

Road Transportation and Food Production

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Many signs point to a worsening world food crisis. The gravity of the situation is measured by current deficits, future increases in demand due to population growth, and the presence of high rates of population increase in countries with low rates of agricultural productivity. There is also a growing scarcity of new land, hence a growing dependence on costly techniques for achieving higher yields per acre, including the distribution of commercial fertilizers and other agricultural inputs. In addition, there is a continuing migration from rural areas where surplus food is produced to urban areas where it is consumed. The effect of these conditions is to increase the importance of transportation as a means of increasing food production and of facilitating its distribution.

Transport policy makers in developing economies, however, have generally focused on transport requirements for industry. Industrialization has introduced new transport demands in emerging nations and is characteristically the source of the largest volumes and concentrations of traffic. As a result, attention and resources have been diverted from the more pervasive but less spectacular task of providing transportation for agriculture. The fact remains that this aspect of the transport problem, especially the transporting of food, is proving to be both more difficult and more urgent.

This report analyzes the transportation aspects of the food problem through a broad systems approach that includes both transportation and non-transportation investments. It suggests new planning and organizational arrangements to permit economic tradeoffs between transportation and other ingredients of an agricultural takeoff.

•GETTING ENOUGH to eat is the highest priority problem for most of the world's people today. Transportation policy makers can play a major role in overcoming this problem. This is true of both the facilities and services they provide and of the approach they take to programming needed investments. The task will be magnified by the expansion of world population, by the growth of urbanization, and by the increasing mechanization and modernization of agriculture. These trends mean that additional inputs will have to be delivered to permit intensive cultivation, and that larger surpluses of farm production will have to be moved from farm to city.

THE INCREASING REQUIREMENTS FOR FOOD

Population projections to the year 2000 indicate that the number of people to be fed will be roughly double what it is today (Table 1). The United Nations estimates that as early as 1980 the annual food grain requirements of the developing countries alone will jump from 470 million tons in 1960 to 767 million tons. The added burden on transportation facilities will be disproportionately heavy. The reason for this is the in-

TABLE 1
ESTIMATES OF POPULATION GROWTH, WORLD AND
DEVELOPING CONTINENTS, 1960-2000
(in millions)

Item	World	Africa	Latin America	Asia
1960	2,910	237	206	1,620
2000	6,267	517	592	3,870
Increase 1960-2000:				
Numbers	3,357	280	386	2,250
Percent over 1960	115	118	187	139
Increase 1960-80:				
Numbers	1,310	96	142	850
Percent over 1960	45	41	69	53

Source: U.S. Department of Agriculture. World Food Forum, Proc., Washington, 1962.

49 percent, and in Pakistan 79 percent. Comparable trends were recorded in the Philippines, Korea, Turkey, China, Peru, Venezuela, Colombia, and Kenya (Table 2).

Along with urbanization and industrialization, efforts to raise living standards throughout the world will hopefully result in substantial increases in incomes. In countries with minimum diets, such increases will mean added outlays for food as well as changes in the kinds of food consumed. Family budget data for 16 urban communities in tropical Africa, for example, indicate that well over half of all consumer expenditure goes for food (1). Furthermore, as incomes rise, food purchases shift from corn, wheat, rice and other staples to a more varied diet that includes dairy products, meat, fresh fruits and vegetables. The result is a disproportionate demand for the high-quality transportation services that perishable products demand.

INPUTS NEEDED FOR HIGHER YIELDS

It is no longer possible to produce more food simply by expanding the area under cultivation. The supply of virgin land is disappearing, and major increases in output can be accomplished only from high yields per acre. India, China, and Pakistan, which account for 60 percent of the total population of the underdeveloped world, are now almost entirely dependent on increasing yields per acre for additional food output (2).

To accomplish more production per acre presupposes improved systems of transportation, because adequate inputs of fertilizer, seed, machinery, and other ingredients of intensive agriculture are required. When food output is raised by expanding the cultivated area, the inputs used are generally small. But efforts to achieve higher yields per acre require heavy inputs, especially fertilizer. This also creates surplus output that farmers must move to market.

TABLE 2
INCREASES IN URBAN POPULATION IN SELECTED
COUNTRIES, 1950-60^a

Country	Millions in 1960	Percentage Increase 1950-60
India	35.0	49
Pakistan	6.9	79
Philippines	2.7	51
Korea	5.2	76
Turkey	3.4	96
China (Taiwan)	2.6	64
Peru	1.5	79
Venezuela	2.1	147
Colombia	4.0	177
Kenya	0.41	416
Congo	0.83	247

Source: Urban Land Institute. World Urbanization: Expanding Population in a Shrinking World. Tech. Bull. 43, pp. 45-46, 1962.

^aUrban areas of 100,000 or more.

creasing rate of urbanization, and particularly the concentration of growth in the larger cities, which will require more food to move from farm to city.

In most of the less-developed countries, a relatively small percentage of the population still lives in urban areas: 9 percent in Sierra Leone, Kenya, and Sudan, 10 percent in Burma and Afghanistan, 18 percent in India. But the trends are upward, and can be expected to continue in that direction as improvements in agriculture reduce farm employment and accelerate migration from the countryside. Between 1950 and 1960, for example, urban population in India increased

49 percent, and in Pakistan 79 percent. Comparable trends were recorded in the Philippines, Korea, Turkey, China, Peru, Venezuela, Colombia, and Kenya (Table 2). Although in most developing countries only one-fourth to one-half of what is produced is sold, the proportion of farm output that is marketed will increase as intensive agriculture expands and as the improvement of transportation reduces costs and makes marketing possible. The effect of improved transport is illustrated by the construction of all-weather roads to serve Indian villages. These facilities have been a primary factor in increasing farm incomes. Where grain production continued to be the principal activity, improved transport reduced the cost of local haulage by a sufficiently wide margin to

greatly increase the inputs and marketable output per acre. In some cases transport improvements resulted in altering the pattern of agriculture from less remunerative food grains to vegetables and dairy products. The higher returns resulting from this shift make it possible to purchase increasing amounts of fertilizer.

The effect of intensive agriculture on transportation demand is measured by increases that have taken place in the use of commercial fertilizers. In 1952-53, the world consumption of fertilizers totaled 17 million metric tons. Less than a decade later, in 1960-61, the total had risen to 29 million metric tons. The largest increases were in Latin America, where consumption rose 163 percent, and in the Far East, where the increase was 115 percent.

While many factors contribute to higher agricultural yields, including improved seed, insect and disease control, irrigation, drainage, and mechanization, the use of commercial fertilizer is probably the factor most responsible (3). Experiments designed to isolate the productivity effects of fertilizer have been conducted in a number of countries, and the results, summarized in Table 3, show the very substantial increases in yield that can be obtained.

Per-acre yields in developing countries have not increased by very much as yet. From the late 1930's to 1960, the increase for Asia and Latin America was only 10 percent, compared to 190 percent for North America. But the move toward greater use of fertilizers is illustrated by Indian agriculture in the Fourth Plan. The level of fertilizer consumption in India is extremely low—one-hundredth of the level achieved in Japan. Yet the goal of 120 million tons of food grain production in 1970-71 is a 30 percent increase over 1965-66. To achieve this goal, the use of nitrogen fertilizer will have to be increased from two-thirds of a million tons per year to 2 million tons, a 24 percent increase.

Other inputs for Indian agriculture will also add to the transport burden. By 1970-71 the area to be treated with plant protection materials is expected to quadruple, requiring a 167 percent increase in the availability of pesticides, weedicides, and rodent control materials. The use of hand and power sprayers and dusters will add further to the distribution of agricultural inputs.

Local industry is also expected to expand the production of small gasoline engines used for plant protection, small irrigation works, and other purposes. During the Fourth Plan period the supply of new power-operated machines plus manually operated equipment will rise by one-third of a million units. Agricultural equipment to be delivered in the entire five-year period will total 1,260,000 units.

Tanganyika provides another illustration of the trends. Between 1945 and 1960 there was a twentyfold increase in the tonnage of fertilizer imported, most of it used by estate agriculture producing sugar, tea, and tobacco. There has also been a massive increase in the use of chemical insecticides and fungicides. The growing demand for food has made it increasingly difficult to apply the old method of increasing fertility by letting the land lie fallow for fifteen or twenty years before cultivation is resumed. Research has now indicated how soil maintenance is possible, but in Africa, as elsewhere, the economic barrier is often transportation: ". . . the high cost of carrying

fertilizer from port to farm, and the high cost of carrying crops from farm to market. With improved lower cost transportation we may look for the gradual spread of fertilizer use . . ." (4).

Obviously the effects of fertilizer can be realized only if adequate facilities make it possible that fertilizers reach the cultivator at the right time (5). This means roads, vehicles, and a network of distribution centers in rural areas, within easy reach of the farmer. In developed countries these are taken for granted, but in poor countries the lack of such facilities precludes the general use of fertilizers,

TABLE 3
EFFECT OF FERTILIZER ON YIELDS OF SELECTED CROPS

Country	Crop	Duration of Experiment (years)	Percent Increase in Yield per Fertilized Hectare ^a
India	Tea	10	92
West Germany	Hay	10	146
India	Tapioca	1	197
Tanganyika	Peas	1	217
United States	Wheat	4	247
Puerto Rico	Sugar Cane	5	318

Source: Food and Agriculture Organization of the United Nations. The State of Food and Agriculture, 1963, p. 144.

^aWith most favorable combination of primary nutrients, nitrogen, phosphorus, and potassium.

as well as the adoption of other technological innovations. ". . . it can be stated with confidence that reduction of distribution costs is now the essential condition for bringing many technical innovations effectively into play" (6).

Along with fertilizers, a related factor in the improvement of agriculture has been the increasing reliance on mechanization, which in turn has depended on the availability of roads and other transport facilities. In 1960, for example, there was a total of 11 million tractors in use on farms throughout the world. But 9 million of these were operating in countries with highly developed agriculture—in North America, Europe, and Oceania. All of the Far East had only 70,000 tractors. Tractors are rapidly increasing in number in many low-income countries, however, and the trend is creating new demands for transportation of fuel and lubricants, as well as spare parts. The farm tractor is also used as a transport vehicle, and depends on improved roads for moving produce to market and hauling supplies to the farm.

RELATION OF ROADS TO PRODUCTION

The transport implications of improving agricultural yields can be seen in the relationship throughout the world between the miles of road per square mile of cultivated area and agricultural progress. In agriculturally advanced Western countries, the number of miles of farm-to-market roads per square mile of cultivated land varies between 3 to 1 and 4 to 1. The lower ratio is found mainly in grain-producing areas where fields are large. The ratio rises where farms are smaller and the topography difficult. In Britain, France, Japan, and the United States, the ratio is around 4 to 1. In Taiwan and Denmark it is closer to 3 to 1. In India this ratio is only about two-thirds of a mile of road to a square mile of cultivated land. In Malaya it is about $\frac{3}{4}$ to 1, and in the Philippines around 1 to 1. The statistics indicate that a certain minimum density of farm-to-market roads is present where rural development has achieved high levels, and that none of the poor countries has nearly enough mileage (7).

In India farmers using modern technology are nearly all within a mile or a mile and a half of some sort of reasonably good road. Very few farmers farther than this are using modern methods. Without discounting the many other factors involved in persuading villagers to use modern technology, there is a definite relationship between proximity to a road and the rate of change. Since three-fourths of the villages of India are more than a mile and a half from a road (Table 4), it appears that under present access conditions, any hope of raising productivity in Indian agriculture may be limited to around one quarter of the total farm population. Without improved roads, it appears that most agricultural development efforts will not succeed.

India depends on imports of 6 to 7 million tons of food grains annually. The production of more food is the number one problem to be resolved. Yet India's rural areas are virtually isolated from the rest of the economy, with the result that neither farm supplies nor new ideas can move to where they are needed. Only 11 percent of India's 500,000 villages are connected with the rest of the country by an all-weather road. Seventeen percent of these villages are more than 10 miles from all-weather roads. One out of every three villages is more than 5 miles from a dependable road connection.

Indian attempts to improve the standards of rural road transport are based on plans determined mainly by political and geographic considerations rather than agricultural requirements. The objective of the program, with a target date of 1981, was to bring every village in a developed agricultural area within 4 miles of hard-surfaced road and 1.5 miles of any road

TABLE 4
PERCENTAGE DISTRIBUTION OF VILLAGES BY
DISTANCE FROM THE NEAREST
HARD-SURFACE ROAD IN INDIA, 1958-59

Distance	Percentage of Villages
Within village	10.9
Up to $1\frac{1}{2}$ miles	18.2
Between $1\frac{1}{2}$ and $3\frac{1}{2}$ miles	20.7
Between $3\frac{1}{2}$ and $5\frac{1}{2}$ miles	12.3
Between $5\frac{1}{2}$ and $10\frac{1}{2}$ miles	15.9
Between $10\frac{1}{2}$ and 20 miles	9.6
Above 20 miles	7.8
Information not available	4.6
Total	100.0

Source: Ministry of Community Development.

by that year (8). Other villages were to be brought within 8 to 12 miles of a surfaced road, or 3 to 5 miles of an unsurfaced road. This program is unrelated to the use of the roads, or to the objectives of the rural economy. Villages that are simply brought nearer to an all-weather road, rather than connected with it, are hardly in a better position to help increase the production and marketing of food.

INTENSIVE AGRICULTURAL DISTRICT PROGRAM

A solution to India's rural road problem is suggested by the new Intensive Agricultural District Program undertaken to concentrate needed agricultural inputs in certain areas having promising potentials for increased production. This "package program" was designed to provide the means of realizing this potential. The means include help to the farmer in drawing up a farm plan, covering soil preparation, water management, application of fertilizers, seed, pesticides, tools, power sprayers, dusters and other farm machinery. The IADP approach also included a variety of "off-the-farm" activities essential to increased productivity, such as training, credit, cooperatives and storage. But despite the reliance on a greater volume of inputs, plus the marketing of increased output, the program did not include measures designed to improve transportation.

As could be expected, however, the areas where intensive efforts have been a success are those that are more accessible. For example, in the Ludhiana District of the Punjab, the package program has led to marked increases in wheat production per acre where access by road has made the program operable (Ludhiana District has 800,000 acres and 1.2 million people. It is about 40 miles by 20 miles. In each of the ten blocks of the District, there are 80 villages, 1,000 to 2,000 huts, 300 depots for the sale of fertilizer, and 1,000 rural credit societies.) After three years of the Five-Year experiment, the yield per acre had increased 40 percent, the area under cultivation had grown, and total output had expanded 68 percent. The consumption of chemical fertilizers increased from 5,500 tons in 1960 to 24,000 tons in 1963-64. The use of superphosphate had increased from 36 tons to 6,000 (9).

As a result of these efforts, farmers in Ludhiana District in 1962-63 were getting an additional return of 126 rupees per acre compared to extra costs of 54 rupees. And in Orissa, rice yields have averaged 2,574 pounds per acre in the package districts compared to 1,760 pounds elsewhere. The added return was 110 rupees per acre, compared to added costs of 60 rupees (10).

In areas where transportation is poor, however, supply problems have limited the effectiveness of the Intensive Agricultural District Program. Despite the variety of assistance available to the farmer, lack of transport has inhibited the program. In many areas of the Punjab, village access roads are poor, and the clay surface becomes so bad during two to three months of the year that it cannot be walked on, let alone be used by bicycles or animal-drawn carts. In these areas it has not been possible to grow vegetables and other perishables for market, since transport must be quick and reliable to enable growers to move their produce to town daily. On a poor road the trip to market, if it is possible at all, may be too hard on the bullocks. Their task is to get the plowing and cultivating done, so that farmers are reluctant to use them for transport. Milk producers living on a poor road find it uneconomical to market their milk because the milk collector, who travels by bicycle, cannot carry enough on a bad road to make the trip pay. He is able to carry at least twice as much milk on a good road, and therefore avoids collecting from farms with poor access.

The return realized by wheat farmers is also limited by the cost of transport over bad roads from his village to the main highway. Average charges for bullock cart transportation to market were found in one location to be from 10 to 20 cents per 82 pounds for only a few miles. This cuts the farmer's margin and prevents him from purchasing the things he needs to run his farm efficiently.

Farmers are also unable to specialize where transport is poor. Each grower attempts to keep himself and his family supplied with a variety of food, and he retains more than he may actually need since he knows that in the event of a short supply it will be difficult to obtain deliveries from other sources.

Farmers on bad roads have additional problems. They find it difficult to persuade rural electric authorities to extend service to areas where maintenance of lines will be impeded by poor access. Plant protection measures as well as fertilizing are made difficult due to infrequent deliveries and unreliable schedules. A very small percentage of high school age children are able to get to school. Literacy workers shun the village that is poorly served by road, and agricultural extension workers find it either impossible or too time-consuming to visit farmers on muddy roads. Villages far from an all-weather road complain of being unable to get help in constructing a well. Thus it can be said that even where a variety of help is available to the farmer, it will stop short of his farm unless it is adequately served by road.

COMBINING PUBLIC WORKS AND AGRICULTURAL DEVELOPMENT

In East Pakistan, one of the most densely populated areas in the world, access problems have also been a serious obstacle to rural development. Transport is particularly hampered by the combination of low-lying land, intricate river system, and monsoon flooding. Farm-to-market transportation has been accomplished principally by country boat, a method made unreliable during the winter drought and summer rains.

Several years ago an effort was begun to remedy some of the conditions that made agricultural yields in East Pakistan among the lowest in the world. The farming population was idle during the four dry winter months. Half the landowners were in debt. High interest rates discouraged the financing of fertilizer and other inputs. The situation was not the kind that one would expect a roadbuilding program to cure. Yet the rural public works program in East Pakistan, concentrating on roadbuilding in relation to the development of agriculture, has demonstrated how roads plus other necessary measures can create successful agriculture (11).

A key step was the organization of a pilot rural works program financed by the Department of Agriculture. New roads were selected for labor-intensive construction by the villagers. The roads were of low-type design, adequate for marketing crops by rickshaw and bullock carts rather than by headloading. The result was an 80 percent reduction in transport costs that increased the price realized by the farmer by more than 1 rupee (21 cents) per maund (82 pounds) of paddy. In addition, the amount of wages paid to those who worked on the program greatly stimulated purchases in the area and overcame the traditional suspicion of government. The cooperatives expanded very rapidly, and the program helped to uncover significant skills and organizational ability among rural residents.

When the effort was expanded to the whole of East Pakistan, thousands of miles of roads were constructed or repaired, canals and embankments were improved, and bridges and culverts constructed. There was a project every ten miles throughout the province. With great numbers of workers participating, projects were completed quickly at a very low cost. A total of two million man-months of work was provided in one year, and the new purchasing power created an estimated million man-months more. The next year, 1963-64, the rural works program was doubled.

The physical accomplishments from 1961 to 1964 included the improvement or construction of 24,000 miles of village-to-market roads and more than 700 miles of asphalt roads. Work was also done on 5,400 bridges and culverts and on 6,000 miles of drainage canals (12).

TRENDS IN MOTOR TRUCKING

Improved highway transport requires vehicles as well as roads, and this aspect of the problem is often left to chance. In India today the principal vehicles are bullock carts. While animals have the reputation of furnishing low-cost transportation, the facts indicate that for most types of work this is an illusion. The bullock averages 1.5 miles per hour with a load of 1.5 to 3 tons. Costs on a ton-mile basis are 22 to 44 cents per ton-mile.

The attraction of bullock carting has declined with the rising cost of carts, bullocks, and their upkeep, and with the improvement of roads and the use of trucks. In Madras it was once common to carry freight up to fifty miles by bullock. Now twenty-five miles

TABLE 5
GROWTH IN THE NUMBER OF TRUCKS,
SELECTED COUNTRIES, 1956-1964^a

Country	Number of Trucks		Percentage Increase, 1956-1964
	1956	1964	
Nicaragua	2,461	4,577	86
Peru	43,616	73,232	68
Mexico	194,491	352,681	81
Argentina	148,505	496,500	234
Brazil	301,449	655,874	118
Chile	41,370	82,548	100
Turkey	35,050	80,695	130
India	94,102	219,591	133
Pakistan	13,100	21,137	61
Thailand	19,300	59,160	207
Burma	9,200	18,400	100
Nigeria	16,625	33,455	101
Algeria	50,663	86,500	71
Sudan	9,495	16,540	74
Japan	687,000	3,324,749	384

Source: Department of Commerce. World Motor Vehicle Registrations, January 1956; and, World Motor Vehicle Production and Registration, 1963-64.

^aFrom January 1956 to January 1964.

TABLE 6
GOODS TRANSPORT BY TRUCK IN INDIA^a

Product	Tons	Ton-Km (thousands)	Average Haul (km)
Delhi to Bombay			
Foodgrains	3,683	1,195	324
Fruit and vegetables	5,951	1,921	323
Fodder	1,919	307	160
Cotton	1,225	829	677
Livestock	1,095	1,421	1,298
Building materials	1,240	335	270
Oil	2,515	1,199	477
Sugar	1,343	717	534
Textiles	3,366	3,271	972
Ghee and vegetable oils	1,540	980	636
Iron and steel	2,202	1,467	666
Machinery	1,837	2,381	1,296
Medicine and chemicals	1,600	1,551	970
Provisions	1,363	1,149	843
Other	11,759	9,883	840
Total	42,638	28,610	671
Madras to Cochin			
Foodgrains	7,212	1,721	239
Fruits and vegetables	3,868	1,474	381
Wood	2,993	658	220
Oil	2,878	701	244
Iron and steel	2,622	1,026	392
Textiles	2,215	773	349
Fertilizer and manure	1,727	392	228
Medicine and chemicals	1,543	432	281
Tea and coffee	1,378	476	346
Cotton	1,324	497	376
Provisions	1,258	372	296
Building materials	1,180	232	197
Machinery	1,138	389	342
Other agricultural products	1,108	324	293
Other commodities	11,369	3,591	316
Total	43,813	13,066	298

^aData from a 7-day survey in 1963.

is generally the limit. Thus the number of carts has remained stationary, and from 1950 to 1960 the share of total road traffic moving by bullock cart has fallen from 50 percent to 25 percent (13).

The substitution of farm trucks for bullock carts will be hastened both by better roads and by the increasing mechanization of agriculture. Trucks do not operate on the usual dirt road or track, but both buses and trucks, including three-wheelers, are appearing on many rural roads that have been improved to motorable standards. The introduction of tubewells and mechanical threshers, as well as the small tractor, will likewise encourage the shift to motor transport, since the economic justification of the bullock as a method of transport is tied to other non-transport duties such as water pumping, millet threshing, and plowing.

But equally important to local transportation are adequate long-distance transport facilities from local marketing centers to urban consuming centers. With the development of motor roads, growing volumes of agricultural products and agricultural inputs have been moving by truck. For perishable produce such as apples moving from Pakistan's Northwest Frontier Province to Lahore, the movement is principally by truck. The same is true for the hauling of vegetables from the Punjab, and for milk shipments to Delhi. A successful effort to increase food supplies assumes a growing role for motor trucking, for the time required to transport by rail often precludes the movement altogether or involves heavy losses en route.

Indian agriculture has become increasingly dependent on over-the-road transport for the marketing of perishables. On the route from Delhi to Bombay, for example, the largest single class of freight is fruits and vegetables (Table 6). Approximately 40 percent of total tonnage represents products of agriculture. The most remarkable accomplishment of road transportation to date is the fact that growth has taken place despite every kind of obstacle: poor roads, inadequate terminals, the high price of vehicles, high taxes, restrictive licensing policies, and police harassment of vehicle operations at local tax barriers and other check points. The evidence illustrates how desirable truck transport

has become from the standpoint of farm economics, even where service is extremely poor.

In Ghana the process of marketing food has been greatly enhanced in recent years by the advent of trucking and the expanded production of cash crops which the truck has permitted. In a recent survey of truck operations, it was found that 55 percent of food destined for Accra was moving over 50 miles, and that 30 percent came from places 100 miles away or more. With speedy truck transport, a high degree of specialization in food cropping had developed. None of the regions supplying Accra shipped any appreciable volume of more than one commodity (14).

TRANSPORT'S CONTRIBUTION TO RURAL DEVELOPMENT

In addition to improved transport of agricultural inputs and resulting outputs, agriculture also depends on better education, health, and a wide variety of innovations that contribute to rural development. Transportation investments can contribute importantly to achieving these other goals that underlie the transformation of agriculture.

This is illustrated by a recent case history of the economic impacts following construction of the 20-mile Ramnad-Mandapam road in Madras (15). Before the road was built, the towns of Ramnad and Mandapam were joined by rail and by a narrow path, unusable even as a cart track. Mechanized passenger transport was totally absent.

After the new road was opened, things began to happen. Two bus companies with four buses began operations. Regional industries began to grow, such as milling and pottery, with accompanying increases in employment. The fishing industry expanded rapidly, for now the surplus catch could be marketed in regions away from local consuming areas. Many retail shops were opened.

The trend in prices indicates a steady decrease in geographical price differentials between rural areas and the more accessible towns. A network of feeder roads, partly induced by the new highway, has helped bring village prices more in line with those prevailing in the Ramnad market. There has also been an increase in the number of elementary schools and in student enrollment. Six post offices are operating compared with three before the road was built, and a number of dispensaries have been established (16).

The situation is duplicated in many parts of India and Pakistan. In one village in Rajasthan the construction of a 5-mile hard-surfaced link road changed the whole pattern of farm life. There was an increase in tubewell construction, sugar cane was grown and transport provided to the mill. A cooperative society was started and is supplying fertilizer, and there is a hospital, an animal hospital, two new schools, and four bus lines with connections to Delhi. Further benefits from road programs include increased employment and incomes in the villages. Road work can be done in the slack season, and can supplement farm income at a time when needs are greatest.

PLANNING TRANSPORTATION FOR FOOD

A successful strategy to guide rural transport planning might best be found by aiming first at the realization of increased food production and marketing. If the resources available to improve agriculture are to be employed to maximum advantage, it will be necessary to weigh the merits of various combinations of inputs. It will generally be essential to build some type of road to provide the necessary minimum standard of transportation. There will be the further questions whether transport services should be animal-drawn or motorized, whether vehicle capacity can be reduced by minimizing peak transportation demand through storage facilities and processing plants, and what role can be played by cooperative organizations and local governments.

Decision makers cannot afford to overemphasize transportation and neglect fertilizers. They cannot afford, within the transportation sector, to concentrate on roads to the exclusion of vehicles, or to neglect storage and processing solutions that might make for a more successful agricultural program than could be obtained by transport solutions alone. The decision maker has to weigh all of the significant factors and combinations of factors capable of increasing agricultural output. It is obvious that the methods of allocating resources to transport and of conducting rural development programs today are not designed to arrive at anything like an optimal solution.

Yet it is clear that the time for transport planning in isolation has passed; that a systems approach to agricultural development is essential if the problem of feeding the world's people is to be successfully resolved. This will require the closest collaboration of transport and agriculture ministries at the national level and establishment of broadly conceived agricultural development agencies at the local level. The basic requirement will be flexibility in the use of funds in order to achieve the maximum supply of food.

A model of a combined agriculture and transportation plan, including related investments, should include the following:

1. Cooperative establishments providing for (a) the distribution of fertilizer, seed, insecticides and tools, and the rental of tractors and other equipment; (b) loans for the purchase of agricultural inputs, payable through the delivery of produce for marketing; and (c) the sale of consumer goods.
2. A network of storage facilities to minimize loss of crops and to reduce the peak flow of perishables at the harvest.
3. The establishment of processing plants that will provide off-peak employment, reduce spoilage, and maximize local income.
4. A network of roads located on the basis of agricultural production potentials, whose construction and maintenance will provide local employment and foster the development of local government institutions capable of performing other kinds of public services.
5. A truck fleet, operated by cooperatives where desirable, to provide pickup and delivery service.

Systems analysis provides the tool by which transportation can be viewed as one of the essential ingredients of agricultural progress. With the help of the computer, it is now possible to simulate the inward and outward flows of traffic and to test the effectiveness of various transport and non-transport methods of handling these flows. Developing nations can view transportation planning as part of the whole process of assuring enough food for sustained economic growth.

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