Paper 1

Sustainability and Growth

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INTRODUCTION

THE CONCEPT OF sustainability, or sustainable development, refers to the future. It requires us to attempt to make certain kinds of predictions.

The development planner or policymaker, wishing to be satisfied that current activities or new infrastructure schemes are sustainable, must formulate a reasoned response to a question of this sort: "Should we believe that this project—this irrigation system, for example—operated in the manner now current or proposed, can continue operating satisfactorily for as far ahead in time as we can forecast—say, 20 years from today? Or do we perceive reasons for doubting that it will survive, under its present operating policies?"

Any discussion of sustainability therefore involves forecasting of the future. In doing this we need to focus our attention primarily on those aspects which we believe are most likely to change during our forecasting timespan.

Because it concerns the future, sustainability is closely interlinked with growth. Many kinds of growth proceed in the socioeconomic structure of developing countries. Most of these growth patterns put additional stresses—new demands and new constraints—upon infrastructural facilities and resources. Growth changes the external context within which the system must function, so that what is proven to work satisfactorily at one period may be found unsustainable at some later period.

SOME DIMENSIONS OF GROWTH

Which kinds of growth have strong influence on the way irrigation systems perform? They include growth of population, growth of wealth, growth of demand for the products of irrigated agriculture, growth of the agricultural population, growth of their outputs and growth of resource consumption.

In the past two decades, wide regional and national differences have appeared in most of these classes of growth. As a result of such different growth histories, countries now face widely differing sustainability prospects. Statements about global averages or global trends are therefore likely to be poor guides to formulation of national policies.

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Growth of Population

The growth of population continues to be a dominant feature, but almost everywhere in the world it is reducing, and it is not as overwhelming a consideration as it appeared 20 years ago. Table 1 shows the patterns that have emerged in a sample of five principal large regions and in ten developing countries.

Table 1. Growth of population (units: percent per year).

	1965–1980	1980–1989	1989–2000	2000–2025	GDP/person, 1989 (US$/year)
World	2.0	1.8	1.6	1.3	3,838
East Asia	2.2	1.6	1.5	0.9	577
South Asia	2.4	2.3	1.9	1.4	280
Latin America	2.5	2.1	1.8	1.3	1,921
West Asia/North Africa	1.9	2.0	2.0	1.7	1,819
Sub-Saharan Africa	2.7	3.2	3.2	2.7	337
Korea	2.0	1.2	0.9	0.5	4,998
Brazil	2.4	2.2	1.7	1.1	2,166
Malaysia	2.5	2.6	2.2	1.4	2,155
Thailand	2.9	1.9	1.3	1.0	1,258
Philippines	2.8	2.5	1.8	1.3	739
Indonesia	2.4	2.1	1.6	1.1	527
India	2.3	2.1	1.7	1.2	283
Nigeria	2.5	3.4	3.2	2.5	254
Bangladesh	2.7	2.6	2.1	1.4	183
Tanzania	2.9	3.1	3.3	2.7	107

There is a tendency for more affluent countries to have lower rates of population growth: the data for these ten countries show a negative correlation of about 60 percent between gross domestic product per person, and population growth. At the end of the colonial era, countries had rather more uniformity in these matters than they do today. In the period 1965-80, the coefficient of variation of population growth among these ten countries was just 11 percent. As they have evolved along different development paths, the variation now is about 38 percent, and is still widening rapidly.

Growth of Demand

Growth of demand for the products of agriculture does not depend only on the growing numbers of people. The other main driving force of agricultural demand is the growth of living standards.

People hope that in various senses, matters will be better next year than they were last year. Economists seek to measure this by the growth of gross domestic product per person (Table 2). In relatively poor societies, a high proportion of each additional unit of personal or family income is expended on the products of agriculture (Table 3). In affluent societies, where basic nutritional needs are well satisfied, the impact of an increment of income is different. Less of it is spent on agricultural products, and that fraction tends to be applied to diversification of the food intake, rather than to simple increase of its quantity.

Table 2. Growth of gross domestic product (GDP).

	GDP/person 1990 (US$/year)	Agricultural production as % of GDP	Growth of GDP 1980-90 %/year	Growth of agricultural production%/year
World	4,220		3.2	2.7
Korea	5,523	9	9.7	2.8
Brazil	2,753	10	2.7	2.8
Malaysia	2,369		5.2	3.8
Thailand	1,437	12	7.6	4.1
Philippines	713	22	0.9	1.0
Indonesia	602	22	5.5	3.2
India	300	31	5.3	3.1
Nigeria	300	36	1.4	3.3
Bangladesh	214	38	4.3	2.6
Tanzania	84	59	2.8	4.1

Table 3. Food consumption as percentage of total household consumption.

	Food consumption %	GDP per person 1990
Korea	35	5,523
Brazil	35	2,753
Malaysia	23	2,369
Thailand	30	1,437
Philippines	51	713
Indonesia	48	602
India	52	300
Nigeria	52	300
Bangladesh	59	214
Tanzania	64	84

Growth of Output

In recent decades there have been striking regional differences in the performance of countries in meeting these patterns of growing demand (Table 4). The countries of East and Southeast Asia have performed particularly well, with patterns of growth in food production and in agricultural production generally, that have been generally well in excess of population growth. This is different from the other major regions of the developing world, where food production per person has been rather static or declining during the 1980s.

Table 4. Index of food production per person.

Base: 1979-81 = 100

	1982-84	1985-87	1988-90
World	102.00	104.08	103.96
East and South Asia	108.64	113.86	120.44
Central + South America	100.10	100.45	102.65
West Asia/North Africa	97.27	100.81	96.16
Sub-Saharan Africa	95.78	98.13	97.33
Korea	101.54	98.95	101.63
Brazil	101.88	105.39	110.78
Malaysia	109.78	136.00	155.02
Thailand	103.50	102.31	105.17
Philippines	93.35	86.54	86.25
Indonesia	108.68	119.63	127.69
India	107.56	108.63	118.90
Nigeria	97.74	105.02	112.85
Bangladesh	98.17	95.14	96.50
Tanzania	95.23	92.31	88.28

The most successful of the major regions has been the one containing most of the world's irrigated land. That fact is encouraging for those involved in irrigation; but it would be very rash to claim that irrigation itself is the sole cause of the success.

The output growth pattern has not been at all uniform, however, in the region of South and East Asia, either in total food production or in the output of the major irrigated crop, rice (Table 5). Performance in this respect has varied from average increases of around 2.5 percent per year in India, Indonesia and Vietnam, to a decrease of 4.5 percent per year in Malaysia, where self-sufficiency was abandoned as a national policy goal early in this period.

Table 5. Paddy production per person.

Units: kg/person

	1979-81	1988-90
Bangladesh	228	233
India	108	132
Indonesia	196	241
Malaysia	149	99
Philippines	163	152
Thailand	363	367
Vietnam	220	278

Growth of Agricultural Population

Although the world's population is growing by about 1.8 percent per year, its agricultural population is not. Growth in that sector has dropped to less than half of this rate. As Table 6 shows, there is no country in our sample of ten where the proportion of people involved in agriculture has increased in the 1980s. Generally, the percentage has decreased by some 6 percent.

Table 6. Agricultural population.

Population	Growth in number of agricultural population		Agricultural population as % of total population	
	1980-89 %/year		1980	1989
Korea	-	1.32	36.4	25.7
Brazil	-	0.28	31.2	24.9
Malaysia	+	0.17	41.6	33.0
Thailand	+	1.33	70.9	65.0
Philippines	+	1.49	51.8	47.2
Indonesia	+	0.79	57.2	49.3
India	+	1.51	69.7	66.8
Nigeria	+	2.16	68.1	65.1
Bangladesh	+	2.11	74.8	69.2
Tanzania	+	2.42	85.6	81.4

This is a wealth-related process, as the table shows. In the richer countries, the percentage involved in agriculture is much less than in their poorer counterparts; and in richer countries, the pace of the exodus from agricultural occupations is greatest. The negative correlation between the GDP and the proportion of population involved in agriculture is about 79 percent.

Growth of Resource Use

The question, whether the satisfying of increasing demand has involved great increase in the resources used, is an essential one, but data at global, regional and (usually) national levels are very weak. Three kinds of physical resources need to be considered: land, water, and chemical inputs. It is difficult to make clear statements about any of these.

We have statistics about how much land is currently under crops, how much is irrigated, and so on. It is much more difficult to establish current utilization levels, or the extent of formerly cultivated land that may have been abandoned due to processes related to cultivation, such as waterlogging or salinization, or the amount by which shifting cultivation may have been reduced.

In principle, irrigation enables a society to satisfy its food needs from a smaller quantity of land, and thus reduces various land use stresses. Table 7 confirms that this seems to be true of East and South Asia, where the generally satisfactory food output performance of recent times has been achieved from a small and steadily reducing area per person. The two regions with highest reliance on irrigation have been able to keep their total land use for agriculture more or less stable, whereas it has continued to expand at rates of 0.50-0.75 percent per year in sub-Saharan Africa and in Central and South America.

Table 7. Land utilization.

	Cropped land (M ha)		% irrigated	Growth of irrigated area %/year 1979-89	Cropped land (ha/person)	
	1979	1989	1989	1979-89	1979	1989
World	1,452.3	1,476.7	15.8	1.07	0.332	0.284
East+South Asia	378.2	382.2	33.6	1.10	0.167	0.140
Central+South America	167.3	180.1	8.8	1.49	0.472	0.410
West Asia/North Africa	84.3	82.6	23.7	1.09	0.408	0.303
Sub-Saharan Africa	149.4	156.6	1.4	2.17	0.398	0.308
Korea	2.2	2.1	63.5	0.32	0.059	0.050
Brazil	69.0	78.6	3.4	4.73	0.582	0.534
Malaysia	4.8	4.9	7.0	0.70	0.354	0.280
Thailand	18.1	22.1	19.1	4.08	0.397	0.403
Philippines	7.7	8.0	20.3	3.33	0.164	0.131
Indonesia	19.4	21.3	35.5	3.49	0.131	0.118
India	168.4	169.0	25.5	1.24	0.250	0.202
Nigeria	30.3	31.3	2.8	0.54	0.400	0.298
Bangládesh	9.2	9.3	29.5	6.24	0.107	0.083
Tanzania	5.1	5.2	2.9	3.35	0.282	0.199

About trends in the use of agricultural water, our data (above the level of individual systems) remain distressingly weak except in countries that are seriously deficient in this resource, such as Egypt or North China. As a rough guideline we may say that countries, or provinces of countries, that have renewable water resources much greater than 1,000 m^3/person/year, do not seem to accord a high priority to economic management of this resource. In tropical and subtropical climates, the annual water requirement to grow sufficient basic foodstuffs for self-sufficiency is in the order of 500-600 m^3 /person/year. As Table 8 indicates, many countries are still operating well beyond these levels; but the provincial variations from these averages, and the year-to-year variations, are causing droughts with a sufficient frequency to develop a demand for better data on this vital aspect.

Table 8. Water resources and utilization.

	Renewable water resources m^3/person/y 1990	Estimated utilization for agriculture m^3/person/y	% utilization for agriculture
World	7,690	436	5.7
East and South Asia	3,729	448	12.0
Central and South America	3,566	428	12.0
West Asia/North Africa	1,446	659	45.6
Sub-Saharan Africa	8,010	120	1.5
Korea	1,450	196	13.5
Brazil	36,070	107	0.3
Malaysia	26,300	275	1.0
Thailand	3,210	581	18.1
Philippines	5,180	471	1.9
Indonesia	14,020	76	5.0
India	2,450	498	20.3
Nigeria	2,730	21	8.0
Bangladesh	20,391	224	1.1
Tanzania	2,780	25	0.9

SUSTAINABILITY

Like growth, sustainability has many dimensions, and many meanings in the minds of those who use the word. It is inherently unmeasurable, because it is in the future. We can however learn some lessons from past cases of unsustainability.

It is useful to think of sustainability in terms of its opposite. There are many cases of great irrigation systems, in Egypt for instance, or in China, that seem to have proved their sustainability by continuing to function over centuries. We should however look for cases which have not been continuously successful, or reasons why past success may change in the future.

We can identify the following major categories of reasons for potential unsustainability:

physical
resource base
institutional
economic
environmental

Let us examine these in turn, and identify some specific examples of unsustainability.

Physical Unsustainability

In this category we may place two main sorts of problem: irrigation systems which are operated in such a manner that their resource base (especially their land, but sometimes also their water) deteriorates severely in quality; and systems whose installed equipment or other facilities deteriorate to the point where they are far from being able to fulfill their intended purpose.

The first group contains most notoriously, systems subject to the related (but distinct) phenomena of waterlogging and salinization, as in large areas of southern Punjab and central Sind in Pakistan; parts of central and southern Iraq; various Central Asian systems; systems in the coastal plain of Peru; and some of the systems developed in the 1960s on the west flank of the Nile Delta. In all of these areas there are significant areas that have dropped fully out of cultivation, and seem unlikely to return. They are all located in areas of very low rainfall, to which irrigation water is conveyed by rivers and canals from relatively remote mountain rainfall zones.

There is probably a much larger amount of land on which the waterlogging or salinization processes have depressed output without actually bringing about unsustainability. In many such cases, however, that simply seems to push them towards our subsequent category of likely economic unsustainability.

Unsustainability of installations is also perhaps less common as a cause of complete collapse, but is more often a source of partial failure and weak performance. Probably the most common causes of this are deficient attention to maintenance, and choice of technology that does not suit actual capabilities for operation or maintenance. India and Sudan are examples of countries with significant difficulties in the first of these areas; the frequency of demands for system rehabilitations shows that many countries share the problem.

Unsustainable Resource Use

The principal external resource used by irrigation systems is water. Irrigated agriculture is, potentially at least, in competition with other users, notably domestic and industrial, for this resource. There is also increasing concern about the need to preserve certain water resources for wildlife and environmental needs. In countries with virtually no rainfall (for example, Egypt) irrigation uses between 80 percent and 90 percent of the gross water resources. In such circumstances, there is great and increasing pressure upon irrigation managements to adopt water-saving technologies, and policies are sought that may further enhance this pressure by treating all water as an economic good.

The situation however varies enormously from country to country, and within countries. As Table 8 shows, many countries with substantial irrigation networks have still great reserves of unutilized water. On the other hand, sometimes that water is in locations which are unpopulated or are unfavorable to irrigated agriculture.

The question of sustainability of water use should therefore be considered for each river basin or hydrologic unit separately. The irrigation organizations themselves are not the best authorities for judging this issue, since they are competitors for the resource. Regulatory frameworks, independent and strong enough to ensure that allocative decisions are genuinely adhered to, seem to be necessary.

Quality, as well as quantity, of water must be part of such processes. In this respect, irrigated agriculture is sometimes perceived as a significant polluter due to drainage return flows that are contaminated with surplus agricultural chemicals.

Unsustainability of Institutions

Svendsen has said that "over a period of ... a few seasons, no piece of infrastructure is stable or sustainable without institutions to operate, repair, adapt and maintain it."

This is an important observation, reminding us that sustainability can never be treated just as a physical attribute, or in any way an inherent attribute of an irrigation system.

Today, the institutions that govern irrigation are changing, quite rapidly in many countries. Ideas of privatization, commercialization, control by farmers' associations, financial autonomy, provincialization and much else proliferate.

In the discussion of sustainability, those developments can be viewed in two rather opposite ways. Some may say that we are seeing the unsustainability of national, centrally funded irrigation bureaucracies which cannot forever command tax-payers' financial inputs. Others may say that the sustainability of the emerging institutions is unknown, and that the process therefore carries great risks.

There is a certain amount of truth in both such views of the matter. It seems safe to predict that we shall have to be concerned and vigilant about the viability of irrigation institutions, especially the newer models, for the next decade or two.

Economic Unsustainability

The economic sustainability of irrigation has to be considered at several levels: its contribution to the national trade balance, and the financial viability of each managing unit, from the national or provincial agency through the local organization to the individual farmer. At each of these units cash flows must be sufficient to sustain operations, maintenance, investment and adequate rewards that motivate the participants.

Throughout the world, governments have been trying, during the 1980s, to introduce more financial autonomy at the higher management levels, and to reduce their dependence on central funding or subsidy. This has been accompanied by an emphasis on fee collection from users of irrigation facilities, and parallel emphasis on the intermediary financial role of users' associations, both as a transmission route for collected fees, and as a cost-cutting strategy through the transfer of tasks and (sometimes) staff to their control.

The correct balance of resource transfers between these various levels, in order to ensure that the whole enterprise survives and functions, has not yet (in many countries) become satisfactorily established and more change should be anticipated. It does not seem likely that users can find the means to defray all the charges of the former central bureaucracies.

In many countries, especially those higher in the World Bank's "middle-income" category (say, those where GDP per person exceeds US$1,500 per year) there seem to be increasing difficulties in sustaining farmers' motivation. This problem expresses itself first in declining cropping intensity, and later in abandonment of cultivation on individual holdings. In some countries of South America, Southeast Asia and north Africa, we are now seeing partial replacement of traditional peasant cultivators by urban investors, often growing more remunerative crops for which higher investment levels are required.

Environmental Unsustainability

The interaction of an irrigation system with its external environment operates in two ways: the environment may affect the irrigation system, and vice versa. In developed countries, especially the United States and Australia, there have been well-known cases of the second problem, such as changing of the hydrology of the Florida coastal lagoons, salt intrusion in the Murray River, and toxification of shellfish in California. Adverse effects of these kinds occur also in developing countries but may sometimes be obscured by data deficiencies. Such cases are likely to be brought to the attention of irrigation organizations more forcefully in the future as the effectiveness of environmental regulatory procedures increases. In some cases, as the United States experience has shown, these matters can lead to enforced abandonment of an existing irrigation system.

A special category of environmental problem is the diminishing of inland lakes, where abstraction of irrigation water from tributary rivers may be a contributing factor, as in the Aral Sea and Lake Chad, as well as in many smaller lakes and wetlands.

The developing countries have a greater proportion of cases where changes in the environment of the water-supplying catchment area may threaten the continued existence of an irrigation system, through sedimentation of its facilities or (less severely in most instances) through change of its hydrology. The costs of dealing with this process are generally much greater than an irrigation organization can obtain. Where this is common, as it is in most mountainous or even hilly countries, the sustainability of the irrigation system requires the evolution of new institutional processes (possibly including resource transfers) through which the human activities that cause the upper-catchment changes can be influenced and moderated. It has been amply demonstrated in the past that the application of law alone does not suffice to deal with this problem; and in the case of international rivers it lies beyond the reach of law.

SUMMARY

The following is a short synopsis of some of the major points above.

a. The developing countries have diverged on to widely differing growth paths.

b. Since sustainability of irrigation systems is largely a question of predicting impacts and responses to future growth, this means there are no generic solutions to the sustainability issue. Each country and each river basin must be considered on its own.

c. Many countries of East and South Asia have had high success in increasing food production significantly ahead of population growth throughout the 1980s. This can however lead to oversupply, price weakness, and reduced utilization of land.

d. Sustainability of irrigation is not a physical characteristic. It depends greatly upon having effective institutions.

e. There has been and continues to be much institutional change. The viability of the new bodies has, in most cases, not been clearly established. Some of the countries which have pioneered new institutional forms have thereafter exhibited a relatively weak record in respect of crop production, and therefore of basic earning capacity.

f. In several countries, usually at somewhat higher general economic levels, problems of farmer motivation are appearing, expressed as underutilization of irrigation facilities. These seem to reflect the lower earnings of agriculture relative to other economic sectors. The problem appears as economic choices (for the individual) become more numerous.

g. Competition for water threatens the viability of irrigation in water-deficient environments. It is not by any means a general problem at present, but the growth of populations and of economies means that it will become a problem in an increasing number of river basins.