World Development Vol. 33, No. 12, pp. 2067–2083, 2005

Printed in Great Britain
0305-750X/$ - see front matter
ELSEVIER
www.elsevier.com/locate/worlddev
doi:10.1016/j.worlddev.2005.07.009

# Big Is Ugly? How Large-scale Institutions Prevent Famines in Western India

DONALD W. ATTWOOD *
*McGill University, Montreal, Canada*

**Summary.** — For centuries, recurrent droughts have caused severe famines in the Deccan region of western India. By 1920, large-scale institutions integrated this region into an industrial and globalizing world—ending famines and causing a rapid decline in mortality rates, hence a rise in human welfare. These results are contrary to the "small is beautiful" discourse of some anti-globalization theorists. Yet, as these theorists suggest, big institutions also often make inefficient use of vital resources. Institutions such as the Deccan irrigation canals can be essential to survival yet require careful redesign to ensure future food security.


*Key words* — India, famines, food security, irrigation, mortality rates, globalization

## 1. INTRODUCTION

This paper examines the impacts, over the last 150 years, of modern, *large-scale* systems of transport, marketing, administration, and irrigation on famines and food security in a drought-prone region of western India. The topic is relevant to debates on the effects of economic globalization—debates that encompass many other issues besides food security. [1] (For analysis of these issues, see Bhagwati, 2004; Nayar, 2001.) One theme of these debates concerns the scale at which institutions seem effective and beneficial, for humans and the biosphere.

To those fighting for human rights and the environment, big institutions seem to have run amok, threatening what they claim to protect. In some cases, one can only agree. A broad critique of bigness has been forcefully suggested by Arundhati Roy, who calls for: "The dismantling of the Big. Big bombs, big dams, big ideologies, big contradictions, big countries, big wars, big heroes, big mistakes." (1992, p. 12). Of course, "big" institutions need not be global and may, in fact, be anti-global. But as Nayar's (2001) analysis suggests, big state institutions have emerged in the developing world in opposition to the ex-colonial powers of the North Atlantic region. Thus, large-scale institutions, whether public or private, have arisen either in alliance with, or opposition to, the forces of globalization. [2]

Opponents of globalization tend to assume that small-scale, localized institutions can solve our social and environmental problems (see, e.g., Daly & Cobb, 1994). There is an element of "new traditionalism" in some variants of anti-globalization discourse. As applied to India, new traditionalist discourse assumes that "traditional or pre-colonial Indian society was marked by harmonious social relationships [and] ecologically sensitive resource use practices" (Sinha, Gururani, & Greenberg, 1997, p. 67). [3] The reassertion of local knowledge and traditional practice is seen as a general solution to our problems (e.g., Shiva, 1989).

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* This research was supported by the International Development Research Centre (Ottawa), les Fonds pour la Formation de Chercheurs et l'Aide à la Recherche (Quebec), the Social Sciences and Humanities Research Council of Canada, the Shastri Indo-Canadian Institute, and McGill University. My thanks to Amita Baviskar, B.S. Baviskar, Oliver Coomes, Jameela Jeeroburkhan, Thomas Legrand, Jessica Leech, Karen McAllister, Deborah Sick, and the anonymous reviewers for their comments, corrections, and suggestions; and also to T.W. Schultz for his encouragement. Final revision accepted: July 19, 2005.

As explained later, I agree with the premise that some large-scale institutions make inefficient—that is, wasteful—use of human and environmental resources. Big institutions integrate smaller ones into new systems, but the big can dictate terms that are harmful to the small. That is, big institutions create power differentials that lead to abuse of humans and the biosphere (as also happened in the premodern world). This danger contributes to the utopian vision implicit in much of the anti-globalization discourse on small-scale, localized traditions. However, I feel compelled to enter a strong dissent against this utopian vision. We now depend on large-scale institutions and modern technologies for our daily bread. Without them, food would be scarcer and famines more common, the poor would be hungrier, and many more would die in infancy. This general assessment is shared by economists and others concerned with food security issues (e.g., Evenson & Gollin, 2003; Johnson, 2000; Smil, 2000). The need to imbue big institutions with a stronger focus on efficiency and equity cannot be met by dismantling them and retreating into a pre-industrial world.

This paper brings these issues down to earth through a historical case study of the Deccan plateau region of western India. If the paper works, readers who may be skeptical of economic abstractions will see the concrete ways in which Indian villagers have come to depend on large-scale state and market institutions for their daily survival.

My argument is that, first, large-scale institutions founded on industrial technologies have contributed to famine protection, food security, and human welfare in ways that were formerly unfeasible. Second, however, some of these institutions—such as large-scale surface irrigation systems—manage vital resources inefficiently. Thus large-scale institutions may be *both* inefficient and essential for human welfare. The challenge is to reduce their inefficiency in ways that enhance their sustainable contributions to welfare. The contribution of this paper is to argue that we do not face dichotomous or manichean choices concerning globalization and the management of big institutions. Rather, we face the challenge of reforming these institutions so that they attain more efficiently and equitably the ends for which they were created.

To reduce any possible ambiguity, let me state that our world requires institutions both great and small—indeed, small-scale institutions such as families are vital for our existence. Moreover, it is often necessary for institutions at different scales to work together. For example, there would be no possibility of attaining food security in India without the combined efforts of millions of small family farmers. Conversely, farmers working in isolation (without sub-continental markets, for example) could not attain security for themselves, let alone for the whole country.

My evaluation of institutional change draws on the theoretical approach used by Sen and others (e.g., Drèze & Sen, 1989, 2002; Morris & McAlpin, 1982; Sen, 1993, 1999; UNDP, 2001). A core assumption is that welfare among the poor requires, most fundamentally, sheer survival. The age at which a person dies is the most important single fact about his or her welfare. Sen and his colleagues hold that the basic goal of development is expansion of human capabilities, particularly for people whose survival is precarious. For such people, poverty is not simply a lack of money; it entails insecure livelihoods with high risks of early death due to infection and malnutrition. Hence, mortality rates and average life expectancies are prime indicators of welfare for a population—and thus of the success or failure of development policies over time.

Using these criteria, I find that villagers in the drought-prone Deccan plateau region of western India are now better off than they were prior to 1860, when they lived in semi-isolated, nearly self-sufficient communities threatened by periodic droughts and famines. The prevalence of famines before 1860 is outlined below (Section 2(a)). Protection from famines came in a series of steps that gradually integrated these villages into industrial civilization via modern, large-scale institutions: first, into distant market networks created by industrial transport systems (Section 2(b)); second, into administrative systems for famine prevention (Section 2(c)); and third, into large-scale canal irrigation systems (Section 2(d)). Section 2 concludes with an analysis of demographic trends resulting from these changes (Section 2(e)). The analysis builds on the work of Drèze (1995) and Drèze and Sen (1989), adding new data and arguments based on my intensive study of the region formerly known as the Bombay Deccan (e.g., Attwood, 1992).[4]

Section 3 examines inefficient, large-scale resource management, particularly as regards the Deccan canals (Section 3(a)). It then offers some brief comments on current food security problems falling outside the range of famine protection (Section 3(b)) and on the policies of economic liberalization which have, since 1991, increasingly opened India to world trade and investment (Section 3(c)).

## 2. FAMINE PREVENTION IN WESTERN INDIA

In discourse on precolonial India, there is a long-established myth that glorifies the "village community" as embodying the virtues of self-sufficiency, social harmony, and (in recent years) harmony with nature. Ironically, this myth was first articulated by 19th-century colonial officials, then later embraced by leaders of the nationalist movement. Since independence (1947), many historians and anthropologists have discarded the myth, though it remains potent among ultra-nationalists and also supports the "new traditionalist" discourse of some environmental activists. For those who believe in this myth, the old, harmonious, and locally autonomous way of life has been destroyed by colonialism, capitalism, and the "development project" of the post-colonial state—that is, by globalization and the expansion of state power.

It is true that local knowledge and priorities for achieving a better life have often been ignored or swept aside by modern, large-scale institutions. Without denying the heavy costs paid by many people, consideration of the benefits (in terms of lives saved) is also in order.

Before 1900, survival in the semi-arid Deccan plateau region of western India was a "gamble in the rains." Periodic droughts and famines took many lives, and infectious diseases became deadliest when people, especially infants, were malnourished. Village communities (whose self-sufficiency, social stability, and harmony with nature have often been exaggerated by those never obliged to live in one) could not overcome the mortal dangers posed by regional droughts and crop failures. Starting in the latter part of the 19th century, industrial transport and market systems, later combined with modern, large-scale systems of administration and irrigation, began providing better food security. After 1921, these institutions caused a sharp decline in mortality rates and thus a rapid rise in population. Before discussing how this happened, we need to assess earlier patterns of scarcity and insecurity.

### (a) *Rainfall and famines*

Risk of crop failure is high in semi-arid regions such as the western Deccan plateau of peninsular India, where mean annual rainfall is low and unreliable. The western Deccan, now a part of Maharashtra state and formerly known as the Deccan Division of the Bombay Presidency, has long been labeled a "famine belt." My ethnographic and historical research has focused on this region (e.g., Attwood, 1992). The western Deccan lies in a rain shadow area east of the coastal mountains, with the darkest shadow covering a belt about 200–300 km wide. In eastern Pune district, for example, average annual rainfall is less than 50 cm and highly uncertain. Directly to the west, the coastal mountains capture up to five meters of monsoon rain sweeping inland from the Arabian Sea. Before the late 19th century, this water either flowed back to the sea via short, steep rivers along the western coast or else flowed eastward through seasonal rivers across the Deccan plateau and into the Bay of Bengal. Only a tiny fraction of this seasonal flow was captured by Deccan farmers using wells or medium-scale diversion weirs (*bandharas*).

The consequences of dependence on rain-fed agriculture are evident in Figure 1, showing fluctuations in the average annual price of staple subsistence crops—*jowari* (sorghum) and *bajri* (millet)—from 1821 to 1910 in Sholapur city, on the eastern side of the famine belt. This graph, compiled by Keatinge (1912) as Director of Agriculture for the Bombay Presidency, portrays in dry numbers a dramatic narrative of variations in welfare and misery.

Consider the huge price fluctuations before 1860. These derived from two causes: first, the uncertainty of rainfall, and second, the inelasticity of demand for basic food crops. (A third cause is discussed below.) When local crops failed, prices soared, and the poor starved. Farmers tried to insure themselves against this fate. As Keatinge noted, "In former days, grain was stored by cultivators in every village during a good year, and each tract had to grow enough to feed itself." (1912, p. 150). However, there were periods when regional droughts persisted for several years, depleting food stored in better times. As we shall see, droughts caused major famines in the Bombay Deccan during the 19th century, costing hundreds of thousands of lives and limiting the long-term growth of the regional population.

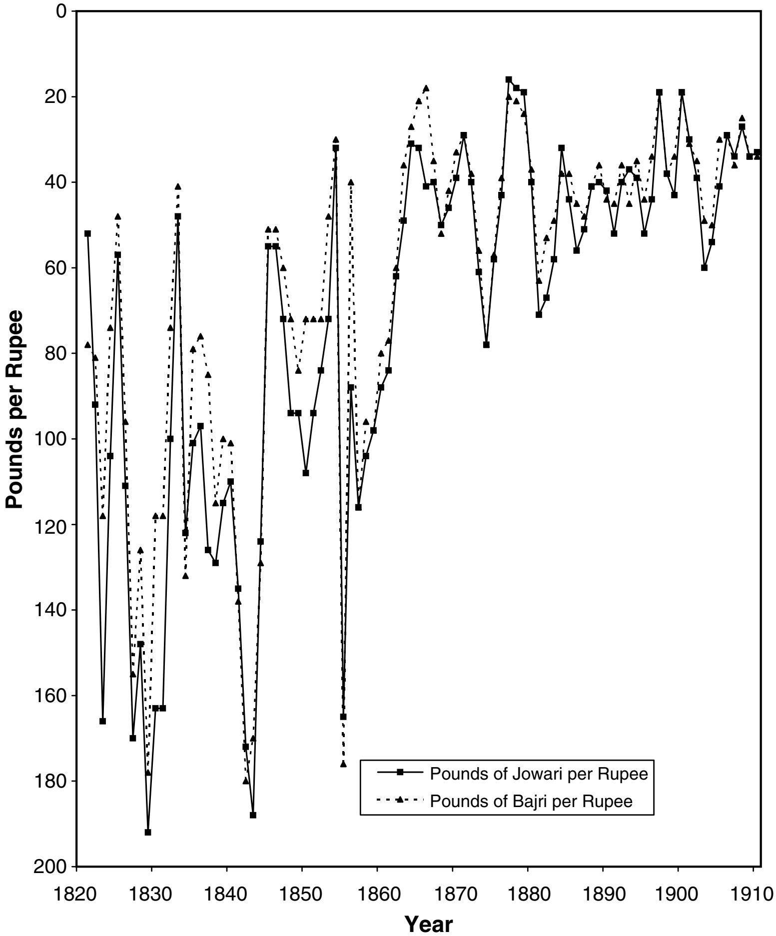


Figure 1. *Fluctuations in the price of jowari and bajiri at Sholapur. Source: Redrawn from Keatinge (1912, chart opposite p. 150).*

Great famines also devastated this region in earlier times. The famine of 1630–32, for example, was one of the worst ever:

> According to the contemporary poet-saint Ramdas, most of the people were reduced to beggary, which rendered begging fruitless. Villages were depopulated as some people died of starvation and others were forced to leave their homes in search of livelihood elsewhere. The famine took a heavy toll of population, and according to Ramdas, only about 5% of the population survived. There may be exaggeration in this general statement, but the loss of man and animal power was no doubt considerable. (Kulkarni, 1973, p. 560)

One historian estimates that, in this famine, three million perished in nearby Gujarat and one million died in the Deccan. It was mainly the poor who died in the first year, but in the second year, the rich also began to die (Habib, 1963, pp. 103–104). People did not just expire gently: children were sold or abandoned, human flesh was consumed and even sold in markets (Braudel, 1981, pp. 76–77). Widespread famines recurred in the Deccan in 1655, 1682, and 1684. In 1702–04, another great famine is estimated to have killed over two million people (Fukazawa, 1982, p. 476).

In this semi-arid region, droughts (and potential famines) are still a regular occurrence. Drought has been a serious threat to other civilizations as well. The collapse of the Akkadian empire, the Old Kingdom of Egypt, and even (despite its humid ecozone) the Classic Mayan civilization may have been caused by prolonged and severe droughts (Kolbert, 2005, p. 66).

### (b) *Transport, markets, and famines*

Starting in the latter part of the 19th century, famine prevention in the Bombay Deccan was gradually achieved by modern systems of transportation, marketing, administration, and irrigation. As regards transport, Figure 1 shows the dramatic impact of railway building in the 19th century. Along with unreliable rainfall and inelastic demand for food, a third factor amplified the sharp fluctuations in food supply before 1860. Until then, the food economy of Sholapur and the nearby countryside was a relatively isolated system. In 1853, Karl Marx described the consequences of isolation in one of his published letters on India:

> It is notorious that the productive powers of India are paralysed by the utter want of means for conveying and exchanging its various produce… It was proved before a Committee of the British House of Commons, which sat in 1848, that "when grain was selling from 6s. to 8s. a quarter at Khandesh, it was sold at 64s. to 70s. at Poona, where the people were dying in the streets of famine, without the possibility of gaining supplies from Khandesh, because the clay roads were impracticable." (Marx, 1853, p. 83)

The distance from Khandesh to Poona (both lying within the Bombay Deccan) was only about 300 km.

Foodgrains are bulky commodities. Prior to the industrial revolution, only sailing ships could carry them over long distances at reasonable cost. (Imperial Rome fed itself with wheat from North Africa.) However, the Bombay Deccan, flanked on the west by rugged coastal mountains, could never rely on water transport to stabilize its food supply. Before the 19th century, goods were carried over these mountains by headloads and pack mules. Not even an ox cart could cross this barrier. Thus, seaports could not supply the western Deccan with food. Moreover, on the plateau itself, rivers became shallow and unnavigable after the rainy season (mid-June to mid-October). [5]

As the passage from Marx suggests, preindustrial land transport (by bullock cart, for example) was too slow and expensive to mitigate a regional food crisis. If food could not move far, then people had to. For centuries, famines forced villagers to migrate in search of food and employment. Habib comments that "famines, thus, from time to time, introduced into the stolid isolation of agricultural production, a terrible element of fluidity and confusion. If there had been nothing else, this alone would have sufficed to explain the migratory characteristics of the medieval peasantry" (1963, p. 110). [6]

In the 19th century, the severity of the food crises in western India began to change, and the graph for food prices in Sholapur city shows a remarkable transformation (Figure 1). After 1860, the range of extreme variation declined to less than half the previous range. [7] After 1880, price variance shrank even more, and extreme fluctuations occurred less often, with only two years of severe famine in the late 1890s.

What caused this change in food supply and price behavior? As recommended by Marx, railways were built. These first linked major towns and cities: Sholapur was connected in 1860. In the latter part of the 19th century and early decades of the 20th, railway lines were extended to most populous districts in India. Thus large-scale, industrial technology brought a radical improvement in the ability to move foodgrains from surplus to deficit areas.

The impact of railways on the stability of food supply has been studied in detail by the historian John Hurd. He compared annual grain prices among 188 sample districts throughout India over the period from 1861 to 1921. The results show a sharp decline in price variations among these districts. As Hurd explains:

> Before railways, inter-regional price differences were pronounced, and the local prices of grain, cotton, and other agricultural commodities fluctuated with the changes in local supply conditions, particularly rainfall. As the railway network expanded, and with it trade in commodities, price differences between regions narrowed dramatically… That railways constituted the determining factor in this decline is confirmed by the consistently lower price-differences in those districts with railways as compared with those without railways. (1983, p. 746)

In other words, local food scarcities in any given district and season were increasingly smoothed out by the invisible hand of the market, which now had the means to transport bulky foodgrains, rapidly and in large quantities, from districts where harvests were good and prices low to districts where scarcity was pushing prices up. Because railways were cost-efficient (and some lines were subsidized by taxes), price differences between food-scarce and food-surplus districts fell dramatically (Drèze, 1995, p. 78).

None of this is meant to suggest that railways had only benign effects. Railway construction contributed to deforestation (Gadgil & Guha, 1993) and to the spread of epidemics (Visaria & Visaria, 1983, p. 502). Indeed, one point of this paper is that technical improvements may solve some problems while creating others.

British India was subcontinental in scale. Post-colonial India (minus Pakistan and Bangladesh) retains that scale, with a population larger than Europe's and a host of regional languages, cultures, and agroecological systems. A market network integrating these regions is similar in scale to the European Union. Since India is a single nation-state, I use the phrase "large-scale" to characterize its systems of transport and market integration. In most other world regions, the term "international" would also apply.

### (c) *Famine relief administration*

More efficient transport and markets provided necessary, but not sufficient, conditions for famine protection in the Bombay Deccan. By 1900, railway lines extended to most Deccan districts. Yet there were severe famines in the Deccan and much of the Bombay Presidency in 1896–97, 1899–1900, and 1911–12. [8] In 1899–1900, an estimated 166,000 people died in the Deccan, and 462,000 in the Presidency as a whole. Famine mortality peaked that year at 37.9 deaths per 1,000 population (McAlpin, 1983, p. 76). Part of the problem was that, in 1896–97 and again in 1899–1900, there were massive crop failures in much of the rest of India, limiting the effectiveness of inter-regional trade for stabilizing food supplies (Drèze, 1995, p. 75).

Food crises of this magnitude made big kinks in the population curve for western India, as shown in Figure 2, based on decennial censuses from 1871 to 1941. [9] Prior to 1921, total population rose and fell in a stair-step pattern, with a very slow net annual growth rate of 0.14% (Visaria & Visaria, 1983, p. 490). Due to famines and epidemics, population declined sharply in the 1870s and 1890s. The last great mortality events came in the 1910s: there were two moderately severe famines, overshadowed by deaths from bubonic plague and then by the influenza pandemic of 1918 (McAlpin, 1983, p. 80). After 1921, concentrated mortality crises ceased to affect the curve. The result was a rapid rise in total population, a trend that continues today. This trend began with a decline in mortality rates, followed (as elsewhere) by a lagged decline in fertility.

Thus, after 1921, recurrent crop failures due to drought no longer resulted in famines. Railroads and markets were essential but not sufficient for this transition. Railways had a strong effect on regional price differentials before 1890 (Hurd, 1983, p. 746), yet the following decade brought high levels of famine mortality in western India. Efficient transport and markets could supply the food, but crop failures threw many agricultural laborers out of work, and rising food prices slowed the regional economy, reducing employment all around. How were workers without wages to buy food? As noted by one late-19th century observer, most famines of that time were "rather famines of work than of food" (quoted in Drèze, 1995, p. 73).

Effective administrative procedures for famine relief were implemented after the terrible famines of the 1890s. The main component was provision of employment (for wages) on famine relief works (Drèze, 1995, p. 82; McAlpin, 1983, p. 176). These were public infrastructure projects, such as roads, dams, and canals, already slated for construction and then geared up to absorb workers needing employment in a crisis. Other components included "gratuitous relief" for those unable to work, plus loans to farmers for digging wells and buying seed or cattle (McAlpin, 1983, pp. 178–181).

These policies had been formulated at the all-India level in 1880 yet were not vigorously applied until after the horrors of the late 1890s (Drèze & Sen, 1989, pp. 123–124). Thereafter, famine mortality declined rapidly, despite recurrent crop failures. Railways protected regional food supplies, while famine relief ensured that needy people had access to this food.

The evolution of effective famine-relief administration highlights a point stressed by Sen (1981, 1993): famine prevention is not simply a question of total food supply. That is, food supply and food security are not the same, since the latter depends on social entitlements (via employment, kinship, etc.) to shares in the available supply.

The system of famine relief works, still in use in Maharashtra, provides employment and wages to those at risk of losing their entitlements during recurrent droughts. After independence (1947), famine prevention has improved, partly due to government stockpiling of food for distribution through ration shops. Democratization also made a significant difference. When famine relief is needed, "The

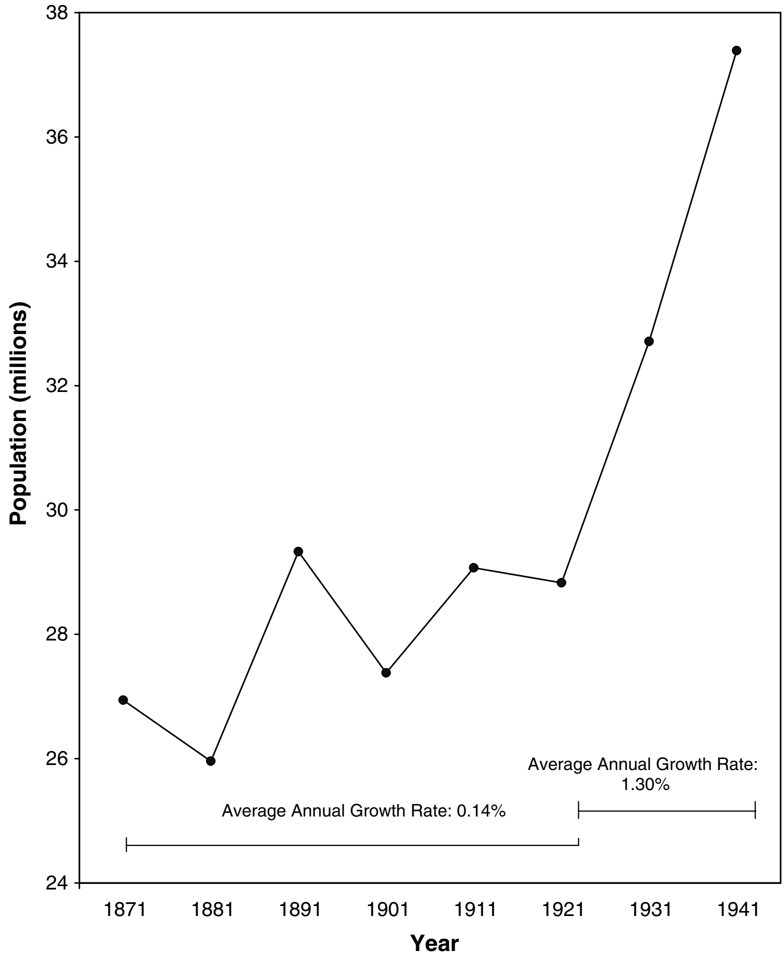


Figure 2. *Population of India, West Zone. Source: Data from Visaria and Visaria (1983, p. 490).*

vigour of political opposition has now made it impossible for the government to remain passive without major political risks" (Drèze & Sen, 1989, pp. 125–126). Indeed, "no substantial famine has ever occurred in a democratic country where the government tolerates opposition, accepts the electoral process, and can be publicly criticized" (Drèze & Sen, 1989, p. 133).

This system was put to a severe test from 1970 to 1973, when Maharashtra experienced widespread and continuous droughts. Famine-relief measures were so effective that this prolonged crisis had almost no measurable demographic effects, whether assessed in terms of "increases in mortality rates, nutritional deterioration, land sales, or migration to other states" (Drèze & Sen, 1989, pp. 128–129; also Drèze, 1995, pp. 121–153). The relief system evolved in Maharashtra to the point that it tacitly created a "right to employment" during hard times (Echeverri-Gent, 1993). This system depends on complementary market institutions for long-distance food redistribution. The state provides employment and wages while markets move food to where it is needed.

Thus, western Maharashtra has passed from recurrent and lethal food crises to effective famine protection based on a combination of large-scale systems: industrial transport, national (equivalent to international) markets, and reliable public administration. Modern, large-scale irrigation canals also played a role in this transformation.

### (d) *Canal irrigation and food security*

The modern era of big-dam construction began in 19th-century India, with massive projects in the northern Gangetic plains (Postel, 1999, pp. 43–47). The British Raj focused first on "productive" works: on canals that could generate annual revenues equal to the interest on their capital cost (Stone, 1984, p. 25). The insecurity and poverty of farming in the Bombay Deccan (and the extra engineering costs discussed below) inspired no faith that canals built in this region would repay their costs. However, the 1880 report of the Indian Famine Commission "drew attention to the *indirect* returns to irrigation works (including savings on famine relief expenditure)" (Stone, 1984, p. 26, emphasis in original). This led to mechanisms for financing "protective" irrigation works and thus to the construction of large-scale storage dams and canals in the Bombay Deccan.

Smaller irrigation works, such as wells and *bandharas* (diversion weirs) had long been common in this region (Attwood, 1992, pp. 50–51). Yet these suffered from a dismal flaw: in serious droughts, they dried up. [10] Unlike the perennial, snow-fed rivers renewing abundant groundwater beneath the vast Gangetic plains to the north, seasonal rivers in the Bombay Deccan cut through an irregular, rocky plateau, replenishing groundwater along narrow corridors. Step back a mile or two from a Deccan river, and you will likely find that groundwater depends on unreliable local rainfall.

Two to five meters of monsoon rain fall annually in the coastal mountains, whence flow these seasonal rivers. Build a storage dam in the mountains, and you can irrigate many villages. The Mutha dam and canal system was completed in 1874. Construction of a much larger system, the Nira Left Bank Canal, began in 1876 as a famine relief work. It went into operation in 1885 with an estimated command area nearly eight times larger than the Mutha (Attwood, 1992, p. 51). Much of my ethnographic research was done in Malegaon, a village irrigated by the Nira canal.

This canal was conceived as "protective" against famines. Yet strange problems of low and irregular demand arose after water began flowing to the villages. As the Director of Agriculture later wrote, "It might be thought that when a canal is opened in these arid regions the owners of the land under command would lose no time in making use of the water provided" (Keatinge, 1921, p. 80). Yet there was no regular demand for canal water, particularly not for the staple subsistence crops, sorghum and millet. Of course, demand soared during the famines of the late 1890s. But irrigation of sorghum and millet dropped back more than 50% in years of better rainfall (Attwood, 1992, p. 53). Much canal water went to waste as farmers used it only to save their grain crops from drought, not to increase their normal output. Why?

By 1903, M. Visvesvaraya, Executive Engineer for Irrigation (Poona District), was able to answer this question. [11] His analysis may be summed up as follows: (1) Deccan black soil, which covers much of the river valleys, is exceptionally water retentive. (2) In this soil, hardy subsistence crops, such as sorghum and millet, grow adequately in years of poor rainfall, though not in a complete drought. (3) Thus, when the rains were late, farmers waited until the last minute before requesting canal water to save their crops. (4) This frantic last-minute demand along the whole length of the canal led to a chaotic situation in which water could not possibly be delivered in time to all who needed it (Visvesvaraya, 1903, pp. 3–4).

Later technical studies confirmed Visvesvaraya's assessment (see Inglis, 1927; Inglis & Gokhale, 1928, 1934). Using data from a later study by Gadgil (1948), I found another reason why demand for canal water was low. Whether using canal or well water, Deccan farmers grew their main subsistence crops (sorghum and millet) on only about one-sixth of their irrigated areas. Irrigation was otherwise used mainly for cash crops (Attwood, 1987, 1992, pp. 55–58). This makes sense, given that both well and canal water were costly. Another factor was that, in years of good rainfall, there were ample supplies of grain on the market, and inelasticity of demand meant that prices would fall sharply. As we have seen in Figure 1, access to distant markets meant that prices never fell as far after 1860 as they did before. Even so, cash-strapped farmers felt little incentive to pay for irrigating subsistence crops in years of normal rainfall. [12]

On the other hand, Visvesvaraya found that farmers were quite willing to spend money to irrigate a lucrative cash crop. He learned this by observing an innovative group, the Saswad Malis, who migrated to the Nira valley after the canal was opened. With their experience as growers of irrigated market crops, the Malis established big sugarcane farms on land which they rented along the canal. (Later, they were imitated by local farmers whose prior experience was mostly confined to rain-fed subsistence crops.) Unlike foodgrains, sugarcane needed regular irrigation throughout the year. Hence Visvesvaraya proposed the creation of sugarcane "blocks" along the Nira canal. A farmer who contracted for a block would get a year-round supply of water for sugarcane on one-third of the block area; the other two-thirds would get eight months of irrigation, suitable for double-cropping foodgrains during the *kharif* (monsoon) and *rabi* (winter) seasons. The new block system was immediately successful: it raised and stabilized demand for canal water (Attwood, 1987, 1992, p. 62). One appeal of the blocks was that they involved a committed supply of canal water for six years at a time.

This reduced the problem which was once a fiscal burden, an administrative embarrassment, and a waste of a vital resource. Prior to the block system, demand for canal water was generally low and uncertain. With low demand, the government could not recover even a fraction of the interest on the capital cost of the Deccan canals. As Visvesvaraya pointed out (before cane blocks were introduced), in his testimony to the Indian Irrigation Commission (IIC): "These results which have been more or less the same in all recent years, have discredited the Bombay works in the estimation of the Government of India. The annual grants for new works have in consequence been curtailed and the strictest economy is enforced in the maintenance of existing works" (IIC, 1902, p. 225).

Fiscal embarrassment was exacerbated by the high cost of canals in the Deccan. The perennial, snow-fed rivers of northern India required only diversion dams to irrigate large areas of the Gangetic plains, but the seasonal rivers of the Deccan required far more expensive storage dams. As Visvesvaraya noted: "It may be roughly stated that, on account of the great cost of storage, water-supply is three to six times more expensive here." (IIC, 1902, p. 225). As custodians of the most expensive water in India, Visvesvaraya and his colleagues were understandably keen to find a use for it. Sugarcane, grown on the block system, provided the regular demand they needed.

It might be supposed that irrigation of this costly and thirsty crop eroded the protective functions of the Deccan canals, but the opposite was, in fact, the case. Two-thirds of each cane block received two-season irrigation for other crops. Thus, foodgrains were double-cropped on the cane blocks—which was impossible on rain-fed land. Because cane was rotated with these crops, they produced much higher yields due to irrigation and the residual effects of heavy manuring for sugarcane. For these and other reasons, canal officials found that "*the irrigation of seasonal crops follows sugarcane and does not precede it*" along the newer canals (Inglis & Gokhale, 1934, p. 21, emphasis in original). Farmers would only pay for regular irrigation of seasonal crops when they could also gain water for cane. Under this system, the Deccan canals made a substantial contribution to stabilizing food production in the region (Attwood, 1987, 1992, pp. 62–65).

Canal tracts also provided refuge for hard-pressed farmers from the upland dry villages located between river valleys. Compared with foodgrains, sugarcane cultivation and processing required far more labor per acre (Attwood, 1987, 1992, p. 64; Gadgil, 1948; Patil, 1932). As cane cultivation expanded, much of this labor demand was met by cyclical and permanent migration from villages outside the canal zones. As population grew, canal-irrigated villages absorbed surplus labor from other areas, including periodic flows of refugees from ever-recurrent droughts.

The effects were apparent in terms of both famine mortality and relief expenditures. For example, the crop failure of 1911–12 was nearly as severe and widespread as that of 1899–1900, yet in 1911–12, famine mortality (per 1,000 population) was less than a sixth of the earlier level (McAlpin, 1983, pp. 170–171). Better famine relief operations were partly responsible for the difference. As well, many people from the dry villages, who might otherwise have sought employment on relief works, migrated to the canal areas instead. Thus, direct expenditure on famine relief measures actually declined along with famine mortality rates (Irrigation Inquiry Committee, 1938, p. 99).

Stable food supplies and employment are both essential for famine protection. The Deccan canals made substantial contributions on both counts. In the Bombay Deccan, severe mortality crises disappeared after 1921, and death rates began a sustained decline. The same happened in the northern province of Punjab for similar reasons: widespread canal and well irrigation put an end to food crises after 1921 (Das Gupta, 1995). [13]

When Visvesvaraya testified before the Irrigation Commission in 1902, the future of the

Deccan canals looked bleak due to the uncertain demand for, and extra-high cost of, canal water. After he was authorized to introduce sugarcane blocks, the canals became less wasteful of money and water. As a result, the government sanctioned a whole new series of Deccan canals, plus expansion of the Nira Left Bank Canal, resulting in a sevenfold increase of canal-irrigated area between 1900 and 1938 (Attwood, 1992, p. 66). Hence the protective effects of canal irrigation kept pace with the accelerated rise in population after 1921.

### (e) *Long-term impacts on mortality*

Contrary to neo-Malthusian assumptions, India's population has grown due to declining mortality, not rising fertility. Mortality crises have been averted by large-scale institutions that provided famine protection and then later raised per-capita food output. The latter achievement was made possible by international agricultural research and the widespread adoption of high-yielding seed varieties, starting in the 1960s (Evenson & Gollin, 2003; Ruttan, 2002). Since World War II, gains in food output have also been accompanied by widespread vaccination, control of epidemics, and other public health measures. Yet except for quarantines used to control plague (McAlpin, 1988), it would be a mistake to attribute the rapid decline in death rates in western India *before* 1950 to modern medicine and public health measures. Sulpha drugs came into use in the West after 1935, followed later by antibiotics (McKeown, 1988, p. 81). It is unlikely that these or other modern medical discoveries had any significant impact on the overwhelmingly rural population of India before 1950. Moreover, since 1950, the World Health Organization has found that infectious diseases are far more fatal to people who are malnourished (McKeown, 1988, pp. 52–55). In other words, famine control and food security are the bedrock on which other public health measures rest.

As we shall see in Section 3(b), despite effective famine control, problems of food security have not been fully solved in Maharashtra or India. Along with public health measures, improvements in food security vary widely by region, with some regions showing rapid mortality declines and others showing a lack of progress comparable to the poorest countries in the world (Drèze & Sen, 2002, pp. 83–89). Progress in Maharashtra has generally been above average for India as a whole.

There is little doubt that enhanced food security has been a major cause of rapidly declining mortality in most of the developing world (cf. Das Gupta, 1995; Johnson, 2000; McKeown, 1988). Better nutrition strengthens a child's resistance to infectious disease, the main cause of infant mortality. India's infant mortality rate has declined to 70 per 1,000 live births, one-fourth of its level a century ago (Visaria & Visaria, 1983, p. 500; UNDP, 2001, p. 168). Now at 48, Maharashtra's infant mortality rate has declined even faster (Drèze & Sen, 2002, p. 395).

In the first two decades of the 20th century, estimated annual death rates in the Deccan division of the Bombay Presidency fluctuated between 32 and 54 per 1,000 people (McAlpin, 1983, p. 55). After 1921, mortality rates declined both in western India and India as a whole (Visaria & Visaria, 1983, pp. 500–507).[14] By 1999, annual mortality had fallen to 8.9 deaths per thousand people for India and 7.5 for Maharashtra (Drèze & Sen, 2002, p. 395).

In 1901, India's average life expectancy at birth was in the range of 20–24 years (Visaria & Visaria, 1983, p. 502). At the end of the 20th century, average longevity was about 61 years for India as a whole and 65 years for Maharashtra (Drèze & Sen, 2002, p. 395). By averting periodic food crises, famine prevention has helped to lower mortality rates and raise average life expectancies. Over the last 50 years, average longevity in India has risen faster than ever occurred in the history of the now-developed countries (Johnson, 2000).

As elsewhere, mortality declines have been followed by lagged fertility declines (Das Gupta, 1995). India's total fertility rate (average number of children per woman) has fallen to 3.3 since the 1960s, when it exceeded 5.0. Fertility has declined faster than expected for a population not wealthy by world standards (Drèze & Sen, 2002, pp. 191–193, 395; cf. Adlakha, 1997; Caldwell, Reddy, & Caldwell, 1988).[15] This remarkable change in fertility behavior has been masked by the increasing youthfulness of the population, caused by the sharp decline of infant mortality. Each woman now has, on average, fewer children, but there is a much larger proportion of young women moving through their reproductive years. Thus, the main driving force behind population growth today is momentum, resulting from the bulge of young-adult cohorts. Slowing population momentum takes longer than reducing fertility rates. Even so, India's youngest age cohorts (which predict changes in momentum) are already smaller than they were (Drèze & Sen, 2002, p. 194).

## 3. YES, BIG CAN BE UGLY

Large-scale institutions do not solve all problems and tend to create problems of their own. This is easily demonstrated in the case of canal irrigation (Section 3(a)). And effective famine protection, important as it is, does not solve all problems of food security (Section 3(b)). These problems must now be viewed in the context of India's economic liberalization, which has led to deeper involvement with global markets (Section 3(c)).

First, a caveat. Large-scale institutions result from the expansion of state power and/or private enterprises. Some critics of globalization seem to think that society and nature are harmed primarily by market-driven institutions. My view of 20th-century history is that, to the contrary, the worst and largest abuses have stemmed from misuse of state power. On the global stage, the rise and decline of Soviet power is one of many examples. In India, the hypertrophy of state bureaucracy (on the Soviet model) retarded economic growth for four decades after independence. The irrigation bureaucracy offers a prime example of how big state institutions go wrong.

### (a) *Irrigation administration*

We noted above that, about 100 years ago, farmers along the Nira canal were reluctant to use much canal water for subsistence crops. One reason was that administrative procedures were not well suited to their needs. Every season, farmers had to submit separate applications for each crop in each field, and applications took time to process. This made it difficult for farmers to respond flexibly to variations in the amount and timing of the rains. Thus, administrative rules increased the incentive for farmers to wait and see before making formal requests for canal water. As a result, it was impossible for canal officials to engage in systematic planning for the allocation of water, season by season. When sugarcane blocks were introduced, they appealed both to farmers and officials in part because they established a stable six-year contract for using canal water.

According to a recent study comparing irrigation administration in six Indian states, obstructive procedures are still the rule for most canal-irrigated crops in Maharashtra (Leaf, 1998, pp. 161–166). Indeed, only in Punjab did Leaf find irrigation rules shaped with due attention to farmers' needs. The other five states suffer from discontinuities between these needs and bureaucratic regulations, as well as discontinuities among state agencies mandated to raise agricultural production (Leaf, 1998).

After independence (1947), governments focused on building more and larger canals, not on improving older ones. With a democratic constitution and the great majority of voters living in rural areas, [16] massive vote blocs demanded new canals and subsidized water. Big dams and other mega-projects had great allure for politicians and technocrats, enabling them to expand their public and private control over resources (McCully, 2001, chap. 9). As elsewhere, mega-dams also appealed to big engineering and construction firms, though in India's centrally planned economy, these were often public- rather than private-sector enterprises.

China, the United States, and India lead the world in building large dams. [17] According to the country study on India for the World Commission on Dams (WCD), India's peak years of dam construction were 1970–89, when 2,256 out of a total of 4,291 big dams were built (Rangachari, Sengupta, Iyer, Banerji, & Singh, 2000, pp. 2–3). In the scramble to dam every river, some dams were announced without even a preliminary technical survey (Rangachari *et al.*, 2000, p. 59). Even narrow cost–benefit analyses (ignoring social and environmental costs) were often pro forma fictions: "costs were grossly underestimated and benefits overestimated... The entire appraisal process developed into a huge systematic exercise in self-deception" (Rangachari *et al.*, 2000, p. 67). Many of these new dams were built in Maharashtra.

Thus, India's new canals became more rather than less wasteful. Economic losses began escalating in the 1980s, partly due to rising marginal costs as dam builders shifted from easier to more difficult sites. There was also an "utter lack of financial management in this large sector" (Rangachari *et al.*, 2000, p. 67). Recovery ratios (the percent of working costs recovered from irrigation fees) fell from 93% in the 1970s to 9% in the late 1980s. By 1993, annual operating losses by the irrigation sector exceeded Rs. 30 billion per year (Rangachari *et al.*, 2000, p. 209). Fiscal losses, combined with an ever-shrinking list of feasible new dam sites, eventually slowed the runaway pace of dam construction.

Fiscal irresponsibility went hand-in-hand with wastage of water. "Water use efficiency rates are presently estimated to be only 38–40% for canal irrigation" (Rangachari *et al.*, 2000, p. 178). This problem is not confined to India. Throughout the world, large-scale surface irrigation systems incur heavy losses due to evaporation, percolation, over-irrigation at the head ends, waterlogging, salinization, subsidies to water users, and other causes (WCD, 2000).

Since the 1980s, big dams have come under attack due to their social and environmental costs, which have never been properly assessed for any dam in India. Concerning these problems there is a large literature, which I shall not attempt to summarize (see, e.g., Baviskar, 1996; McCully, 2001; Morse & Berger, 1992; WCD, 2000). Still, we should note that social and environmental losses have not been paid for by economic gains. Net economic gains from big dams and canals have become severely limited or even negative (Rangachari *et al.*, 2000, pp. 56–67, 209–211). This fits the picture of massive waste by India's state-managed industrialization project from 1956 to 1991 (see, e.g., Attwood, 1992, p. 316; Bardhan, 1984, pp. 29–31; Nayar, 1990, p. 290).

India's canal systems have been much criticized (e.g., Chambers, 1988; Leaf, 1998; Wade, 1985), yet the situation does not appear hopeless. "A 10% increase in the present level of water use efficiency of the existing irrigation systems would be equivalent to the creation of an additional 14 m ha [million hectares] of irrigated area" (Rangachari *et al.*, 2000, p. 178). This could ensure future food security with less damage to the environment.

The goal of greater efficiency means that the management of big institutions (canal bureaucracies) must better complement the small ones (family farms). In the Bombay Deccan, efficiency problems were studied decades before independence by irrigation engineers, who concluded (perhaps too easily) that intractable uncertainties were inherent in management of the region's canals. As C.C. Inglis, Superintending Engineer of the Irrigation Development and Research Circle, explained: "The Deccan problem, therefore, is to supply an ever-varying supply to meet an ever-varying demand (bearing in mind all the time that the reserves available are strictly limited, and dependent to a considerable extent on the succeeding monsoon)" (Inglis, 1929, p. 4).

Unpacking this synopsis, Inglis and Joglekar (1928) pointed to four main areas of uncertainty: (1) The total supply of canal water varied from year to year because it depended on seasonal rainfall in the coastal mountains. (2) The total demand also varied because, in black cotton soils, subsistence crops could often (but not always) tolerate fluctuations in annual rainfall. (3) The soils also varied, "so that the crops grown, and [water] supply required, vary widely from outlet to outlet and even in different parts of the same field" (Inglis & Joglekar, 1928, p. 2). (4) And finally, unexpected late rains could throw off all calculations of demand for canal water in the *rabi* (winter) season (Inglis & Joglekar, 1928; cf. Visvesvaraya, 1903, p. 4).

The Deccan engineers drew attention to contrasting conditions in northern India (Inglis & Joglekar, 1928, p. 1). Northern rivers and canals are fed by snow-melt from the Himalayas, which tends to yield a more predictable flow. Moreover, the Gangetic plains are covered with vast areas of flat, alluvial soils. Thus, in the north, the engineering challenges of canal construction and operation were much simpler. Still, engineers in the Bombay Deccan hoped, as we must hope, that canal design and management could be improved by adopting more efficient practices found in the north, especially in Punjab (Leaf, 1998, pp. 137–142).

Well irrigation is more widespread and far more efficient in terms of the proportion of water reaching the crops. However, rural vote blocks also demand subsidized electricity for pumping groundwater. "Currently, agriculture pays Rs. 0.21 per kW h, while the supply cost of power is Rs. 1.86 per kW h" (Rangachari *et al.*, 2000, p. 176). Thus, big subsidies contribute to the depletion of aquifers which could have been renewable resources.

Millions of small farmers depend on irrigation for their livelihoods. Simply removing subsidies for canal water and electricity would be politically unfeasible and would surely harm the small farmers. What is needed is a system of graduated rate increases for big users. Graduated rate increases would tend to discourage wasteful use of water by those who can afford to make wider choices among crops and irrigation technologies. And as the history of sugar production in the Bombay Deccan shows, technical innovations by big farmers tend to drive down the costs of similar innovations by small farmers.

(b) *Other problems of food security*

Problems of food security do not end with famine prevention. Indeed, they are still found in all parts of the world. India currently has no problem with food supply: "There is little evidence that the problem of producing enough food to keep up with population growth is a real problem now—or in the foreseeable future" (Drèze & Sen, 2002, p. 196). Yet "the incidence of nutritional deprivation in India is among the highest in the world" (Drèze & Sen, 2002, p. 196). [18] The problem stems not from shortfalls in production but from problems of distribution. This entitlement failure takes on greater urgency now that famines have been prevented. India's production of foodgrains is far in excess of consumption, creating a situation of "hunger amidst plenty" (Drèze & Sen, 2002, pp. 336–340)—further evidence that food security is not simply a matter of food supply. India has huge buffer stocks of surplus foodgrains that could be distributed to the poor via food-for-work projects or other means (Umali-Deininger & Deininger, 2001).

(c) *Economic liberalization*

Starting in 1991, India has moved toward policies of economic liberalization (i.e., toward greater integration with the global economy). As with the irrigation sector, cumulative fiscal losses in the state-managed economy led to a severe economic crisis, causing India to seek help from the IMF (Nayar, 2001, pp. 129–133). At this point, India's leaders accepted the need for liberalization; in fact, glaring contrasts with the export-oriented economies of East Asia convinced many leaders well before 1991 (Nayar, 2001, pp. 142–150). The fiscal crisis simply helped to overrule privileged interest groups—such as unions in public-sector industries—that were adamantly opposed to reform.

Drèze and Sen (2002) make a convincing case that neoliberalism alone will not solve India's longstanding problems of poverty and hunger. Whatever the new potential for rapid and sustained economic growth, most would agree that markets alone cannot make up for lapses of public administration, such as India's failure to provide universal primary education.

How, then, will liberalization affect problems of food security? As we have seen (in Section 2(c)), markets alone do not protect the most vulnerable people from famines. Neither should we expect markets to protect those who are chronically underemployed and undernourished. As accelerating growth in the private sector does not yet provide employment for all, public food-supply programs must be expanded. In the state of Kerala, economic growth was slow before 1990, yet the proportion of severely undernourished children is now 5%, as compared with an all-India average of 18% (Drèze & Sen, 2002, p. 394, 401). If this much can be achieved in one state, it can be achieved in all.

## 4. CONCLUSIONS

There is no real paradox in the assertion that large-scale institutions, both public and private, are essential but often inefficient. Huge but inefficient irrigation systems are now vital for feeding a global population that may grow beyond sustainable limits.

So what is the future of big institutions? What lessons from the past can we hope to find? One lesson is that more efficient use of water, soil, energy, and other resources will enable us to feed ourselves over the next few decades (see, e.g., Postel, 1999; Smil, 2000). For example, if irrigation subsidies are reduced, at least for bigger users, then price incentives will promote technical changes and greater efficiency.

The concern with efficiency should not be seen as merely economistic, as seeking to "get the prices right." Greater efficiency means a better fit between the management of large- and small-scale institutions, such as irrigation bureaucracies and family farms. For canal irrigation, the crucial challenges lie in the realm of coordination, organization, and cooperation (Chambers, 1988; Leaf, 1998; McCully, 2001; Mosse, 2003; Ostrom, 1990; Postel, 1999; Uphoff, 1986; Wade, 1985). These are not simple challenges. Along the Deccan canals, engineers and agronomists understood the basic problems of coordination by the 1920s. Yet progress toward solving these problems has been, at best, incremental and incomplete.

Still, progress has been made, and past experience may be instructive. Sugarcane blocks were introduced on the Nira canal in 1903. Irrigation engineers had observed the innovative group of Saswad Malis, who began cane farming on rented lands after the canal was opened. This showed the engineers how to find a consistent demand for canal water. Happily, the sugarcane block system also raised the production of foodgrains and the demand for labor—thus helping prevent famines. While we must be wary of privileging one crop or category of farmers, this process of reshaping irrigation policy by following farmers' innovations needs to be more consistently applied. We must also accept that better results are achieved via diversity and experimentation, and that it is impossible to plan or predict the full consequences of innovations in advance.

Problems of institutional reform tend to become intractable due to entrenched bureaucratic and other interests. Research on cooperatives in rural India found that rampant inefficiencies and inequities stemmed primarily from top-down management by state officials, precluding locally adaptive resource management (Attwood, 1989; Attwood & Baviskar, 2002; Baviskar & Attwood, 1995). Comparative analysis of irrigation management in six Indian states arrives at the same conclusion (Leaf, 1998).

To counteract inefficient, top-down management, experimental efforts to include farmers in the "participatory management" of irrigation canals are under way in the state of Andhra Pradesh (Oblitas & Peter, 1999). Such experiments are vital, yet we must note that "participatory" rhetoric tends to ignore conflicts of interest within and between villages and also between farmers and officials (Baviskar, 2001). Irrigation specialists have warned that the participatory approach will fail if it simply serves as a guise for off-loading costs onto local associations of water users (Leaf, 1998; Mosse, 2003). Irrigation systems need to be redesigned from the bottom up, with significant gains to farmers for their participation.

Modern irrigation canals and other big institutions protect us from nature's unpredictability and have saved millions of lives, but now we need systems that are smarter, not bigger. More efficient use of resources already appropriated or managed by existing institutions would take us a long way toward complete, sustainable food security.

## NOTES

1. Economic globalization is understood here to mean rapid growth of international trade and investment, accompanied by the spread of new technologies. In countries such as China and India, recently intensified integration in global markets has also been accompanied by policy shifts toward economic liberalization.

2. According to Ostrom (1990, p. 51), institutions "can be defined as the sets of working rules" that determine who makes decisions in a given arena, what matters they decide, what procedures they follow, what information is used, and what payoffs go to whom. In discussing "large-scale" institutions, I refer to those (such as modern dams and canals, railway systems, or subcontinental markets) that reach far beyond the organizational and technological capacities of local villages or even pre-industrial empires.

3. A balanced evaluation of new traditionalist discourse appears in Mosse (2003, pp. 8–13).

4. This analysis is based partly on secondary sources but also on old (out of print) technical reports from the Departments of Agriculture and Public Works of the Bombay Presidency, as well as my own previous ethnographic and historical research on the Bombay Deccan.

5. Regarding the isolated food systems of the Bombay Deccan (prior to 1860), I may need to enter a caveat. This region probably resembled the majority of inland districts at the time. Still, there has been far too much written about the splendid isolation and self-sufficiency of India's pre-colonial villages. The desirability of isolation has already been questioned, and here I question its authenticity. Long before the 19th century, people moved around the countryside for trading, collecting taxes, making war, fleeing famines, and going on pilgrimages. When possible, they carried trade goods of high value and low bulk, such as gold, silver, gems, spices, and silks. Moreover, for many centuries, villagers on the coastal plains of Gujarat engaged intensively in commercial production and trade across the Arabian sea (Attwood, 1996; Chaudhuri, 1990, pp. 137–138). Likewise, villages on the Malabar coast were connected 1,000 years ago with trade networks extending from China to Africa and Europe (Ghosh, 1992). Compared to these coastal regions, the Deccan plateau was more isolated from major trade routes. Even so, I would not care to have my comments taken as endorsing the old myth of self-sufficient "village republics."

6. It has sometimes been suggested that a "moral economy" of localized redistribution could protect people in such crises (Scott, 1976). However, "The efficiency of all traditional systems of reciprocal aid is

probably higher against life cycle risks than drought risks. Life cycle risks do not have a high covariance among residents of a small geographic area… On the other hand, drought affects the whole reciprocal group similarly, as all members experience the drought at the same time, although to various degrees" (Jodha, 1977, p. 22, quoted in McAlpin, 1983, p. 46).

7. Before 1860, the standard deviation in *jowari* prices was 40.18. From 1860 to 1910, it fell to 15.97, or 40% of its previous value; after 1880, it fell to 30% of the value before 1860. The standard deviation in *bajri* prices declined even more after 1860.

8. These were single crop years, starting with the monsoon (*kharif*) season in June.

9. The "West Zone" of India in this period (1871–1941) corresponded with the Bombay Presidency (later Bombay Province). The Bombay Deccan was one division of the Presidency.

10. This flaw cannot be wished away by efforts to revive traditional water-harvesting techniques (see Agarwal & Narain, 1997), though such efforts can bring significant payoffs in years of "normal" rainfall. Since the early 1970s, for example, Maharashtra state has subsidized the widespread construction of percolation tanks, increasing the flow of rainwater into aquifers and wells.

11. Sir M. Visvesvaraya later became Chief Engineer and Divan of Mysore state and was knighted by the British crown (Inglis & Gokhale, 1934, p. 6).

12. In addition, the rules of canal administration were in some ways not well suited to farmers' needs. We return to this set of problems in Section 3(a).

13. In colonial (undivided) Punjab, canal irrigation covered a larger proportion of the gross cropped area than in the Bombay Deccan. This is still true of Punjab compared with Maharashtra.

14. One major exception was the Bengal famine of 1943.

15. At 2.7, Maharashtra's total fertility rate is below the all-India average and not very far above the replacement level (2.1). In two southern states, Kerala and Tamil Nadu, the total fertility rate has fallen *below* the replacement level (Drèze & Sen, 2002, p. 395).

16. "In 1951, only one-sixth of the population of the sub-continent was resident in urban areas" (Visaria & Visaria, 1983, p. 520).

17. China, India, and the Soviet Union demonstrate that big-dam building had little to do with the dynamics of capitalism and much to do with over-weaning statism. A case can be made that the same was even true of dam building in the western United States (McCully, 2001, pp. 15–16).

18. Rosegrant and Cline (2003, p. 1917) estimate that there are about 85 million malnourished children in South Asia—the largest such concentration in the world.

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