Articles

Famine: Causes, Prevention, and Relief

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Famines are generally caused by decline in food production in successive years brought about by poor weather, war, or both. The consequent complex interactions between prices, employment, and assets impoverish victims and lead to sharply increased mortality. Government policy is a key determinant as to whether or not these conditions mature into wisespread famine. India and Bangladesh have succeeded in controlling famines in recent years, but problems in most of Africa remain intractable due to civil unrest and a paucity of resources, including trained people, institutions, and infrastructure. General economic development and political consensus is needed to reduce Africa's vulnerability to famine. In this context, judiciously provided foreign aid can be of immense help.

FAMINE HAS OCCURRED THROUGHOUT HISTORY AND IN almost every corner of the globe. With economic development, the global incidence of famine is declining, except in Africa, where such disasters continue to threaten with increasing regularity. Both preparedness for these remaining vestiges of famine and their eventual elimination require thoughtful actions after and between crises. Tackling famine also requires political commitment by rich nations that can contribute know-how and resources and by poorer nations that must respond to the needs of their citizenry.

One of the earliest accounts of famine was recorded on stone more than 6000 years ago, but the misery and deprivation of famine certainly predate written history (*1*). Since A.D. 10, the United Kingdom has suffered more than 180 famines (*1*) and between 106 B.C. and 1929, China had 1828 famines, an average of 90 famines in each 100 years (*2*). In famines associated with the bubonic plague (1345–1348), as many as 43 million Europeans died, including as much as two-thirds of the Italian population (*2*). Five hundred years later, because of a blight of the potato crop, approximately 1 million (roughly 12 percent) Irish perished and an equal number migrated (*3, 4*). When Joseph predicted that seven fat years would be followed by seven lean years, the Pharaoh ordered the granaries stocked, "that the land perish not through famine" (*5*).

The modern era certainly has not been free of famine. Because famine typically strikes impoverished areas with a history of high mortality rates and poor record-keeping, death counts are mostly guesswork. More than 3 million people may have perished in the great Bengal famine of 1943; in 1974 another 1.5 million from that region starved in the new country of Bangladesh (*6, 7*). China suffered a horrific famine from 1959 to 1961 that was kept secret from the outside world. Estimates of mortality range from 16 to 64 million, depending on the definitions and methods of calculation, but it was clearly the worst famine of the 20th century (*8*).

Famine is not a newcomer to Africa, which has suffered from localized famines for centuries. Recent famines have caught world attention as the scale of death and media coverage have grown. In the early 1970's, famine struck many corners of the continent simultaneously; death estimates were 100,000 in the sparsely populated Sahelian countries of Mauritania, Senegal, Burkina Faso, Chad, Niger, and Mali, and 200,000 in Ethiopia (*7*). Estimates vary from 75,000 to 1.5 million civilians in the 1968–1969 war-related famine in Biafra (*9–11*). Accurate information on the 1983–1985 famine in Africa is scant, and disaster appears to be continuing as drought, locusts, and civil war plague certain countries. Such problems suggest that small famines frequently may go unnoticed in isolated areas.

Famine should be distinguished from chronic hunger. Although both are symptoms of poverty and a lack of food, famine is an extreme on the hunger continuum. It is distinguished by large-scale loss of life, social disruption, and an economic chaos that destroys production potential (*1, 6*). Symptoms include migration, distress sales of land, livestock, and other productive assets, the division and impoverishment of society's poorest families, crime, and the disintegration of customary moral codes. Breaking this downward spiral requires special efforts to eliminate the causes of famine and mitigate its effects.

Indeed, progress against famine is evident today. Mortality estimates indicate that in much of the world, famines are lessening in their frequency and intensity. More areas of the world are famine-free, and even the severest droughts in developed countries do not lead to famines. Furthermore, India, Bangladesh, and a few African countries have demonstrated that with careful planning and management, very poor developing countries can block the chain of events that traditionally leads from crop failure to widespread death.

As our knowledge of causes, prevention, and preparedness expands, we must take action to abolish future famines. Today's global food surpluses, advancements in international transportation and economic development generally offer opportunity for guaranteeing short-run emergency supplies and for supporting the many tasks involved in developing long-run food security.

Causes

The underlying cause of famine is crop failure which undermines incomes of the already very poor. The most obvious causes of crop failure are bad weather, civil disruption, or both. When a crop fails, the subsistence farmer is robbed of his sole source of income, the food he grows largely for consumption and for meager sales. For other poor groups, such as landless laborers, wage earners, and pastoralists, the crop failure reduces incomes indirectly through distorted prices, reduced employment, or a combination of the two.

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Table 1. Crop failures in India and the State of Bihar (*13*).

Crop	Tons ($\times 10^3$)		
	1964–65	1965–66	1966–67
	India		
All food grains	89,360	72,340	74,230
	Bihar		
All food grains	7,429	7,060	4,047
Rainy season crops			
Rice	4,914	4,262	1,645
Maize and millets	680	855	1,030
Dry season crops			
Wheat, barley, and pulses	1,835	1,943	1,372

These underlying forces can be exacerbated by market disruptions due to hoarding, inflation, or war, and by further changes in the income distribution. Government errors of omission and commission permit the natural disaster to mature into famine. Sen (*7*) has emphasized how lack of income to purchase food can exacerbate famine, but attention should not be drawn away from the critical role of agricultural production in determining income of the poor in developing countries and from monitoring a vital link in the chain of causality of famine.

Succession of Poor Crop Years

Seldom does famine arise from a single bad growing season. Rural people can usually absorb such shortfalls by depleting stocks or borrowing food and money from wealthier relatives and neighbors, although large farmers are usually better insulated than small ones (*12*). History has illustrated that the second and subsequent years of crop failure portend disaster. For example, in 1966 and 1967 droughts and floods struck India, causing two successive years of crop failure (*13*) (Table 1). For India as a nation, food grain production fell from its predrought high by roughly 14 percent in each year. In the state of Bihar, farmers responded to the dryness by switching from rice to the more drought-resistant maize and millet crops. In the first year of the disaster, total food grain production fell only 5 percent. In 1966 and 1967 even hardier crops could not compensate for the rice crop failure, and production fell by 45 percent from the 1964–1965 level. The extremely good crop year of 1964–1965 helped protect consumption in the following year, but 1966–1967 was characterized by prefamine conditions of migration, high prices, hoarding, profiteering, and hunger.

Recent famines in Africa show a similar pattern. The disaster that struck the Sahelian states in 1974 was the culmination of 8 years of poor weather and crops. In 1983 and 1984, drought, floods, and civil war once again crippled Ethiopia, Sudan, and the Sahel.

The production drop may be localized, and aggregate production may not fall in a famine year. For example, both in 1974 and 1984, floods in Bangladesh destroyed a portion of the rice crop; however, the same rains boosted the harvest in upland regions. Clay (*14*) cautions that "the paradox of hunger without severe loss of production depends on the level of aggregation." If a region is defined broadly enough, surpluses will outweigh deficits, although any given locality may go hungry. As long as markets are fragmented by poor transport and government inhibitions to trade and income maintenance efforts fail, the production loss remains threatening.

Prices. Shocks to agricultural production often send agricultural prices soaring. The poor are squeezed from both sides as prices rise for the goods that they buy and fall for the goods that they sell. Because food expenditures represent a major share of a poor family's budget (71 percent, Fig. 1), a leap in food prices puts a survival diet out of reach. A 10 percent decline in food supply leads to declines that differ by class in income, expenditures, and ultimately consumption; the poorest reduce total food consumption by 35 percent, whereas the wealthiest tighten their belts by only 8 percent (Fig. 2). In absolute terms, the poor decrease their consumption of food grains more than ten times as much as the wealthy in response to the same decline in supply (*15*) (Table 2). For those already living on the edge, this is famine.

In order to preserve their food grain consumption, the rich adjust by decreasing their demand for luxury foods and nonfood goods (Fig. 2). The price of such goods in comparison with grain prices tends to fall during periods of famine. The demand for livestock (a major component of "high protein foods" in Table 2) is especially vulnerable. Consumer demand for the emaciated beasts collapses while at the same time, herders and farmers sell off livestock to purchase cheaper grain calories, further saturating the shrunken market. Predictably, nomadic herders have been especially hard hit by African droughts; in some regions of Ethiopia in 1974, the exchange rate between animals and grain deteriorated as much as 73 percent (*7*).

Likewise the large decline in nonfood expenditures by the prosperous precipitates dramatic price shifts for discretionary purchases vis-à-vis grain prices. In the Bengal famine, the terms of trade for common goods such as cloth, bamboo umbrellas, milk, fish, and haircuts, all produced by the poor, deteriorated as much as 70 to 80 percent between June 1942 and July 1943 (*7*).

Employment. Employment crumbles as producers and consumers adjust to the decline in agricultural production, further impoverishing marginal groups. The contrast in employment between a normal and a dry year in North Arcot, in the state of Tamil Nadu, India, is shown in Table 3 (*16*). Labor is distinguished by type of family and nature of work. Employment was considerably lower in the drought year than in the normal year, about 35 percent for all groups combined. Losses were especially severe for the landless; employment fell 40 percent for agricultural laborers and 45 percent for other laborers.

Several forces contribute to these declines. With less farming activity, landowners do not hire as many farm laborers. In North Arcot, agricultural employment declined for all but the largest farmers. Given the futility of tending crops, small farmers, agricultural laborers and other laborers shifted to low-productivity tasks, such as additional tending of livestock. Second, the fall in demand of well-to-do consumers for nonfood purchases (see Table 2) has effects on employment as well as on prices. In the North Arcot example, the nonagricultural sector lost proportionately more jobs than the agricultural sector. In a situation of economic distress, large

Table 2. Decline in per capita monthly consumption when the supply of food grains falls 10 percent. [Adapted from (*15*, table 4]

Item	Consumption decline*	
	Poorest 20%	Richest 5%
All foods	2.22	2.54
Food grains	1.91	0.17
High protein foods	0.28	0.96
Other foods	0.03	1.41
Nonfoods	1.05	4.24
Total	3.27	6.77

*Measured by using money expenditure in constant 1963–1964 rupees as a common denominator for summing different foods. Hence, a small proportion with decline depicted is due to reduced quality (*15*). The present exchange rate of the U.S. dollar for rupees is approximately 1 to 13. The initial level of consumption is much higher for the richer than for the poorer to a specified absolute reduction in a much larger percentage reduction for the poor group than the rich group.

farmers cornered the few jobs in both the agricultural and nonagricultural sectors.

Changes in the labor intensity of agriculture following price disturbances represent a third potential interaction between crop failures and employment. As shortages forced up the price of rice in Bangladesh in 1974, that crop became more profitable in comparison with jute (*6*). In response, farmers shifted into rice from the far more labor-intensive jute production, which further contributed to unemployment for landless laborers.

As these examples make clear, famine conditions redistribute incomes away from the poor, dealing them a smaller portion of a shrinking pie. The more employment falls, the less prices have to rise (and vice versa) in order for the economy to reach a new equilibrium following the agricultural disruption; either way, the poor bear the burden of adjustment. Furthermore, this process has a lasting effect because the poorest, with minimal stocks, resources, and access to credit, are forced to sell productive assets such as livestock, tools, and land. Such assets are usually sold on a falling market and reacquired after the famine at one-half to three times more than the sales price (*17*). Because they are able to protect their food consumption, employment, and productive assets, the more prosperous members of the community do not starve and rebound more quickly after famine.

A change in the distribution of income not only results from famine conditions, but can exacerbate them. Added income in the hands of one group in society would, in the face of fixed food supplies, cause them to bid up food prices. The laggards, with no protection against inflated food prices, would lose their access to food. As Fig. 1 indicates, income gains by a subset of the poor are more likely to disrupt the food balance than income gains to the well-to-do; poor people use the additional income to satisfy their demand for basic food staples whereas the well-to-do buy goods and services with a high employment content. Certainly changes in the income distribution contributed to the Bengal famine of 1943 as incomes generated by the wartime boom and government welfare policies protected some but not all groups of the poor from rapidly escalating food prices (*7*).

Nonetheless, demand is but one side of the food equation. Policies that focus solely on the distributional issues implied by a lack of purchasing power can worsen the claim on existing supplies (as occurred in Bengal). Furthermore, they distract attention not only from the long-term problem of abysmally low agricultural production, but also from the conditions of war, poor roads, and inadequate institutions that impede famine relief.

Government Policy

Government policy sets the stage for all famines. If proper policies are in place, natural disaster need not evolve into famine. Poor policies and armed conflicts heighten a nation's vulnerability to natural disaster, although in some cases, policies and wars may even spark the crisis.

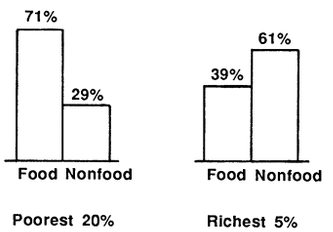

Fig. 1. Household budget shares of the poor and rich in India, 1964–1965 (*15*).

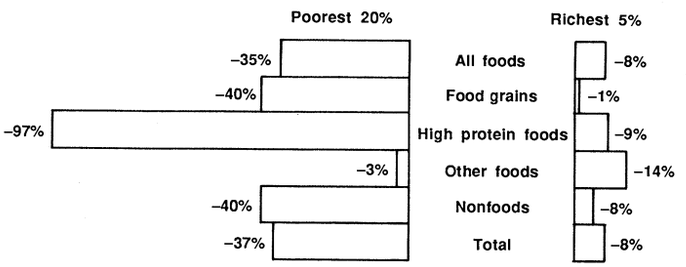

Fig. 2. Decline in per capita monthly consumption when supply of food grains falls by 10 percent (*15*).

During China's Great Leap Forward, inflated 1958 grain statistics led the government to reallocate acreage coercively to nongrain production in 1959, while at the same time increasing purchases from the rural areas. In addition, technical mismanagement on the part of overzealous and poorly qualified cadres and officials brought on serious damage to farmlands by deep plowing, close planting, and water conservation errors. When 2 years of terrible weather hit the country in 1960 and 1961, the famine took on unprecedented proportions (*8, 18–20*).

Although war cannot be blamed solely on the national government, the government's response to war greatly influences the evolution of a food crisis. War can contribute to food crises in several ways, including drawing labor from food production, disrupting the marketing of agricultural inputs and crops, destroying fields, creating refugees, and hindering relief efforts.

In certain cases, war has induced famine in the absence of adverse weather conditions. The food crisis in Kampuchea peaked in 1979 after a decade of war-induced upheaval. Following the U.S. bombings and the genocidal and agricultural policies of the Pol Pot regime, the Vietnamese invasion of January 1979 dealt a crowning blow. The fleeing Khmer Rouge pursued a "scorched earth policy" (*21*, p. 84), both destroying and confiscating seeds, crops, and draught animals. Chaos hindered planting and the 1979–1980 rice harvest was 60 percent below normal (*22–25*).

An oft-cited example of war-related famine in a developed country is the Netherlands during the World War II. Approximately 10,000 people of all social classes starved during the winter of 1944–1945

Table 3. Average days per year of family labor per household in North Arcot, Tamil Nadu, India [adapted from (*16*, table 4)]. The normal crop year is 1983–1984; the drought year is 1982–1983.

Type of labor	Small farmers*		Large farmers*		Agricultural laborers		Other laborers	
	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought
Own farm: crops	116	58	198	81				
Livestock†	76	138	145	135	22	50		65
Agricultural employment	327	193	17	41	574	376	141	107
Nonagricultural employment	60	16	23	26	139	14	287	64
Total	579	405	383	293	735	440	428	236

*Small farmers operate less than 2.5 acres; large farmers operate more than 2.5 acres. †Includes some nonfamily labor.

when the occupying Nazis blocked the import of food supplies (*10, 26*).

Armed conflicts coincided with drought conditions in Chad, Angola, Ethiopia, Sudan, and Mozambique during the famines of 1983 through 1985 (*27, 28*). The worst hit regions of Ethiopia, Eritrea and Tigray had been at war with the government for 22 and 9 years, respectively (*29*). Although it is unclear whether the Mengistu government tried intentionally to starve those regions, its refusal to permit safe passage for relief teams through the war zones and its controversial resettlement program impeded relief efforts (*28*).

At times it is the combination of war, mismanagement, and poor weather that leads to famine. In Bengal the policy of removing all boats carrying more than ten passengers from the coast of Bengal and the limitation of cereal and rice trade between provinces hampered the flow of food to needy areas in 1942 (*7*). In Ethiopia some food was exported out of famine regions in 1973. In 1983, the Ethiopian government levied taxes in some drought-afflicted areas as part of the funding drive for the 10-year anniversary of the revolutionary government (*28*).

It was man-made disasters, not natural ones, that absorbed more than three-quarters of the disaster assistance channelled through the World Food Program in 1982 (*25*). Although famines may be more controllable in recent years, some investigators suggest that the incidence of war-induced famines is on the upswing (*30*) and that the worst famines in recent times are those associated with wars (*4*).

Although governments make errors, famine relief cannot be left to the vagaries of the marketplace. As has already been shown, market forces, working through price and employment, place practically the whole weight of adjustment to a decline in food supply on the poor who are already the least well fed, and the effect is a major redistribution of income away from the poor. Positive government action must break the links that lead from natural disaster to death.

Preparedness and Relief

There are positive steps that governments can take to ward off famine conditions by insulating the population from psychological or mental damage, migration, impoverishment, loss of assets, and death. In order to avoid the haphazardness of last-minute efforts to relieve such widespread suffering, governments must put in place measures to cope with the early stages of an incipient famine.

Because famines seldom arise overnight, policy-makers must be alert to conditions that threaten the food system or public health. The best indicator of all is the political system itself with its network of politicians sensing conditions at all levels of society. Their observations of social distress can be supplemented with statistical analyses of prices, hoarding, smuggling, transportation bottlenecks, food imports, refugees, or malnutrition, and even satellite photography (*31*). Such indicators are specific to the particular location and require a thorough understanding of the dynamics of the local food system, which is why local politicians are especially well placed. But for local government to be heard, a central government must be listening. A free press has a major role in amplifying the messages of distress, carrying them to the capital for action by the bureaucracy, and harassing the bureaucracy for its inattention.

An early warning system sounds the alert. Once the crisis has been detected and diagnosed, a complementary plan of programs and previously established emergency measures must be quickly implemented. As long ago as the 1880's, India designed its Famine Codes in great detail to respond quickly and efficiently to disaster conditions. Similar ideas now are embodied in the government's Drought Management Plan (*32*). Following the food crises of the early 1970's, the Food and Agriculture Organization of the United Nations set up the Global Information and Early Warning System and the International Emergency Food Reserve.

By formalizing such procedures, several low-income countries have controlled natural disasters from developing into widespread famines. For example, in Bihar, India, symptoms of distress mounted following successive crop failures. Late in 1966, local administration was reinforced, communication lines improved, radio famine bulletins issued, and voluntary and official relief bodies formed (*33*). Existing public works and relief schemes grew from an average employment of 8,000 to a peak of 700,000 by the end of 1967 (*33, 34*). The system of fair price shops and rationing was expanded, supported in part by massive quantities of food aid. There were inoculations given against smallpox and cholera. Water goals were set at 2 gallons per person per day and supported by well-drilling and water transport projects. Agricultural support included loans, efforts to save crops, pumps, and road projects. Out of a population of 53 million, estimates of starvation deaths only ranged from the hundreds to several thousands: more severe and widespread famine was averted (*33*).

Another state of India, Maharashtra, suffered three consecutive years of especially hostile weather from 1970 to 1972. Food grain production was 18 percent, 29 percent, and 54 percent below normal from 1971 to 1973, and there were great scarcities of food and water. A massive relief effort was undertaken, again based on employment projects with a productive, development focus on soil conservation, afforestation, canal excavation, irrigation, and drinking water. Nearly 5 million people were employed in relief work during the height of the crisis in 1973 and 1974, including large numbers of women who were employed at the same wages as men. Human and animal lives were protected by food and fodder distribution schemes, in addition to medical relief to combat epidemics. Given the efficiency of the state government, one may take seriously Subramanian's (*35*) report that of the 25 to 30 million people threatened in the rural areas, there were no famine deaths during the drought period. Of course, chronic hunger and its effects continued through the period.

Ten years after the 1974 calamity, the Bangladeshi government was far better prepared for natural disaster. When monsoon flooding in 1984 wiped out as much as 30 percent of the crops in some districts, famine conditions were minimized. Clay (*36*) points to better institutions, some early warning mechanisms, better agricultural data, and the government's greater commitment and ability to contain the famine. Since the previous disaster, storage capacity had been expanded and distributed throughout the country to hasten response time. Employment and supplemental feeding programs were already in place, supporting living standards for the poor, and were expanded when the crisis mounted. More plentiful agricultural and foreign exchange resources better protected farmers from floods and crop failures and enhanced the country's capacity to import from the world market. Improved donor relations, including the presence of multilateral World Food Program and multiyear commitments of food aid, kept reliable supplies in the pipeline (*36, 37*).

Botswana, within Africa's Kalahari desert, suffers from an average of three severe drought years each decade (*38*). In 1975 the government took the initial steps toward designing a drought prevention plan and in 1978 a private group, the Botswana Society, convened a national symposium on drought (*39*). In the same year the government established the Interministerial Drought Committee; it meets monthly to review data on rain, agricultural conditions, national grain storage levels, donor commitments, and nutritional standards (*40*). The agricultural indicators signal the need for agricultural support measures such as credit, seed distribution, and cattle buy-outs, and the nutritional data trigger expansion of ongoing feeding programs and employment schemes. During the

1983 drought, Botswana was able to limit the increase in child malnutrition from 26 to 31 percent, and in this context reportedly withstood the drought better than its South African neighbors (*38*). Holm and Morgan suggest several factors contributing to Botswana's success: disaster measures in drought-prone Botswana are a political necessity; Botswana's proximity to South Africa benefits its trade and transportation network; diamond mine revenues have strengthened the government's budget and foreign exchange positions; and the country has a politically stable, liberal democracy (*38*). In addition to and as a result of these factors, Botswana receives a generous share of foreign aid to support its programs.

As these examples show, success in warding off famine requires tremendous coordination and efficiency. The international community should not despair, to the further loss of the poor, that aid is delivered inefficiently but should instead work to ameliorate the nearly impossible conditions that accompany disaster situations. Famine prevention, preparedness, and relief complement each other. Data collected on crops, climate, prices, and so on provide early warning indicators that can be applied to development planning. Ezekiel (*41*) has shown that unexpected changes in rural public works employment can indicate potential famine conditions months in advance, as people abandon their failing crops for stopgap employment. In addition to signaling an alert, such programs simultaneously provide jobs and purchasing power to likely victims before the situation deteriorates, while supporting the road, port, and bridge building projects that enhance both relief and prevention efforts.

Prevention

Famine preparedness and relief necessarily emphasize distribution. Prevention returns us to the underlying cause of famine—summarized by Leibenstein (*42*, p. 112) as "vulnerability to a decline in food supply or to a decline in entitlement." In order to prevent famine, both the supply side and the demand side of the food equation must balance at a higher level (*43*), one that provides a margin of safety in food supplies, employment, and income for the poor. This process requires economic development and political stability.

Thirty years of experience have demonstrated that the transformation from an agrarian to an industrial society must proceed through the development of the agricultural sector (*43, 44*). Policies must focus on increasing the productivity of the rural workers who make up the majority of the country's laborers. As agricultural surpluses grow, producers sell rather than consume a greater portion of their output. Livestock numbers grow, absorbing surplus grain and providing animal protein. In time, the farm work force shrinks, liberating resources for industrial expansion. As wealth grows, food becomes a smaller portion of the household budget. In the event that disaster strikes, food stocks are adequate, livestock are slaughtered, foreign trade and finances are adjusted, unemployment is limited, and price swings are tolerable. The conditions of scarcity that characterize famine cease to arise.

Initiating agricultural productivity growth is a complex and time-consuming process. To oversimplify, there are three priorities: agricultural research, the increased use of purchased inputs in farming, and the development of a comprehensive physical and human infrastructure.

Modern science offers new opportunities for eliminating famine. By radically increasing yields per acre, science can generate food margins adequate to withstand weather shocks. Plants can also be bred for drought resistance; development of short-cycle varieties in Senegal, for example, saved the groundnut and millet crops from total devastation by erratic rains in recent years (*45*). Science can also help generate the employment and hence income needed to buy this food. Evidence from India indicates that high-yielding wheat varieties require 60 percent more labor per hectare, but less labor per unit of output, than traditional varieties (*46*). However, technology does not transfer directly. National research institutions must be established in developing countries to hasten the adaptation of technologies from other agricultural zones.

Similarly, modern farm inputs, and the institutions to provide them, are needed to complement agricultural research, which relies heavily on fertilizers, herbicides, insecticides, and commercial seed; mechanization may be necessary in specific cases where seasonal labor shortages or low labor productivity prevail.

Transportation, communications, and administrative capacity are obviously essential in the long run for preventing famines and in the short run for relieving them. The image of the isolated, self-sufficient village may be romantic but certainly is not practical, particularly as growing populations press against the limited land base. Economic development demands and provides an infrastructure capable of moving goods in and out of the farming sector. Agricultural commercialization generates the incomes and surpluses necessary to absorb occasional disruptions. Relief measures require roads, communication, and political ties or else pockets of famine remain inaccessible, as in Eritrea and Tigray, Ethiopia. Food aid used for relief measures can be extended into the post-famine period to build infrastructure and provide administrative capacity.

Of course, since rapidly growing populations exacerbate the need for increased food production, family planning can also contribute to long-term famine prevention. However, particularly in rural areas, family planning seems to accompany or follow the processes of agricultural growth and commercialization.

Tackling Famines in Africa

Africa has become the quintessential famine arena. In 1972 and 1973, continuing drought in Ethiopia and the Sahel caused water holes to dry up, crops to fail, and humans and livestock to perish. Disaster again struck sub-Saharan Africa in 1983. According to the Food and Agriculture Organization, abnormal food shortages were reported in more than half of Africa's countries, placing at risk as many as 30 million people, or 16 percent of the total population (*47*). By 1985, 11 million people were displaced and herds were decimated (*48*). Death counts for the region are still uncertain: a United States Senate staff report estimated 1 million deaths in Ethiopia and the Sudan together (*11*).

Even in periods without famine, the continent is characterized by poverty, malnutrition, high infant mortality and high birth rates. Kumar (*49*) estimated from a sample of 12 African countries that almost 25 percent of all preschool children are chronically undernourished (below the 90 percent reference of height-for-age). She also showed that Africans tend to gain and lose weight with the seasons, since the most strenuous energy demands occur just before harvest when grain bins are bare. Data from Zambia show that even when people eat more calories during the planting and weeding seasons, their body weight still declines. Because area planted decreases after a poor crop year, food shortages become a self-perpetuating process, trapping Africa in a downward spiral (*49*). Although infant mortality rates have shown significant declines in recent years, sub-Saharan Africans lose on average about ten times as many infants per thousand population as North Americans or Europeans (*50*). Birth rates, however, are among the highest in the world, and the rate of population increase is the highest of all continental regions (*50*).

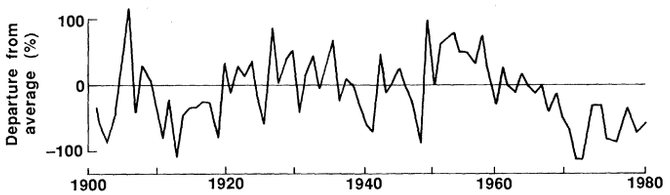

Fig. 3. Precipitation for the Sahel region. [Adapted from (*55*)]

The African food situation is discouraging, and much of the continent remains vulnerable to famine. Food production has been very poor in Africa as compared with Asia, and the gap between the two is widening. In Asia (excluding China), annual food production growth rates per capita were 0.2 percent in the 1960's and 0.8 percent in the 1970's. The corresponding rates for sub-Saharan Africa were −0.4 and −1.5 percent (*51*). Increased food imports and dependency on food aid failed to compensate for this shortage, and per capita consumption of grain decreased at an annual rate of 0.4 percent during the 1970's while world consumption increased by 0.8 percent (*52*).

Reflecting low food production, marketable surpluses for the peasant sector are lower in Africa than those in Asia. This large sector consumes nearly all of what it produces, bringing to market only the remaining 10 to 20 percent (*53*). In addition, labor productivity in the dominant peasant sector is less than half that in the comparable sector of India (*54*).

Reasons for the low marketing and productivity are complex. Weather certainly has played a role in recent years. It is unclear whether current drought is part of a long-term trend or short-term cycle, but in recent years it has been drier than in the 1950's and early 1960's (Fig. 3) (*55*). Increased population and livestock pressure on marginal lands has accelerated desertification. In some areas, the deserts are expanding by 10 to 15 kilometers a year, and once fertile land is turning into sand (*56*).

Earning a profit in farming is difficult when poor infrastructure hinders the movement of farm inputs and produce and when poor policies limit incentives. Africa has an especially poor infrastructure. A comparison of kilometers of road and percentage of paved road in several African nations, India, and the United States (Table 4) shows that road infrastructure in African nations is very bad.

Popular focus with respect to poor economic performance in Africa has emphasized the need for policy reform, including higher agricultural prices, substitution of rural for urban bias, elimination of state-controlled marketing systems, and state and other types of large-scale farms. Most governments in Africa are proceeding with such policy reforms, returning attention to the positive needs of research, reliable input supply, and infrastructure emphasized here.

Table 4. Road networks, including primary highways, secondary roads, and dirt roads, in selected countries, 1977 through 1981. [Adapted from (*53*) and (*57*); data are from the most recent year available]

Country	All roads (km/km^2)	Paved road (%)
Burkina Faso	0.06	5.0
Ethiopia	0.03	11.0
Kenya	0.09	12.0
Niger	0.01	32.0
Nigeria	0.12	28.0
Senegal	0.07	25.0
Tanzania	0.05	5.0
Zambia	0.05	15.0
India	0.49	39.0
United States	0.68	82.0

Good policy is difficult in the face of political unrest as governments try to achieve national unity in the wake of a purposely divisive colonial history. Cooperative efforts to achieve regional food security, such as the Southern African Development Coordination Conference, have promise, but are limited by problems of consensus. Given these political problems, it is still difficult for many African governments to focus even on relief measures, let alone on long-term projects of agricultural development.

In addition to the need for peace and sound policies, Africa must develop its own combination of green revolution technologies akin to those that launched Asian development. This is no minor task, considering the well-known paucity of trained people, resources, and institutions in Africa.

Foreign assistance has an important role to play in solving these problems. Food and financial aid can be used by African nations to build infrastructure, support relief, employment, and nutrition projects, as well as provide foreign expertise and training for citizens. Foreign assistance must be applied in the context of the national political environment, an especially difficult task in war-torn or once-colonized countries. Thoughtful application of foreign assistance can help build nations if care is taken to avoid the divisive tendencies of power politics. Though the application of foreign assistance may be inefficient, it is by no means dispensable.

Curing famine, especially in Africa, takes time. We must not look for miracle shortcuts to a problem that has plagued society for centuries, yet we must hesitate no longer. By adopting lessons learned elsewhere, we will gradually be able to treat disaster situations as they occur and finally achieve the development that will eradicate famine.

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Focal Points in Mass Spectrometry

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Mass spectrometry has advanced with the renaissance of time-of-flight mass analysis, the use of ion traps as analyzers and reactors, the application of tandem mass spectrometers to problems in ionic reaction mechanisms and chemical analysis, and the development of new desorption ionization techniques. These developments have allowed determination of the molecular weight distributions for polymers through the 10,000-dalton range, as well as the molecular weight and partial sequence of biopolymers of similar size. Surfaces can be characterized by use of the mass, energy, and angle distributions of particles ejected by sputtering or by laser-induced desorption. Mass spectrometry has yielded new information on the kinetics of catalytic surface reactions and on the reactivity of metal clusters.

THE APPLICATIONS OF MASS SPECTROMETRY HAVE SPREAD into physical chemistry (bond dissociation energies, ion enthalpies, proton affinities), organic chemistry (structure elucidation, organic ion structure and fragmentation), the biological sciences (drug metabolism, stable isotope tracer work, modifications in biopolymers), the earth sciences (chronology), and environmental science (trace organic analysis). Important contributions have been made to surface and materials sciences in the past, and it is in these areas that we foresee dramatic progress.

In this article we examine a number of selected areas in which mass spectrometry appears particularly vigorous, or poised to become so. Special emphasis is placed on those aspects that impinge on surface science. In each area the treatment is both expository and critical. We restrict attention to particular work, so that each subject is focused sharply, and attention can be devoted to its impact and future direction.

The traditional divisions in science are yielding, and, when divisions give way, new interdisciplinary alliances emerge. The cross-disciplinary areas of science cluster around particular techniques, not least around mass spectrometry, a subject that has great depth and breadth. The growing importance of instrumentation in science has been noted by Abelson, who wrote "instruments shape research, determine what discoveries are made and perhaps even select the types of individuals likely to succeed as scientists" (*1*, p. 182).

Ion Chemistry

The applications of mass spectrometry require two principal capabilities, the generation of ions with masses indicative of the molecular weight of the analyte and the formation of fragment ions from which molecular structure can be inferred. Although spectral comparison is the principal method used in arriving at structures, the correlation of spectra with structure is based ultimately on an

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