973.

According to these potentials as shown in Table 3, under the stated assumptions, average production in 1985 as compared with the 1969-71 average could increase 53 percent for corn, 52 percent for soybeans, 58 percent for feed grains, 65 percent for wheat and 62 percent for cotton. These estimates provide some idea for the near to intermediate term of the magnitude of the production potential of U. S. agriculture. These potentials also provide a preview of the potential problems for U. S. agriculture in case foreign and domestic demands do not materialize to absorb large increases in the nation's production potential for food and fiber. These estimates underscore the importance of guiding production potentials in light of demand through public policies and structures some of which are suggested in the latter part of this paper.

## World and Domestic Demands Relative to Production Possibilities and U. S. Land Base by Year 2000

The longer run future demand and supply of food will depend upon trends which can be influenced by policies of societies. These trends on either the demand or supply side can be accentuated or dampened by variables which nations select to manipulate as policy instruments. The capacity of land resources to meet future food demands similarly depends on policies which are within the capabilities of governments should they decide to initiate and implement them. The problem of food availability to meet future consumer requirements is primarily one for other countries of the world, especially developing and low-income countries. The U. S. has ample land resources and food supply capacity to meet domestic food demands for many decades ahead. We can do so

at relatively low real prices for food as far as our own demand is concerned and still have exportable surpluses. The uncertain future for the United States is not whether it has land resources and producing capacity to meet its own food needs, but the extent to which world food demand grows more rapidly than world supply and whether this difference becomes an effective demand for our farm products. The U. S. could still produce much more than enough food to meet home demand but domestic consumers would have to pay a higher real price to get it in competition with world consumers. Domestic food producers would, of course, benefit accordingly. Under opposite circumstances, effective world demand for U. S. produced food at dampened levels, we will be faced with surplus capacity of the magnitude prevailing in the 1950 and 1960 decades. Under these circumstances, land again would have to be retired from crop production to meet the price targets specified in the Agricultural Act of 1973. We now review long-range world and domestic alternatives in food production and demand.

World Possibilities

The relative future balance between world food supply and demand will depend on how other governments restrain or promote variables representing both. Variables on the demand side will be crucial in determining the intensity with which either hunger and malnutrition fall on consumers of less developed countries in the future, or conversely, high food prices burden American consumers. The major variables on the demand side are population and per capita incomes. With continued higher growth in population but little progress in per capita incomes, demand in international markets by developing countries will remain low, misery of their population will prevail, they will have relatively small access to international markets and U. S. food production can over-ride domestic demand sufficiently to pose possibilities of surplus

capacity and even idled land. Conversely, low population growth rates and continued progress in per capita incomes could allow consumers worldwide to greatly upgrade their diets, reach more broadly out into world markets to augment their supplies and compete with U. S. consumers at higher prices for the very large output their country can produce.

Variables on the long range supply side relate largely to the reclamation and development of land, promotion of higher-yielding technologies and their communication to farmers and investment in modern inputs and their distribution. We have recently completed a large-scale study which allows comparison of outcomes under alternatives in both supply and demand.[1/] There is not just one outcome which is possible or necessary, but numerous possible future outcomes depending upon how governments manage the variables relating to food supply or demand. There is room for optimism--if governments are willing to face the alternatives and select policies which will allow attainment of those favorable to welfare of their own populations and prevent extreme burdens on world food supplies and land use. The adequacy of world food supplies and the positive opportunities of land use rest largely in their hands.

In our assessment of future food supplies relative to demand, we considered numerous variants in population and income growth, agricultural productivity and cropland base for the world. The corresponding projections are included in Table 4 for a number of these and include three levels of population, two levels of per capita income and two availabilities of land. The low land bounds suppose the amount of land cropped over the world remains at approximately 1970 levels. However, since there still is land which can be converted to

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1/ Blakeslee, Leroy L., Earl O. Heady and Charles F. Framingham. World Food Production, Demand and Trade. Iowa State University Press, Ames, Iowa, 1973.

crops, especially in certain countries of Africa, South America and South Asia, we estimated output for a set of high land bounds which assume cropping of land which has favorable characteristics in climate, topography, transportation and markets and which can produce human food crops. Additional land has physical and climatic characteristics favorable to cropping but currently lacks transportation and market facilities. Productivity trends are the same for all sets of demand and land availability alternatives; namely, at postwar trend rates during the 1960's. These data, estimated separately on a country-by-country basis then aggregated, cover the world except for China, North Vietnam and minor areas. In a set of estimates including China and both its supply and demand potentials, the possibilities under the several combinations of alternatives are qualitatively the same--deficits being accentuated under high demand variants and balances remaining relatively favorable under high land bounds and restrained population growth. We present data for cereals only (but have estimates also for other major food categories) since outcome for other products are similar under each set of alternative futures. Estimates allow food consumption for cereals to grow with income and population either directly through human consumption or indirectly through livestock consumption.

Table 4. Estimated world food deficit (-) or Surplus of Production (+) over demand or requirements, under alternatives in food demand and supply variables for year 2000 (1000 metric tons).[1]

| Population Level | Constant Per Capita Incomes | Historical Rate of Growth in Per Capita Incomes |
|---|---|---|
| | Low land bounds | |
| Low | 302,191 | 177,069 |
| Medium | 158,248 | -22,989 |
| High | 43,193 | -132,801 |
| | High land bounds | |
| Low | 322,988 | 137,876 |
| Medium | 179,055 | -2,182 |
| High | 64,000 | -11,914 |

[1]Derived from tables 10.09-10.20 of Blakeslee, Leroy L., Earl O. Heady and Charles F. Framingham. World Food Production, Demand and Trade. Iowa State University Press, Ames, 1973.

Under the most unfavorable circumstances of high population and income growth and low land bounds, world cereal production would fall short of consumption requirements or demand possibilities by 132.8 million metric tons in the year 2000.[1/] With low population and income growth and high land bounds, our projections even suggest that a world surplus of food commodities could prevail. With only medium population growth, a controversial upward trend in per capita food consumption and agricultural productivity and cropping of favorably available land, projected world food requirements could approximate (only slightly exceed) world production possibilities.

[1/] We use the term demand possibilities since the quantities are not based on a projection of market equilibrium. In reality, commodity price flexibilities would cause reduced consumption to be equated with supply at higher prices under some circumstances, etc.

Which one of these outcomes will prevail in the future depends on the wisdom and abilities of countries and their policy makers. These projections of production potential and demand in 2000 suggest minimally that with modest momentum in agricultural improvement and restrained population growth, the world food situation need not deteriorate over the next 25 years. Of course, the pressure of demand on food supplies will depend importantly on the rate at which per capita incomes increase over this period. If they increase at trend or higher rates, food will have a higher real price than otherwise. But the cause and consequence will rest with the improved welfare of mankind, in comparison with demand growth reflected mainly through population increases. In the one case, food takes on a relative scarcity because man has enough income to buy more of it and drive its real price up; in the other case, relative scarcity grows out of restrained supplies holding populations in misery near subsistence levels. These data indicate that potentials in supply expansion and demand constraints are such that the world has sufficient land and could attain a favorable balance in the next three decades. It could do so to the extent that broad problems of hunger might be erased in simultaneous war on equity problems of economic development. Those who will guarantee that these ends can be attained, or that they will be forfeited with subsequent decades of misery for people, are government leaders in countries of large populations with high birth rates or in countries of large unexploited agricultural resources. Leaders in the former countries which have the long-run solution of population in their hands will either deliver it or let it slip through humanity's hands; it is the leaders in the latter countries who can provide short-run solutions but, try as hard as they may, cannot extend food supplies to match population growth that other countries do not control.

Hence, while our results suggest that the world is not necessarily faced with calamity in the next 30 years but only if the politicians and administrators of selected developing countries do enact agricultural, development and trade policies which hurry and guarantee adequate food supplies. Over the longer run, however, praise or blame for these same politicians and administrators will rest on their actions in initiating and implementing appropriate population policies. The lack of adequate birth control technologies is not a sufficient excuse for nonattainment. Needed immediately and on a much more intensive basis are: much larger and more effective communication programs to bring sufficient awareness to all of the population; larger public investments to provide the staffs, personnel and administrative facilities to accomplish the task; effective economic incentives either in the cost of the techniques or in the return for their application; and actual sincerity and concern for future generations to stir the present generation of public officials into action. Of course, the ultimate goal is economic growth and per capita incomes at levels which cause families to exert their own initiative. Perhaps one threshold level is attained when the level of affluence of children cause them to draw on family income more heavily as consumers than they contribute to it as resources. But the world can hardly wait for this threshold level to be attained in all countries. The politicians and officials of these countries must speed effective public population policies. Whether the citizens of their countries live in misery at food subsistence levels in a half century will depend on the actions they take in the next two or three decades. Leaders of developed countries can provide encouragement through technical financial assistances, but success or failure depends mainly on the leaders and citizenry of developing countries during future decades beginning now.

U. S. Possibilities

The potential of U. S. land resources serving as an adequate base for our own food needs, contributing to world supplies and allowing land to be diverted to other priority uses similarly depends on a set of future variables. The major variables involved include population, per capita income, food preferences, agricultural technology, national environmental restraints which might be imposed, and programs or policies which allow a more efficient allocation of land and water resources. To gauge these possibilities, we also have made projections to 2000 of U. S. food supply capacity relative to our ability to meet domestic demands and contribute to world markets beyond 1967-69 export levels. In other words, we ask the question: How much land from our 1970 cropland base is available for producing exports beyond our own consumer demand levels in 2000 and the 1967-69 levels of exports? Projections assume trend levels of productivity gains (except under Model D) and per capita incomes and that both water and land, on an inter-regional basis, can be allocated optimally among crop and livestock products. The projections are based on estimates for 254 individual production and market regions of the nation, outcomes for several population levels, modest environmental restraints represented by restrictions on use of fertilizer and insecticides, accentuated technological trends in the Southeast and the potential of substituting soybean protein foods for meat. The models examining these alternatives are summarized in Table 5.

Model A assumes trend levels of technology in 2000 and a 300 million population. Model B is similar except that it uses a 280 million population--a level more nearly in prospect. Model C supposes a limitation on nitrogen use at 50 pounds per acre (approximately half of the present use). Model D assumes a 325 million population, exports double the 1967-69 level and an advanced rate of technological advance in the Southeast (simply to a level which allows this

Table 5. Alternative futures for population, technology, exports and environmental limits in relation to land use and availability, estimates for 2000.[a]

| Variant or Condition | 1964 | Model A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|
| Population[b] | | 300[c] | 280[d] | 280[d] | 325[e] | 280[d] | 300[b] |
| Export level | | 1967-69 | 1967-69 | 1967-69 | double 1967-69 | 1967-69 | 1967-69 |
| Technology | | trend | trend | trend | advanced | trend | trend |
| Environmental or food limit | | none | none | nitrogen | none | insecticide | protein subs. |
| Total dryland[f] (acres) | 1,155 | 1,227 | 1,192 | 1,230 | 1,238 | 1,195 | 1,148 |
| Total irrigated[f] (acres) | 31.3 | 27.2 | 26.0 | 27.2 | 28.6 | 26.5 | 23.8 |
| Excess cropland[g] (acres) | 55.5 | 16.4 | 51.0 | 12.9 | 4.5 | 48.1 | 95.0 |

[a]Source: Heady, Earl O., Howard C. Madsen, Kenneth J. Nicol and Stanley H. Hargrove. Agricultural and Water Policies and the Environment. Center for Agricultural and Rural Development. Iowa State University, CARD Report 40T. Ames, Iowa, 1972.

[b]Million.

[c]Population level C of U.S. Department of Commerce.

[d]Population level D of U.S. Department of Commerce.

[e]Population level B of U.S. Department of Commerce.

[f]Used cropland for crops in meeting domestic demand and specified export levels.

[g]Cropland not needed for domestic demand and specified export levels.

region to catch up with the rest of the country). Model E assumes banning of insecticides on corn and cotton while Model F assumes that consumers substitute soya protein foods for up to 25 percent of beef demand projected to 2000.

Summary results for these several alternative futures also are presented in Table 5. With the more likely population level of Model B, the nation would still have 51 million additional acres of cropland which could be devoted to exports--or would have to be idled in the absence of export possibilities beyond 1967-69 levels and support price requirements as implied in the Agricultural Act of 1972. Even with the higher population level of Model A, sufficient capacity of our agricultural land base is still indicated in figures of the last line which show acres in excess that needed to meet domestic demand in 2000 and 1967-69 export levels. Under the higher population level and export indications for Model D, our land base would still more than meet approximate needs if the rate of technical advance in the Southeast were brought up to the level of the rest of the country. Models C and D indicate that environmental restraints through limits on nitrogen use and elimination of pesticides on corn and cotton would still allow considerable reserve capacity in land (above projected 2000 domestic consumption and exports at 1967-69 levels). If, however, soya food products were substituted for as much as 25 percent of projected beef consumption in 2000, a vast amount of land (95 million acres of our cropland base) would be available for producing greater exports, for allocating to other domestic uses--or to be idled under public price support and supply control programs--even with a population of 300 million. In addition to this potential capability and flexibility in land use for the future, the nation also could use less irrigated land and less water for agriculture than at the present.

We have examined only a few future alternatives in American agriculture and land use. These data indicate, however, that the farm sector has considerable flexibility and capacity for meeting long term domestic food needs and export potentials--depending on how variables, which the nation can manipulate through various policies, are meshed in the future. Obviously, our domestic problem is not one of absolute scarcity in the land supply. It is one of how land and related resources such as water are allocated among alternatives both in agriculture and among economic sectors. Possibilities before us are represented in variables which can be altered by public policies. We now turn to these policy alternatives.

## Policy and Structural Changes Reconciling Land Needs for Food and Fiber Demands With National Land Use Policy and Planning

Land needs in satisfying food and fiber demands arising from domestic and world factors are important considerations in U. S. federal, state and local land use policies and planning. Most lands of the nation are presently dedicated to the agriculture sector. Agriculture's widespread use of the nation's lands affects water and air quality of other land. In responding to domestic and export demands for food and fiber, agricultural uses may be expected to expand and contract from time to time as export demands come and go. Thus, land use within the U. S. becomes interrelated with happenings throughout the world including population growth, increase in per capita income, currency exchange rates, export policies, trade balances, drouths, floods, pests and war.

Without land use policy and planning within the U. S. reflecting urban, industrial, transportation, recreational, aesthetic and other domestic needs, our land uses become passive and dependent upon exogenous forces and bear their consequences. Therefore, it appears essential that land policies and planning be developed in consideration of all demands, domestic and foreign, on our land in reconciling agricultural uses with other uses. In this context, so called prime agricultural lands may also become prime lands for other uses as well. Policy and planning are required to guide their allocation.

In reconciling land needs for food and fiber demands with other equally important domestic demands, numerous policy and structural changes are needed. These include (1) helping other countries meet their food needs within these countries, (2) helping build and manage a World Food Bank to provide stability of food supplies for emergency uses, (3) building and managing a U. S. Food Security Reserve to insure minimum reserves of food for our nation as insurance against shortages, excessive and volatile prices and emergencies, (4) establishment of standby price and production policies to protect agricultural producers and to provide cushions and guides in adjusting agricultural production in an orderly manner in reacting to changing food and fiber demands as well as national land use policy needs, (5) establishment of land use policy goals and procedures for reconciling food and fiber needs with the land use needs of other sectors of the nation, and (6) continuing needs for adequate research and education as essential foundations for orderly progress of a democratic and progressive nation.

## Helping Less Developed Countries Meet Their Food Needs

Obviously, the U. S. can neither feed the world not make significant dents in world food needs emanating from population explosions and increasing per

capita incomes in less developed countries. We can, however, share our knowledge and technology with developing nations and we can provide loan funds preferably through world and regional funding entities. Also, we can export agricultural products and inputs through normal channels of trade in a manner and to a degree consistent with our national interests including our land use policies and minimum food reserves.

But our major means for aiding less developed countries rests with research and the training of their nationals through knowledge transfer. As stated in an ancient Chinese proverb, "Give a man a fish and he can eat a meal but teach a man to fish and he can eat a lifetime of meals." At the present time, however, the United States has dropped to 14th among the more developed nations of the world in the percent of gross national product allocated to economic development assistance to developing countries. Furthermore, support for development assistance appears declining in the Congress. Although development assistance requires serious reappraisal, the needs and opportunities are greater now than ever before. Our appraoch should become positive and rejuvenated based upon an analyses of experiences, both successes and failures of U. S. and other countries. Our approach should be based particularly upon our invaluable resources of extension and research personnel coupled with our reservoir of knowledge of food production and distribution and research methods.[1/]

## Building and Managing a World Food Bank

High on the agenda for reconciling world food needs for food with uses of U. S. land resources is the establishing of a World Food Bank with

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1/ For further ideas on this approach, see Earl O. Heady and John F. Timmons, "Objectives, Achievements, and Hazards of the U. S. Food Aid and Agricultural Development Programs in Relation to Domestic Policy," Chapter 13 in Alternatives for Balancing World Food Production and Needs. Iowa State University Center for Agricultural and Economic Development. The Iowa State University Press, Ames, Iowa. 1967.

appropriate regional food reserves under the auspices of international initiatives, probably the United Nations. The World Food Bank could accumulate reserves from surpluses or quotos from member countries for distribution to less developed nations experiencing catastrophic crop shortfalls resulting from weather, pest, disease or political causes but unable to purchase emergency supplies in world markets.

Food stocks of the World Food Bank would necessarily have to be managed in a manner that would neither (1) interfere seriously with world markets nor (2) depress production within recipient countries. U. S. food transfers previously handled through Public Law 480 could be channeled through the World Food Bank.

The Food and Agriculture Organization in its biennial conference, November, 1973, in Rome endorsed the concept of forming a world food reserve to insure minimum food availabilities. The task of following up with possible implementation of the concept will be on the agenda of the World Food Conference scheduled for November, 1974. Sponsored by the United Nations, general coordination of the conference has been assigned by the U. N. General Assembly to the U. N. Economic and Social Council.

Building and Managing a U. S. Food Security Reserve

Recent experiences with food, feed grain and fiber shortages and consequent price gyrations occasioned by sporadic large exports of these products dictate that the U. S. establish a National Food Security Reserve with minimum reserve stocks of corn, wheat, soybeans and feed grains. Such a reserve would provide insurance against natural disasters such as drouths, foods, pest infestations and other natural catasrophies.

Such reserves could be accumulated during good crop years to ease shortages and prices during poor crop years. These reserves would constitute a prudent investment in national security against unforeseen contingencies. Costs of the reserve should be borne by the federal government and considered as premiums on insurance against food shortages and high prices.

These stocks would necessarily have to be managed in a manner that would not interfere with normal ranges of production and prices in the markets Management of these reserves would be coordinated with the management of reserves in the above described World Food Bank.

Establishing Standby Production and Price Stability Policies

Because of price yield and cost gyrations affecting agricultural production, standby policies and programs should be established to cushion effects upon producers and to guide production in an orderly manner in response to demands. These measures would probably include land retirement and price floors for products. Experiences with supply management and income policy with their failures and successes over the past four decades should be analyzed in developing new standby policies for production and price stability.

Land Use Policy and Planning Needs

As our society becomes more complex and complicated through (1) population growth, (2) distribution of people and their activities, (3) increased per capita affluence, (4) expanding applications of technology and (5) foreign events, there arises many serious problems of congestion, resource depletion and environmental deterioration. These problems call for planning which in turn calls for land use policies within which land use planning may be guided, undertaken and made effective.

Public interest in the use of natural resources and in environmental quality is manifested in public discussions and pressures for action. Reacting to these discussions and pressures, local, state and federal governments have been striving to articulate and ameliorate land use and environmental problems. According to the U. S. Senate Committee on Interior and Insular Affairs, over 200 land use policy measures were introduced in one or both houses of the 92nd Congress.[1/] Likewise, numerous land use measures have been introduced in state legislatures. The Council of State Governments reports that seven states have developed statewide land use plans and 16 more states currently are developing some kind of a state land use plan.[2/] Some of these plans will be discussed by other speakers at this AAAS meeting, according to the program.

Meanwhile, nongovernmental organizations are pressing for recognition of current land use problems and for public action to ameliorate these problems. The League of Women Voters voiced its concern thusly: "Conflicting passions rise as interstate highways are built around business districts or through parklands, as wetlands are filled for construction sites or drained for farming, as vacation resorts are planned along windswept beaches. Central to these and other environmental issues is the choice of land use. How shall we plan for the future use of our land?"[3/] This question is being raised repeatedly throughout our nation today.

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1/ U. S. Congress, Senate, Committee on Interior and Insular Affairs. 1972. National land use policy. 92nd Congress, 2nd Session, Washington, D. C., page 1.

2/ Council of State Governments. 1972. The states' role in land resource management. Chicago, Ill., page 7.

3/ League of Women Voters of the United States. 1971. How shall we plan for our land? Current Focus, Pub. No. 501, Washington, D. C., page 1.

Need for land use policy is not new. Almost a half century ago, Professor B. H. Hibbard of the University of Wisconsin observed: "Thus far, there has been no genuine land policy in and for the United States. True enough, there have been temporizing plans, some of them good for a time, and for certain sections. But a plan involving and comprehending the welfare of the whole nation, varied to fit the different parts of the country, we have not had."[1/]

Four decades ago, the nation and states engaged in a widespread land use planning effort by the Natural Resources Planning Board and by state and county land use planning committees, respectively. A review of these efforts by states and counties would appear appropriate as efforts toward land use planning are renewed in the 1970's.

The need for a genuine land use policy certainly has not diminished over the intervening four or five decades. In fact, today the need for developing land use policies is fast reaching crisis proportions.

Senator Henry Jackson, chairman of the Senate Committee on Interior and Insular Affairs, explained the need in the following manner: "Environmental crises, energy crises, indeed most of the domestic crises which confront us, can be traced to decisions as to how our land is used. This lends emphasis to the statements of numerous public officials and concerned citizens who maintain that many land use decisions of wide public concern are being made on the basis of expediency, tradition, short-term economic considerations, and other factors frequently unrelated or contradictory to the real concerns of sound land use policy. The rapid and continued growth of the nation's population, expanding urban development, proliferating transportation systems, large-scale industrial and economic growth, conflicts in patterns in land use, fragmentation of

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1/ Hibbard, B. H. 1972. A history of public land policies in the United States. Macmillan Co., New York, N. Y.

governmental entities exercising land use planning powers, and the increased size, scale and impact of private actions have today created what many Americans perceive to be a national land use crisis."[1/]

Within the past two years, the National Governors' Conference presented the states' view on the need for land use policy: "Across the nation, a failure to conduct sound land use planning has required public and private enterprise to delay, litigate, and cancel proposed public utility and widespread and commercial developments because of the unresolved land use questions, thereby causing an unnecessary waste of human and economic resources and a threat to public service, often resulting in decisions to locate utilities and industrial and commercial activities in the area of least public and political resistance, but without regard to relevant environmental and economic consideration.?[2/]

Widespread recognition of the need and support for the development of land use policies is evident. However, land use policy actions remain stymied, fluid and in the process of formulation. Now is the time to provide idea inputs into land use policy formulation. As time passes and legislation is enacted, policy will become fixed, and options for guiding and shaping land use policy actions will likely diminish.

Formulation of effective land use policies that include consideration of foreign as well as domestic considerations is not an easy task. Such policy issues remain to be discussed, developed and molded into legislation, administrative

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1/ U. S. Congress, Senate, Committee on Interior and Insular Affairs. 1972. National land use policy. 92nd Congress, 2nd Session, Washington, D. C., page 1.

2/ National Governors' Conference, Office of Federal-State Relations. 1971. Policy positions of the National Governors' Conference. Washington, D. C., page 36.

orders and judicial decisions. This task is a challenge to all of us as citizens and as professional workers.[1/]

Continuing Needs for Research and Education

Research and education have played an essential role in building within the U. S. the most productive agricultural industry in the world. This industry has provided more plentiful food with higher quality at lower prices than any other nation. Also, agriculture has provided essential raw materials for textile, plastic and many other industries. Within the past year, U. S. agriculture provided almost $20 billion of exports amounting to almost one-third of the value of all U. S. exports.

In light of proven contributions and future needs for research and education, it is disturbing to find that our national government is handicapping the future of the agricultural industry and the nation with reduced support for research and education by impounding and failing to appropriate needed funds.

High priority and expanded resources should be devoted to increased research needed for rural development and for land use policy and planning at national, state and local levels of application. Likewise, research is needed in developing and appraising constituent policies and structures for the standby production and price measures, the National Food Security Reserve and the World Food Bank. Also, high on the agenda for research is analysis of ways and means for extending technical and capital assistance to less developed countries. In addition, technical research must continue on means for increasing productivity under least cost technologies and on the management of land and its related natural resources.

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1/ Ideas on land use policies and planning guidelines are developed further in (1) John F. Timmons, "Public Land Use Policy: Needs, Objectives, and Guidelines," Journal of Soil and Water Conservation, September-October, 1972, pp. 196-210, and (2) John F. Timmons, "Guidelines for Developing State and National Public Land Use Policies," in Toward An Effective Land Use Policy for Michigan, Michigan State University, East Lansing, Michigan, 1973, pp. 5-16.